Central Pilbara Hub

Targeted Matters of National Environmental Significance Vertebrate Fauna Survey

Biologic Environmental Survey

Report to BHP WAIO

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1	Andrew Hide, Debbie Gleeson, Verity Steptoe	Chris Knuckey, Ryan Ellis	Alice Taysom	29/08/2022
2	Debbie Gleeson	Chris Knuckey, Andrew Hide	Alice Taysom	31/10/2022
3	Penny Booshooft Brighton D'Rozario	Andrew Hide	Alice Taysom	23/12/2022
4	Verity Steptoe	Andrew Hide	Alice Taysom	11/05/2023

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EXECUTIVE SUMMARY

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a desktop assessment and single season targeted vertebrate fauna survey of the Central Pilbara Hub (CPH). The CPH (hereafter referred to as the Study Area) is located approximately 80 kilometres (km) north-west of Newman and covers an area of approximately 60,000 hectares (ha).

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on Matters of National Environmental Significance (MNES; i.e. species listed under the *Environment Protection and Biodiversity Conservation Act 1999*). MNES species targeted for this survey included:

- northern quoll (*Dasyurus hallucatus*) – Endangered;
- greater bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable;
- ghost bat (*Macroderma gigas*) – Vulnerable;
- night parrot (*Pezoporus occidentalis*) – Endangered;
- grey falcon (*Falco hypoleucos*) – Vulnerable; and
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable.

The field survey was undertaken by seven experienced zoologists over five separate trips, comprising two trips in November 2021 and three trips between April and May 2022. Species specific targeted sampling during the field survey comprised habitat and habitat feature (i.e. cave and water features) assessments, ultrasonic and acoustic sound recordings, camera trap transects, targeted searches and nocturnal searches.

Fauna Habitats

A total of 11 broad fauna habitat types were recorded and mapped across the Study Area, comprising Stony Plain (35.51%, 21,051.01 ha), Hillcrest/ Hillslope (23.89%, 14,160.00 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Hardpan Plain (4.21%, 2,495.29 ha), Undulating Low Hills (3.34%, 1979.6 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha), Medium Drainage Line (0.61%, 362.20 ha) and Major Drainage Line (0.09%, 54.94 ha). The remaining 2.41% (1,428.48 ha) of the Study Area comprised Cleared/ Disturbed areas.

Of the 11 broad fauna habitats occurring within the Study Area, Gorge/ Gully, Breakaway/ Cliff, Major Drainage Line and Drainage Area/ Floodplain all provide critical habitat for MNES species, including northern quoll, ghost bat, Pilbara leaf-nosed bat, Pilbara olive python and grey falcon. These habitats provide critical breeding, roosting, foraging and dispersal habitat for some or all of the target species to various extents.

Northern Quoll

No evidence of northern quoll was recorded within the Study Area during the current survey. Sampling for northern quoll during the survey included a total of 1,503 camera trap nights on 21 camera trap transects and approximately 191 search hours over 70 targeted search transects.

The Study Area falls within the current distribution of the northern quoll. A total of 538 northern quoll records were identified within 50 km of the Study Area in the desktop assessment (BHP, 2022; DBCA, 2022b). The species has previously been recorded within the Study Area, from scats in Hillcrest/ Hillslope habitat at Camp Hill in 2011 and a live individual (BHP, 2022; Onshore & Biologic, 2011). Additionally, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area: 14 times via motion camera detection images (10 records), scat recordings (three records) and trapping (one record). The scarcity of previous records within or close to the Study Area suggests the species is likely to occur at very low densities. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species. While Hillcrest/ Hillslope and Medium Drainage Line habitat represent supporting foraging and dispersal habitat for the species. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, the species is considered to highly likely to occur. However, due to the scarcity of contemporary records, this species is likely to occur at low densities and is unlikely to be reliant on the habitats within the Study Area for long-term persistence at a local scale or population abundance at a regional scale. The Study Area is unlikely to contain a 'population important for the long-term survival of the species', as defined by the Department of Environment (DoE (2013, 2016).

Greater Bilby

No evidence of greater bilby was recorded within the Study Area during the current survey. Sampling for greater bilby during the survey included 16 greater bilby targeted plot searches and two transects totalling 15 person search hours.

The Study Area falls within the western extent of the species' current distribution, whereby the species or species' habitat is likely to occur (DoE, 2022e). A total of 18 database search records of the greater bilby occur within 50 km of the Study Area (BHP, 2022; DBCA, 2022b). One previous record (unknown type of record) of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given its historic date or that it is situated on a stony hill, which does not provide habitat. The next closest record occurs 14 km west, also from 1984. The nearest contemporary record is from the Fortescue Valley in 2020 with evidence of possible greater bilby diggings, located 37 km west of the Study Area, with all remaining records no earlier than 2013.

Drainage Area/ Floodplain habitat (9,644.57 ha) within the Study Area is considered marginal habitat for the greater bilby, as it often comprises heavy soils which provide low burrowing suitability and is therefore regarded as supporting habitat for the species. Although some areas of marginal habitat for the greater bilby occur within the Study Area, it is unlikely the species occurs due to the limited extent, and relative isolation, of habitat to other areas of suitable habitat as well as a lack of contemporary

records. Therefore, the Study Area is unlikely to support an 'important population' as defined by DoE (2013).

Pilbara Leaf-nosed Bat

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey from 15 individual calls, located within Gorge/ Gully, Breakaway/ Cliff and Hillcrest/ Hillslope habitats. The timing of the calls recorded during the current survey indicated that the calls are likely to be representative of a foraging individual or individuals, which are unlikely to be habitually using a nearby cave as a diurnal roost. Sampling for the Pilbara leaf-nosed bat during the current survey included ultrasonic Song Meter recorders at 68 locations, for a total of 802 recording nights.

The Study Area is located at the eastern extent of the Pilbara leaf-nosed bat's distribution; whereby the species or species' habitat may occur (DoE, 2022b). The database search identified a total of 10 records within 10 km of the Study Area (with records from 2006 – 2018) and only one record occurred directly within the Study Area, a detection in 2013 (BHP, 2022; DBCA, 2022b). The Pilbara leaf-nosed bat has previously been recorded three times within the Study Area (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011).

No evidence of a Pilbara leaf-nosed bat diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except three which had no usage.

The Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat (Habitat Rating 4 (very high) as defined by Bat Call (2021b). Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species (Habitat Rating 2 (low) as defined by Bat Call (2021b). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. Given no roosting by the species has been recorded within or in the vicinity of the Study Area, habitats occurring are likely to only provide supporting foraging and/or dispersal habitat for the species.

The entire Pilbara represents one interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022), meeting the requirements of an 'important population' as defined by DoE (2013). Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by Bat Call (2021b). Given the absence of a critical roost within, or in the immediate vicinity of the Study Area, it is unlikely that the Study Area represents a significant area for this species.

Ghost Bat

Ghost bat was recorded on 33 nights at four locations within the Study Area during the current survey. Sampling for ghost bat during the current survey included ultrasonic Song Meter recorders at 68 locations, for a total of 802 recording nights.

A total of 559 previous records of ghost bat occur within and surrounding the Study Area (within 50 km of the Study Area), including 115 records within the Study Area and a further 459 within 12 km (BHP,

2022; DBCA, 2022b). This includes 73 records from Mudlark Well, 40 records from Pineapple Hill and Camp Hill, two records within the MAC and Yandi Rail Corridor.

Within the Study Area, critical foraging habitat is provided by Stony Plain, Drainage Area/ Floodplain, Mulga Woodland, Minor Drainage Line, Medium Drainage Line, and Major Drainage Line when proximal (>12 km) to roosting caves. As suggested by Bat Call (2021a) these habitats represent "productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground" and/or contain "isolated trees and trees on the edge of thin thickets on the plains" and "trees along the edges of watercourse woodlands". Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered 'important' as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area, supporting this important population, which would also be used by ghost bats from other Category 2 caves at South Flank.

Night Parrot

No evidence of night parrot was recorded within the Study Area during the current survey. Sampling for night parrot during the survey included acoustic recorders deployed at 35 locations, totalling 371 recording nights.

The distribution of the night parrot is very poorly understood in Western Australia; however, the Study Area occurs within the species' potential distribution, as currently mapped by DoEE (2019b). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east, adjacent to the Cloudbreak Mine (FMG, 2021).

Habitat within the Study Area was considered marginal for the species, as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for the species. Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

Grey Falcon

No evidence of the grey falcon was recorded within the Study Area during the current survey. Sampling for this species within the Study Area included approximately 180 person hours of targeted searches undertaken at 60 sites during the current survey.

The Study Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur (DoE, 2022c). The desktop assessment returned ten records of the grey falcon, including near the Study Area (DBCA, 2022b; Ecologia, 1998c, 2004b; ENV, 2008a).

The Study Area contains habitat considered critical habitat for grey falcon, primarily within Major Drainage Line Habitat, and to a lesser extent, the Medium Drainage Line habitat, which provide potential breeding, foraging, and dispersal habitat for the species. The Stony Plain, Hillcrest/ Hillslope and Drainage Area/Floodplain habitat, may also provide supporting habitat for the species.

As the grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020), grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

Pilbara Olive Python

No evidence of Pilbara olive python was recorded within the Study Area during the current survey. Sampling for the species within the Study Area included 70 diurnal searches (approximately 193 person search hours) and three nocturnal searches (comprising eight person search hours).

The Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d). The desktop assessment returned 64 records of the Pilbara olive python with four records within the Study Area (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008). A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area on 27th March 2022.

The Pilbara olive python is regularly encountered in the vicinity of rocky habitats (i.e. Gorge/ Gully and Breakaway/ Cliff habitats) and drainage systems (i.e. Major Drainage Lines), particularly where pooling water occurs (DSEWPaC, 2011b; Pearson, 1993). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). Gorge/ Gully habitat, Breakaway/ Cliff and Major Drainage Line provide critical habitat within the Study Area for the species.

Although no evidence of the Pilbara olive python was recorded within the Study Area during the current survey, the species is notably cryptic and it is likely that a breeding population occurs within the Study Area based on the proximity of previous records and the presence of critical breeding and foraging habitat. Therefore, this population, if present, would be considered an 'important population' as defined by DoE (2013) supported by critical habitat within the Study Area.

Other Fauna of Significance

One non-target species of significance was identified during the current survey: the Western pebble-mound mouse (*Pseudomys chapmani*). This species was recorded on 135 occasions from secondary evidence (pebble-mounds).

1 INTRODUCTION

1.1 Background

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a desktop assessment and single season targeted vertebrate fauna survey of the Central Pilbara Hub (CPH). The CPH (hereafter referred to as the Study Area) is located approximately 80 kilometres (km) north-west of Newman and covers an area of approximately 60,000 hectares (ha). The Study Area comprises three separate areas (Figure 1.1):

- Pineapple Hill and Camp Hill;
- Mining Area C (MAC) to Yandi Rail Corridor; and
- Mudlark Well.

This assessment will provide local and contextual information that may inform future environmental approvals across the Study Area.

1.2 Survey Objectives

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on Matters of National Environmental Significance (MNES; i.e. species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)). MNES species targeted for this survey included:

- northern quoll (*Dasyurus hallucatus*) – Endangered;
- greater bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable;
- ghost bat (*Macroderma gigas*) – Vulnerable;
- night parrot (*Pezoporus occidentalis*) – Endangered;
- grey falcon (*Falco hypoleucos*) – Vulnerable; and
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable.

1.3 Conformance

This assessment was carried out in a manner consistent with the following documents developed by the Western Australian Environmental Protection Authority (EPA), DBCA (formerly Department of Parks and Wildlife [DPaW]), the Department of Climate Change, Energy, the Environment and Water (DCCEEW - formerly the Department of Environment [DoE]), Department of Sustainability, Water, Population, and Communities [DSEWPaC] and Department of Environment, Water, Heritage and Arts [DEWHA]), relevant survey-specific license conditions and BHP WAIO:

- (BHP WAIO, 2022) Vertebrate Fauna Surveys in Western Australia Procedure (Document Number: SPR-IEN-EMS-012) Version: 9;
- BHP (2018) Biological survey spatial data requirements (SPR-IEN-EMS-015);

- DBCA (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia;
- DEWHA (2010a) Survey guidelines for Australia's threatened bats;
- DEWHA (2010b) Survey guidelines for Australia's threatened birds;
- DoE (2016) EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus)*;
- DPaW (2017) Interim guidelines for the preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia;
- DoE (2013) Significant impact guidelines 1.1: Matters of National Environmental Significance;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles;
- EPA (2020b) Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment;
- EPA (2020a) Statement of environmental principles, factors and objectives;
- TSSC (2016a) Conservation advice: *Macroderma gigas*, ghost bat;
- TSSC (2016c) Conservation advice: *Rhinonicteris aurantia* (Pilbara form), Pilbara leaf-nosed bat;
- TSSC (2016b) Conservation advice: *Macrotis lagotis*, Greater bilby;
- EPA (2016) Environmental factor guidelines – terrestrial fauna;
- TSSC (2008a) Approved conservation advice for *Liasis olivaceus barroni* (olive python – Pilbara subspecies); and
- TSSC (2008b) Approved conservation advice for *Pezoporus occidentalis*, night parrot.

660000
680000
700000
720000
7480000
7460000

Yandi Rail Spur Line
Yandi Rail
Mining Area C Railway
MS1039
Yandicoogina Rail
Pineapple Hill
and Camp Hill
Juna Downs Rd
Juna Downs Junction Rail
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MAC to Yandi
Rail Corridor
MS1072
Great Northern Hwy
Karijini
National
Park
Mudlark Well

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail
- National Park
- Section 5(1)(g) Reserve

IBRA Region
- Pilbara

IBRA Subregion
- Chichester
- Fortescue
- Hamersley
- Roebourne

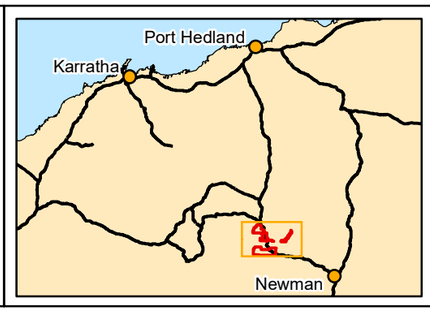
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 1.1: Study Area and regional context

2 EXISTING ENVIRONMENT

2.1 Biogeography

The Study Area is located within the Hamersley (PIL03) subregion of the Pilbara bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA; Thackway & Cresswell, 1995) (Figure 1.1). The Pilbara bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges (Thackway & Cresswell, 1995). Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008). The Hamersley subregion is characterised by mountainous areas of Proterozoic sedimentary ranges (ironstone ranges) and plateaux dissected by gullies and gorges (Kendrick, 2001). Vegetation comprises mulga low woodland over bunch grasses on fine-textured soils dominates in valley floors, while skeletal soils of the ranges are dominated by snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* (Kendrick, 2001). Drainage is typically into the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick, 2001).

2.2 Climate

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Thackway & Cresswell, 1995). Summer rainfall is usually the result of tropical low pressure systems and cyclonic activity in the region (Leighton, 2004). Winter rainfall is generally lighter and often associated with cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall ranges from 200–350 mm, although there are significant fluctuations between years (BoM, 2022; McKenzie *et al.*, 2009).

2.3 Geology

The Hamersley subregion contains Proterozoic sedimentary ranges and gorges of basalt, shale and dolerite. This subregion also contains calcrete deposits (Kendrick, 2001). The Study Area occurs across six broad (1:500,000) geological units, Wittenoom Formation (A-HAd-kd), Brockman Iron Formation (P_-HAb-cib), Mount McRae Shale and Mount Sylvia Formation (A-HAu-xsl-ci), Weeli Wolli Formation (P-Haj-xci-od), Marra Mamba Iron Formation (A-HAm-cib) and Jeerinah Formation (A-FOj-xs-b) (Figure 2.1; Table 2.2). The two dominant formations of the Study Area are Wittenoom Formation (17,521.57 ha, 29.56%) and Brockman Iron Formation (17,413.61, 29.37%). The Wittenoom Formation is characterised by thinly bedded dolomite and dolomitic shale, with minor black chert, shale, banded iron formation and sandstone and the Brockman Iron Formation characterized by banded iron-formation, chert, mudstone, and siltstone.

Marra Mamba Iron Formation is the geology most predisposed to forming deep caves in the Pilbara suitable for use by ghost bats, while the larger hills of Brockman Iron Formation also form suitable caves (Armstrong & Anstee, 2000; Cramer *et al.*, 2022).

Table 2.1: Geology units within the Study Area

Unit Name	Geological unit	Description	Extent in Study Area	
			Ha	%
Wittenoom Formation	A-HAd-kd	Thinly bedded dolomite and dolomitic shale, with minor black chert, shale, banded iron formation and sandstone	17,521.57	29.56
Brockman Iron Formation	P_-HAb-cib	Banded iron-formation, chert, mudstone, and siltstone; metamorphosed	17,413.61	29.37
Mount McRae Shale and Mount Sylvia Formation	A-HAu-xsl-ci	Mudstone, siltstone, chert, banded iron-formation, and dolomite; metamorphosed	8,724.47	14.72
Weeli Wolli Formation	P_-HAj-xci-od	Banded iron-formation (commonly jaspilitic), mudstone, siltstone, and numerous dolerite sills; metamorphosed	7,635.96	12.88
Marra Mamba Iron Formation	A-HAm-cib	Chert, banded iron-formation, mudstone, and siltstone; minor carbonate; metamorphosed	7,173.29	12.10
Jeerinah Formation	A-FOj-xs-b	Siliciclastic sedimentary rocks, mafic volcanic rocks and minor felsic volcanic rocks; local carbonate rocks, chert, and dolerite sills	814.21	1.37
Total			**59,283.12**	**100**

2.4 Soils

The CSIRO (2009) Atlas of Australian Soils described and mapped the soils of Australia following Bettany *et al.* (1967). The Study Area occurs over three soil units, Fa13 (28,407.86 ha, 47.92%), Fb3 (18,716.32 ha, 31.57%) and Fa14 (12,157.83 ha, 20.51%) (Figure 2.2). The dominant soil type, Fa13, is characterised by ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5. 11) soils on the steeper slopes. Associated are (Dr2.33 and Dr2.32) (Bettany *et al.*, 1967).

The second most dominant soil type is Fb3, which is characterised by high-level valley plains set in extensive areas of unit Fa13. There are extensive areas of pisolitic limonite deposits: principal soils are deep earthy loams (Um5.52) along with small areas of (Gn2.12) soils (Bettany *et al.*, 1967). The remainder of the Study Area is soil type Fa14, characterised by steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. (Dr2.33 and Dr2.32) soils which occur on the pediments are more extensive than in unit Fa13. (Um5.52) and (Uf6.71) soils occur on the valley plains (Bettany *et al.*, 1967).

660000
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7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
Juna Downs Rd
Juna Downs Junction Rail
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Bedrock Geology

- P_-HAw-fr; Woongarra Rhyolite
- P-HAj-xci-od; Weeli Wolli Formation
- P-HAb-cib; Brockman Iron Formation
- AP-HAu-xsl-ci; Mount McRae Shale and Mount Sylvia Formation
- A-HAd-kd; Wittenoom Formation
- A-HAm-cib; Marra Mamba Iron Formation
- A-FO-od; Fortescue Group
- A-FOj-xs-b; Jeerinah Formation

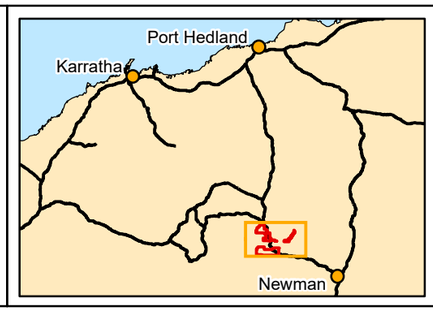
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.1: Broad Geology of the Study Area

660000 680000 700000 720000

7480000 7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
MS1072
Packsaddle Rd
Juna Downs Junction Rail
West Angelas Rail
West Angelas Rd
Ja2
Fa13
Fa14
Fa15
Fb3
My55

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Soil Unit

- Fa13
- Fa14
- Fa15
- Fb3
- Ja2
- My55

N

biologic Environmental Survey

Scale: 1:220,000

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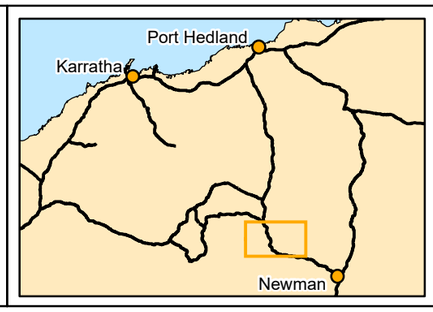
Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.2: Soils of the Study Area

2.5 Land Systems

Payne *et al.* (1988) and Van Vreeswyk *et al*. (2004) classified and mapped the land systems of the Pilbara bioregion according to similarities in landform, soil, vegetation, geology and geomorphology. An assessment of land systems provides an indication of the diversity and distribution of fauna habitats present within the Study Area.

Eleven land systems occur within the Study Area, the dominant being the Boolgeeda land system, which covers approximately 51.08% (30,285.24 ha) of the Study Area (Figure 2.3; Table 2.2). The Boolgeeda land system is defined as “stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands” (van Vreeswyk *et al.*, 2004). The second most dominant is the Newman land system, covering approximately 32.26% (19,125.50 ha) of the Study Area, which is defined as “rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands”. The third most dominant system is the Wannamunna land system, accounting for 10.27% (6,091.12 ha) of the Study Area and characterised as “hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands)”. The remaining eight land systems account for the remaining 6.39% (3,782.17 ha) and include Platform, Robe, Egerton, McKay, Rocklea, Calcrete, River and Pindering (Figure 2.3; Table 2.2).

Of the eleven land systems occurring within the Study Area, the Newman land system contains the most significant habitats for many of the target MNES species. The rocky ridges and mountains associated with this land system can support important refugia and foraging habitats for Pilbara leaf-nosed bat, ghost bat, and northern quoll. The occurrence of this land system within the Study Area is however, patchily distributed throughout the area (Figure 2.3).

Table 2.2: Land systems of the Study Area

Land system	Land type	Description	Extent in Study Area	
			Area (ha)	%
Boolgeeda (Bgd)	Stony plains with spinifex grasslands	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	30,285.24	51.08
Newman (New)	Hills and ranges with spinifex grasslands	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	19,125.50	32.26
Wannamunna (Wnm)	Wash plains on hardpan with mulga shrublands	Hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands).	6,091.12	10.27
Platform (Pla)	Stony plains with spinifex grasslands	Dissected slopes and raised plains supporting hard spinifex grasslands.	3,020.89	5.10
Robe (Rob)	Mesas, breakaways and stony plains with spinifex grasslands	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	302.32	0.51
Egerton (Ege)	Stony plains with spinifex grasslands	Highly dissected hardpan plains supporting mulga shrublands and hard spinifex hummock grasslands.	197.68	0.33

Land system	Land type	Description	Extent in Study Area	
			Area (ha)	%
McKay (McK)	Hills and ranges with spinifex grasslands	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	86.60	0.15
Rocklea (Roc)	Hills and ranges with spinifex grasslands	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	81.74	0.14
Calcrete (Cal)	Calcrete plains with spinifex grasslands	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	57.07	0.10
River (Riv)	River plains with grassy woodlands and tussock grasslands	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands	31.29	0.05
Pindering (Pdg)	Wash plains on hardpan with mulga shrublands	Gravelly hardpan plains supporting groved mulga shrublands with hard and soft spinifex.	4.58	0.01
Total			**59,284.03**	**100**

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McKay System
Platform System
Wannamunna System
Newman System
Pindering System
Calcrete System
Oakover System
Robe System
Yandi Rail Spur Line
Rocklea System
MS1039
Yandicoogina Rail
Platform System
McKay System
River System
Boolgeeda System
Packsaddle Rd
Juna Downs Junction Rail
Juna Downs Rd
Yandicoogina Rail
Paraburdoo System
Elimunna System
Spearhole System
West Angelas Rail
Newman System
Mining Area C Railway
MS1072
Platform System
Oakover System
Calcrete System
Pindering System
Wannamunna System
Platform System
Egerton System
West Angelas Rd
Newman System
Rocklea System
Boolgeeda System
Jamindie System
McKay System
Rocklea System
Spearhole System
Egerton System
Great Northern Hwy
Boolgeeda System

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Land System

- Boolgeeda System
- Calcrete System
- Egerton System
- Elimunna System
- Jamindie System
- McKay System
- Newman System
- Oakover System
- Paraburdoo System
- Pindering System
- Platform System
- River System
- Robe System
- Rocklea System
- Spearhole System
- Wannamunna System

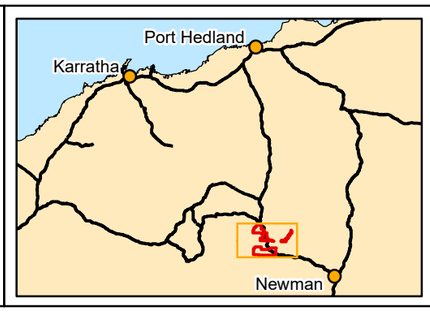
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



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CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.3: Land Systems of the Study Area

2.6 Surface Hydrology

Three major watercourses are located either within the Study Area (Marillana Creek, in the north-east) or in close proximity (Weeli Wolli Creek and Turee Creek East approximately 2 km to the south) (Figure 2.4). Yandicoogina Creek and numerous un-named tributaries of Marillana Creek also intersect the northern portion of the Study Area. The Marillana Creek flows in an easterly direction, running through the very north-eastern tip of the Study Area towards Yandicoogina Creek and Weeli Wolli Creek (approximately 8–13 km to the east of the Study Area). Marillana Creek and Yandicoogina Creek (flows to the north) are important sources of surface water runoff to Weeli Wolli Creek, which flows to the north and discharges into the Fortescue River Valley. Both Marillana Creek and Yandicoogina Creek typically only flow during the wet season following significant rainfall and are periodically subject to major flooding as a result of cyclonic weather events in the region. Marillana Creek and Yandicoogina Creek are also influenced by dewatering discharge from BHP WAIO's Yandi operations and Rio Tinto Iron Ore's Yandicoogina operations. Marillana Creek is a source of recharge to the Marillana Creek CID groundwater aquifer (WRC, 2003)

2.7 Pre-European Vegetation

Beard (1975) broadly (1:1,000,000) mapped the major structural vegetation types of Western Australia. Shepherd *et al.* (2002) reinterpreted and updated the vegetation association mapping to reflect the National Vegetation Information System (NVIS) standards (ESCAVI, 2003). This update also accounts for extensive clearing since Beard (1975) mapping.

Three vegetation associations occur within the Study Area (Table 2.3; Figure 2.5). The dominant vegetation association is HAMMERSLEY-18 which covers approximately 64.58% (38,286.11 ha) of the Study Area, followed by HAMMERSLEY-82, which covers approximately 34.24% (20,299.77 ha) of the Study Area. The remaining 1.18% (697.91 ha) of the Study Area is comprised of the HAMMERSLEY-29 association. The HAMMERSLEY-18 comprises of low Mulga woodland dominated by *Acacia aneura*.

Table 2.3: Vegetation associations within the Study Area

Vegetation Association	Description	Extent in Study Area	
		Area (ha)	%
HAMMERSLEY-18	Low woodland; mulga (*Acacia aneura*)	38,286.11	64.58
HAMMERSLEY-82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	20,299.77	34.24
HAMMERSLEY-29	Sparse low woodland; mulga, discontinuous in scattered groups	697.91	1.18
Total		**59,283.79**	**100**

660000 680000 700000 720000

7480000 7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
Manillana Creek
Yandicoogina Creek
Juna Downs Rd
Juna Downs Junction Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MS1072
Weeli Wolli Creek
Pebble Mouse Creek
Weeli Wolli Creek

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Surface Hydrology

- Minor
- Major

N

biologic Environmental Survey

Scale: 1:220,000

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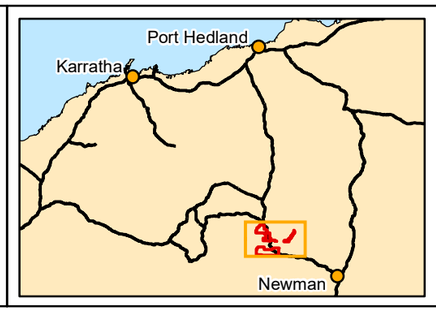
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.4: Surface hydrology of the Study Area

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7480000
7460000

Juna Downs Rd
Juna Downs Junction Rail
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Vegetation Association

- Hammersley 18
- Hammersley 29
- Hammersley 567
- Hammersley 82

N

biologic Environmental Survey

Scale: 1:220,000

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Coordinate System: GDA2020 MGA Zone 50
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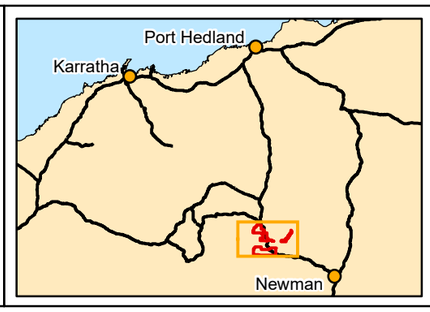


BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.5: Pre-European vegetation assocations of the Study Area

2.8 Land Use and Tenure

The Study Area is located on two pastoral leases, the northern portion occurring on the Juna Downs Station and a small section in the north-east on Marillana Station. A small portion on the southern edge and eastern section occurs on vacant Crown Land, with the north-west section adjacent to Juna Downs Station, designated as Unallocated Crown Land. Karijini National Park is located immediately adjacent to the Study Area's western most boundary, with a small section of the Study Area located within the boundary of Karijini National Park (7.24 ha).

3 DESKTOP ASSESSMENT

3.1 Methods

A desktop assessment, comprising database searches and a literature review (Appendix A), was undertaken prior to the field survey. The purpose of the desktop assessment was to identify vertebrate fauna potentially occurring within the Study Area, with a focus on targeted MNES and other significant species.

3.1.1 Database Searches

Five fauna databases were searched (Table 3.1); three to obtain information on all species previously recorded (BHP, 2022; BirdLife Australia, 2022; DBCA, 2022a), one to identify species of significance previously recorded (DBCA, 2022b), and one to identify species of significance known or likely to occur within the region based on modelled distribution (DCCEEW, 2022).

Table 3.1: Details of database searches conducted

Database	Data Access/ Receival Date	Search Area
DBCA (2022a) NatureMap	14/03/2022	Approximate central point of the Study Area (-22.9600 S, 118.7700 E) with a 50 km buffer
DBCA (2022b) Threatened and Priority Fauna Database	14/03/2022	
BirdLife Australia (2022) Birdata	3/03/2022	
DCCEEW (2022) Protected Matters Search Tool	3/03/2022	
BHP (2022) BHP WAIO Fauna Records Database	24/05/2022	

3.1.2 Literature Review

A total of 79 assessments were reviewed, comprising 53 detailed surveys, six targeted surveys, 24 basic surveys and one desktop assessment (Table 3.2). Of the 79 assessments reviewed, 20 assessments overlapped with a portion of the Study Area, 28 assessments were within 10 km of the Study Area and the remaining 31 assessments were within 50 km (Table 3.2). Figure 3.1 illustrates the location of surveys conducted for BHP (BHP survey ID in Table 3.2) in relation to the Study Area.

Table 3.2: Literature sources used for the review

Report	BHP Survey ID	Survey Type	Distance from Study Area
Biologic (2019) Pineapple Hill Detailed Vertebrate Fauna Survey.	10216	Detailed	Within Study Area
Ecologia (1998a) Mining Area C Biological Survey.	336	Detailed	Within Study Area
ENV (2010a) Area C West NVCP Flora, Vegetation and Fauna Assessment.	374	Basic and detailed	Within Study Area
Onshore and Biologic (2011) Camp Hill Exploration Leases Level 2 Flora & Vegetation Survey and Level 1 Fauna Assessment.	381	Basic	Within Study Area
Biota (2013a) Area C West to Yandi level 2 Vertebrate Fauna Survey.	1070	Detailed	Within Study Area

Report	BHP Survey ID	Survey Type	Distance from Study Area
Biologic (2013a) Area C West Vertebrate Fauna Survey.	1086	Detailed	Within Study Area
Ecologia (2004b) Packsaddle Range Biological Survey.	357	Basic	Within Study Area
ENV (2008b) Area C West Fauna Assessment.	372	Detailed	Within Study Area
Biologic (2013d) Mudlark Vertebrate Fauna Survey.	1080	Detailed	Within Study Area
ENV (2009a) Munjina and Ministers North (Yandi Hub) Fauna Assessment.	423	Detailed	Within Study Area
Biologic (2011a) Area C and Surrounds Vertebrate Fauna Survey.	1008	Detailed	Within Study Area
Biologic (2017) Ministers North level 2 vertebrate fauna survey.	10082	Detailed	Within Study Area
Biologic (2011e) Southern Flank Vertebrate Fauna Study.	1021	Detailed	Within Study Area
Ecologia (2004a) Area C: Deposits D, E and F Biological Survey.	348	Detailed	Within Study Area
Outback Ecology (2010) Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey.	366	Detailed and basic	Within Study Area
Outback Ecology (2008) Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment.	344	Detailed	Within Study Area
Ecologia (2008b) Marillana Creek (Yandi) Iron Ore Mine Modification.	122	Detailed	Within Study Area
Biologic (2010) East Packsaddle Level 1 Vertebrate Fauna Study.	350	Targeted	Within Study Area
Biota (2010) Yandicoogina Junction South West and Oxbow Fauna Survey.	1187	Detailed	Within Study Area
Astron (2019) Hope Downs 2 Proposal Fauna Survey March 2019.	-	Detailed	Within Study Area
Biota (2009) Yandicoogina Targeted Northern Quoll survey.	-	Targeted	<1 km
Biologic (2018) Ministers North to Yandi Corridor Two Phase Targeted Fauna Survey.	10140	Targeted	<1 km
Ecologia (2005b) Mudlark Well Exploration Project Biological Survey.	421	Detailed	<1 km
Ecologia (2006c) Ministers North Biological Survey.	-	Basic	<1 km
Astron (2010) Packsaddle West Flora and Fauna Assessment.	-	Basic	<1 km
ENV (2008a) Area C Southern Flank Deposit Fauna Assessment.	-	Basic	<1 km
ecologia (1999) West Angelas Iron Ore Project Mine Access Road Corridor Vertebrate Fauna Assessment Survey.	-	Basic	~2 km
360 Environmental (2017) Upper Marillana and Munjina Baseline Vertebrate Fauna survey.	10084	Detailed	~2 km
HGM (1999) Marillana Creek Western Access Corridor - Biological Assessment.	-	Basic	~2 km
Ecologia (2008a) Area A and Additional Areas Level 2 Terrestrial Fauna Survey.	-	Detailed	~3 km

Report	BHP Survey ID	Survey Type	Distance from Study Area
ENV (2007a) Area C R-Deposit Fauna Assessment.	349	Detailed	~3 km
Bamford Consulting (2012b) Vertebrate Fauna Assessment of the Iron Valley Project Area	-	Detailed and targeted	~5 km
Biota (2014b) Yandi Billiards Targeted Northern Quoll Survey	-	Targeted	~5 km
Ecologia (1998c) West Angelas Iron Ore Project Vertebrate Fauna Assessment Survey	-	Detailed	~6 km
Ecologia (1997) Hope Downs Biological Survey	-	Detailed	~7 km
Ecologia (2014) Greater West Angelas Terrestrial Fauna Assessment	-	Detailed	~7 km
Ecologia (1998b) Weeli Wolli Creek Biological Assessment Survey.	101	Detailed	~8 km
Biologic (2011f) Yandi Vertebrate Fauna Review	-	Basic and targeted	~8 km
Biota (2012d) South Flank to Jinidi Level 2 Fauna Survey.	1093	Detailed	~9 km
Integrated Environmental (1980) An Ecological Appreciation of the West Angelas Environment, Western Australia 1979	-	Detailed	~9 km
Maunsell and Bamford Consulting (2003) Yandi Life of Mine Fauna and Flora	-	Basic	~9 km
Ecologia (2004c) Yandi Overland Conveyor and Stockyard Fauna and Flora Assessment	-	Flora survey with fauna desktop survey	~9 km
Biota (2005a) Fauna Habitats and Fauna Assemblage of Deposits E and F at West Angelas Survey	-	Detailed	~9 km
Biologic (2012) Jinidi to Mainline Vertebrate Fauna Survey.	1065	Detailed	~9 km
Biologic (2013e) Targeted conservation significant fauna survey- Karijini tenement E47/17	-	Basic targeted	~10 km
Bamford Consulting (2012a) Fauna Assessment Nyidinghu Iron Ore Project	-	Detailed	~10 km
Biota (2014a) Yandi Billiards Phase 1 Seasonal Fauna Survey	-	Detailed	~10 km
Ecologia (1995) Yandi Stage II Iron Ore Project: Biological Assessment Survey	-	Detailed	~10 km
ENV (2010b) Jinayri Access Road Vertebrate Fauna Survey.	499	Detailed	~11 km
Biologic (2011c) Barimunya Camp Vertebrate Fauna Survey	-	Basic	~12 km
Phoenix (2014) Terrestrial Fauna Survey for the Extension Project	-	Basic	~13 km
Ecologia (2006b) Marillana Terrestrial Vertebrate Fauna Survey.	408	Detailed	~13 km
Biologic (2013c) Marillana Vertebrate Fauna Survey.	1077	Detailed	~13 km
ENV (2008c) Jinayri Vertebrate Fauna Assessment.	1010	Detailed	~14 km
Biota (2013b) South Parmelia Vertebrate Fauna Survey.	1224	Detailed	~15 km
Biologic (2011b) Area C to Yandi Fauna Survey	-	Basic	~15 km

Report	BHP Survey ID	Survey Type	Distance from Study Area
Ecologia (2005c) Upper Marillana Exploration Project Biological Survey.	115	Basic	~15 km
ENV (2007d) Upper Marillana Exploration Lease Fauna Assessment	-	Basic	~16 km
Ecologia (2006a) Jirridi Terrestrial Vertebrate Fauna Survey.	497	Detailed	~16 km
ENV (2011) Upper Marillana and Munjina Flora, Vegetation and Fauna Assessment	-	Basic	~18 km
ENV (2010c) Jinayri Mining Lease Vertebrate Fauna Survey	-	Detailed	~19 km
Biota (2005c) Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas.	1242	Detailed	~19 km
Biota (2012b) Koodaideri Project Targeted Fauna Survey	-	Detailed	~20 km
Biota (2012a) Koodaideri Northern Extension Fauna Survey	-	Detailed	~20 km
Biota (2012c) Koodaideri Southern Infrastructure Corridor Fauna Survey	-	Detailed	~20 km
Rapallo (2012) Level 2 Fauna Survey and Targeted Northern Quoll Survey of the Lamb Creek	-	Detailed	~20 km
Biologic (2011d) Jinidi Vertebrate Fauna Survey	-	Basic	~21 km
Biota (2012c) Rapid Growth Project 5: M270SA Fauna Assessment	-	Basic	~22 km
ENV (2007c) Mindy North Exploration Lease Fauna Assessment.	411	Basic	~23 km
Ecologia (2005a) Mindy-Coondiner Exploration Project Biological Survey.	413	Basic	~24 km
Ecologia (2009) Marillana Iron Ore Project Vertebrate Fauna Assessment	-	Detailed	~24 km
Biota (2004) Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor	-	Detailed	~28 km
ENV (2009b) Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	-	Basic	~33 km
Ninox (2009) A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Mining Area, Near Newman, Western Australia.	1243	Detailed	~39 km
Biota (2002) Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey	-	Detailed	~45 km
Biota (2008) Marandoo Mine Phase 2 Seasonal Fauna Survey	-	Detailed	~47 km
ENV (2007b) Coondiner and Mindy East Exploration Leases Fauna Assessment.	386	Detailed	~47 km
ENV (2008e) RGP5: Quarry 6 Fauna Assessment	-	Basic	~48 km
Bamford Consulting (2005) Fauna Survey of Proposed Iron Ore Mine, Cloud Break.	1166	Detailed and targeted	~49 km

650000 700000 750000 800000

7500000

7450000

Nanutarra Munjina Rd

Karijini Dr

Great Northern Hwy

1166

10084 423 115 1070 122 MS1039

408 1077 1065

411 413 411 1242

10216 381 1086

10140 122 1187 423 10082

366

357 354 101 499

348 336 MS1072 344 1008 349

386 413 386

372 374 1021 1093 1010 497 1224

372 421 1080 421

1243

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

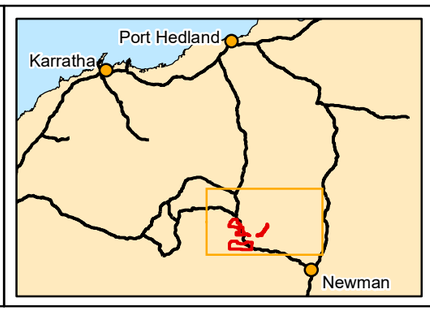
N

biologic Environmental Survey

Scale: 1:425,000

0 10 20 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.1: Previous fauna surveys within 50 km of the CPH Study Area

Legend

Year - Survey ID - Report Title

- 2019 - 10216 - Pineapple Hill Level 2 Vertebrate Fauna Survey
- 2017 - 10082 - Ministers North Level 2 Vertebrate Fauna Survey
- 2017 - 10084 - Upper Marillana and Munjina Baseline Vertebrate Fauna Survey
- 2017 - 10140 - Ministers North to Yandi Corridor Level 2 Vertebrate Fauna survey
- 2013 - 1224 - South Parmelia Level 2 Vertebrate Fauna survey
- 2013 - 1070 - Area C West to Yandi Level 2 Vertebrate Fauna
- 2013 - 1086 - Area C West Vertebrate Fauna Survey
- 2013 - 1080 - Mudlark Vertebrate Fauna Study
- 2013 - 1077 - Marillana Vertebrate Fauna Survey
- 2012 - 1093 - South Flank to Jinidi Level 2 Vertebrate Fauna Survey
- 2011 - 381 - Camp Hill Flora and Vegetation Survey Report and Fauna Assessment
- 2011 - 1021 - Southern Flank Vertebrate Fauna Study
- 2011 - 1008 - Area C and Surrounds Vertebrate Fauna Survey
- 2011 - 1065 - Jinidi to Mainline Vertebrate Fauna Survey
- 2010 - 499 - Jinayri Access Road Vertebrate Fauna Survey
- 2010 - 374 - Area C West NVCP Flora Vegetation and Fauna
- 2010 - 1187 - Yandicoogina Junction South West Oxbow Fauna Survey
- 2009 - 366 - Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna
- 2009 - 1243 - Fauna Survey of Proposed Hope Downs 4 Mining Area
- 2009 - 423 - Munjina and Minsters North (Yandi Hub) Fauna Assessment
- 2008 - 372 - Area C West Fauna
- 2008 - 344 - Area C Deposit A, D, P1 and P3 Vertebrate Fauna Survey Outback
- 2008 - 1010 - Jinayri Vertebrate Fauna Assessment
- 2008 - 122 - Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Fauna Survey
- 2007 - 386 - Coondiner and Mindy East Exploration Lease Fauna Assessment
- 2007 - 411 - Mindy North Exploration Lease Fauna Assessment
- 2007 - 349 - Area C Deposit R Fauna
- 2006 - 497 - Jirridi Terrestrial Fauna Survey
- 2006 - 408 - Marillana Terrestrial Vertebrate Fauna Survey
- 2005 - 115 - Upper Marillana Exploration Project Biological Survey
- 2005 - 421 - Mudlark Well Exploration Project Biological Survey
- 2005 - 1242 - Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas.
- 2005 - 413 - Minidy-Coondiner Exploration Project Biological Survey
- 2005 - 1166 - Fauna Survey of Proposed Iron Ore Mine Cloud Break
- 2004 - 357 - Area C Packsaddle Range Biological Survey
- 2004 - 348 - Area C Deposits D, E and F Biological Survey
- 2001 - 354 - Area C Packsaddle Vertebrate Fauna
- 1998 - 101 - Weeli Wolli Creek Biological Assessment Survey
- 1998 - 336 - Mining Area C Biological Survey

biologic Environmental Survey

3.2 Results

In addition to the seven target MNES species (Figure 3.2), a further 26 significant species were identified in the desktop assessment as having previously been recorded and/ or have the potential to occur within the Study Area (Figure 3.3). Overall, the 33 total significant species identified in the desktop assessment comprised 10 mammals, 15 birds and eight reptiles (Table 3.3; Appendix B). Of the 33 species, 15 have previously been recorded within the Study Area:

- northern quoll (*Dasyurus hallucatus*) – Endangered (EPBC/BC Act);
- ghost bat (*Macroderma gigas*) – Vulnerable (EPBC/BC Act);
- northern short-tailed mouse (*Leggadina lakedownensis*) – Priority 4 (DCBA);
- western pebble-mound mouse (*Pseudomys chapmani*) – Priority 4 (DCBA);
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable (EPBC/BC Act);
- letter-winged kite (*Elanus scriptus*) – Priority 4 (DCBA);
- eastern osprey (*Pandion haliaetus*) – Migratory (EPBC/BC Act);
- fork-tailed swift (*Apus pacificus*) – Migratory (EPBC/BC Act);
- grey falcon (*Falco hypoleucos*) – Vulnerable (EPBC/BC Act);
- peregrine falcon (*Falco peregrinus*) – Specially Protected (BC Act);
- wood sandpiper (*Tringa glareola*) – Migratory (EPBC/BC Act);
- common greenshank (*Tringa nebularia*) – Migratory (EPBC/BC Act);
- Pilbara barking gecko (*Underwoodisaurus seorsus*) – Priority 2 (DCBA);
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable (EPBC/BC Act); and
- Pilbara flat-headed blind-snake (*Anilios ganei*) – Priority 1 (DCBA).

The remaining 18 species have previously been recorded within a 50 km radius of the Study Area (Table 3.3). Several of these records may be inaccurate as the Study Area is outside of the distribution of the species of concern, e.g. north-western free-tailed bat, dwarf bearded dragon, Gunther's skink and lined soil-crevice skink (Table 3.3). The northern brushtail possum (*Trichosurus vulpecula* subsp. *arnhemensis*) (Vulnerable EPBC/BC Act) was previously recorded once (0.8 km outside of the Study Area, just south of the Camp Hill area). However, recent molecular analysis indicates that the population of the Pilbara region represents a different species to *Trichosurus vulpecula arnhemensis* (Biologic, 2021b).

In total, the desktop assessment identified 409 vertebrate fauna species, which have previously been recorded within or have the potential to occur within the Study Area, comprising 68 mammals, 181 birds, 149 reptiles and 11 amphibians.

Table 3.3: Species of significance with the potential to occur over the Study Area

Scientific Name	Common name	Conservation Status				Recorded within Study Area
		EPBC	BC	DBCA	IUCN	
Mammals						
Dasyuridae						
Dasycercus blythi	Brush-tailed mulgara			P4		
Dasyurus hallucatus	Northern quoll	EN	EN		EN	X
Sminthopsis longicaudata	Long-tailed dunnart			P4		
Megadermatidae						
Macroderma gigas	Ghost bat	VU	VU		VU	X
Molossidae						
Ozimops cobourgianus	North-western free-tailed bat			P1		
Muridae						
Leggadina lakedownensis	Northern short-tailed mouse			P4		X
Pseudomys chapmani	Western pebble-mound mouse			P4		X
Phalangeridae						
Trichosurus vulpecula subsp. arnhemensis	Northern brushtail possum	VU	VU			
Rhinonycteridae						
Rhinonicteris aurantius 'Pilbara form'	Pilbara leaf-nosed bat	VU	VU			X
Thylacomyidae						
Macrotis lagotis	Greater bilby	VU	VU		VU	
Birds						
Accipitridae						
Elanus scriptus	Letter-winged kite			P4	NT	X
Pandion haliaetus	Eastern osprey	MI	MI			X
Apodidae						
Apus pacificus	Fork-tailed swift	MI	MI			X
Ciconiidae						
Ephippiorhynchus asiaticus	Black-necked stork				NT	
Falconidae						
Falco hypoleucos	Grey falcon	VU	VU		VU	X
Falco peregrinus	Peregrine falcon		OS			X
Laridae						
Sterna caspia	Caspian tern	MI	MI			
Gelochelidon nilotica	Gull-billed tern	MI	MI			
Psittacidae						
Pezoporus occidentalis	Night parrot	EN	CR		EN	
Rostratulidae						
Rostratula australis	Australian Painted Snipe	EN	EN		EN	
Scolopacidae						
Calidris ferruginea	Curlew sandpiper	CR/MI	CR/MI		NT	

Scientific Name	Common name	Conservation Status				Recorded within Study Area
		EPBC	BC	DBCA	IUCN	
Tringa glareola	Wood sandpiper	MI	MI			X
Actitis hypoleucos	Common sandpiper	MI	MI			
Tringa nebularia	Common greenshank	MI	MI			X
Threskiornithidae						
Plegadis falcinellus	Glossy ibis	MI	MI			
Reptiles						
Agamidae						
Pogona minor minima	Dwarf bearded dragon		VU			
Carphodactylidae						
Underwoodisaurus seorsus	Pilbara barking gecko			P2		X
Pythonidae						
Liasis olivaceus subsp. *barroni*	Pilbara olive python	VU	VU			X
Scincidae						
Ctenotus uber subsp. *Johnstonei*	Spotted ctenotus			P2		
Cyclodomorphus branchialis	Gunther's skink		VU		NT	
Lerista macropisthopus remota	Unpatterned robust slider			P2		
Notoscincus butleri	Lined soil-crevice skink			P4		
Typhlopidae						
Anilios ganei	Pilbara Flat-headed Blind-snake			P1		X

550000 600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd
Karijini Dr
Marble Bar Rd
Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
Newman
Great Northern Hwy

BHP (2022)

Bird
- Grey falcon - VU

Mammal
- Northern quoll - EN
- Ghost bat - VU
- Greater bilby - VU
- Pilbara leaf-nosed bat - VU

Reptile
- Pilbara olive python - VU

DBCA (2022)

Bird
- Grey falcon - VU

Mammal
- Northern quoll - EN
- Ghost bat - VU
- Greater bilby - VU
- Pilbara leaf-nosed bat - VU

Reptile
- Pilbara olive python - VU

Legend

- Study Area
- Desktop Assessment Area
- State Road
- Rail

N

biologic Environmental Survey

Scale: 1:700,000

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Projection: Transverse Mercator
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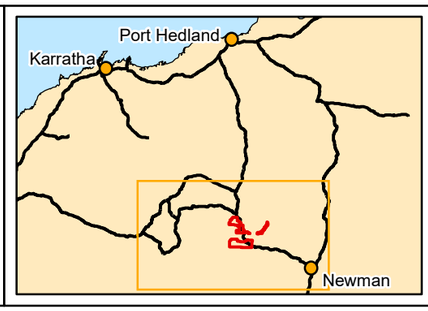


BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.2: Targeted MNES fauna records from the desktop assessment

650000 700000 750000 800000 850000

7500000

7450000

7400000

Nanutarra Munjina Rd

Karijini Dr

Great Northern Hwy

Newman

BHP (2022)

Bird

- Common greenshank - MI
- Eastern osprey - MI
- Fork-tailed swift - MI
- Gull-billed tern - MI
- Wood sandpiper - MI
- Peregrine falcon - OS

Mammal

- Western pebble-mound mouse - P4

Reptile

- Pilbara flat-headed blind-snake - P1
- Pilbara barking gecko - P2

DBCA (2022)

Bird

- Letter-winged kite - P4
- Caspian tern - MI
- Common greenshank - MI
- Eastern osprey - MI
- Fork-tailed swift - MI
- Glossy ibis - MI
- Gull-billed tern - MI
- Southern giant petrel - MI
- Wood sandpiper - MI
- Peregrine falcon - OS

Mammal

- Brush-tailed mulgara - P4
- Northern short-tailed mouse - P4
- Western pebble-mound mouse - P4

Reptile

- Pilbara flat-headed blind-snake - P1
- Pilbara barking gecko - P2
- Unpatterned robust slider - P2

Legend

- Study Area
- Desktop Assessment Area
- State Road
- Rail

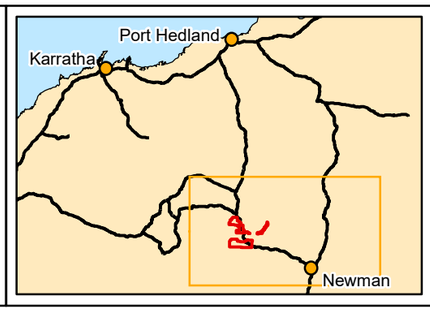
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.3: Additional significant fauna records from the desktop assessment

4 GENERAL FIELD METHODS

4.1 Survey Timing and Personnel

Due to the size of the Study Area, the field survey was undertaken over five separate field trips, with areas of focus during each trip determined by BHP WAIO survey priorities (Table 4.1, Figure 1.1). A helicopter was utilised to assist with sampling, particularly for the remote areas for 1-2 days during each field trip.

Table 4.1: Details of field surveys undertaken

Field trip #	Dates	Duration (days)	Area targeted
1	11th - 15th November 2021	5	Pineapple Hill
2	23rd - 28th November 2021	6	Pineapple Hill
3	4th - 13th April 2022	10	Within and surrounding the high priority survey areas within the MAC to Yandi rail corridor and Camp Hill area (northern areas)
4	27th April - 6th May 2022	10	Mudlark Well (southern section)
5	25th - 30th May 2022	6	Retrieval of any equipment not yet retrieved, as well as infill sampling, targeted searches and nocturnal searches throughout the Study Area

The field survey was led by Andrew Hide who has 16 years of experience undertaking fauna surveys, including surveys of a similar scope within the Pilbara region. The field personnel who contributed to the current field survey collectively have over 30 years of experience undertaking fauna surveys within the Pilbara region, including targeted surveys for the MNES that were the focus of this assessment (Table 4.2).

Table 4.2: Survey personnel and experience

Personnel	Position and Role	Qualification	Experience
Andrew Hide	Senior Zoologist	BSc (Hons) Natural Resource Management	16 years' EIA (consulting) 16 years' field survey 16 years' vertebrate zoology/ ecology
Thomas Rasmussen	Senior Zoologist		17 years' EIA (consulting) 17 years' field survey 17 years' vertebrate zoology/ ecology
Sam Lostrom	Senior Zoologist	BSc (Hons) Marine Biology and Zoology	5 years' EIA (consulting) 7 years' field survey 7 years' vertebrate zoology/ ecology
Andrew McCreery	Senior Zoologist	BSc (Hons) Environmental Science and Conservation Biology	9 years' EIA (consulting) 10 years' field survey

Personnel	Position and Role	Qualification	Experience
			10 years' vertebrate zoology/ ecology
Jari Cornelis	Zoologist	MSc Philosophy, BSc Zoology and Ecology	4 years' EIA (consulting) 5 years' field survey 5 years' vertebrate zoology/ ecology
Aleesha Turner	Zoologist	BSc Applied Science (Wildlife Biology) (Hons)	2 years' EIA (consulting) 3 years' field survey 3 years' vertebrate zoology/ ecology
Sam Edwards	Zoologist	BSc Environmental Management and Sustainability	1 years' EIA (consulting) 3 years' field survey 1 years' vertebrate zoology/ ecology
Georgina Mattner	Zoologist	BSc Animal Ecology	1 years' EIA (consulting) 5 years' field survey 1 years' vertebrate zoology/ ecology

The survey was conducted under the *Animal Welfare Act 2002*'s Licence to use animals for scientific purposes (License No. U244/2022-2024), administered through the Department of Primary Industries and Regional Development (DPIRD). This is enabled through Biologic's chosen Animal Ethics Committee (AEC), Murdoch University, under permit RW3354/21. DBCA Regulation 27 "Fauna Taking (Biological Assessment) Licence", issued to Chris Knuckey (licence number BA27000560). Under Section 40 of the BC Act, threatened species sampling was completed under a DBCA "Authorisation to Take or Disturbed Threatened Species" issued to Chris Knuckey (authorisation number TFA 2021-0138).

4.2 Climate and Weather

Current climatic data for the Study Area (MAC) was provided by BHP WAIO. Long-term climatic data is not available for the Study Area itself; however, long-term data is available from the Bureau of Meteorology (BoM) weather station at Newman Aero (Station 007176), located approximately 110 km north-west of the Study Area (BoM, 2022). The Newman Aero weather station is expected to provide the most accurate long-term average (LTA) dataset for climatic conditions experienced within the Study Area).

In the 6 months prior to the November 2021 and May 2022 surveys, minimum and maximum temperatures recorded at MAC were similar to the long-term averages for most months (Figure 4.1). Rainfall was generally below the long-term average in the months preceding the November 2021 survey but generally above average prior to the May 2022 surveys (Figure 4.1). In total, the rainfall received at MAC in the Study Area in the 12 months prior to the surveys (November 2020 to October 2021, 511.4 mm) was above the annual long-term average for the same period (314.5 mm), mainly due to unusually high rainfall caused by a tropical low recorded in February 2021. Observed maximum and minimum temperatures and total rainfall recorded during the survey are provided in Table 4.3.

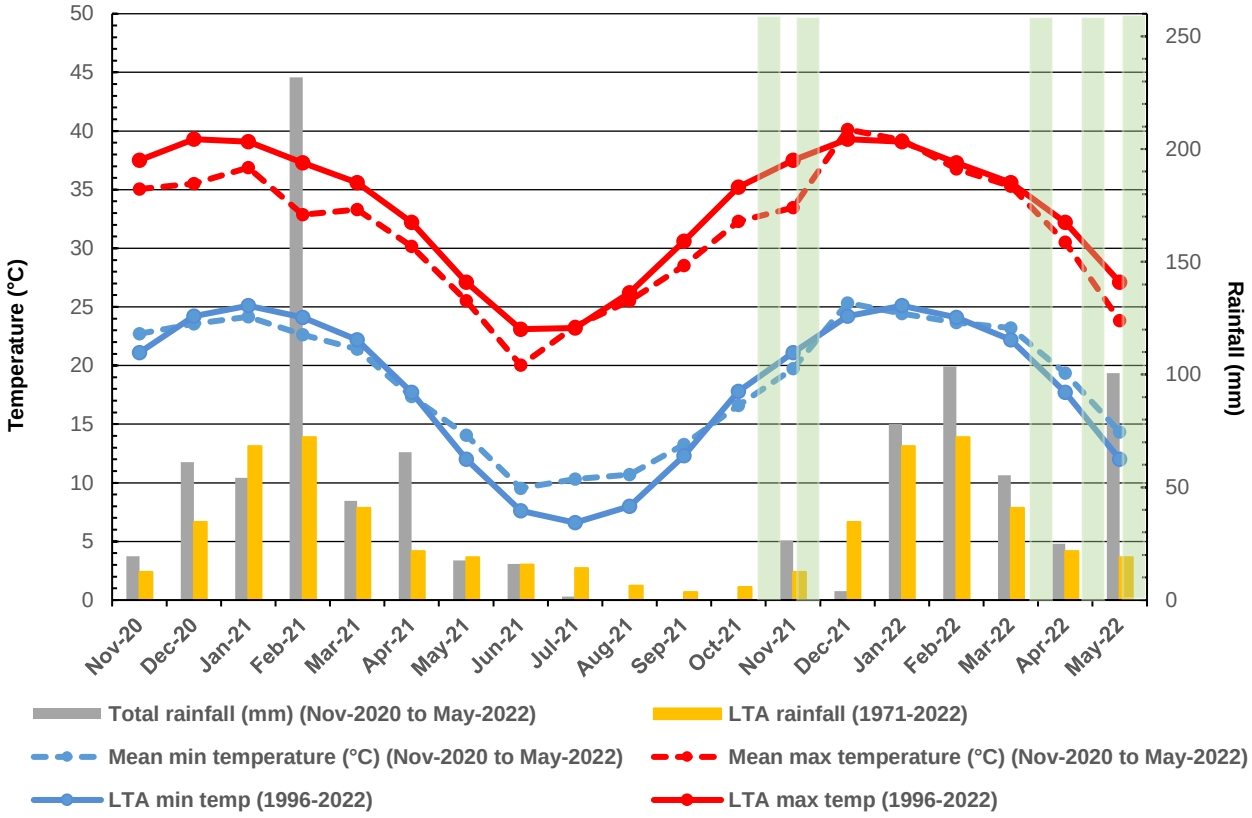


Figure 4.1: Long-term climatic data for Newman Airport (BoM, 2022) and current climatic data for MAC (data provided by BHP WAIO) with approximate survey timing of the five trips shown in green shaded box

Table 4.3: Climatic conditions recorded for MAC (data provided by BHP WAIO) during the surveys

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Trip 1 – November 2021			
11/11/2021	15.0	28.8	0.0
12/11/2021	15.9	29.6	0.0
13/11/2021	17.8	31.2	0.0
14/11/2021	20.4	33.3	0.0
15/11/2021	19.8	35.1	0.0
Mean temp/ total rainfall	**17.78**	**31.6**	**0.0**
Trip 2 – November 2021			
23/11/2021	17.8	31.8	0.0
24/11/2021	20.1	32.0	0.0
25/11/2021	19.3	32.4	0.0
26/11/2021	19.4	32.6	0.0
27/11/2021	20.8	34.4	0.0
28/11/2021	23.3	35.7	0.0
Mean temp/ total rainfall	**20.1**	**33.2**	**0.0**

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Trip 3 – April 2022			
4/04/2022	20.1	33.2	0.8
5/04/2022	20.5	33.2	0.0
6/04/2022	20.6	31.5	0.0
7/04/2022	20.7	32.3	0.0
8/04/2022	21.4	33.5	0.0
9/04/2022	22.2	34.0	0.0
10/04/2022	18.2	34.0	0.0
11/04/2022	17.2	33.1	0.0
12/04/2022	15.8	32.1	0.0
13/04/2022	18.8	32.8	0.0
Mean temp/ total rainfall	**19.6**	**33.0**	**0.8**
Trip 4 – April/ May 2022			
27/04/2022	20.1	24.5	0.0
28/04/2022	16.2	22.4	11.2
29/04/2022	16.6	22.4	0.0
30/04/2022	17.0	21.9	0.0
1/05/2022	16.0	24.1	1.0
2/05/2022	16.6	26.5	0.0
3/05/2022	14.2	28.6	0.0
4/05/2022	18.2	27.5	0.0
5/05/2022	14.2	24.1	0.0
6/05/2022	13.2	24.6	0.0
Mean temp/ total rainfall	**16.2**	**24.7**	**12.2**
Trip 5 – May 2022			
25/05/2022	10.8	23.6	0.2
26/05/2022	13.3	25.5	0.0
27/05/2022	16.6	20.7	0.0
28/05/2022	16.4	23.0	1.0
29/05/2022	14.9	17.5	17.4
30/05/2022	9.0	16.2	6.0
Mean temp/ total rainfall	**13.5**	**21.1**	**24.6**

4.3 Habitat Assessments and Mapping

A total of 291 habitat assessments were undertaken in the field to define and delineate broad fauna habitats present and their suitability to species of significance. Habitat assessments were undertaken at all sampling locations and opportunistically where changes and/or variation in habitats occur to achieve representative coverage of the whole Study Area. Habitat assessments were conducted and attributes assessed using attribute terminology prescribed by BHP, which have been modified from the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: leaf litter %, wood litter, hollow bearing trees and dominant species;
- land surface: abundance and size of coarse fragments, rock outcropping, water bodies;
- substrate: bare ground, rock size, rock type, rock outcropping, soil texture and colour; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Fauna habitat in the Study Area was mapped using the vertebrate fauna habitat assessments completed during the field surveys in conjunction with previously completed mapping, as well as high-resolution aerial imagery, vegetation, topographical, geology and soil mapping. Categories followed those defined by BHP WAIO (2022). Habitats were delineated and mapped across the Study Area at a scale of approximately 1:25,000.

4.4 Targeted Searching and Sampling

The methods used during the survey were specific to each targeted species and comprised:

- northern quoll camera traps and scat searches;
- Pilbara leaf-nosed bat and ghost bat ultrasonic recorders;
- Pilbara leaf-nosed bat and ghost bat roost searches;
- greater bilby plot searches;
- night parrot acoustic recorders; and
- Pilbara olive python searches.

Further discussion of the specific methods, as related to each of the target species, is provided in Section 6 (Figure 4.2).

4.5 Opportunistic Fauna Records

At all times while surveying, any opportunistic fauna observations within the Study Area were recorded, particularly of any significant species. These records included those from primary (i.e. direct observation of species) or secondary (e.g., burrows, scratching's, diggings and scats) evidence.

4.6 Assessment of Significance

4.6.1 Fauna Habitats

Habitat units were categorised as providing critical, supporting or nil habitat for MNES species confirmed or likely to occur. The categorisation of critical and supporting habitat followed that of BHP WAIO (2022). Due to differing habitat preferences of significant species (including habitat features and/or microhabitats), habitat significance was assessed on a species-by-species basis.

It should be noted that assessment of habitat significance applies only to habitat occurring within the Study Area, and therefore may not be representative of significance applied to the same habitat in other areas outside the Study Area. For example, a habitat within the Study Area may be deemed unsuitable due to the absence of certain habitat features and/ or suitable connecting habitat (e.g. wildlife movement corridors) which are required for the species persistence, despite the same habitat occurring outside the Study Area being considered of greater significance. The significance of habitats within the Study Area may also be influenced by other habitats occurring within the Study Area and more broadly, including areas adjacent to the Study Area, particularly if representative of critical habitat.

4.6.2 Significance of Species Occurrence

For the target species, an assessment was made on the significance of their occurrence based on the most relevant and prescriptive guidance documents relative to each species. For northern quoll the significance of occurrence was based on definitions of the DoE (2016), specifically whether the individuals present in the Study Area were representative of a “populations important for the long-term survival of the northern quoll”. These are populations that are:

- high density quoll populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present;
- occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e. granite habitats in WA, populations surrounded by desert and without permanent water; and/or
- subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocation.

For the greater bilby, ghost bat and Pilbara olive python (species listed as vulnerable under the EPBC Act, but with no specific criteria to assess significance of occurrence), the significance of occurrence was based on criteria defined by DoE (2013), specifically whether their occurrence in the Study Area represented an ‘important population’. An ‘important population’ is a population that is necessary for a species’ long-term survival and recovery - this may include populations identified as such in recovery plans, and/or that are DoE (2013):

- 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.

For the Pilbara leaf-nosed bat, the entire Pilbara is suggested to represent an 'important population' (TSSC, 2016c). Thus the significance of occurrence was based on the presence of Priority 1 and 2 refuges (Permanent Diurnal Roosts and Non-permanent Breeding Roosts) (TSSC, 2016c).

For the night parrot, the significance of occurrence was based on definitions by the DoE (2013), specifically the presence of a 'population'. A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area, including, but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

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7480000 7470000

VPIH-005 VCPH-202 VCPH-203 VCPH-191 VCPH-190 VPIH-023 VPIH-020 VPIH-002 VPIH-021 VPIH-015 VPIH-016 VPIH-013 VPIH-012 VPIH-018 VCPH-204 VCPH-073 VCPH-205 VPIH-017 VPIH-001 VCPH-072 VPIH-010 VPIH-003 VPIH-022 VPIH-004 VPIH-007 VPIH-014 VPIH-009 VPIH-008 VCPH-206 VCPH-060 VPIH-024 VCPH-198 VPIH-011 VCPH-197 VCPH-057 VPIH-006 VCPH-071 VPIH-019 VPIH-025 VCPH-189 VPIH-026 VCPH-045 VCPH-004 VCPH-024 VCPH-044 VCPH-080 VCPH-081 VCPH-084 VCPH-083 VCPH-043 VCPH-079 VCPH-052 VCPH-029 VCPH-030 VCPH-042 VCPH-031 VCPH-006 VCPH-051 VCPH-032 VCPH-040 VCPH-036 VCPH-188 VCPH-033 VCPH-035 VCPH-039 VCPH-038 VCPH-034 VCPH-037 VCPH-047 VCPH-008 VCPH-048 VCPH-021 VCPH-050 VCPH-010 VCPH-070 VCPH-199 VCPH-192 VCPH-064 VCPH-176 VCPH-002 VCPH-082 VCPH-049 VCPH-028 VCPH-046 MS1072

Great Northern Hwy

Yandicoogina Rail

Packsaddle Rd

West Angelas Rail

West Angelas Rd

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Nocturnal Search
- Targeted Search
- Ultrasonic Recorder

N

biologic Environmental Survey

Scale: 1:110,000

0 2 4 6 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2a: Vertebrate fauna sampling in the Study Area - Pineapple Hill and Camp Hill

700000
710000
720000
7480000
7470000

MS1039
VYAN-41
VYAN-31
Yandicoogina Rail
VCPH-013
VCPH-056
VCPH-054
VCPH-058
VCPH-026
VCPH-055
VCPH-001
VCPH-007
VCPH-022
VCPH-017
VCPH-027
VCPH-015
VCPH-062
VCPH-063
VCPH-061
VCPH-020
VCPH-003
VCPH-107
VCPH-023
VCPH-019
VCPH-009
VCPH-018
VCPH-059
VCPH-016
VCPH-014
VCPH-005
VCPH-025
Mining Area C Railway
West Angelas Rd
Mining Area
C Railway
VCPH-011
VCPH-053
VCPH-012
MS1072

Legend

- Study Area
- Approval Boundary
- Local Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Nocturnal Search
- Targeted Search
- Ultrasonic Recorder

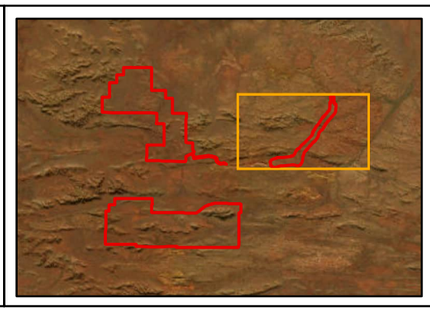
N

biologic Environmental Survey

Scale: 1:80,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2b: Vertebrate fauna sampling in the Study Area - MAC to Yandi Rail Corridor

670000 680000 690000

7450000

7440000

Great Northern Hwy

MS1072

VCPH-131 VCPH-180 VCPH-065 VCPH-173 VCPH-158 VCPH-243 VCPH-121 VCPH-156 VCPH-087 VCPH-195 VCPH-124 VCPH-123 VCPH-174 VCPH-157 VCPH-125 VCPH-130 VCPH-066 VCPH-155 VCPH-154 VCPH-179 VCPH-068 VCPH-172 VCPH-102 VCPH-101 VCPH-077 VCPH-171 VCPH-170 VCPH-128 VCPH-104 VCPH-148 VCPH-100 VCPH-103 VCPH-099 VCPH-152 VCPH-105 VCPH-151 VCPH-146 VCPH-150 VCPH-088 VCPH-153 VCPH-149 VCPH-078 VCPH-200 VCPH-098 VCPH-097 VCPH-067 VCPH-246 VCPH-160 VCPH-133 VCPH-248 VCPH-247 VCPH-245 VCPH-120 VCPH-119 VCPH-249 VCPH-244 VCPH-183 VCPH-181 VCPH-201 VCPH-250 VCPH-116 VCPH-132 VCPH-106 VCPH-076 VCPH-129 VCPH-178 VCPH-242

VCPH-115 VCPH-114 VCPH-234 VCPH-113 VCPH-112 VCPH-233 VCPH-111 VCPH-175 VCPH-227 VCPH-235 VCPH-207 VCPH-230 VCPH-110 VCPH-184 VCPH-108 VCPH-069 VCPH-185 VCPH-228 VCPH-186 VCPH-209 VCPH-229 VCPH-134 VCPH-138 VCPH-109 VCPH-089 VCPH-122 VCPH-144 VCPH-090 VCPH-142 VCPH-135 VCPH-140 VCPH-086 VCPH-117 VCPH-127 VCPH-193 VCPH-126 VCPH-094 VCPH-136 VCPH-251 VCPH-194 VCPH-118 VCPH-196 VCPH-252 VCPH-177 VCPH-239 VCPH-253 VCPH-137 VCPH-096 VCPH-240 VCPH-093 VCPH-241 VCPH-145 VCPH-139 VCPH-095 VCPH-221 VCPH-147 VCPH-143 VCPH-187 VCPH-219 VCPH-217 VCPH-215 VCPH-141 VCPH-225 VCPH-222 VCPH-074 VCPH-223 VCPH-159 VCPH-168 VCPH-161 VCPH-162 VCPH-092 VCPH-169 VCPH-091 VCPH-163 VCPH-166 VCPH-165 VCPH-164 VCPH-167 VCPH-224 VCPH-075 VCPH-182 VCPH-232 VCPH-220 VCPH-218 VCPH-231 VCPH-085

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Targeted Search
- Ultrasonic Recorder

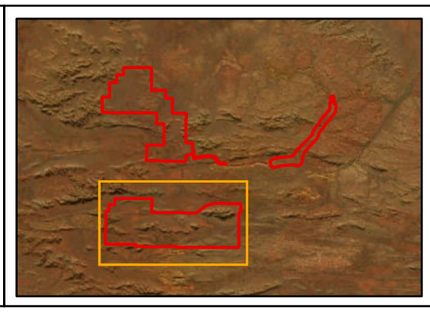
N

biologic Environmental Survey

Scale: 1:90,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2c: Vertebrate fauna sampling in the Study Area - Mudlark Well

5 FAUNA HABITATS

5.1 Fauna Habitats of the Study Area

A total of 11 broad fauna habitat types were recorded and mapped across the Study Area, comprising in decreasing extent of occurrence: Stony Plain (35.51%, 21,051.01 ha), Hillcrest/ Hillslope (23.89%, 14,160.00 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Hardpan Plain (4.21%, 2,495.29 ha), Undulating Low Hills (3.34%, 1,979.59 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha), Medium Drainage Line (0.61%, 362.20 ha) and Major Drainage Line (0.09%, 54.94 ha) (Figure 5.1). The remaining 2.41% (1,428.48 ha) of the Study Area comprised Cleared/ Disturbed areas. Descriptions of the distinguishing characteristics and the occurrence within the Study Area for each of these habitat types are presented in Table 5.1, and the data from on-site habitat assessments are presented in Appendix C.

Of the 11 broad fauna habitats occurring within the Study Area, Gorge/ Gully, Breakaway/ Cliff, Major Drainage Line and Drainage Area/ Floodplain all provide critical habitat for MNES species, including northern quoll, ghost bat, Pilbara leaf-nosed bat, Pilbara olive python and grey falcon (Table 5.1). These habitats provide critical breeding, roosting, foraging and dispersal habitat for some or all of the target species to various extents. Within these habitats, critical breeding, roosting, foraging and dispersal habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat, and Pilbara olive python, occur particularly in areas with caves and overhangs (within Gorge/ Gully, Breakaway/ Cliff habitat) or where pooling water occurs for prolonged periods following rainfall events (within Major Drainage Line and Gorge/ Gully habitat). These habitats may be relied upon by these species for long-term survival within the Study Area, particularly when suitable caves and water features occur within these habitats. Major Drainage Line habitat provides the grey falcon with critical breeding, roosting and foraging habitat while supporting habitat is provided by Drainage Area/ Floodplain habitat (Table 5.1).

While Hillcrest/ Hillslope, Stony Plain, Mulga Woodland, Undulating Low Hills, Hardpan Plain, Medium Drainage Line and Minor Drainage Line habitat potentially provide foraging and dispersal habitat for ghost bat, Pilbara leaf-nosed bat and grey falcon this is dependent on the proximity of the habitat to other areas of critical habitat, particularly roosting habitat. Therefore, while the habitat may still be utilised, it is likely to be less frequent and is considered to only provide supporting foraging and dispersal habitat. None of the supporting habitats occurring within the Study Area are likely to be relied upon by any species for long-term survival within the Study Area or more broadly in the vicinity. All fauna habitats mapped that provide supporting habitat are broadly distributed and well represented across the Pilbara bioregion and surrounding regions, and therefore support fauna assemblages which are generally common and widespread. The condition of habitats within the Study Area was primarily Excellent to Good. The greatest disturbance was caused by grazing by cattle (*Bos taurus*), frequent fires and access tracks/ exploration activity; however, the overall level of disturbance was minimal.

Table 5.1: Broad fauna habitats occurring within the Study Area

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Stony Plain **21,051.01 ha** **35.51%**	Stony Plain comprise low-lying open plains and the rolling hills below upland areas, with very slight to no gradient. The substrate consists of gravel and pebbles, with vegetation dominated by *Triodia*, although scattered trees also occur. Vegetation within this habitat varied in composition but was generally dominated by scattered Mulga and *Acacia* forming an over-storey, with patches of various small to medium shrub species, over low hummock grasslands of *Triodia.* Scattered *Corymbia and Eucalyptus* are usually present.	Within the Study Area Stony Plain habitat is common throughout, particularly within Pineapple Hill and Mudlark Well, primarily at the base of the Hillcrest/ Hillslope habitat. Stony Plain is one of the most common and widespread habitat types within the Pilbara region. The vegetation and substrate which make up this habitat type are characteristic features of the region.	• **Critical habitat for:** ○ **Ghost bat** – foraging habitat where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal (~10 km) to roosting habitat	
Hillcrest/ Hillslope **14,160.00 ha** **23.89%**	The Hillcrest/ Hillslope habitat comprised a rocky substrate, often with exposed bedrock, on moderate to steep slopes leading into lower footslopes. This habitat was characterised by steep slopes with a high proportion of coarse fragments dominated by ironstone. These can contain cracks and crevices. Instances of Gorge/ Gully is contained within this habitat. This habitat is usually dominated by open *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	Within the Study Area Hillcrest/ Hillslope habitat is common and widespread throughout, it is of particularly high density within the northern portion of the MAC to Yandi Rail Corridor Area as well as from Mudlark Well. Hillcrest/ Hillslope habitat is common and widespread habitat types within the Pilbara region. The vegetation and substrate which make up this habitat type are characteristic features of the region.	• **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal (~10 km) to roosting habitat	
Drainage Area/ Floodplain **9,644.57 ha** **16.27%**	Lower lying plain often subjected to sheet flow following large rainfall events. Vegetation and substrates of this habitat was variable, often comprising scattered *Eucalyptus* over *Acacia* and/or *Grevillea* shrubs with an understory dominated by *Triodia* hummock grasses and/or mixed tussock grasses on alluvial substrates, often comprising heavy clays and gravel. Tussock grasses can be dominant within Drainage Area/ Floodplain habitat as a result of high rainfall events.	Within the Study Area Drainage Area/ Floodplain habitat occurs in high proportion within the Pineapple Hill Area with scattered areas throughout the MAC to Yandi Rail Corridor and Mudlark Well. This fauna habitat is common throughout the Pilbara bioregion. Across the region its structure and condition are variable as a result of rainfall events and disturbance (i.e. fire and cattle grazing).	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat	
Mulga Woodland **4,043.20 ha** **6.82%**	Mulga Woodland habitat comprises stands of mulga (*Acacia aneura*) over clay or stony substrates. Differs from other plains by having a monoculture of mulga compared to a diversity of other *Acacia* species.	Within the Study Area Mulga Woodland habitat primarily occurs within low lowing areas, but also occurs within rocky areas, primarily occurs at Camp Hill and Mudlark Well. This habitat is relatively common throughout the Pilbara region, usually occurring in areas of drainage or sheet flow.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Hardpan Plain **2,495.29 ha** **4.21%**	Hardpan Plain habitat comprised flat low lying clay based plain dominated by stands of mulga, with a high proportion of the substrate comprising bare soil. Often sparsely vegetated with large areas often void of vegetation.	Within the Study Area Hardpan Plain habitat occurs within low lowing areas, primarily at Camp Hill and Mudlark Well. This fauna habitat is common throughout parts of the Pilbara bioregion. Structure and condition is variable as a result of rainfall events and disturbance (i.e. fire and cattle grazing).	• **N/A**	
Undulating Low Hills **1,979.59 ha** **3.34%**	The Undulating Low Hills habitat comprises low hills and undulating stony plains of higher elevation than Stony Plain. The habitat supports hard spinifex with a mantle of gravel and larger rocks with occasional outcropping or minor breakaway. Vegetation is dominated by hard *Triodia* hummock grasslands with scattered *Eucalyptus* trees and *Acacia*, *Eremophila* and/or *Grevillea* shrubs.	Within the Study Area Undulating Low Hills habitat primarily occurs within the south-eastern portion of Mudlark Well. Undulating Low Hills habitat is a characteristic habitat type of the Pilbara region. Its occurrence throughout the region is widespread and common.	• **Supporting habitat for:** ○ **Ghost bat** – where proximal to roosting habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat	
Minor Drainage Line **1,639.45 ha** **2.77%**	Minor Drainage Line habitat usually lacked a tall dense upper storey, but with a dense mid storey, including sparse *Eucalyptus* sp., and *Acacia* sp. over tussock grasses and *Triodia* sp. hummock grasses.	Within the Study Area Minor Drainage Line habitat is common throughout, primarily surrounding areas of higher elevation, particularly the Hillcrest/ Hillslope habitat. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Northern quoll** – where proximal to breeding habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat ○ **Pilbara olive python** – where proximal to breeding habitat	
Gorge/ Gully **1,564.61 ha** **2.64%**	Gorge/ Gully habitat was characterised by rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open (but not as open as Minor Drainage Lines). Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Within the Study Area Gorge/ Gully habitat occurs throughout, primarily within Mudlark Well. A reasonably common habitat in the Pilbara, usually associated with ranges; however, because this habitat type is narrow and linear, they only represent a small proportion of the total land area.	• **Critical habitat for:** ○ **Northern quoll** – critical breeding, denning, foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical breeding, roosting, foraging and dispersal, when in range of approparite roosting habitat ○ **Ghost bat** – critical breeding, roosting. ○ **Pilbara olive python** – critical breeding, denning, foraging and dispersal • **Supporting habitat for:** ○ **Ghost bat** - foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area)	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Breakaway/ Cliff **858.97 ha** **1.45%**	The Breakaway/ Cliff habitat comprised a single sided rock face, within the steep mid-upper slope comprising bare rock outcrops or cliffs. Does not comprise the entire slope.	Within the Study Area Breakaway/ Cliff habitat throughout, but primarily within Mudlark Well. A reasonably common habitat in the Pilbara, usually associated with ranges; however, because this habitat type is narrow and linear, they only represent a small proportion of the total land area.	• **Critical habitat for:** ○ **Northern quoll** – critical breeding, denning, foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical breeding, roosting, foraging and dispersal, when in range of appropariate roosting habitat ○ **Pilbara olive python** – critical breeding, denning, foraging and dispersal	
Medium Drainage Line **362.20 ha** **0.61%**	Medium Drainage Line habitat comprised scattered *Eucalyptus* and *Acacias,* or mulga woodland, with an understory dominated by tussock grasses. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing. This habitat type is prone to pooling and ponding in areas.	Within the Study Area Medium Drainage Line habitat occurs in discrete linear areas at Pineapple Hill, Camp Hill, and Mudlark Well. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Northern quoll** – where proximal to breeding habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat ○ **Pilbara olive python** – where proximal to breeding habitat	
Major Drainage Line **54.94 ha** **0.09%**	The Major Drainage Line habitat supported an upper story of relatively tall *Eucalyptus. The habitat* is prone to flooding and is more likely to retain water when inundated. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing.	Within the Study Area the Major Drainage Line habitat occurs in discrete linear areas, comprised within the MAC to Yandi Rail Corridor. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Northern quoll** – critical foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical foraging and dispersal ○ **Grey Falcon** – critical breeding, roosting, foraging and dispersal ○ **Pilbara olive python** – critical foraging and dispersal ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area)	
Cleared/ Disturbed **1,428.48 ha** **2.41%**	Cleared/ Disturbed areas include areas where the natural vegetation and microhabitats have been disrupted, usually devoid of native vegetation. This includes tracks, laydown areas, camps, major roads/ highways and historic, large-scale clearing.	Within the Study Area Cleared/ Disturbed areas are primarily restricted to discrete linear corridors, including roads and access tracks.	• **N/A**	No photo

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Great Northern Hwy

Yandicoogina Rail

Packsaddle Rd

West Angelas Rail

MS1072

West Angelas Rd

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hardpan Plain
- Hillcrest/ Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Stony Plain

N

biologic Environmental Survey

Scale: 1:110,000

0 2 4 6 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1a: Fauna habitats in the Study Area - Pineapple Hill and Camp Hill

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710000
720000
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MS1039
Yandicoogina Rail
MS1072
Mining Area C Railway
West Angelas Rd
Mining Area
C Railway

Legend

- Study Area
- Approval Boundary
- Local Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hillcrest/ Hillslope
- Major Drainage Line
- Minor Drainage Line
- Stony Plain

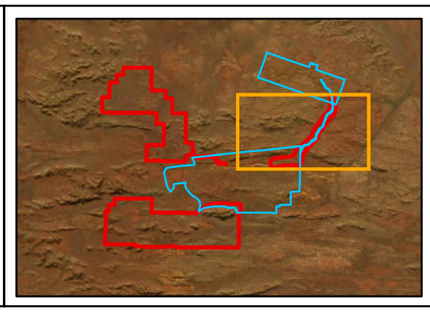
N

biologic Environmental Survey

Scale: 1:80,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1b: Fauna habitats in the Study Area - MAC to Yandi Rail Corridor

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680000
690000
7450000
7440000
Great Northern Hwy
MS1072

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hardpan Plain
- Hillcrest/ Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Stony Plain
- Undulating Low Hills

N

biologic Environmental Survey

Scale: 1:90,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1c: Fauna habitats in the Study Area - Mudlark Well

5.2 Habitat Features of the Study Area

5.2.1 Caves

Caves can be important features within a landscape, particularly in arid zone systems, often providing stable microclimates, shelter and protection (Medellin *et al.*, 2017). A total of 34 caves are known within the Study Area, comprising: nine caves that are being currently monitored as part of the MS1072 Fauna Management Plan monitoring program; six caves previously assessed as having potential to support Pilbara leaf-nosed bat and ghost bat and 19 new caves identified and assessed during the current survey for suitability for Pilbara leaf-nosed bat and ghost bat (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *2023*, *in prep.*) (Table 5.2; Figure 5.2).

Underground refuges used by Pilbara leaf-nosed bat were categorised by Bat Call (2021b) into four categories as detailed further in Section 6.3.1. The caves were classified primarily as nocturnal refuge (Category 4) caves for Pilbara leaf-nosed bats, and none were assessed as likely or potentially suitable as Category 1, 2 or 3 (permanent or semi-permanent diurnal) roosts.

Caves and roosts used by ghost bats can be classified into four categories (Bat Call, 2021a) as detailed further in Section 6.4.1. Of the 34 caves occurring within the Study Area, five (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified as Category 2 roosts (maternity/ diurnal roost caves with regular occupancy for ghost bats) (Table 5.2). Three caves in the Study Area (CACW-01, CMUD-08 and CACW-11) were identified as Category 3 (diurnal roost caves with occasional occupancy) and 23 were identified as Category 4 (nocturnal roost caves with opportunistic usage) for ghost bats (Table 5.2). The remaining three caves recorded in the Study Area showed no evidence of usage by the ghost bat and are unlikely to be suitable for this species.

CMUD-01 and CMUD-10 are potential maternity roosts for ghost bat. CMUD-01 has a demonstrated presence of pregnant females across seven (out of eight) years of monitoring, making it the most consistently used cave by pregnant females of the caves monitored in the MS1072 Fauna Management Plan monitoring program (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *2023*, *in prep.*). Elevated progesterone levels were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, in prep.-a). CMUD-10 has also demonstrated presence of pregnant females over six (out of eight) years of monitoring (Biologic, in prep.-a).

Of the 34 caves, 23 occur within Gorge/ Gully habitat, five within Breakaway/ Cliff habitat and six within Hillcrest/ Hillslope habitat. Cave searching survey effort was focussed on the areas of Gorge/ Gully habitat most likely to have the highest quality caves, therefore it is possible that not all caves have been located within the Study Area and additional caves may occur.

Table 5.2: Summary of caves recorded in Study Area

Cave ID	Previous Cave ID	Origin of data	Coordinates		Ghost Bat Significance	Pilbara Leaf-nosed Bat Significance
			Latitude	Longitude		
CMIN-01	-	Current survey	-22.8364	119.1238	Category 4	Category 4
CACW-02	-	Current survey	-22.8516	118.7906	No usage	No usage
CMIN-02	-	Current survey	-22.8049	119.1499	No usage	No usage
CMUD-03	-	Current survey	-23.0532	118.8123	Category 4	Category 4
CMUD-04	-	Current survey	-23.0385	118.6580	Category 4	Category 4
CMUD-05	-	Current survey	-23.0577	118.6216	Category 4	Category 4
CMUD-06	-	Current survey	-23.0579	118.6216	Category 4	Category 4
CMUD-07	-	Current survey	-23.0160	118.6501	Category 4	Category 4
CMUD-09	-	Current survey	-23.0816	118.6588	Category 4	Category 4
CMUD-11	-	Current survey	-23.0417	118.8685	Category 4	Category 4
CMUD-12	-	Current survey	-23.0396	118.8741	No usage	No usage
CMUD-13	-	Current survey	-23.0748	118.7932	Category 4	Category 4
CMUD-14	-	Current survey	-23.0669	118.7197	Category 4	Category 4
CMUD-15	-	Current survey	-23.0765	118.6262	Category 4	Category 4
CMUD-16	-	Current survey	-23.0756	118.6251	Category 4	Category 4
CMUD-17	-	Current survey	-23.0151	118.6891	Category 4	Category 4
CMUD-18	-	Current survey	-23.0476	118.9036	Category 4	Category 4
CMUD-19	-	Current survey	-23.0349	118.6186	Category 4	Category 4
CMUD-20	-	Current survey	-23.0354	118.6188	Category 4	Category 4
CMUD-01	M01	Monitoring	-23.0813	118.6607	Category 2	Category 4
CMUD-02	M02	Monitoring	-23.0715	118.634	Category 2	Category 4
CACW-01	ACW01	Monitoring	-22.8696	118.792	Category 3	Category 4
CMUD-08	ACW08	Monitoring	-23.0363	118.6605	Category 3	Category 4
CMUD-10	ACW10	Monitoring	-23.0284	118.7207	Category 2	Category 4
CACW-11	ACW11	Monitoring	-22.8701	118.7921	Category 3	Category 4
CACW-13	ACW13	Monitoring	-22.8698	118.7923	Category 4	Category 4
CACW-17	ACW17	Monitoring	-22.8415	118.7627	Category 4	Category 4
CACW-31	ACW31	Monitoring	-22.8649	118.7912	Category 2	Category 4

Cave ID	Previous Cave ID	Origin of data	Coordinates		Ghost Bat Significance	Pilbara Leaf-nosed Bat Significance
			Latitude	Longitude		
CMIN-03	ACY 1	Biologic (2011b)	-22.8740	119.1024	Category 2	Category 4
CPIN-02	CPIN-02	Biologic (2022)	-22.7704	118.7281	Category 4	Category 4
CPIN-03	CPIN-03	Biologic (2022)	-22.7956	118.6074	Category 4	Category 4
CPIN-04	CPIN-04	Biologic (2022)	-22.7954	118.6072	Category 4	Category 4
CPIN-05	CPIN-05	Biologic (2022)	-22.7961	118.6079	Category 4	Category 4
CPIN-20	CPIN-20	Biologic (2022)	-22.8084	118.6210	Category 4	Category 4

5.2.2 Water Features

Water sources are a limiting factor for many ecosystems (James *et al.*, 1995), particularly within arid-zone ecosystems such as the Pilbara (Burbidge *et al.*, 2010; Doughty *et al.*, 2011), and often represent areas of comparatively high ecological productivity (Murray *et al.*, 2003). Water features have varying levels of significance to the target species of this assessment. For northern quolls, water features can represent areas of high productivity, and therefore may contain a relatively high abundance of feeding resources (Braithwaite & Griffiths, 1994; Oakwood, 2000), when in suitable habitat (e.g., rocky habitats, and to a lesser degree, drainage lines). For Pilbara leaf-nosed bats, water features can provide significant drinking and foraging sources, and are a key component to 'gorges with pools' being recognised as the priority foraging habitat for the species (TSSC, 2016c). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011a; Pearson, 1993).

Six water features were recorded during the current survey (Table 5.3), comprising four river pools (located within Major Drainage Line habitat within Gorge/ Gully habitat), one waterhole (located within Gorge/ Gully habitat) and one livestock tank overflow (located within Drainage Area Floodplain habitat) (Table 5.3; Figure 5.2). Previously recorded water features have also been recorded along the Major Drainage Line habitat within the MAC to Yandi Rail Corridor (Biologic, 2020d). It is possible that additional water features occur within the Study Area, particularly within the Major Drainage Line, Medium Drainage Line and Gorge/ Gully habitat (Figure 5.2).

All of the waterholes recorded in the current survey were considered to provide significant foraging habitat for the northern quoll, Pilbara leaf-nosed bat and Pilbara olive python.

Table 5.3: Water features recorded in the Study Area during the current survey

Water Feature ID	Description	Coordinates		Habitat
		Latitude	Longitude	
WMIN-03	River pool	-22.8510	119.1150	Major Drainage Line Within Gorge/ Gully
WMUD-01	Waterhole	-23.0653	118.7074	Gorge/ Gully
WMIN-01	River pool	-22.8345	119.1314	Major Drainage Line Within Gorge/ Gully
WMIN-02	River pool	-22.8310	119.1336	Major Drainage Line Within Gorge/ Gully
WMIN-04	River pool	-22.8486	119.1111	Major Drainage Line Within Gorge/ Gully
WPIN-01	Livestock tank overflow	-22.7821	118.6602	Drainage Area Floodplain

660000 680000 700000 720000 740000

7480000 7460000

Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
CPIN-02
WPIN-01
CPIN-05
CPIN-03
CPIN-04
CPIN-20
CMIN-02
CACW-17
CACW-02
Packsaddle Rd
Yandicoogina Rail
CMIN-01
WMIN-02
WMIN-01
WMIN-04
WMIN-03
CACW-31
CACW-01
CACW-13
CACW-11
CMIN-03
West Angelas Rail
West Angelas Rd
MS1072
CMUD-17
CMUD-07
CMUD-19
CMUD-10
CMUD-08
CMUD-20
CMUD-04
CMUD-05
CMUD-12
CMUD-18
CMUD-03
CMUD-11
WMUD-01
CMUD-14
CMUD-06
CMUD-02
CMUD-13
CMUD-16
CMUD-01
CMUD-15
CMUD-09
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Habitat Feature

- Cave
- Water Feature

N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 31/10/2022

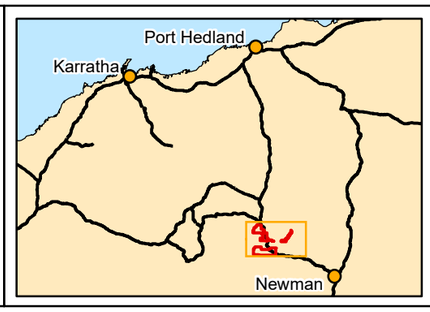

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Figure 5.2: Fauna habitat features recorded in the Study Area

6 TARGET SPECIES

6.1 Northern Quoll (*Dasyurus hallucatus*)

6.1.1 Species Profile

The northern quoll is listed as Endangered under the EPBC Act and BC Act. The species was once widely distributed across northern Australia, however, it is now restricted to three isolated populations; the Pilbara, the Kimberley and Northern Territory, and Queensland (DoE, 2016). Northern quolls are opportunistic omnivores, consuming a wide range of invertebrates and small vertebrates also in addition to fruit, nectar, carrion and human refuse (Dunlop *et al.*, 2017).

As a result of facultative die-off, the abundance of the species is cyclical, and the annual reproduction is highly synchronised (Oakwood *et al.*, 2001). In the Pilbara, abundance is lowest toward the end of winter into early spring after the mating season, as a significant proportion of adult males die off and young have not yet begun to forage independently (Braithwaite & Griffiths, 1994; Oakwood, 2000). Conversely, the population density is thought to be highest in the summer months, prior to the mating season and when juveniles have begun foraging independently (Oakwood, 2000). Schmitt *et al.* (1989) reported relatively small home ranges in rugged habitat in the Kimberley (i.e. 2.3 ha for females and 1.8 ha for males), whereas in the western Pilbara, minimum activity areas (often used as an estimator of home range) are 75–443 ha for females and 5–1,109 ha for males (King, 1989). It should be noted here though that the method used to calculate minimum activity areas in this latter study can potentially overestimate home ranges (Burgman & Fox, 2003).

The northern quoll is both arboreal and terrestrial, inhabiting ironstone and sandstone ridges, scree slopes, granite boulders and outcrops, drainage lines, riverine habitats (Braithwaite & Griffiths, 1994; Oakwood, 2002), dissected rocky escarpments, open forest of lowland savannah and woodland (Oakwood, 2002, 2008). Rocky habitats tend to support higher densities, as they offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; Oakwood, 2000). Other microhabitat features important to the species include rock cover, proximity to permanent water, and time-since last fire (Woinarski *et al.*, 2008). Dens occur in a wide range of habitat features, including rock overhangs, tree hollows, hollow logs, termite mounds, goanna burrows and human dwellings/infrastructure, where individuals usually den alone (Oakwood, 2002; Woinarski *et al.*, 2008). At present, northern quolls are relatively common in the northern Pilbara region (generally within 150 km of the coast) but are much less common in southern and south-eastern parts of the region (Cramer *et al.*, 2016b).

The species has experienced a precipitous decline in much of its former range in northern Queensland and the Northern Territory in direct association with the spread of the cane toad, *Bufo marinus* (Braithwaite & Griffiths, 1994; Fitzsimons *et al.*, 2010). Other threats include predation from feral predators such as foxes and cats, inappropriate fire regimes, disease, habitat degradation through grazing and weed invasion, habitat destruction through mining and agriculture (Woinarski *et al.*, 2011). The potential invasion of the Pilbara by the cane toad is regarded as the most significant future threat

to the northern quoll in the Pilbara; however, there is little knowledge of the relative impact of the other key threats, and their interactive effects, currently and in the future (Cramer *et al.*, 2016b).

6.1.2 Previous Records

The Study Area falls within the current distribution of the northern quoll, whereby the species or species' habitat is likely to occur (DoE, 2022a). A total of 538 northern quoll records were identified within 50 km of the Study Area in the desktop assessment (BHP, 2022; DBCA, 2022b) (Figure 6.1). The vast majority of these records (475) occur in the vicinity of Koodaideri, approximately 21.5 km north of the Study Area. The scarcity of records elsewhere within the desktop assessment search area (50 km of Study Area) suggests that the species is patchily distributed and/or occurs at low abundance in the broader area. However, a higher number of records in the vicinity of Koodaideri may be partially due to greater survey effort in this area.

The species has previously been recorded within the Study Area, from scats in Hillcrest/ Hillslope habitat at Camp Hill in 2011 and a live individual (BHP, 2022; Onshore & Biologic, 2011) (Figure 6.1). Additionally, Astron (2019, 2020) recorded the northern quoll in an area approximately 8 to 20 km east of the Study Area: 16 times via motion camera detection images (10 records), scat recordings (five records) and trapping (one record). The scarcity of previous records within or close to the Study Area suggests the species is likely to occur at very low densities.

6.1.3 Survey Methods

Targeted Searches

Targeted searches for secondary northern quoll evidence (e.g., scats, remains and tracks) were conducted along 70 transects, equating to a total of approximately 193 person hours (Table 6.1).

Table 6.1: Targeted searches completed for northern quoll within the Study Area

Transect Name	Date	Habitat	Person hours
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-020	28/05/2022	Major Drainage Line	4
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-041	9/04/2022	Medium Drainage Line	1.5
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4
TCPH-081	12/04/2022	Gorge/ Gully	4

Transect Name	Date	Habitat	Person hours
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2
TCPH-091	4/05/2022	Medium Drainage Line	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-166	4/05/2022	Medium Drainage Line	2
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5

Transect Name	Date	Habitat	Person hours
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5
TPIH-02	12/11/2021	Gorge/ Gully	3
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
Total			**193.26**

Camera Trap Transects

Twenty-one camera trap transects were deployed throughout the Study Area in suitable northern quoll breeding/ shelter habitat (e.g. Gorge/Gully), high quality foraging/ dispersal habitat (e.g., Major Drainage Line) or habitat directly adjacent to breeding/ shelter habitat (Table 6.1; Figure 6.2). Where possible, survey design and effort followed methods recommended by DoE (2016); however, due to the size of the Study Area, the number of cameras deployed at any given site were based on the extent of suitable habitat with an approximate spread of one camera every 50–100 meters (m). Cameras were deployed for between three and 22 consecutive nights, for a total of 1,503 camera trap sampling nights (Table 6.2).

Where possible, cameras were oriented to enable differentiation of individuals via spot patterning (following Hohnen *et al.*, 2012) and baited with universal bait mixture (comprising oats, peanut butter and sardines) contained within a non-reward receptacle (perforated and capped PVC pipe).

Table 6.2: Camera transects sampled for northern quoll within the Study Area

Site	Habitat	Deployment	Retrieval	Total Trap Nights
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	50
VCPH-022	Gorge/ Gully	6/04/2022	28/04/2022	220
VCPH-023	Major Drainage Line	6/04/2022	28/04/2022	220
VCPH-025	Gorge/ Gully	7/04/2022	12/04/2022	50
VCPH-042	Gorge/ Gully	9/04/2022	30/04/2022	180
VCPH-046	Gorge/ Gully	25/05/2022	29/05/2022	20
VCPH-085	Gorge/ Gully	28/04/2022	2/05/2022	40
VCPH-086	Breakaway/ Cliff	28/04/2022	2/05/2022	40
VCPH-095	Breakaway/ Cliff	30/04/2022	4/05/2022	40
VCPH-100	Gorge/ Gully	30/04/2022	4/05/2022	40
VCPH-108	Medium Drainage Line	1/05/2022	6/05/2022	50

Site	Habitat	Deployment	Retrieval	Total Trap Nights
VCPH-132	Gorge/ Gully	2/05/2022	6/05/2022	40
VCPH-176	Medium Drainage Line	25/05/2022	29/05/2022	20
VCPH-180	Gorge/ Gully	26/05/2022	30/05/2022	40
VCPH-181	Breakaway/ Cliff	26/05/2022	30/05/2022	40
VCPH-185	Gorge/ Gully	26/05/2022	30/05/2022	40
VPIH-002	Gorge/ Gully	12/11/2021	28/11/2021	160
VPIH-008	Drainage Area/ Floodplain	13/11/2021	24/11/2021	22
VPIH-009	Gorge/ Gully	13/11/2021	24/11/2021	88
VPIH-015	Gorge/ Gully	14/11/2021	24/11/2021	100
VYAN-31	Major Drainage Line	15/05/2022	18/05/2022	3
Total				**1503**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Munjina Rd
Karijini Dr
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Marble Bar Rd
Newman
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

Astron (2019)
Sampling Type
- Camera Trap
- Individual (alive)
- Scat

BHP (2022)
Sampling Type
- Camera Trap
- Individual (alive)
- Scat

DBCA (2022)
Sampling Type
- Camera Trap
- Individual (alive)

- Scat
- Specimen
- Unknown

N

biologic Environmental Survey

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Projection: Transverse Mercator
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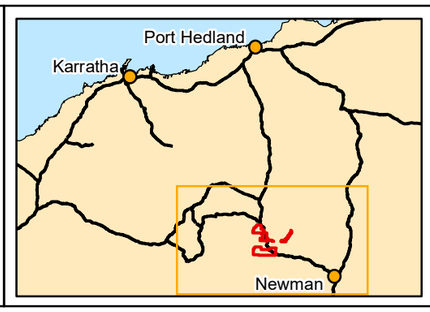

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Figure 6.1: Previous northern quoll records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
Great Northern Hwy
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1039
MS1072

Legend

Study Area
Approval Boundary
Local Road
State Road
Rail

Fauna Habitat
Critical
Supporting
Nil

Sampling Method
Camera Trap (23)
Targeted Search (70)

N

biologic Environmental Survey

Scale: 1:220,000
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Coordinate System: GDA2020 MGA Zone 50
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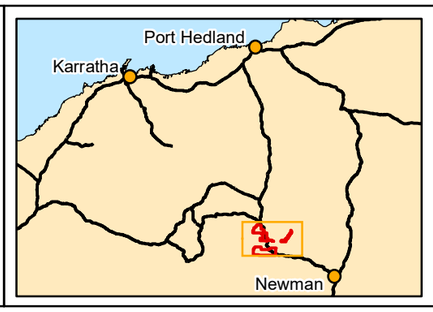

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Figure 6.2: Northern quoll sampling locations and habitat in the Study Area

6.1.1 Survey Results

Targeted Searches

No evidence of northern quoll was recorded within the Study Area during the 193.26 person hours of targeted searches conducted for this species.

Camera Transects

No evidence of northern quoll was recorded at any of the 21 camera transects deployed within the Study Area over a total of 1,503 sampling nights.

6.1.2 Discussion

The Study Area falls within the current distribution of the northern quoll, whereby the species or species' habitat is likely to occur (DoE, 2022a). The species has previously been recorded within the Study Area, however, previous records of northern quolls in the Study Area are scarce and around a decade old (Biologic, 2011e, 2013d; Onshore & Biologic, 2011). In addition, no northern quolls or evidence of their occurrence was recorded during the current survey. Similarly, two previous targeted northern quoll surveys located within 5 km of the Study Area also recorded no evidence of the species (Biota, 2009, 2014a). However, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area. These results suggest that northern quolls may be present in very low densities, or present only intermittently as a result of individuals moving from areas outside the Study Area. This is supported by the lack of records in the desktop assessment relative to the number of surveys completed in the area.

Critical habitat for the northern quoll, as defined by DoE (2016), includes rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species (Figure 5.1; Figure 6.2). Supporting habitat for the northern quoll is provided by Minor Drainage Line and Medium Drainage Line habitat, where proximal to breeding habitat.

Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, this species is considered highly likely to occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale. Furthermore, the Study Area is unlikely to contain a 'population important for the long-term survival of the species', as defined by the DoE (2013, 2016).

6.2 Greater Bilby (*Macrotis lagotis*)

6.2.1 Species Profile

The greater bilby is listed as Vulnerable under the EPBC Act and BC Act. It is one of many Australian arid zone marsupial species that are within a 'critical weight range' (35 grams [g] to 5,500 g) considered significant based on the high risk of predation by introduced foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) (Johnson & Isaac, 2009). Greater bilbies are semi-fossorial and nocturnal, remaining in their burrows during the day and intermittently during the night for rest and refuge. Greater bilby populations naturally occur as scattered solitary individuals or small groups (Smythe & Philpott, 1968; Southgate, 1990a). They are regarded as having low site fidelity and high mobility (Southgate *et al.*, 2007); males regularly move three to five kilometres between burrows on consecutive days and have been recorded moving up to 15 km in a few weeks (Southgate & Possingham, 1995). This high mobility, together with low population density, ensures that the area of occupancy is often far less than the extent of occurrence. As greater bilbies are solitary in nature, lack territoriality and have large home ranges, it is likely that males adopt a roving strategy to find receptive females, consistent with an overlapping promiscuous mating system (Miller *et al.*, 2010).

Populations of greater bilby exist in the Pilbara bioregion (particularly within the Chichester subregion, along the Fortescue River and north-east to Goldsworthy and Shay Gap), in the Dampier bioregion (along 80 Mile Beach north to Beagle Bay) and in the Central Kimberley and Ord-Victoria Plains bioregions south of the Fitzroy and Margaret Rivers (Southgate, 1990a). The species' distribution within the Pilbara region is highly fragmented (Cramer *et al.*, 2017).

Greater bilbies occupy three major vegetation types - open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate, 1990b). Laterite and rock feature substrates are an important part of greater bilby habitat as they support shrub species, such as *Acacia kempeana, A. hilliana* and *A. rhodophylla*, which have root-dwelling larvae prone to supporting a constant food source (Dziminski & Carpenter, 2017; Southgate *et al.*, 2007). These habitats also contain spinifex hummocks, which are quite uniform and discrete, providing runways between hummocks and enabling easier movement and foraging (Southgate *et al.*, 2007). Minimal ground cover is a common feature in greater bilby habitats, as it allows easy foraging (Dawson *et al.*, 2018). Habitat within the Pilbara bioregion seems to consist mostly of spinifex sand plain associated with major drainage line sandy terraces. In general, the distribution of greater bilbies can be limited by the availability of suitable burrowing habitat, such as dunes where burrow excavation is easier (Moseby & O'Donnell, 2003), and are not found in predominantly rocky areas or mountains where they would be unable to dig suitable burrow systems or dig for food.

6.2.2 Previous Records

The Study Area falls within the western extent of the current distribution of the greater bilby, whereby the species or species' habitat is likely to occur (DoE, 2022e). The desktop assessment identified 18 previous records of the species within 50 km of the Study Area (BHP, 2022; DBCA, 2022b) (Figure 6.3). One previous record of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given that it is situated on a stony hill, which does not provide habitat. This record also may be of a misidentified goanna burrow. The next closest record occurs 14 km west, also from 1984. The most contemporary record (2020) is from the Fortescue Valley, located 37 km west of the Study Area; however, this record was of possible greater bilby diggings so may be inaccurate. Integrated Environmental (1980) recorded the greater bilby 8.7 km from the Study Area, however, this record is historic.

6.2.1 Survey Methods

Greater Bilby Plots Searches

Greater bilby sampling within the Study Area comprised 2 hectare (ha) survey plots (greater bilby plots) distributed within areas of suitable habitat across the Study Area, in accordance with survey guidelines for the species (DBCA, 2017). Each greater bilby plot was subjected to targeted searches for a minimum of 18 minutes and comprised searches for secondary evidence for the species, including burrows, diggings, tracks and scats, as described by Southgate *et al.* (2019). Due to the size of the Study Area, plot searches were supplemented with additional linear transect searches in areas of suitable habitat (as recommended by (DBCA, 2017)).

Overall, a total of 16 greater bilby plots, and two transects were sampled for the greater bilby within the Study Area. Each plot was searched for between 0.3 and 1 person hour, equating to a total of 15 person hours of targeted sampling (Table 6.3; Figure 6.4).

Table 6.3: Greater bilby sampling locations within the Study Area

Transect Name	Date	Habitat	Sampling Method	Person hours
TCPH-010	5/04/2022	Mulga Woodland	Plot	1
TCPH-036	8/04/2022	Mulga Woodland	Transect	1
TCPH-037	8/04/2022	Hardpan Plain	Plot	1
TCPH-047	12/04/2022	Hardpan Plain	Transect	1
TCPH-059	10/04/2022	Drainage Area/ Floodplain	Plot	0.3
TCPH-064	11/04/2022	Mulga Woodland	Plot	1
TCPH-101	30/04/2022	Drainage Area/ Floodplain	Plot	0.4
TCPH-102	30/04/2022	Drainage Area/ Floodplain	Plot	0.3
TCPH-171	4/05/2022	Hardpan Plain	Plot	1
TCPH-173	5/05/2022	Hardpan Plain	Plot	0.5
TCPH-174	5/05/2022	Mulga Woodland	Plot	1
TCPH-192	27/05/2022	Mulga Woodland	Plot	1.5
TCPH-199	27/05/2022	Mulga Woodland	Plot	1.5

Transect Name	Date	Habitat	Sampling Method	Person hours
TCPH-201	27/05/2022	Mulga Woodland	Plot	1
TCPH-231	28/05/2022	Drainage Area/ Floodplain	Plot	0.5
TCPH-232	28/05/2022	Hardpan Plain	Plot	0.5
TCPH-243	29/05/2022	Hardpan Plain	Plot	0.7
TCPH-249	29/05/2022	Mulga Woodland	Plot	0.8
Total				**15**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Munjina Rd
Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Karijini Dr
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1089
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022)
Sampling Type
- Burrow (inactive)
- Digging

DBCA (2022)
Sampling Type
- Burrow
- Camera Trap
- Digging
- Unknown

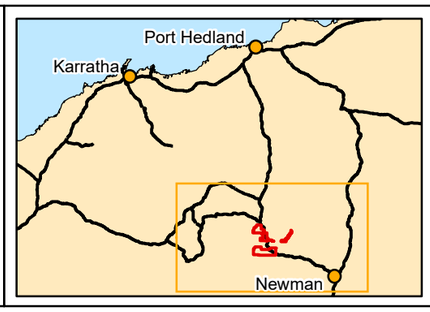
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.3: Previous greater bilby records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1039
MS1072

Legend

Study Area
Approval Boundary
Local Road
State Road
Rail

Sampling Method

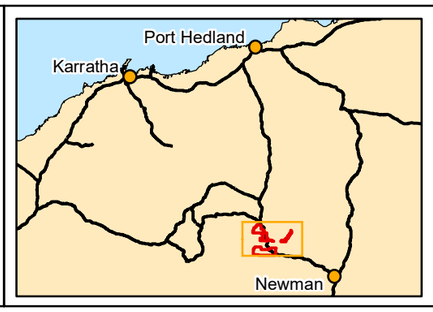
Bilby Plot
Targeted Search (20)

N

biologic Environmental Survey

Scale: 1:220,000
0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.4: Greater bilby sampling locations in the Study Area

6.2.1 Survey Results

Greater Bilby Plots Searches

No evidence of greater bilby (tracks, scats, diggings, or burrows) was recorded within the Study Area during the 15-person hours of targeted searches for this species.

6.2.2 Discussion

Although the Study Area is located within the western extent of the current distribution of the greater bilby, where the species or species' habitat is likely to occur (DoE, 2022e), no greater bilbies or evidence of their occurrence was recorded during the current survey. Furthermore, the records of the greater bilby within or near the Study Area are either likely to be inaccurate (e.g. incorrect coordinates provided) or are historic.

Extant populations of the greater bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (Southgate, 1990b). Within the Pilbara region, the species is often recorded within spinifex sandplains associated with paleo-drainage lines and perched drainage lines where the substrate of sand, soil, sandy clay, or sandy gravel is suitable for burrowing (Dziminski & Carpenter, 2017). Within these sandplain habitats, there is also an association with particular *Acacia* spp. containing root dwelling larvae that the species use for food resources (Dziminski & Carpenter, 2017). Outside of the Pilbara, the species has also been recorded within Mulga Woodland habitat (Southgate, 1990b).

Within the Study Area, only marginally suitable habitat was identified for greater bilby, present in areas with higher concentrations of sand, primarily within the Drainage Area/ Floodplain habitat. The Drainage Area/ Floodplain habitat (9,644.57 ha) often comprises heavy soils which provide low burrowing suitability and is therefore regarded as supporting habitat for the species. Sampling for greater bilby was also completed within Mulga Woodland and Hardpan Plain habitat; however, this habitat was considered low suitability for the species, also due to the low burrowing suitability. It is considered unlikely that the greater bilby occurs within the Study Area due to the lack of critical habitat (e.g. sandplains) and because any areas of supporting habitat were isolated and relatively small. This is supported by the lack of contemporary records in the vicinity of the Study Area. Therefore, the Study Area is unlikely to support an 'important population' as defined by DoE (2013).

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

6.3.1 Species Profile

The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and the BC Act. Within the Pilbara, the species is recognised as a geographically isolated population (or form) of the orange leaf-nosed bat, distributed across northern Australia and separated from the Pilbara population by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara population is regarded as representing a single interbreeding population comprising multiple colonies (TSSC, 2016c; Umbrello *et al.*, 2022). Currently, there are 48 confirmed permanent diurnal categories 1 and 2 roost sites (17 of known location and 31 yet to be found) throughout the Pilbara region (Bat Call, 2021b).

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they require warm (28–32ºC) and very humid (85–100%) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (June to November), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (December to May), when conditions are generally wetter and more humid, individuals typically disperse roosting in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). Bat Call (2021b) categorised underground refuges used by the species into four categories:

- **Permanent diurnal (Categories 1 and 2) roosts** – critical habitat that is essential for the daily and long-term survival of the Pilbara leaf-nosed bat. Category 1 are maternity roosts where seasonal presence of young is proven. Category 2 are occupied year-round but without the proven presence of young.
- **Semi-permanent diurnal (Category 3) roosts** – critical habitat that is essential for the long-term survival of the Pilbara leaf-nosed bat. Used diurnally during some part of the year, but not occupied year-round. May be used during the breeding cycle and may facilitate long distance dispersal in the region, particularly in autumn. Often associated with nearby Category 1 or 2 permanent roost as a 'satellite' roost, that together make up a colony.
- **Nocturnal refuge (Category 4)** – not considered critical but important for persistence in the local area). Are occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Includes most moderately deep caves and shallow abandoned mines.

Foraging sites surrounding known or suspected roosts can be critical to the survival of the species as the species forages within the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016c). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016a) in the dry season and up to 50 km during the wet season (Bullen, 2013). Bat Call (2021b) categorised foraging habitat into five Habitat Ratings:

- **Habitat Rating 5 (outside a diurnal roost)** – Pilbara leaf-nosed bats are present permanently and will be detected nightly. Areas immediately outside a diurnal roost entrance.
- **Habitat Rating 4 (very high)** – Pilbara leaf-nosed bats are very likely to forage and/or drink if in range of a roost. Includes deep gorges.
- **Habitat Rating 3 (high)** – Pilbara leaf-nosed bats are likely to forage if in range of a roost. May be detected passing along creek lines, vegetation lines, rock faces or foraging in the most productive areas. Includes deep gorges.
- **Habitat Rating 2 (moderate)** – Pilbara leaf-nosed bats may occasionally forage due to presence of suitable vegetation, seasonal water and may also use areas as a flyway.
- **Habitat Rating 1 (low)** – Pilbara leaf-nosed bats are unlikely to forage but may traverse while crossing to more productive areas.
- **Habitat Rating 0 (poor)** – Pilbara leaf-nosed bats are unlikely to be detected. Includes bare open ground (e.g., salt and clay pans without vegetation and bare mesa and ridgeline tops).

6.3.2 Previous Records

The Study Area is located at the eastern extent of the current distribution of the Pilbara leaf-nosed bat, whereby the species or species' habitat may occur (DoE, 2022b). The database search identified a total of 1,314 records of Pilbara leaf-nosed bat occur within 50 km of the Study Area (Figure 6.5), however a significant portion of these records (97.4%, 1,281 records) originate from a single location within the Koodaideri locality, approximately 25.5 km north of the Study Area (BHP, 2022; DBCA, 2022b). Of the remaining records, only 10 occur with 10 km of the Study Area (with records from 2006 – 2018) and only one record occurred directly within the Study Area, a detection in 2013 (BHP, 2022; DBCA, 2022b).

The Pilbara leaf-nosed bat has previously been recorded three times within the Study Area (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011). Additionally, ENV (2007a) recorded the species approximately 3.5 km away from the Study Area while Ecologia (2014) recorded the species multiple times foraging approximately 7 km away from the Study Area. In 2008, Biota (2013a) recorded one call of a Pilbara leaf-nosed bat at one location within the Study Area and concluded that the call probably represented a foraging individual and that it was unlikely to be using a nearby cave as a diurnal roost. The other previous records from the Study Area were made by Biologic (2011e) in 2011 and Onshore and Biologic (2011) in 2010; both of which were from a single call deemed likely to be indicative of a transient individual originating from another area. The nearest permanent diurnal roost is believed to be the East Turee Creek roost, a yet to be located roost, located in the south-east corner of Karijini National Park, approximately 20 km west of the western edge of the Study Area (Bat Call, 2021b). The next nearest permanent diurnal roost, the Kalgan Creek roost, is located approximately 50 km east of the eastern extent of the Study Area.

6.3.3 Survey Methods

Targeted Searches

Targeted searches were undertaken at 67 locations across the Study Area on foot to determine the presence and extent of any prospective roosting habitat (i.e. caves) likely to be utilised by Pilbara leaf-

nosed bats and/or ghost bats (Table 6.4; Figure 6.6). Where suitable caves or overhangs that may be utilised by the species were located, detailed cave assessments and searches were undertaken to search for evidence of occurrence and determine the likely use of the cave as a roost site. Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 186 hours of search effort to find potential night or day roost sites was undertaken (Table 6.4; Figure 6.6).

Table 6.4: Targeted searches completed for Pilbara leaf-nosed bat and ghost bat within the Study Area

Transect Name	Date	Habitat	Person hours
TPIH-02	12/11/2021	Gorge/ Gully	3
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4
TCPH-081	12/04/2022	Gorge/ Gully	4
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5

Transect Name	Date	Habitat	Person hours
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5
TCPH-020	28/05/2022	Major Drainage Line	4
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5
Total			**186.76**

Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders at 70 sites within the Study Area during the survey (Table 6.5; Figure 6.6). Sampling at each location focussed on habitat features of potential significance (i.e. water features or potential caves) and habitat or habitat features most likely to support the species (i.e. foraging and dispersal corridors provided by Major Drainage Line habitat). Recorders were deployed for between two and 133 consecutive nights at each site, resulting in a total of 802 recording nights (Table 6.5; Figure 6.6).

The audio settings used for the SM units followed the manufacturer's recommendations (Wildlife Acoustics, 2011, 2017) and were set to account for all species known to occur within the region (McKenzie & Bullen, 2009). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of Pilbara leaf-nosed bat and ghost bat calls only.

Table 6.5: Ultrasonic sampling locations within the Study Area

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-003	Major Drainage Line	5/04/2022	9/04/2022	4
VCPH-012	Drainage Area/ Floodplain	5/04/2022	9/04/2022	4
VCPH-013	Gorge/ Gully	6/04/2022	9/04/2022	3
VCPH-014	Stony Plain	6/04/2022	6/04/2022	3
VCPH-015	Major Drainage Line	6/04/2022	9/04/2022	3
VCPH-016	Minor Drainage Line	6/04/2022	9/04/2022	3
VCPH-017	Major Drainage Line	6/04/2022	9/04/2022	3
VCPH-018	Breakaway/ Cliff	6/04/2022	28/04/2022	25
VCPH-019	Gorge/ Gully	6/04/2022	9/04/2022	3
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	6
VCPH-027	Gorge/ Gully	8/04/2022	28/04/2022	20
VCPH-041	Medium Drainage Line	9/04/2022	13/04/2022	4
VCPH-042	Gorge/ Gully	9/04/2022	30/04/2022	20
VCPH-043	Gorge/ Gully	9/04/2022	13/04/2022	4
VCPH-044	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-045	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-046	Gorge/ Gully	9/04/2022	12/04/2022	3
VCPH-048	Mulga Woodland	9/04/2022	12/04/2022	3
VCPH-049	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-053	Minor Drainage Line	10/04/2022	28/04/2022	18
VCPH-063	Gorge/ Gully	10/04/2022	28/04/2022	18
VCPH-079	Stony Plain	12/04/2022	29/04/2022	17
VCPH-081	Gorge/ Gully	12/04/2022	30/04/2022	17
VCPH-082	Hillcrest/ Hillslope	13/04/2022	29/04/2022	16
VCPH-084	Gorge/ Gully	13/04/2022	29/04/2022	16
VCPH-085	Gorge/ Gully	28/04/2022	2/05/2022	4
VCPH-087	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-088	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-089	Gorge/ Gully	29/04/2022	2/05/2022	3

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-090	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-091	Breakaway/ Cliff	29/04/2022	2/05/2022	3
VCPH-092	Drainage Area/ Floodplain	29/04/2022	2/05/2022	3
VCPH-093	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-094	Breakaway/ Cliff	29/04/2022	2/05/2022	3
VCPH-108	Medium Drainage Line	1/05/2022	6/05/2022	5
VCPH-128	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-129	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-130	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-131	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-132	Gorge/ Gully	2/05/2022	6/05/2022	4
VCPH-133	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-138	Gorge/ Gully	3/05/2022	6/05/2022	3
VCPH-140	Breakaway/ Cliff	3/05/2022	26/05/2022	20
VCPH-143	Gorge/ Gully	3/05/2022	6/05/2022	3
VCPH-177	Minor Drainage Line	25/05/2022	29/05/2022	4
VCPH-178	Stony Plain	26/05/2022	29/05/2022	3
VCPH-179	Hardpan Plain	26/05/2022	29/05/2022	3
VCPH-180	Gorge/ Gully	26/05/2022	30/05/2022	4
VCPH-181	Breakaway/ Cliff	26/05/2022	30/05/2022	4
VCPH-182	Hardpan Plain	26/05/2022	29/05/2022	3
VCPH-183	Stony Plain	26/05/2022	29/05/2022	3
VCPH-184	Drainage Area/ Floodplain	26/05/2022	29/05/2022	3
VCPH-185	Gorge/ Gully	26/05/2022	30/05/2022	4
VCPH-186	Undulating Low Hills	26/05/2022	29/05/2022	3
VCPH-187	Drainage Area/ Floodplain	26/05/2022	29/05/2022	3
VCPH-188	Stony Plain	26/05/2022	29/05/2022	3
VPIH-001	Drainage Area/ Floodplain	11/11/2021	24/11/2021	13
VPIH-003	Drainage Area/ Floodplain	12/11/2021	24/11/2021	12
VPIH-004	Drainage Area/ Floodplain	12/11/2021	15/11/2021	3
VPIH-005	Gorge/ Gully	12/11/2021	24/11/2021	12
VPIH-006	Stony Plain	12/11/2021	24/11/2021	12
VPIH-008	Drainage Area/ Floodplain	23/11/2021	28/11/2021	4
VPIH-016	Stony Plain	24/11/2021	26/11/2021	2
VPIH-017	Medium Drainage Line	24/11/2021	28/11/2021	4
VPIH-023	Gorge/ Gully	27/11/2021	9/04/2022	133
VPIH-024	Gorge/ Gully	27/11/2021	9/04/2022	133
VPIH-025	Gorge/ Gully	29/11/2021	9/04/2022	131
VYAN-31	Major Drainage Line	15/05/2022	18/05/2022	3
Total				**802**

600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd
Karijini Dr
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022) Sampling Type
- Unknown

DBCA (2022) Sampling Type
- Acoustic Recorder
- Secondary Evidence
- Specimen
- Ultrasonic Call
- Unknown

N

biologic Environmental Survey

Scale: 1:700,000

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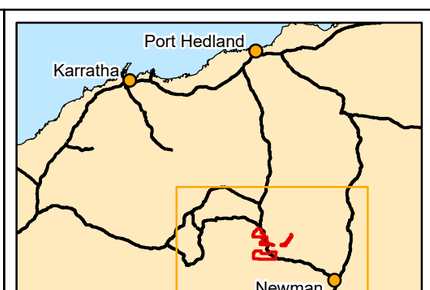
Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.5: Previous Pilbara leaf-nosed bat records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
MS1039
MS1072
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (67)
- Ultrasonic Recorder (68)

Record

Pilbara leaf-nosed bat - VU

- Ultrasonic Recorder (6)

N

biologic Environmental Survey

Scale: 1:220,000

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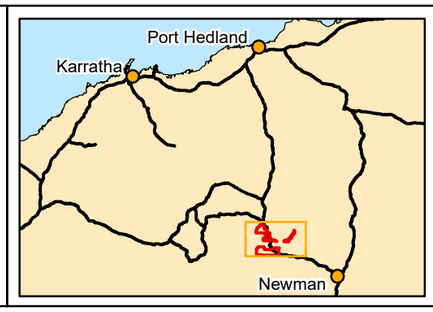
Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.6: Pilbara leaf-nosed bat sampling locations, records and habitat in the Study Area

6.3.4 Survey Results

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey (from 15 individual calls) within Gorge/ Gully, Hillcrest/ Hillslope and Breakaway/ Cliff habitats (Table 6.6). These locations were all close to caves or moderate to major outcropping (Table 6.6).

Table 6.6: Pilbara leaf-nosed bat recorded within the Study Area

Site	Habitat feature	Habitat	Date	Calls
VCPH-128	Major outcropping	Gorge/ Gully	2/05/2022	1 call (at 2011)
VCPH-133	Cave	Hillcrest/ Hillslope	2/05/2022	9 calls (between 2330 and 0454)
VCPH-130	Moderate outcropping	Gorge/ Gully	3/05/2022	1 call (2159)
VCPH-140	Cave	Breakaway/ Cliff	19/05/2022	4 calls (2130)

No evidence of a Pilbara leaf-nosed diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except three which had no usage (Table 5.2). Nocturnal roost caves recorded within the Study Area are likely to be intermittently used by foraging and dispersing individuals from diurnal roost(s) located outside the Study Area.

6.3.5 Discussion

The Pilbara leaf-nosed bat was recorded more times within the Study Area during the current survey than any of the previous studies (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011); however, the number of calls was still very low compared to earlier studies. The timing of the calls recorded during the current survey indicated that the calls are likely to be representative of a foraging individual or individuals, which are unlikely to be habitually using a nearby cave as a diurnal roost. This is consistent with previous studies.

The nearest known permanent diurnal roost for this species (East Turee Creek roost) is located approximately 20 km west of the western edge of the Study Area (Bat Call, 2021b). Pilbara leaf-nosed bats are predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016a); however, seasonal variation is known to occur, with foraging occurring up to 20 km in the dry season and up to 50 km during the wet season (Bullen, 2013). Long-distance movements by the species have also been recorded, with a single monitored individual recorded from two roost caves located 170 km from each other approximately 12 months apart (Bullen & Reiffer, 2019), suggesting the species may forage and/or disperse over greater distances than previously thought. Given this, it is possible that the Pilbara leaf-nosed bats occasionally recorded in the Study Area may have originated from the East Turee Creek roost. It is also possible that these Pilbara leaf-nosed bats may originate from an undiscovered roost site near the Study Area.

The Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha) and Major Drainage Line (0.09%, 54.94 ha) habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat. These habitats provide potential roosting, foraging and dispersal habitat for the species, and also tend to contain important habitat features for the species, such as nocturnal refuges and water features. As such these habitats represent a Habitat Rating 4 (very high) as defined by (Bat Call, 2021b).

Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species. As such these habitats represent a Habitat Rating 2 (low) as defined by (Bat Call, 2021b). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. These water features would provide supporting habitat rather than critical habitat because they are not permanent and are situated further than 8.7 km from the nearest roost.

The results of this survey support the desktop findings by Biologic (2020e), which demonstrated that the Pilbara leaf-nosed bat is relatively scarce within the broader Newman area. This is likely due to the limited occurrence of potential roosting habitat in the vicinity of the Study Area. The scarcity of records in the broader vicinity of the Study Area suggests the Pilbara leaf-nosed bat is relatively uncommon in the area and its occurrence may be restricted to foraging and/or dispersal events only.

The Pilbara population is regarded as representing a single interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022). Thus, the entire population of Pilbara leaf-nosed bat present in the Pilbara is suggested to represent an 'important population'. Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by (Bat Call, 2021b). Given the absence of a critical roost within, or in the immediate vicinity of, the Study Area, it is unlikely that the Study Area represents a significant area for this species.

6.4 Ghost Bat (*Macroderma gigas*)

6.4.1 Species Profile

The ghost bat is listed as Vulnerable under the EPBC Act and the BC Act. The species occurs in disjunct colonies across northern Australia (TSSC, 2016a). In the Pilbara region, the species occurs in all four subregions. The Pilbara population is estimated to comprise between 1,300 and 2,000 individuals (TSSC, 2016a). The largest population occurs within the Chichester subregion (estimated at approximately 1,500 individuals) where known populations are largely restricted to disused mines (TSSC, 2016a).

The distribution of ghost bats in the Pilbara is determined by the presence of suitable roosting sites. Natural roosts generally comprise deep, complex caves beneath bluffs or low rounded hills (Armstrong & Anstee, 2000). Centralised breeding sites in the Pilbara are largely restricted to abandoned mines in the Chichester Ranges; however, there are also a number of smaller maternity roosts in the Chichester and Hamersley Ranges (Armstrong & Anstee, 2000). Based on available data, breeding has been documented in natural caves at Mining Area C, Mt Brockman and West Angeles in the Hamersley sub-

region, and at Callawa and Tambrey Station in the Chichester subregion (Armstrong & Anstee, 2000). Ghost bats are known to move between a number of caves seasonally, or as dictated by weather conditions, and require a range of cave sites (Hutson *et al.*, 2001). Outside the breeding season, male bats are known to disperse widely, most likely during the wet season when conditions would allow bats to use caves that would otherwise not be suitable (Worthington-Wilmer *et al.*, 1994). Genetic studies indicate that females are likely to stay close to the maternity roosts (Worthington-Wilmer *et al.*, 1994).

Caves and roosts used by the species can be classified into four categories (Bat Call, 2021a):

- **Category 1 maternity/ diurnal roost sites with permanent ghost bat occupancy**: Maternity/ diurnal roost caves with permanent ghost bat occupancy. There are several documented permanent roost caves and underground mines in northern Australia. These may be abandoned underground mines;
- **Category 2 maternity/ diurnal roost caves with regular occupancy**: Maternity/ Diurnal roost caves with regular (but not continuous) ghost bat occupancy that is capable of supporting one or more reproducing females and their habitat. These may be abandoned underground mines;
- **Category 3 diurnal roost caves with occasional occupancy**: There are many caves and adits where one to a few ghost bats roost occasionally, or rarely; and
- **Category 4 nocturnal roost caves with opportunistic usage**: shallow caves, shelters and deep overhangs that support opportunistic usage for resting and feeding.

Foraging habitat for ghost bats is classified as occurring within 12 km radius of these categorised caves (Bat Call, 2021a) or 1,200 ha of habitat surrounding each of these caves. The habitat includes:

- productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground;
- isolated trees and trees on the edge of thin thickets on the plains;
- trees along the edges of watercourse woodlands; and
- gully or gorge system that opens onto a plain or riparian line.

Historically, ghost bats were documented to have a short-range foraging strategy of up to 3 km (average 1.9 km), with vantage points changing approximately every 15 minutes, and average foraging areas of 61 ha having been recorded in the Northern Territory (Tidemann *et al.*, 1985). However, recent studies using VHF tracking and GPS/satellite tracking technologies show that ghost bats, both male and female, forage over much larger areas up to 12 km from their diurnal roost (Augusteyn *et al.*, 2018; Bat Call, 2021a). It also appears that bats generally return to the same area each night (Tidemann *et al.*, 1985), although it has been suggested that ghost bats in the arid zone are semi-transient through most areas and will readily travel large distances (>4 km) (Biologic, 2020c). Ghost bats have a ‘sit and inspect’ foraging strategy; whereby they hang on a perch and visually inspect their surroundings for movement. Once their prey is detected it may be captured in the air, gleaned (i.e. taken from the surface of a substrate by a flying bat) from the ground or vegetation, or dropped on from a perch (Boles, 1999).

Recent studies at BHP WAIO's South Flank mine have physically observed a ghost bat exiting a cave and moving immediately towards broad drainage plains, comprising of Mulga Woodland and Major Drainage Line (Biologic, 2020c). Such areas are often highly productive and comprise an abundance of foraging structures (Biologic, 2020c).

6.4.2 Previous Records

The Study Area falls within the current distribution of the ghost bat, whereby the species or species' habitat is likely to occur (DoE, 2022b). In Western Australia, the species has experienced a significant north-westward distribution contraction, presumably associated with increasing aridity (TSSC, 2016a). Numerous caves regarded as important for ghost bats are known to occur near the Study Area, at South Flank and West Angelas.

A total of 559 records of ghost bat occur within 50 km of the Study Area (Figure 6.7), with 115 records occurring within the Study Area (BHP, 2022; DBCA, 2022b). This includes 73 records from Mudlark Well, 40 from Pineapple Hill and Camp Hill, two records within the MAC to Yandi Rail Corridor. Of the total ghost bat records, 459 occur within 12 km of the Study Area (classified foraging range), with all records occurring between 2005 and 2019 (BHP, 2022; DBCA, 2022b).

Other than long-term ghost bat monitoring studies currently being completed around the South Flank area, which monitors four Category 2 and three Category 3 roosts in the Study Area (Biologic, *2023*), the majority of ghost bat records within the Study Area are around a decade old (up until 2014) (Table 6.7).

Table 6.7: Ghost bat previously recorded in and near the Study Area

Report	Records
Biologic (2019)	Recorded the ghost bat 13 times (11 times from scats collected from caves, once from direct observation of two individuals within a cave and once from ultrasonic recorder) all within Gorge/ Gully and Hillcrest/ Hillslope habitats within the Pineapple Hills tenements Study Area. Scats were also recorded at 12 of the caves; five of these are located in the Study Area (CPIN-02, CPIN-03, CPIN-04, CPIN-05 and CPIN-20) (Figure 5.2).
Biologic (2013a)	Recorded at 35 wide-spread locations at Area C West in 2011. A confirmed maternity roost at South Flank.
(Onshore & Biologic, 2011)	Camp Hill, also located within the Study Area, has suitable caves and overhangs and scats were recorded in 2010 from a number of locations, suggesting that this species may be resident in this area.
Biologic (2011a)	20 confirmed ghost bat roosts based on the presence of scats and observed a total of 18 individual ghost bats at two caves.
Biologic (2011e)	Observed seven individual ghost bats at two cave locations and identified 16 ghost bat roosts by the presence of ghost bat scats.
Biologic (2010)	18 individual ghost bats and recorded scats in one cave.

Report	Records
Outback Ecology (2010)	Ghost bat scats in Gorge/ Gully habitat.

6.4.3 Survey Methods

Targeted Searches

Targeted searches were undertaken at 67 locations across the Study Area on foot to determine the presence and extent of any prospective roosting habitat (i.e. caves) likely to be utilised by ghost bats and/or Pilbara leaf-nosed bats (Table 6.4; Figure 6.8). Where suitable caves or overhangs that may be utilised by the species were located, detailed cave assessments were undertaken to search for evidence of occurrence and determine the likely use of the cave as a roost site. Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 186.78 hours of search effort to find potential night or day roost sites was undertaken (Table 6.4; Figure 6.8).

Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders at 68 sites within the Study Area during the survey (Table 6.5; Figure 6.8). Sampling at each location focussed on habitat features of potential significance (i.e. water features or potential caves) and habitat or habitat features most likely to support the species (i.e. foraging and dispersal corridors). Recorders were deployed for between two and 133 consecutive nights at each site, resulting in a total of 802 recording nights (Table 6.5; Figure 6.8).

The audio settings used for the SM units followed the manufacturer's recommendations (Wildlife Acoustics, 2011, 2017) and were set to account for all species known to occur within the region (McKenzie & Bullen, 2009). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of ghost bat and Pilbara leaf-nosed bat calls only.

600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Karijini Dr
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022)
Sampling Type
- Camera Trap
- Ultrasonic Recorder
- Unknown
- Scat

DBCA (2022)
Sampling Type
- Acoustic Recorder
- Individual (alive)
- Individual (dead)
- Scat
- Specimen
- Unknown

N

biologic Environmental Survey

Scale: 1:700,000

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Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022

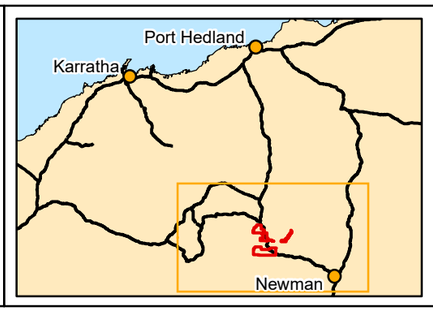

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Figure 6.7: Previous ghost bat records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
MS1039
MS1072
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (67)
- Ultrasonic Recorder (68)

Record

Ghost bat - VU

- Ultrasonic Recorder (32)

N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022

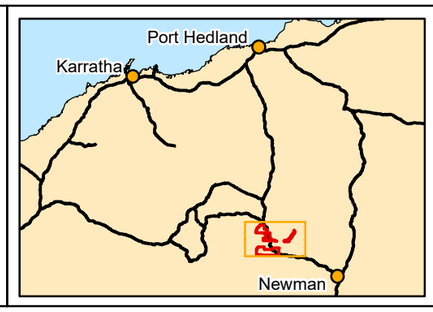

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Figure 6.8: Ghost bat sampling locations, records and habitat in the Study Area

6.4.4 Survey Results

Ghost bats were recorded from echolocation calls at four locations on 33 nights, which were all close to caves or major outcropping (Table 6.8). Calls were recorded from VPIH-23 on 29 nights, VPIH-24 on two nights, VCPH-042 on two nights, and VCPH-046 on a single night (Table 6.8). The number of calls recorded during a given night at VPIH-23 ranged between one and ten (Table 6.8).

Of the 34 caves occurring within the Study Area, five (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified as Category 2 roosts (maternity/ diurnal roost caves with regular occupancy for ghost bats) (Table 5.2). Three caves in the Study Area (CACW-01, CMUD-08 and CACW-11) were identified as Category 3 (diurnal roost caves with occasional occupancy) and 23 were identified as Category 4 (nocturnal roost caves with opportunistic usage) for ghost bats (Table 5.2). The remaining three caves recorded in the Study Area showed no evidence of usage by the ghost bat and are unlikely to be suitable for this species. No scat evidence was recorded from any caves during the current survey.

Unlike the majority of microbats, ghost bats are proficient in navigating and hunting visually without needing to constantly echolocate (Strahan, 2004). For this reason, it is difficult and inaccurate to rely solely on ultrasonic and acoustic recordings of the species to infer absence and/or activity, and therefore very possible the species went undetected at other sampling sites during the survey.

Table 6.8: Ghost bats recorded within the Study Area

Site	Habitat feature	Habitat	Date	Records (calls)
VCPH-046	Major outcropping	Gorge/ Gully	9/04/2022	1
VCPH-042	Cave	Gorge/ Gully	12/04/2022	1
			3/05/2022	1
VPIH-23	Cave	Gorge/ Gully	27/11/2021	5
			28/11/2021	6
			29/11/2021	5
			3/12/2021	5
			7/12/2021	2
			12/12/2021	2
			28/12/2021	2
			7/01/2022	5
			14/01/2022	2
			15/01/2022	4
			20/01/2022	2
			12/02/2022	3
			3/03/2022	10
			7/03/2022	3
			19/03/2022	6
			24/03/2022	1
			25/03/2022	3
			26/03/2022	1
			27/03/2022	1
			28/03/2022	1
			31/03/2022	1
			1/04/2022	1
			2/04/2022	1
			3/04/2022	3
			4/04/2022	3
			5/04/2022	2
			6/04/2022	2
			7/04/2022	2
			8/04/2022	1
VPIH-24	Cave	Gorge/ Gully	28/11/2021	1
			10/02/2022	2

6.4.5 Discussion

The results of the current and previous surveys have confirmed ghost bat occurrence within the Study Area. Based on previous records, the Study Area is likely to be an important area to the ghost bat, based on the presence of critical and supporting habitats. Of the 34 caves occurring within the Study Area, 23 are located within Gorge/ Gully habitat, five within Breakaway/ Cliff habitat and six within Hillcrest/ Hillslope Habitat (Table 5.2; Figure 6.8). Within the Study Area, Gorge/ Gully habitat (2.64%, 1,564.61 ha) often contains important habitat features such as overhangs and caves. Due to the size of the Study Area, it was not feasible to search the entire extent of these habitat types, therefore it is possible additional undiscovered caves occur within the Study Area.

Ghost bats will often forage broadly across habitats, often utilising drainage lines and other habitats where prey species are likely to be most abundant (Richards *et al.*, 2008; Tidemann *et al.*, 1985). Recent studies of ghost bat home range and foraging behaviour in the Pilbara region have identified Drainage Area/ Floodplain, Gorge/ Gully, and Minor Drainage Line as important foraging habitats for the species (Biologic, 2020c). Within the Study Area it is considered that critical foraging habitat is provided by Stony Plain (35.51%, 21,051.01 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Medium Drainage Line (0.61%, 362.20 ha), and Major Drainage Line (0.09%, 54.94 ha) when proximal (>12 km) to roosting caves. As suggested by Bat Call (2021a) these habitats represent “productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground” and/or contain “isolated trees and trees on the edge of thin thickets on the plains” and “trees along the edges of watercourse woodlands”. Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat. The suitability of this habitat, is however, variable depending particular characteristics of the habitat, including the abundance of foraging structures (tree perches) and density of understory vegetation present.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered ‘important’ as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area and would be used by ghost bats that use other High Value Caves at South Flank detailed in Biologic (*in prep.*).

CMUD-01 has evidence of utilisation by pregnant females with elevated progesterone (> 970 ng/g) detected in scats across seven (out of eight) consecutive years of monitoring (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *in prep.-a*, *in prep.-b)* making it the most consistently used cave by pregnant females of the caves monitored in the MS1072 Fauna Management Plan monitoring program (Biologic, *2023*). This result indicates that CMUD-01 is a potential maternity roost. Elevated progesterone levels

were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, *in prep.*). CMUD-10 has also demonstrated evidence of utilisation by pregnant females over six (out of eight) years of monitoring (Biologic, *in prep.*).

6.5 Night Parrot (*Pezoporus occidentalis*)

6.5.1 Species Profile

The night parrot is an elusive, nocturnal ground dwelling parrot listed as Critically Endangered under the BC Act and Endangered under the EPBC Act. The species inhabits arid and semi-arid areas that comprise dense, low vegetation (DPaW, 2017). Based on accepted records, the species' habitat consists of *Triodia* grasslands in stony or sandy environments (McGilp, 1931; North, 1898; Whitlock, 1924; Wilson, 1937), and of samphire and chenopod shrublands, including genera such as *Atriplex*, *Bassia* and *Maireana*, on floodplains and claypans, as well as on the margins of salt lakes, creeks or other sources of water (McGilp, 1931; Wilson, 1937). The current interim guidelines for preliminary surveys of night parrot in Western Australia suggest the species requires old-growth spinifex (*Triodia*) (often more than 50 years' unburnt) for roosting and nesting (DPaW, 2017).

Although little is known about foraging sites, habitats that comprise various grasses and herbs are thought to be suitable. Foraging habitat is not necessarily within or adjacent to roosting habitat as the night parrot has been known to fly up to 40 km in a single night to forage (Murphy *et al.*, 2017). It is assumed that the species may fly cumulative distances of up to 100 km per night during productive seasons and considerably greater than 100 km per night during drought conditions between roosting habitat and foraging habitat (Night Parrot Recovery Team, 2017). *Triodia* is likely to provide a good seasonal food resource, particularly in times of mass flowering and seeding. The succulent *Sclerolaena* and other succulent chenopods also provides a source of food and moisture throughout the year, and are also likely to provide significant habitat (DPaW, 2017). As such, foraging areas include highly productive and floristically diverse alluvial habitats, stony herb fields, sparse ironstone pavements, and quaternary sand drifts and ridges (Night Parrot Recovery Team, 2017). Foraging habitat is likely to be more important when it occurs adjacent to or within approximately 10 km of suitable roosting habitat (DPaW, 2017). During dispersal, or nomadic movements, night parrots may travel distances in the order of several hundred kilometres.

The distribution of the night parrot is very poorly understood. The small number of confirmed or verifiable records prevents the population size from being assessed with any accuracy; however, the population size is speculatively estimated to consist of approximately 50 breeding birds that occur in five subpopulations. The largest of these subpopulations is estimated, with low reliability, to consist of 20 breeding birds (Garnett & Crowley, 2000).

6.5.2 Previous Records

The distribution of the night parrot is very poorly understood in Western Australia; however, the Study Area occurs within the species' potential distribution, as currently mapped by DoEE (2019b). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east,

adjacent to the Cloudbreak mine (FMG, 2021) (Table 6.9). This record currently represents the most recent documented record of the species in Western Australia and was the first to provide evidence of the night parrot persisting in suitable habitat areas adjacent to active mining operations. This follows on from an earlier record in the same area of three individuals sighted at dusk in Mulga woodland near a permanent water soak in 2005 (Davis & Metcalf, 2008) (Table 6.9). That site is heavily degraded from cattle and lacks understory within a larger area; however, larger patches of old-growth *Triodia* grasslands occur in the vicinity along the peripherals of the Fortescue Marsh and chenopod shrublands occur throughout the marsh itself. Another recent record, Kanyirninpa Jukurrpa rangers recorded night parrot calls at two locations on Martu country in 2020 (Michelmore & Birch, 2020).

The night parrot is assumed to be able to travel large distances (up to 100 km per night or more) between roosting habitat and foraging habitat (Night Parrot Recovery Team, 2017). Any night parrots occurring near the Cloudbreak mine (Davis & Metcalf, 2008; FMG, 2021) could potentially use the Study Area as only 50 km separates these two areas. It should also be noted that the night parrot is especially cryptic and rare in occurrence and therefore difficult to record so the records to date may underestimate the occurrence of the species.

Table 6.9: Previous records of night parrot within Western Australia

Location	Date of Observation	Source	Distance from Study Area	Recorded Habitat Type	Other Comments
Minga Well, south of Cloudbreak mine site	12/04/2005	Davis and Metcalf (2008)	~50 km north-east	Mulga woodland. No understorey	Permanent water soak. 3 individuals observed at dusk in a targeted survey
Adjacent to Cloudbreak Mine	~2021 (exact date not given)	(FMG, 2021)	~50 km north-east	Not noted but located near Fortescue Marsh	Adjacent to mining operations
Moojarri Well	~2005 (exact date not noted)	Biota (2005b)	~44 km north north-east	Not noted	Unconfirmed Biota record between Fortescue Marsh and FMG Stage B Rail Corridor
Vacant crown land	15/07/1970	DBCA (2022a)	Undisclosed location	Spinifex grassland (Spinifex and scattered gums) Crest/summit.	Four individuals observed
Martu country (Great Sandy and Little Sandy Deserts)	~2020 (exact date not provided)	Michelmore and Birch (2020)	Undisclosed location	Salt lake system	Acoustic recording
Matuwa (Lorna Glen)	24/11/2009 05/12/2009	Hamilton *et al.* (2017)	~450 km south-east	Lake system-native and introduced grasses, samphire,	One individual each night

Location	Date of Observation	Source	Distance from Study Area	Recorded Habitat Type	Other Comments
				sedges, chenopods. Thick *Eremophila*, Mulga and grasses	
East Murchison	March 2017	Night Parrot Recovery Team (2017), Jackett *et al.* (2017)	Undisclosed location	Spinifex hummock grassland on sandy substrate, encompassed by mulga woodland and a breakaway, separated from the *Triodia* by an open plain of samphire	Living individuals and an active nest

6.5.3 Survey Methods

Acoustic Recorders

Song Meter (SM; Wildlife Acoustics Inc.) acoustic recorders were deployed at 36 sites during the field survey within habitat considered the most appropriate (Table 6.10, Figure 6.9). In an effort to target night parrot, acoustic recorders were deployed in habitat that best meets the description of potential roosting and nesting habitat as recommended by DPaW (2017), stands of large old-growth spinifex (*Triodia* spp.), often 50 years unburn, often forming mosaics with chenopods shrublands. Song Meters were deployed for between one and 20 consecutive nights each, for a total of 371 recording nights. Sampling at 31 of the locations met the recommended sampling period of six consecutive nights (DPaW, 2017). Acoustic recordings were analysed for night parrot calls by specialist Nigel Jackett.

Table 6.10: Night parrot acoustic sampling locations within the Study Area

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-001	Stony Plain	5/04/2022	11/04/2022	6
VCPH-002	Stony Plain	5/04/2022	11/04/2022	6
VCPH-004	Drainage Area/ Floodplain	5/04/2022	11/04/2022	6
VCPH-005	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-006	Stony Plain	5/04/2022	11/04/2022	6
VCPH-007	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-008	Drainage Area/ Floodplain	5/04/2022	11/04/2022	6
VCPH-009	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-011	Stony Plain	5/04/2022	11/04/2022	6
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	6
VCPH-021	Drainage Area/ Floodplain	6/04/2022	13/04/2022	7
VCPH-024	Stony Plain	7/04/2022	13/04/2022	6
VCPH-065	Stony Plain	11/04/2022	1/05/2022	20
VCPH-066	Stony Plain	11/04/2022	1/05/2022	20
VCPH-067	Stony Plain	11/04/2022	1/05/2022	20
VCPH-068	Stony Plain	11/04/2022	1/05/2022	20
VCPH-069	Stony Plain	11/04/2022	1/05/2022	20

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-070	Mulga Woodland	11/04/2022	1/05/2022	20
VCPH-074	Stony Plain	11/04/2022	13/04/2022	2
VCPH-075	Stony Plain	11/04/2022	30/04/2022	19
VCPH-076	Hillcrest/ Hillslope	11/04/2022	1/05/2022	20
VCPH-077	Drainage Area/ Floodplain	11/04/2022	1/05/2022	20
VCPH-080	Hillcrest/ Hillslope	12/04/2022	13/04/2022	1
VCPH-081	Gorge/ Gully	12/04/2022	30/04/2022	18
VCPH-082	Hillcrest/ Hillslope	30/04/2022	6/05/2022	6
VCPH-175	Stony Plain	6/05/2022	26/05/2022	20
VPIH-007	Stony Plain	13/11/2021	24/11/2021	11
VPIH-008	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-010	Stony Plain	13/11/2021	24/11/2021	11
VPIH-011	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-012	Hardpan Plain	24/11/2021	26/11/2021	2
VPIH-013	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-014	Stony Plain	13/11/2021	24/11/2021	11
VPIH-019	Stony Plain	23/11/2021	26/11/2021	3
VPIH-026	Stony Plain	25/11/2021	26/11/2021	1
Total				**371**

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1039
MS1072

Legend

Study Area
Approval Boundary
Local Road
State Road
Rail

Sampling Method

Acoustic Recorder (36)

N

biologic Environmental Survey

Scale: 1:220,000
0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022

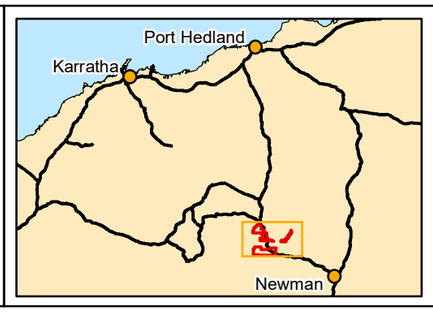

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Figure 6.9: Night parrot sampling locations in the Study Area

6.5.4 Survey Results

Acoustic Recorders

No night parrots were recorded during the current survey from the 371 recording nights at 35 acoustic recording sites. Sampling resulted in a total of 678 non-target records, comprising 37 bird species.

6.5.5 Discussion

No evidence of occurrence of night parrot was recorded within the Study Area during the current survey, including from targeted acoustic recorders deployed in areas of habitat considered possibly suitable for the species. Habitat within the Study Area was considered marginal for the species, as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for the species; however, the occurrence of these habitats is often small in size with no connectivity to other areas of suitable nesting and/or foraging habitat within or in the vicinity of the Study Area. These instances occur within Stony Plain (35.51%, 2,1051.0 ha) and Drainage Area/ Floodplain 16.27% (9,644.57 ha) habitats of the Study Area. Additionally, there is a lack of neighbouring ephemeral freshwater sources and foraging habitat (i.e. succulent chenopod shrubs). This type of foraging habitat is widespread at the Fortescue Marsh, which is located near the recent night parrot record approximately 50 km to the north-east of the Study Area.

Little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, and thus the extent of which the Study Area may still provide habitat for the species is unknown. Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

6.6 Grey Falcon (*Falco hypoleucos*)

6.6.1 Species Profile

The grey falcon is listed as Vulnerable under the EPBC Act and BC Act and are widely distributed over the northern parts of Australia's arid and semi-arid zone (Mullin *et al.*, 2020). Climate characteristics appear to play a crucial role in this species' distribution (Schoenjahn *et al.*, 2019), perhaps because these birds rely on low levels of relative humidity for efficient evaporative cooling (Schoenjahn *et al.*, 2022). Recent estimates suggest the grey falcon comprises a single, widely distributed interbreeding population (although there may be weak population structure between breeding grounds in the east and west of Australia) with around 1,415 females (Mullin *et al.*, 2020). The Pilbara is thought to potentially be a stronghold of the grey falcon (Sutton, 2010).

Grey falcons do not appear to be associated with particular vegetation types (Schoenjahn *et al.*, 2019); they often sit motionless in the canopies of trees or dead branches of eucalypts (Falkenberg, 2010). The species tends to prefer sparsely-treed, open plains and creek lines for hunting (Olsen & Olsen, 1986).

Breeding takes place between mid to late winter and the end of spring (i.e. June to November) (Schoenjahn *et al.*, 2019). Breeding habitat for this species has been observed to be riparian habitat as well as other productive 'oases' within an arid environment, though not necessarily immediately adjacent to waterholes (Sutton, 2010). Nesting often occurs in the abandoned nest of a raptor or corvid in trees or tall infrastructure such as power line towers or communications towers (Olsen & Olsen, 1986; Schoenjahn *et al.*, 2019). Within the Pilbara, grey falcon nests (made using disused stick nests of crows) were observed in two riparian eucalypts (*Eucalyptus coolabah* and *E. camaldulensis*; 23 km apart) on a dry river bed (Sutton, 2010). Ten years later, the area had a lot of scrubby regrowth and the grey falcons were absent (Sutton, 2010). Above-average rainfall in the first half of the year may encourage breeding if summer rainfall triggers growth of seed grasses which in turn increases abundance of granivorous birds which the species prey on (Sutton, 2010).

Grey falcons have an almost exclusive diet of birds (e.g. budgerigars (*Melopsittacus undulatus*), pigeons, doves and zebra finches (*Taeniopygia guttata*)) but can, under unusual circumstances, include non-avian foods (e.g. small mammals) (Schoenjahn, 2013). Whether grey falcons scavenge carrion at all has been disputed, although they do have a tendency to consume their prey on the ground, sometimes by the side of roads and tracks (Schoenjahn, 2018).

Modelling by Runge *et al.* (2014) estimated the minimum range size for this species as 882,558 km^2. Recent research has shown that the grey falcon is a 'reluctant nomad'; only if conditions become a risk to their survival are they likely to move on and then, when they do, they move no further than necessary (Schoenjahn, 2018). The grey falcon tends to stay and forego breeding rather than search for more favourable conditions (Schoenjahn, 2018). In general, this species tends to keep physical activity levels lows (Schoenjahn *et al.*, 2022).

6.6.2 Previous Records

Ten records of grey falcon within 50 km of the Study Area were identified in the desktop assessment (Figure 6.10) (BHP, 2022; DBCA, 2022b). The most proximate record of the species to the Study Area includes a 2004 record of an individual observed in the Packsaddle range, just outside the Study Area (Ecologia, 2004b), multiple of observations of an individual foraging from the same day located approximately 0.8–1.7 km north of Mudlark Well of in 2008 (DBCA, 2022b; ENV, 2008a) and a record of two birds observed approximately 0.5 km south of Mudlark Well in 1997 (Ecologia, 1998c). All remaining records from the desktop assessment are located to the north of the Study Area and are no closer than 27 km.

6.6.3 Survey Methods

Targeted Searching

A total of 60 targeted searches were undertaken within the Study Area that included concurrent searching for grey falcon, undertaken within Major Drainage Line, Minor Drainage Line, Gorge/ Gully and Breakaway/ Cliff habitats (Table 6.11; Figure 6.11). Searches focused on observing active individuals and/or secondary evidence such as nests, feathers or eggs. A total of 180.7 person hours of targeted searches were undertaken within the Study Area (Table 6.11). Opportunistic searches for grey falcon were also undertaken whilst undertaking sampling for other target species and traversing the Study Area.

Table 6.11: Targeted searches completed for grey falcon within the Study Area

Transect ID	Date	Habitat	Person Hours
TPIH-02	12/11/2021	Gorge/ Gully	3
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-041	9/04/2022	Medium Drainage Line	1.5
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4

Transect ID	Date	Habitat	Person Hours
TCPH-081	12/04/2022	Gorge/ Gully	4
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-091	4/05/2022	Medium Drainage Line	3
TCPH-166	4/05/2022	Medium Drainage Line	2
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5
TCPH-020	28/05/2022	Major Drainage Line	4
Total			**180.76**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Wunjina Rd
Karijini Dr
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Desktop Assessment Area
- Approval Boundary
- State Road
- Rail

BHP (2022)
Sampling Type
- Individual (alive)

DBCA (2022)
Sampling Type
- Individual (alive)
- Unknown

N

biologic Environmental Survey

Scale: 1:700,000
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Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022

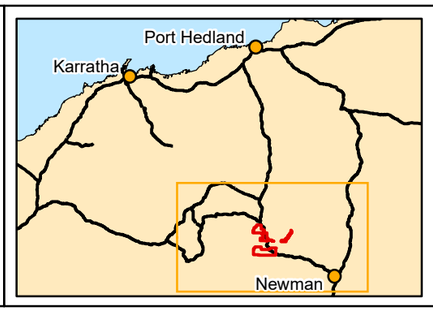

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Figure 6.10: Previous grey falcon records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
MS1039
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (57)

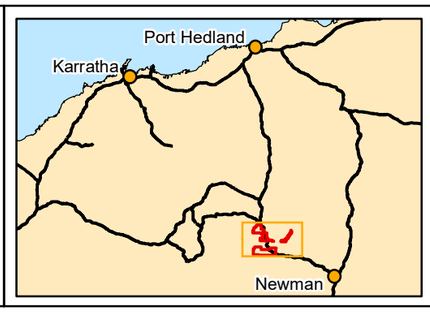
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.11: Grey falcon sampling locations and habitat in the Study Area

6.6.4 Survey Results

No grey falcon or evidence of the species' occurrence was recorded within the Study Area during the 180.7 person hours of targeted searches undertaken at 60 sites during the current survey.

6.6.5 Discussion

Although the Study Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur (DoE, 2022c), no grey falcons or evidence of their occurrence was recorded during the current survey. However, this species has been previously recorded near the Study Area on multiple occasions (DBCA, 2022b; Ecologia, 1998c, 2004b; ENV, 2008a) (Figure 6.10).

The Study Area contains habitat considered critical habitat for grey falcon, primarily within Major Drainage Line Habitat (62.4 ha, 0.11%), and to a lesser extent the Medium Drainage Line habitat (362.20 ha, 0.61%), which provide potential breeding (in the form of mature eucalypts present), foraging, and dispersal habitat for the species. The Stony Plain (2,1051.0 ha, 35.51%), Hillcrest/ Hillslope (1,4162.4 ha, 23.89 %) and Drainage Area/Floodplain (9,644.57 ha, 16.27%) habitat, may also provide supporting habitat for the species.

The grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020) and the Pilbara thought to be a stronghold (Sutton, 2010). Thus, any grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. The species' occurrence within the Study Area is likely to be dependent on the proximity of nesting habitat such as mature eucalypts and infrastructure such as communication and powerline towers, which are present in parts of the Study Area associated with existing mining operations and/or infrastructure projects. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

6.7 Pilbara Olive Python (*Liasis olivaceus* subsp. *barroni*)

6.7.1 Species Profile

The Pilbara olive python is listed as Vulnerable under the EPBC Act and the BC Act. The species is Western Australia's largest snake, averaging 2.5 metres (m), with records up to 4.5 m (Bush & Maryan, 2011; Cogger, 2014). The species has a dull olive-brown upper surface and is pale cream below (Burbidge, 2004; Cogger, 2014). This species is endemic to the Pilbara and northern parts of the Gascoyne bioregions, distributed from Burrup Peninsula, Ord Ranges and Meentheena south to Nanutarra and Newman in the Pilbara, with an isolated population occurring at Mt Augustus in the Gascoyne region (Bush & Maryan, 2011; Storr *et al.*, 2002).

This species is primarily nocturnal and tends to shelter amongst rocky habitats, in small caves or under vegetation during the day. During summer months they will emerge from daytime shelters soon after dark and continue to move until the early hours of the morning (DSEWPaC, 2011b). In the winter months, the species is primarily nocturnal, although adult pythons can sometimes be found basking in the morning sun (DSEWPaC, 2011b). The breeding season of the Pilbara olive python takes place in the cooler months, which extends from June to August and males will travel up three kilometres in search of a mate (DSEWPaC, 2011b). The species is a well-adapted opportunistic ambush predator and common prey items include rock-wallabies, small euros, fruit bats, waterbirds, doves/pigeons and is also likely to include instances of northern quoll and other small mammals (Ellis, 2013; Ellis & Johnstone, 2016; Pearson, 2007; Pearson, 2003; TSSC, 2008a).

The species commonly inhabits moist areas such as gorges, rivers, pools and surrounding hills, but can be found in a range of habitats (Burbidge, 2004; DSEWPaC, 2011b). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). The species is likely to be attracted to these areas due to the productivity and abundance of suitably-sized prey (Pearson, 2003).

6.7.2 Previous Records

The Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d). Pilbara olive pythons are known to occur across the Pilbara bioregion, particularly within the Hamersley subregion, and are most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). The desktop assessment returned 64 records of the species, including on four occasions within the Study Area (Figure 6.12) (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008).

Within the Study Area, the most recent record was a scat within Gorge/ Gully habitat of Pineapple Hill (Biologic, 2019), where it was thought to occur as a resident based on the presence of critical habitat likely to support the species. Additionally, a dead individual was previously located within Gorge/ Gully habitat at Area C in 2008 (Outback Ecology, 2008) and a live individual within Major Drainage Line at Area C West in 2011 Biologic (2013a). A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area.

6.7.1 Survey Methods

Targeted Searching

Diurnal searches for the Pilbara olive python were conducted along 70 transects within suitable habitat during the field survey (Figure 6.13; Table 6.12). Searches focused on observing active individuals and/or secondary evidence such as scats, sloughs or remains. A total of approximately 193 person hours of targeted diurnal searches and eight person hours of nocturnal searches were undertaken within the Study Area (Table 6.12).

Table 6.12: Targeted searches completed for Pilbara olive python within the Study Area

Transect Name	Date	Habitat	Diurnal Searches (Person hours)	Nocturnal Searches (Person hours)
TPIH-02	12/11/2021	Gorge/ Gully	3	-
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5	-
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5	-
VPIH-013	13/11/201	Drainage Area/ Floodplain	-	2
VPIH-015	23/11/2021	Gorge/ Gully	-	2
VCPH-020	28/05/2022	Gorge/ Gully	-	4
TPIH-09	23/11/2021	Gorge/ Gully	2	-
TPIH-18	24/11/2021	Major Drainage Line	3	-
TPIH-20	25/11/2021	Gorge/ Gully	5	-
TPIH-21	25/11/2021	Gorge/ Gully	1	-
TPIH-05	26/11/2021	Gorge/ Gully	0.66	-
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5	-
TCPH-022	6/04/2022	Major Drainage Line	6	-
TCPH-023	6/04/2022	Major Drainage Line	3	-
TCPH-025	7/04/2022	Gorge/ Gully	3	-
TCPH-026	8/04/2022	Breakaway/ Cliff	4	-
TCPH-035	8/04/2022	Breakaway/ Cliff	1	-
TCPH-027	8/04/2022	Gorge/ Gully	3	-
TCPH-003	8/04/2022	Major Drainage Line	4	-
TCPH-046	9/04/2022	Gorge/ Gully	1	-
TCPH-041	9/04/2022	Medium Drainage Line	1.5	-
TCPH-042	10/04/2022	Gorge/ Gully	6	-
TCPH-051	10/04/2022	Gorge/ Gully	1.5	-
TCPH-052	10/04/2022	Gorge/ Gully	4	-
TCPH-056	10/04/2022	Gorge/ Gully	4	-
TCPH-063	10/04/2022	Gorge/ Gully	4	-
TCPH-081	12/04/2022	Gorge/ Gully	4	-
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1	-
TCPH-086	28/04/2022	Breakaway/ Cliff	5	-
TCPH-085	28/04/2022	Gorge/ Gully	2	-
TCPH-089	29/04/2022	Gorge/ Gully	1.5	-
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1	-
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1	-
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1	-

Transect Name	Date	Habitat	Diurnal Searches (Person hours)	Nocturnal Searches (Person hours)
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2	-
TCPH-081	30/04/2022	Gorge/ Gully	3	-
TCPH-095	30/04/2022	Gorge/ Gully	6	-
TCPH-100	30/04/2022	Gorge/ Gully	5	-
TCPH-117	1/05/2022	Gorge/ Gully	4	-
TCPH-123	1/05/2022	Gorge/ Gully	1.2	-
TCPH-125	1/05/2022	Gorge/ Gully	1	-
TCPH-127	1/05/2022	Gorge/ Gully	2	-
TCPH-140	1/05/2022	Gorge/ Gully	2	-
TCPH-130	2/05/2022	Gorge/ Gully	1	-
TCPH-132	2/05/2022	Gorge/ Gully	2.5	-
TCPH-133	2/05/2022	Gorge/ Gully	2	-
TCPH-109	2/05/2022	Major Drainage Line	2	-
TCPH-140	3/05/2022	Gorge/ Gully	9	-
TCPH-145	3/05/2022	Gorge/ Gully	2	-
TCPH-149	3/05/2022	Gorge/ Gully	4	-
TCPH-153	3/05/2022	Gorge/ Gully	2	-
TCPH-160	4/05/2022	Gorge/ Gully	4.5	-
TCPH-170	4/05/2022	Gorge/ Gully	2	-
TCPH-091	4/05/2022	Medium Drainage Line	3	-
TCPH-166	4/05/2022	Medium Drainage Line	2	-
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5	-
TCPH-128	5/05/2022	Gorge/ Gully	4	-
TCPH-129	5/05/2022	Gorge/ Gully	2	-
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1	-
TCPH-180	26/05/2022	Breakaway/ Cliff	1	-
TCPH-181	26/05/2022	Breakaway/ Cliff	2	-
TCPH-185	26/05/2022	Gorge/ Gully	4	-
TCPH-189	27/05/2022	Breakaway/ Cliff	2	-
TCPH-197	27/05/2022	Breakaway/ Cliff	2	-
TCPH-198	27/05/2022	Breakaway/ Cliff	2	-
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4	-
TCPH-193	27/05/2022	Gorge/ Gully	4	-
TCPH-195	27/05/2022	Gorge/ Gully	1.5	-
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1	-
TCPH-209	28/05/2022	Gorge/ Gully	3	-
TCPH-229	28/05/2022	Gorge/ Gully	5.5	-
TCPH-020	28/05/2022	Major Drainage Line	4	-
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5	-
Total			**193.26**	**8**

600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd
Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Karijini Dr
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Desktop Assessment Area
- Approval Boundary
- State Road
- Rail

BHP (2022)
Sampling Type
- Camera Trap
- Scat
- Unknown

DBCA (2022)
Sampling Type
- Individual (alive)
- Individual (dead)

- Secondary Evidence
- Specimen
- Unknown

N

biologic Environmental Survey

Scale: 1:700,000

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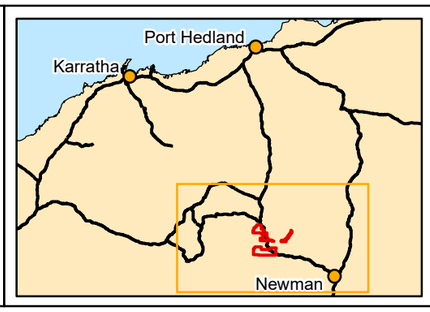
Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.12: Previous Pilbara olive python records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
Packsaddle Rd
West Angelas Rd
Great Northern Hwy
MS1039
MS1072

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Nocturnal Search (3)
- Targeted Search (70)

Record

Pilbara olive python - VU

- Individual (dead) (1)

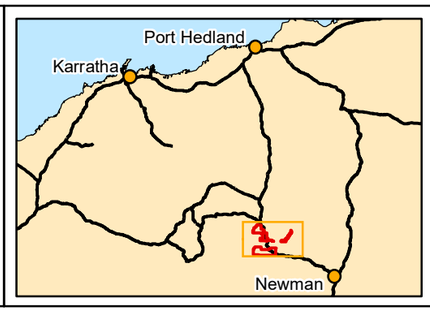
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.13: Pilbara olive python sampling locations, records and habitat in the Study Area

6.7.2 Survey Results

Targeted Searching

No Pilbara olive python or evidence of the species' occurrence was recorded within the Study Area during approximately 201 person hours of diurnal and nocturnal targeted searches during the current survey. However, one deceased individual was recorded approximately 2.1 km outside of the boundary of the Study Area, to the southeast of the Camp Hill area on the 27th March 2022 (Figure 6.13).

6.7.3 Discussion

Although the Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d), no Pilbara olive pythons were recorded within the Study Area . However, Pilbara olive python are a cryptic species and can be difficult to detect through targeted searches alone. Additionally, the current survey was partially undertaken during the cooler months when the species is less active, and this could have affected the results. A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area. Critical habitat likely to support the species occurs within Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats of the Study Area. Furthermore the Pilbara olive python has been previously recorded within the Study Area on four occasions (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008), indicating that the Study Area is utilised by the species.

The Pilbara olive python is regularly encountered in the vicinity of rocky habitats (i.e. Gorge/ Gully and Breakaway/ Cliff habitats) and drainage systems (i.e. Major Drainage Lines), particularly areas with permanent and/ or semi-permanent water features (DSEWPaC, 2011b; Pearson, 1993). Gorge/ Gully habitat (2.64% 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha) and Major Drainage Line (0.09%, 54.94 ha) provide critical potential breeding and dispersal/ foraging habitat for the species within the Study Area (Figure 6.13).

Although not considered critical habitat, Medium Drainage Line habitat (0.61%, 362.20 ha) still provides supporting breeding and foraging habitat for this species within the Study Area, particularly in areas where these habitats provide connectivity between areas of critical (i.e. Gorge/ Gully) habitat, as well as areas prone to pooling and ponding (Figure 5.1). Minor Drainage Line habitat may also be supporting habitat to the species in areas that are prone to pooling and ponding, particularly following large rainfall events, and providing dispersal corridors throughout the landscape (Figure 5.1). The Pilbara olive python may occur throughout the Study Area in these habitats, particularly where they facilitate connectivity between critical habitats.

A total of six water features were recorded in the Study Area, located within Major Drainage Line and Gorge/ Gully habitat (as well as Drainage Area/ Floodplain associated with a cattle watering point: WPIN-01). For Pilbara olive pythons in particular, these water features can often act as critical foraging locations and for that reason the species is more often than not, associated with such features, particularly within rocky habitats, but also, to a lesser degree within Major Drainage Line and Medium Drainage Line habitats where suitable vegetation cover is present (Pearson, 1993). WPIN-01 is not

located near critical habitat (the closest supporting habitat is Medium Drainage Line habitat, 500 m away) and is therefore unlikely to provide good habitat for Pilbara olive pythons.

Although no evidence of the Pilbara olive python was found within the Study Area during the current survey, it is likely that a population occurs within the Study Area based on previous records within and in the vicinity of the Study Area and the presence of critical breeding and foraging habitat. This population, if present, would be considered an 'important population' as defined by DoE (2013).

6.8 Other Fauna of Significance

One non-target species of significance was identified during the current survey: the Western pebble-mound mouse (*Pseudomys chapmani*).

Western pebble-mound mouse

Western pebble mound mouse has previously been recorded on 3053 occasions within 50 km of the Study Area; 311 of these records were within the Study Area. The species has most frequently been associated with undulating lower slopes and foot slopes within the Study Area (Onshore & Biologic, 2011), with records indicating the species occurs as a resident throughout a large portion of the Study Area.

During the current survey, western pebble-mound mouse was recorded a total of 137 times from secondary evidence (pebble-mounds), comprising 70 active mounds, 20 recently inactive mounds, 46 inactive mounds and one inactive burrow (Appendix F; Figure 6.14).

660000
680000
700000
720000
7480000
7460000
Great Northern Hwy
MS1039
MS1072
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Nil

Significant Species

Western pebble-mound mouse (P4)

- Mound (active) (70)
- Mound (inactive) (47)
- Mound (recently inactive) (20)

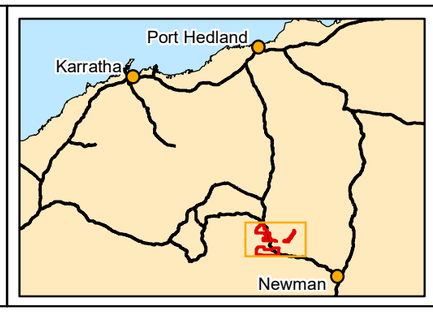
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.14: Other significant species records and habitat in the Study Area during the current survey

6.9 Constraints and Limitations

The (EPA, 2020b) outlines several potential limitations to vertebrate fauna surveys. These aspects are assessed and discussed in Table 6.13 below. No major limitations or constraints were identified for the survey.

Table 6.13: Survey constraints and limitations

Potential limitation or constraint	Constraint	Applicability to this survey
Sources/availability of data and information (recent or historic) and availability of contextual information	No	A significant amount of survey work has been undertaken within the Study Area and in the surrounding region, and most of these previous survey results were available for review.
Competency/ experience of the survey team	No	The field personnel involved in the survey are experienced in undertaking fauna surveys of similar nature, including with the significant species targeted during the survey. Technical personnel with relevant expertise assisted with analysis of ultrasonic recordings (Bob Bullen) and analysis of acoustic recordings (Nigel Jackett).
Scope (faunal groups sampled and whether any constraints affect this)	No	The scope was a targeted fauna survey and was conducted within that framework (EPA, 2020b).
		Northern quoll –The species was sampled following survey guidelines in relation to survey design and effort, site coverage, and detectability (DoE, 2016). A total of 21 camera trap transects were set during this assessment (resulting in 1,503 sampling nights). Targeted searches were undertaken for secondary evidence (e.g., scats).
		Greater bilby – Sampling consisted of targeted greater bilby plots and opportunistic records.
		Pilbara leaf-nosed bat – Sampling consisted of ultrasonic recorders (802 sampling nights) and targeted searches for roosts. Ultrasonic detectors were placed at significant habitat areas including water features where possible.
		Ghost bat – Sampling consisted of ultrasonic recorders (802 sampling nights) and targeted searches for potential roosts. Ultrasonic recorders were placed at significant habitat areas (i.e. water features and/or likely foraging/ dispersal habitats). Ultrasonic recorders are not always successful in capturing present ghost bats; however, this method was supplemented with targeted searches for roosts and any associated secondary evidence.
		Night parrot – Sampling consisted of acoustic recorders at 35 locations containing the best habitat present within the Study Area, resulting in 371 sampling nights. The recorders were deployed for a minimum of six nights at 31 of the locations in accordance with the night parrot survey guidelines (DPaW, 2017). The acoustic detectors range is only ~300 metres (DPaW, 2017), but due to the limited night parrot habitat present within the area, it is considered adequate coverage. Conditions during the recording period was generally good, with limited rain and low winds whilst recorders were deployed.
		Pilbara olive python – Targeted diurnal and nocturnal searches were undertaken in potential habitat for active individuals, scats, and water features likely to support the species.

Potential limitation or constraint	Constraint	Applicability to this survey
Timing, weather, and season	Partial	Field surveys occurred over appropriate or optimal periods for sampling the target species, with the exception of the Pilbara olive python. Most of the targeted searches for this species were undertaken during the cooler months when the species is less active, and this could have affected the results. No other weather or seasonality constraints or limitations were identified during the surveys.
Disturbances (e.g., fire or flood)	No	Disturbances in the Study Area included past frequent fire, access tracks, weed invasion, cattle grazing and mining exploration. However, no temporary disturbance impinged on the results of this assessment.
Proportion of fauna identified	No	All fauna observed during the field surveys were identified to species level. Species identification of fauna recorded via camera traps and Song Meter ultrasonic recorders were able to be accurately identified with the assistance of technical personnel with relevant expertise.
Adequacy of the survey intensity and proportion of the survey achieved	No	A targeted survey was undertaken across the Study Area to assist with decisions on future environmental approvals. The sampling methods and survey intensity was high and focussed on the species of interest.
Remoteness or access issues	No	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used in these areas during this survey were unconstrained by accessibility or remoteness.
Problems with data and analysis, including sampling bias	No	No limitations with data collection and/or analysis were encountered during the field survey or during subsequent analysis.

7 CONCLUSION

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on MNES species. The targeted MNES species for the survey comprised the northern quoll, greater bilby, Pilbara leaf-nosed bat, ghost bat, night parrot, grey falcon and Pilbara olive python.

7.1 Northern Quoll

The species has previously been recorded within the Study Area, however, previous records of northern quolls in the Study Area are scarce and around a decade old (Biologic, 2011e, 2013d; Onshore & Biologic, 2011). In addition, no northern quolls or evidence of their occurrence was recorded during the current survey. Similarly, two previous targeted northern quoll surveys located within 5 km of the Study Area also recorded no evidence of the species (Biota, 2009, 2014a). However, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area. These results suggest that northern quolls may be present in very low densities, or present only intermittently as a result of individuals moving from areas outside the Study Area. This is supported by the lack of records in the desktop assessment relative to the number of surveys completed in the area.

Critical habitat for the northern quoll, as defined by DoE (2016), includes rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species (Figure 5.1; Figure 6.2). Supporting habitat for the northern quoll is provided by Minor Drainage Line and Medium Drainage Line habitat, where proximal to breeding habitat. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, this species is considered highly likely to occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale. Furthermore, the Study Area is unlikely to contain a ‘population important for the long-term survival of the species’, as defined by the DoE (2013, 2016).

7.2 Greater Bilby

No evidence of greater bilby was recorded within the Study Area during the current survey. Although the Study Area is located within the western extent of the current distribution of the greater bilby, where the species or species’ habitat is likely to occur (DoE, 2022e), there are limited previous records of the species occurrence within or surrounding the Study Area (Figure 6.3). One previous record of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given that it is situated on a stony hill, which does not provide habitat.

Critical habitat for the species does not occur within the Study Area, with only marginal habitat occurring in Drainage Area/ Floodplain habitat where patches of sandy substrate occur. However, it is unlikely the species occurs in the Study Area due to the limited extent, and relative isolation, of habitat to other areas of suitable habitat as well as a lack of contemporary records. Therefore, the Study Area is unlikely to support an ‘important population’ as defined by DoE (2013).

7.3 Pilbara Leaf-nosed Bat

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey from 15 individual calls, located within Gorge/ Gully, Breakaway/ Cliff and Hillcrest/ Hillslope habitats. No evidence of a Pilbara leaf-nosed diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except for three which had no usage.

The Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat (Habitat Rating 4 (very high) as defined by (Bat Call, 2021b)). Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species (Habitat Rating 2 (low) as defined by (Bat Call, 2021b)). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. Given no roosting by the species has been recorded within or in the vicinity of the Study Area, habitats occurring are likely to only provide supporting foraging and/or dispersal habitat for the species.

The entire Pilbara represents one interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022), meeting the requirements of an 'important population' as defined by DoE (2013). Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by (Bat Call, 2021b). Given the absence of a critical roost within, or in the immediate vicinity of, the Study Area, it is unlikely that the Study Area represents a significant area for this species.

7.4 Ghost Bat

Ghost bat was recorded on 33 nights at four locations within the Study Area during the current survey. Previous records of the species within and surrounding the Study Area are extensive, with a total of 559 occurring within 50 km of the Study Area, including 115 records within the Study Area and a further 459 within 12 km (BHP, 2022; DBCA, 2022b).

Within the Study Area, critical foraging habitat is provided by Stony Plain, Drainage Area/ Floodplain, Mulga Woodland, Minor Drainage Line, Medium Drainage Line, and Major Drainage Line when proximal (>12 km) to roosting caves. Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered 'important' as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area and would be

used by ghost bats that use other High Value Caves at South Flank detailed in Biologic (*in prep.*). CMUD-01 has shown presence of pregnant females across seven (out of eight) years of monitoring, making it the most consistently used cave by pregnant females monitored in the MS1072 Fauna Management Plan program (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *in prep.-a*, *in prep.-b),* indicating that CMUD-01 is a potential maternity roost. Elevated progesterone levels were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, *in prep.*). CMUD-10 has also demonstrated presence of pregnant females during six (out of eight) of the monitoring years (Biologic, *in prep.*). Furthermore, critical foraging habitat exists across the entire extent of the Study Area and this foraging habitat would likely be used by ghost bats from other High Value Caves at South Flank detailed in Biologic (*in prep.*).

7.5 Night Parrot

No evidence of night parrot was recorded within the Study Area during the current survey, despite targeted sampling involving Song Meter acoustic recorders, as outlined in DPaW (2017). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east, adjacent to the Cloudbreak Mine (FMG, 2021).

Little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, and thus the extent of which the Study Area may still provide habitat for the species is unknown. However, habitat within the Study Area was considered marginal for the species, as per the survey guidelines (DPaW, 2017), as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for night parrot. On occasion suitable habitat did occur; however, the occurrences of these habitats was often small in size with no connectivity to other areas of suitable nesting and/or foraging habitat within or in the vicinity of the Study Area. These instances occur within Stony Plain (35.51%, 2,1051.0 ha) and Drainage Area/ Floodplain 16.27% (9,644.57 ha) habitats of the Study Area.

Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

7.6 Grey Falcon

No evidence of grey falcon was recorded within the Study Area during this assessment. Although the Study Area falls within the current distribution of the grey falcon, whereby the species or species habitat may occur (DoEE, 2019a), there are limited records of the species within or surrounding the Study Area (Table 3.2; Appendix A; Appendix B). The Study Area contains habitat considered critical habitat for grey falcon and includes the Major Drainage Line Habitat (62.4 ha, 0.11%) and to a lesser extent the Medium Drainage Line habitat (362.20 ha, 0.61%) as these habitats provide potential breeding (in presence of mature eucalypts), foraging, and dispersal habitat for the species.

As the grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020), grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given

the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

7.7 Pilbara Olive Python

No evidence of Pilbara olive python was recorded within the Study Area during this assessment, despite 193.26 hours of targeted searches. However, one record of a deceased (roadkill) individual was recorded just outside the Study Area boundary on 27th March 2022. The Study Area falls within the current distribution of the Pilbara olive python, whereby the species or species habitat is likely to occur (DoE, 2022d). Pilbara olive python has been previously recorded in the Study Area four times (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008). Critical habitat for the Pilbara olive python occurs within the Study Area, and includes Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats (Figure 6.13).

Although no evidence of the Pilbara olive python was recorded within the Study Area during the current survey, the species is notably cryptic and it is likely that a breeding population occurs within the Study Area based on the proximity of previous records and the presence of critical breeding and foraging habitat. Therefore, this population, if present, would be considered an ‘important population’ as defined by DoE (2013) supported by critical habitat within the Study Area.

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9 APPENDICES

Appendix A – Summary of Literature Review

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
1. Biologic (2019)	Project: Pineapple Hill Detailed Vertebrate Fauna Survey. 10216 Client: BHP Survey date: Phase 1: 26th April – 6th May 2019 Phase 2: 28th August – 9th September 2019 Survey type: Two phase Detailed survey Experience: Senior Zoologist x 4 Ecologist	Within Study Area	• Active searching • Targeted searches • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal Surveys • Bat echolocation recording • Acoustic recording • Motion sensitive cameras • Cave assessments • Remotely piloted aircraft searches • Opportunistic observations • Secondary evidence	• Stony Plain • Drainage Area/Floodplain • Hillcrest/slope • Gorge/gully • Major drainage line • Mulga Woodland • Minor drainage line	129 vertebrate species • 19 native mammals • 4 introduced mammals • 73 birds • 33 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
2. Ecologia (1998a)	Project: Mining Area C Biological Survey. 336 Client: BHP Survey date: 14th – 30th April 1997 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x 4 Research assistant	Within Study Area	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Medium drainage line • Gorge/gully • Hillcrest/slope • Mulga woodland • Acacia shrubland	143 vertebrate species • 17 native mammals • 4 introduced mammals • 78 birds • 43 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation and motion sensitive camera use.
3. ENV (2010a)	Project: Area C West NVCP Flora, Vegetation and Fauna Assessment. 374 Client: BHP Survey date: 22nd – 31st March 2010 15th August – 4th September 2007 Survey type: 2010 - Basic fauna assessment 2007 – Detailed fauna survey Experience: Senior biologist x2 Biologist x2 Field assistant	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Avifauna census • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Breakaway • Stony plain • Alluvial plain	2007 113 vertebrate species • 18 native mammals • 0 introduced mammals • 72 birds • 32 reptiles • 1 amphibian 2010 72 vertebrate species • 9 native mammals • 0 introduced mammals • 46 birds • 17 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
4. Onshore and Biologic (2011)	Project: Camp Hill Exploration Leases Level 2 Flora & Vegetation Survey and Level 1 Fauna Assessment. 381 Client: BHP Survey date: 2nd – 15th August 2010 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	Within Study Area	• Active searching • Targeted transects • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Medium drainage area • Gorge/gully • Hillcrest/slope • Basalt plain • Sand/ stony plain	89 vertebrate species • 13 native mammals • 4 introduced mammals • 60 birds • 12 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Cooler temperatures and continuing dry conditions may have inhibited reptile and amphibian activity.
5. Biota (2013a)	Project: Area C West to Yandi level 2 Vertebrate Fauna Survey. 1070 Client: BHP Survey date: Phase 1: 25th May – 2nd June 2011 Phase 2: 7th – 15th September 2011 Phase 3: 5th – 8th February 2012 Survey type: Three Phase Detailed fauna survey Experience: Senior Zoologist Zoologist Ecologist	Within Study Area	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gullies • Stony and Loamy Plains • Major Creeks • Minor Creeks • Hillcrest/slopes calcrete Plain • Mulga Plain	172 vertebrate species • 24 native mammals • 4 introduced mammals • 84 birds • 57 reptiles • 3 amphibians	Threatened: • Pilbara leaf-nosed bat (Rhinonicteris aurantia) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Common greenshank (*Tringa nebularia*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	No motion sensitive cameras.
6. Biologic (2013a)	Project: Area C West Vertebrate Fauna Survey. 1086 Client: BHP Survey date: Phase 1: 18th April – 1st May; 8th – 21st May 2011 Phase 2: 12th – 25th September; 3rd – 14th October 2011 Nocturnal survey: 19th – 22nd January 2012 Survey type: Two phase Detailed baseline fauna surveys Experience: Principal Zoologist/ecologist x2 Senior Zoologist x 4 Zoologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Motion sensitive cameras • Bat echolocation recording • Avifauna census • Nocturnal survey • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope • Sandy/stony plain • Basalt Gilgi rocky plain	213 vertebrate species • 26 native mammals • 5 introduced mammals • 100 birds • 79 reptiles • 3 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Northern short-tailed mouse (*Leggadina lakedownensis*) Migratory: • Wood sandpiper (*Tringa glareola*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
7. Ecologia (2004b)	Project: Packsaddle Range Biological Survey. 357 Client:	Within Study Area	• Active searching • Avifauna census • Bat echolocation recording	• Medium drainage line • Gorge/gully • Mulga woodland • Eucalypt woodland	88 vertebrate species • 10 native mammals • 1 introduced mammals	Threatened: • Grey falcon (*Falco hypoleucos*) Priority:	No trapping or motion sensitive camera use.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	BHP Survey date: 5th - 10th May 2004 Survey type: Basic fauna survey Experience: Senior Zoologist Herpetologist Zoologist Research assistant		• Opportunistic observations • Secondary evidence	• Valley plain	• 56 birds • 20 reptiles • 0 amphibian	• Western pebble-mound mouse (*Pseudomys chapmani*)	
8. ENV (2008b)	Project: Area C West Fauna Assessment. 372 Client: BHP Survey date: 15th August – 4th September 2007 Survey type: Detailed fauna survey Experience: N/A	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Breakaway • Stony plain	126 vertebrate species • 17 native mammals • 2 introduced mammals • 72 birds • 34 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
9. Biologic (2013d)	Project: Mudlark Vertebrate Fauna Survey. 1080 Client: BHP Survey date: Phase 1: 12th – 19th May and 31st May – 11th June 2011 Phase 2: 6th – 15th October 2011 and 18th – 28th May 2012 Phase 3: 19th – 22nd January 2012 Survey type: Three phase Detailed fauna survey Experience: Senior Zoologist x5 Principle Zoologist x2 Zoologist	Within Study Area	• Active searching • Targeted searches • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal Surveys • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Hillcrest/slope • Gorge/gully • Major drainage line • Stony Plain • Mulga12	178 vertebrate species • 21 native mammals • 4 introduced mammals • 80 birds • 70 reptiles • 3 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
10. ENV (2009a)	Project: Munjina and Ministers North (Yandi Hub) Fauna Assessment. 423 Client: BHP Survey date: 21st November – 2nd December 2007 Survey type: Detailed fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x4 Taxonomist	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations Secondary evidence	• Minor Drainage Line • Gorge/gully • Hillcrest/slope • Riverine • Breakaway • Alluvial Plain	134 vertebrate species • 15 native mammals • 6 introduced mammals • 66 birds • 45 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Fires just prior to the field survey reduced survey efforts in the Minister's North site.
11. Biologic (2011a)	Project: Area C and Surrounds Vertebrate Fauna Survey. 1008 Client: BHP Survey date: Phase 1: 5th – 18th October 2009 Phase 2: 20th March – 1st May 2010 Survey type: Two phase Detailed survey Experience: Principal Zoologist Senior Zoologist x 3 Herpetologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Hair traps • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope • Calcrete plain • Sandplain	166 vertebrate species • 22 native mammals • 4 introduced mammals • 76 birds • 60 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Peregrine falcon (*Falco peregrinus*) • Pilbara barking gecko (*Underwoodisaurus seorsus*)	
12. Biologic (2017)	Project: Ministers North level 2 vertebrate fauna survey. 10082 Client: BHP Survey date: Phase 1: 15th – 26th October 2016 Phase 2: 3rd – 13th April 2017 Survey type: Two phase Detailed survey Experience: Principal Zoologist Senior Zoologist x 3	Within Study Area	• Active searching • Targeted transects • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal surveys • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope	119 vertebrate species • 15 native mammals • 2 introduced mammals • 54 birds • 45 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Heavy rainfall during stage two survey resulted in site access issues and three sites (1,2,7) were changed (bringing the total number of sites to 10).

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
13. Biologic (2011e)	Project: Southern Flank Vertebrate Fauna Study. 1021 Client: BHP Survey date: Phase 1: 7th – 19th April 2010 Phase 2: 23rd August – 4th September 2010 Survey type: Two Phase Detailed fauna survey Experience: Principal Zoologist Principal Ecologist Senior Zoologist x 2 Herpetologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Motion sensitive cameras • Hair traps • Bat echolocation recording • Nocturnal surveys • Avifauna census • Opportunistic observations • Secondary evidence	• Major drainage line • Mulga • Gorge/gully • Hillcrest/slope • Stony plain • Sandy areas • Coolabah-Lignum	161 vertebrate species • 26 native mammals • 7 introduced mammals • 68 birds • 58 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) • Pilbara barking gecko (*Underwoodisaurus seorsus*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
14. Ecologia (2004a)	Project: Area C: Deposits D, E and F Biological Survey. 348 Client: BHP Survey date: 28th May – 7th June 2004 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x 4 Biologist Research assistant	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott • Avifauna census • Nocturnal surveys • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Mulga woodland • Mallee woodland	104 vertebrate species • 16 native mammals • 1 introduced mammals • 55 birds • 32 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
15. Outback Ecology (2010)	Project: Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey. 366 Client: BHP Survey date: Phase 1: 20th October – 1st November 2008 Phase 2: 5th – 29th March 2009 Recon: 8th – 12th October 2008 Survey type: Two Phase Detailed fauna survey and reconnaissance survey Experience: Senior Zoologist Zoologist x6 Biologist	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Targeted survey • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Drainage Line • Gorge/gully • Hillcrest/slope • Riverine • Sand and Stony Plain • Alluvial Plain • Mulga Woodland	204 vertebrate species • 20 native mammals • 6 introduced mammals • 95 birds • 76 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) Migratory: • Eastern osprey (*Pandion haliaetus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
16. Outback Ecology (2008)	Project: Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment. 344 Client: BHP Survey date: 17th – 31st March 2008 Survey type: Detailed Fauna survey Experience: Zoologist x 3	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal survey • Avifauna census • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope	100 vertebrate species • 8 native mammals • 3 introduced mammals • 61 birds • 26 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
17. Ecologia (2008b)	Project: Marillana Creek (Yandi) Iron Ore Mine Modification. 122 Client: Kellogg, Brown and Root Pty Ltd Survey date: 19th - 30th March 2008 Survey type: Single phase, Detailed survey Experience: Senior Zoologist Zoologist x3	Within Study Area	• Systematic trapping – pitfall, Elliott, cage, funnel • Active searching • Targeted searching • Avifauna census • Bat echolocation recording • Nocturnal survey • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillslope • Stony Plain • Creek Line • Outwash and Valley Plain	116 vertebrate species • 16 native mammals • 3 introduced mammals • 60 birds • 37 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Single phase survey. Reduced ANABAT usage due to rain.
18. Biologic (2010)	Project: East Packsaddle Level 1 Vertebrate Fauna Study. 350 Client: BHP Survey date: Phase 1: 5th – 18th October 2009 Phase 2: 20th March – 1st April 2009 Survey type: Two Phase targeted fauna survey Experience: Senior Zoologist x3 Principal Zoologist Herpetologist	Within Study Area	• Active searching • Targeted searching – transects • Trapping – not specified • Hair trap • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Mulga Association • Gorge/gully • Hillcrest/slope • Major Drainage Line • Drainage Area • Valley and Calcrete Plain • Sandplain	110 vertebrate species • 17 native mammals • 2 introduced mammals • 48 birds • 39 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Eastern osprey (*Pandion haliaetus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
19. Biota (2010)	Project: Yandicoogina Junction South West and Oxbow Fauna Survey. 1187 Client: RITO Survey date: 5th – 12th July 2008 Survey type: Detailed fauna survey Experience: Principal Zoologist Senior Zoologist Zoologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Hillcrest/slope • Stony plain and valley floors • Rocky breakaways and screes	72 vertebrate species • 10 native mammals • 2 introduced mammals • 46 birds • 14 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Single season survey. Sections of site inaccessible by car however, fauna habitats surrounding still representative of the area as a whole. No nocturnal surveys.
20. Astron (2019)	Project: Hope Downs 2 Proposal Fauna Survey March 2019 Client: RITO Survey date: Phase 1: 21 November to 2 December 2017 Phase 2: 18 to 27 May 2018 Phase 3: 8 to 18 March 2019 Survey type: Detailed fauna survey Experience: All technical survey personnel have over five years of experience conducting Level 2 vertebrate fauna surveys	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Motion sensitive cameras • Bat echolocation recording • Night parrot survey • Targeted searches • Nocturnal spotlighting	• Minor drainage line • Gorge/gully • Breakaway • Rocky hill • Low hill and slopes • Alluvial plain • Mulga woodland • Stony plain	174 vertebrate species • 26 native mammals • 7 introduced mammals • 84 birds • 55 reptiles • 2 amphibians	Threatened: • Northern quoll (*Dasyurus hallucatus*) • Ghost bat (*Macroderma gigas*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Rainfall in the three months preceding Phase 2 and Phase 3 was below average, this led to potentially dry unfavorable conditions for vertebrate fauna sampling.
21. Biota (2009)	Project: Yandicoogina Targeted Northern Quoll survey Client: RITO Survey date: 6th – 12th October 2009 Survey type: Targeted fauna survey Experience: Unknown	<1km	• Active searching • Targeted searching – transects			None	
22. Biologic (2018)	Project: Ministers North to Yandi Corridor Two Phase Targeted Fauna Survey. 10140 Client: BHP	<1km	• Active searching • Targeted searching – transects • Trapping – small and large Elliott • Avifauna census	• Basalt Outcrop • Breakaway/Cliff • Gorge/gully • Hillcrest/slope • Minor Drainage Line • Major Drainage Line	94 vertebrate species • 15 native mammals • 2 introduced mammals • 54 birds • 23 reptiles • 0 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected:	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Survey date: Phase 1: 9th – 13th October 2017 Phase 2: 15th – 23rd June 2018 Survey type: Two Phase targeted fauna survey Experience: Senior Zoologist x3 Zoologist		• Bat echolocation recording • Acoustic recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Drainage Area/ Floodplain		• Peregrine falcon (*Falco peregrinus*)	
23. Ecologia (2005b)	Project: Mudlark Well Exploration Project Biological Survey. 421 Client: BHP Survey date: 18th – 23rd August 2005 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x2	<1km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Medium drainage area • Gorge/gully • Hillcrest/slope • Sand/ stony plain	56 vertebrate species • 7 native mammals • 1 introduced mammals • 30 birds • 19 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No nocturnal surveying undertaken due to low temperatures.
24. Ecologia (2006c)	Project: Ministers North Biological Survey. Client: BHP Survey date: 10th – 14th May 2006 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	<1km	• Active searching • Avifauna census • Bat echolocation recording • Night survey • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope	71 vertebrate species • 10 native mammals • 0 introduced mammals • 42 birds • 18 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No trapping done.
25. Astron (2010)	Project: West Packsaddle Flora and Fauna Assessment Client: BHP Survey date: 10th – 19th April 2010 Survey type: Basic fauna survey Experience: Principal Zoologist	<1km	• Active searching • Targeted transects • Avifauna census • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Gorge/gully • Rocky ridges and cliff faces	87 vertebrate species • 13 native mammals • 0 introduced mammals • 60 birds • 14 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern brushtail possum (*Trichosurus vulpecula arnhemensis*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
26. ENV (2008a)	Project: Area C Southern Flank Deposit Fauna Assessment. Client: BHP Survey date: 30th January – 6th February 2007 Survey type: Basic fauna survey Experience: Senior zoologist Zoologist	<1km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Alluvial plain	100 vertebrate species • 13 native mammals • 4 introduced mammals • 56 birds • 23 reptiles • 4 amphibians	Threatened: • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
27. ecologia (1999)	Project: West Angelas Iron Ore Project Mine Access Road Corridor Vertebrate Fauna Assessment Survey Client: Robe River Mining Company Survey date: 3rd – 9th August 1999 Survey type: Basic fauna survey Experience: Senior Zoologist x3 Zoologist Ecologist	1.7km	• Active searching • Trapping – pitfall, Elliott • Nocturnal surveys • Mist netting • Avifauna census • Opportunistic observations • Secondary evidence	• Mulga steppe • mulga grassland • eucalypt steppe	82 vertebrate species • 8 native mammals • 1 introduced mammals • 51 birds • 22 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
28. 360 Environmental (2017)	Project: Upper Marillana and Munjina Baseline Vertebrate Fauna survey. 10084 Client: BHP Survey date: 30th March – 9th April 2017 Survey type: Detailed survey Experience: Unknown	1.8km	• Systematic trapping – pitfall, Elliott, funnel, cage • Active searching • Avifauna census • Motion sensitive cameras • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Mulga Woodland • Drainage Line • Hill Crest/ Slope • Stony Plain	126 vertebrate species • 15 native mammals • 4 introduced mammals • 77 birds • 28 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
29. HGM (1999)	Project: Marillana Creek Western Access Corridor - Biological Assessment. Client: BHP Survey date: 23rd – 30th April 1999 Survey type: Opportunistic fauna survey Experience: Unknown	2.1km	• Active searching • Opportunistic observations • Secondary evidence	• Minor drainage line • Riverine • Alluvial plains • Hillcrest/slope • Mulga woodland	50 vertebrate species • 5 native mammals • 1 introduced mammals • 42 birds • 1 reptile • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Opportunistic survey only.
30. Ecologia (2008a)	Project: Area A and Additional Areas Level 2 Terrestrial Fauna Survey. Client: United Minerals Corporation Survey date: Phase 1: 22nd May – 3rd June 2008 Phase 2: 29th September – 10th October 2008 Survey type: Two Phase Detailed fauna survey Experience: Senior Zoologist Zoologist x 4	3.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Nocturnal surveys • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Degraded Mulga Woodland • Spinifex Plain • Spinifex Hillslope • Mulga woodland • Acacia Shrubland • Cracking Clay	135 vertebrate species • 19 native mammals • 3 introduced mammals • 70 birds • 41 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
31. ENV (2007a)	Project: Area C R-Deposit Fauna Assessment. 349 Client: BHP Survey date: 22nd – 27th November 2006 Survey type: Detailed fauna survey Experience: Senior Biologist/Ornithologist Ornithologist Herpetologist Biologist Taxonomist	3.5km	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Ridges/range crests • Riverine areas • breakaways • flood plains/ valley plains	183 vertebrate species • 28 native mammals • 0 introduced mammals • 89 birds • 64 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	Fire swept through sampling sites on the 24th of November, damaging traps, reducing site access and reducing length of survey time.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
32. Bamford Consulting (2012b)	Project: Vertebrate Fauna Assessment of the Iron Valley Project Area. Client: Iron Ore Holdings Ltd. Survey date: Phase 1: 9th – 19th May 2011 Phase 2: 29th – 30th September 2011 Survey type: Two phase Detailed targeted fauna survey Experience: Senior Zoologist x3 Zoologist x8	~5km	• Active searching • Targeted searching • Elliott trapping • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Alluvial and Flood Plain • Rocky Hillcrest/Slopes • Drainage Line • Stony Plain	97 vertebrate species • 11 native mammals • 2 introduced mammals • 58 birds • 25 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
33. Biota (2014b)	Project: Yandi Billiards Targeted Northern Quoll Survey Client: RTIO Survey date: 5th – 13th August 2014 Survey type: Targeted fauna survey Experience: Zoologist x2	~5km	• Targeted searching • Systematic trapping – cage and large Elliott • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations Secondary evidence	• Alluvial and Flood Plain • Hillcrest/Slopes • Major Drainage Line • Minor Drainage Line • Cave/Overhang	10 vertebrate species • 5 native mammals • 1 introduced mammals • 3 birds • 1 reptile • 0 amphibians		Unconfirmed northern quoll scat found (Molecular results inconclusive)
34. Ecologia (1998c)	Project: West Angelas Iron Ore Project Vertebrate Fauna Assessment Survey. Client: Robe River Mining Company Survey date: Phase 1: 10th June – 10th July 1997 Phase Two: 18th – 3rd October 1997 Survey type: Two phase Detailed fauna survey Experience: Not listed	5.6km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope/ridges • Major creek line • Valley floor/Outwash valley • Mulga woodland • Eucalyptus woodland • Acacia shrubland • Spinifex steppe	West Angelas mine area: 119 vertebrate species • 19 native mammals • 2 introduced mammals • 70 birds • 27 reptiles • 1 amphibian Rail Corridor: 195 vertebrate species • 19 native mammals • 4 introduced mammals • 108 birds • 60 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Pre bat echolocation and motion sensitive cameras

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
35. Ecologia (1997)	Project: Hope Downs Biological Survey. Client: Hancock Prospecting Pty Ltd. Survey date: Phase 1: 18th August – 10th September 1993 Phase Two: 19th – 30th April 1994 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist Zoologist x4 Research assistant	6.6km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Avifauna census • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope/ridges • Major creek lines • outwash plains/ valley plains	158 vertebrate species • 20 native mammals • 4 introduced mammals • 88 birds • 45 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation and motion sensitive cameras
36. Ecologia (2014)	Project: Greater West Angelas Terrestrial Fauna Assessment. Client: RTIO Survey date: Phase 1: 26th September – 6th October 2012 Phase Two: 18th – 27th March 2013 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist Zoologist x4 Research assistant	7km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Nocturnal surveys • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Gorge/gully • Hillcrest/slope/ridges • Mixed Acacia woodland • Mesa top • Cracking clay • Foot slope or plain	169 vertebrate species • 23 native mammals • 2 introduced mammals • 80 birds • 64 reptiles • 0 amphibians	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Pilbara barking gecko (*Underwoodisaurus seorsus*)	
37. Ecologia (1998b)	Project: Weeli Wolli Creek Biological Assessment Survey. 101 Client: BHP Survey date: 9th – 16th August 1999 Survey type: Detailed fauna survey Experience: Senior Zoologist x2 Zoologist x3 Ecologist	8.2km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Colluvial Flats • Melaleuca Forest • Creek Line • Acacia Thicket • Calcrete Gully • Shrub Steppe	135 vertebrate species • 14 native mammals • 3 introduced mammals • 85 birds • 30 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation use and motion sensitive cameras.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
38. Biologic (2011f)	Project: Yandi Vertebrate Fauna Review. Client: BHP Survey date: 9th - 17th December 2010 Survey type: Basic survey and Targeted Experience: Senior Ecologist Senior Zoologist	8.3km	• Targeted searching – transects and caves • Active searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Mulga Woodland • Major Drainage Line • Hill Crests and Slopes • Boulder Piles • Sandplain	75 vertebrate species • 7 native mammals • 1 introduced mammal • 53 birds • 12 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
39. Biota (2012d)	Project: South Flank to Jinidi Level 2 Fauna Survey. 1093 Client: BHP Survey date: Phase 1:11th – 20th April 2011 Phase 2: 2nd – 11th November 2011 Phase 3: 31st January – 3rd February 2012 Survey type: Three Phase Detailed fauna survey Experience: Senior Zoologist x3 Zoologist x8	8.6km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Hilly Areas • Calcrete Plain • Creeks with shrubland/hummock grasslands • Mulga Plains • Stony/Loamy Plains • Major Creeks • Gorge and Breakaway	173 vertebrate species • 24 native mammals • 2 introduced mammals • 79 birds • 63 reptiles • 5 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Parts of the study area were inaccessible by vehicle and were surveyed on foot only.
40. Integrated Environmental (1980)	Project: An Ecological Appreciation of the West Angelas Environment, Western Australia 1979. Client: Cliffs International Inc. Survey date: 1978/79 Survey type: Detailed fauna surveys Experience: Senior Ecologist Zoologist	8.7km	• Active searching • Systematic trapping – pitfall, funnel, Elliott and break back traps • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Major drainage line • Gorge/gully • Hillcrest/slope/ridges • Mulga woodland • Eucalyptus woodland • Stony plain	125 vertebrate species • 18 native mammals • 3 introduced mammals • 64 birds • 48 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Grey falcon (*Falco hypoleucos*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Western pebble-mound mouse (*Pseudomys chapmani*) first described from this survey.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
41. Maunsell and Bamford Consulting (2003)	Project: Yandi Life of Mine Fauna and Flora Client: BHP Survey date: 23rd - 28th September 2003 Survey type: Basic survey Experience: Ecologist x2	8.9km	• Opportunistic observations • Nocturnal surveys • Bat echolocation recording	• Creek Line • Low Hills and mesas • Mulga Woodland • Major Drainage Line	80 vertebrate species • 2 native mammals • 2 introduced mammal • 69 birds • 7 reptiles • 0 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
42. Ecologia (2004c)	Project: Yandi Overland Conveyor and Stockyard Fauna and Flora Assessment. Client: BHP Survey date: 18th-19th October 2004 Survey type: Flora survey with fauna desktop survey Experience: Biologist	9.2km	• Opportunistic observations	• Creek Line • Drainage Line • Acacia shrubland • Rocky hillslope	• 1 native mammal	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Survey conducted to target rare and priority flora and weed species with opportunistic fauna sighting recorded only, no active fauna field component. Three active pebble mounds were recorded in the Yandi Stockyard survey area.
43. Biota (2005a)	Project: Fauna Habitats and Fauna Assemblage of Deposits E and F at West Angelas Survey. Client: Robe River Iron Associates Survey date: 4th – 12th May 2004 Survey type: Detailed fauna survey Experience: Zoologist x3 Ecologist x1	9.4km	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Broad colluvial valleys dominated by Acacia • Hillcrest/slope • Stony plain and valley floors • Incised gullies and creeks	98 vertebrate species • 12 native mammals • 2 introduced mammals • 47 birds • 37 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No motion sensitive cameras.
44. Biologic (2012)	Project: Jinidi to Mainline Vertebrate Fauna Survey. 1065 Client: BHP Survey date: Phase 1: 28th March – 10th April 2011 Phase 2: 22nd August- 3rd September 2011 Survey type: Two phase Detailed fauna survey	9.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations	• Gorge/gully • Hillcrest/slope • Drainage Area • Dune • Sandplain • Grassland • Mulga • Major Drainage Line	197 vertebrate species • 27 native mammals • 4 introduced mammals • 89 birds • 73 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Experience: Zoologists		• Secondary Evidence				
45. Biologic (2013e)	Project: Targeted conservation significant fauna survey- Karijini tenement E47/17. Client: BHP Survey date: 17th- 25th June 2013 Survey type: Basic targeted fauna assessment Experience: Senior Zoologist x 5	9.8km	• Active searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Major drainage line • Drainage area • Gorge/gully • Hillcrest/slope • Stony plain	23 vertebrate species • 6 native mammals • 0 introduced mammals • 13 birds • 4 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Four days of rainfall and lower than long-term average temperatures disrupted survey period.
46. Bamford Consulting (2012a)	Project: Fauna Assessment Nyidinghu Iron Ore Project. Client: Fortescue Metals Group Ltd. Survey date: Phase 1: 7th – 17th April 2011 Phase 2: 16th – 24th June 2011 Survey type: Two phase Detailed fauna assessment Experience: Senior Zoologist x2 Zoologist x8	~10km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Avifauna census • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Alluvial and Flood Plain • Creekline • Rocky Hillcrest/Slopes • Drainage Line • Stony Plain	110 vertebrate species • 6 native mammals • 1 introduced mammals • 56 birds • 45 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	
47. Biota (2014a)	Project: Yandi Billiards Phase 1 Seasonal Fauna Survey. Client: RTIO Survey date: Phase 1: 8th – 18th March 2014 Survey type: Two Phase Detailed fauna survey Experience: Zoologist #	~10km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Audio recordings for birds and amphibians • Opportunistic observations Secondary evidence	• Alluvial Plain • Floodplain • Hillcrest/Slopes • Major Drainage Line • Minor Alluvial Fans • Mulga Woodlands • Pediment Slope	155 vertebrate species • 19 native mammals • 2 introduced mammals • 78 birds • 54 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Brush-tailed mulgara (*Dasycercus blythi*) Migratory: • Fork-tailed swift (*Apus pacificus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
48. Ecologia (1995)	Project: Yandi Stage II Iron Ore Project: Biological Assessment Survey. Client: BHP Survey date: 14th May – 8th June 1995 Survey type: Single phase Detailed survey Experience: Senior Zoologist x 2 Zoologist Research Assistant Field Assistant	10.1km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Riverine • Drainage Gully • Colluvial Flat • Outwash Flat • Scree Slope • Mesa Top	154 vertebrate species • 16 native mammals • 4 introduced mammals • 81 birds • 47 reptiles • 3 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specialy protected: • Peregrine falcon (*Falco peregrinus*)	No cage or funnel trapping. Pre bat echolocation recording.
49. ENV (2010b)	Project: Jinayri Access Road Vertebrate Fauna Survey. 499 Client: BHP Survey date: 20th – 30th May 2009 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x3 Field assistant	10.8km	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Avifauna census • Nocturnal survey • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Gorge • Hill Top • Scree Slope • Minor Drainage Line • Breakaway • Alluvial Plain • Riverine	92 vertebrate species • 12 native mammals • 3 introduced mammals • 47 birds • 28 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
50. Biologic (2011c)	Project: Barimunya Camp Vertebrate Fauna Survey. Client: BHP Survey date: 29th April 2011 Survey type: Basic baseline fauna survey Experience: Senior Ecologist Zoologist	11.9km	• Active searching • Targeted searching • Opportunistic observations • Secondary Evidence	• Drainage Line • Alluvial Slope • Hillcrest/slope	21 vertebrate species • 1 native mammals • 0 introduced mammal • 17 birds • 3 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
51. Phoenix (2014)	Project: Terrestrial Fauna Survey for the Extension Project. Client: AAMC Survey date: 27th March - 5th April 2014 Survey type: Basic survey Experience: Unknown	13km	• Active searching • Targeted searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary Evidence	• Hummock and Tussock Grassland • Open and Closed Shrubland • Hillcrest and Slopes • Minor Creek and Drainage Line • Gorge/Gullies	78 vertebrate species • 10 native mammals • 4 introduced mammals • 32 birds • 29 reptiles • 3 amphibians	Threatened: • Pilbara leaf-nosed bat (Rhinonicteris aurantia) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
52. Ecologia (2006b)	Project: Marillana Terrestrial Vertebrate Fauna Survey. 408 Client: Brockman Resources Ltd. Survey date: Phase 1: 2nd – 9th October 2005 Phase 2: 10th – 17th March 2006 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x3 Zoologist	13.5km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Ridge Top and Scree Slope • Minor Drainage Gully • Stony Plain • Alluvial Plain • Mesa Top	118 vertebrate species • 18 native mammals • 2 introduced mammals • 56 birds • 42 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Access restriction phase one. Reduced reptile activity due to rain during phase two.
53. Biologic (2013c)	Project: Marillana Vertebrate Fauna Survey. 1077 Client: BHP Survey date: Phase 1: 7th – 20th March 2011 Phase 2: 1st – 14th August 2011 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist x4 Principal Zoologist Herpetologist	13.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Sandy Areas • Sand Dunes • Mulga Woodland • Minor Drainage Line • Major Drainage Line	175 vertebrate species • 25 native mammals • 5 introduced mammal • 77 birds • 66 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) • Northern quoll (Dasyurus hallucatus) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
54. ENV (2008c)	Project: Jinayri Vertebrate Fauna Assessment. 1010 Client: BHP Survey date: 5th – 18th March 2008 Survey type: Detailed survey Experience: Zoologist(s)	13.8km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Gorge • Breakaways • Alluvial Plains • Hill Top • Scree Slope	153 vertebrate species • 22 native mammals • 5 introduced mammals • 65 birds • 60 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	
55. Biota (2013b)	Project: South Parmelia Vertebrate Fauna Survey. 1224 Client: BHP Survey date: Phase 1: 11th – 20th April 2011 Phase 2: 2nd – 11th November 2011 Nocturnal Survey: 1st – 4th February 2012 Survey type: Twp phase Detailed fauna survey Experience: Senior Zoologist x4 Zoologist x7	14.7km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Undulating Low Hills • Flood and Colluvial Plains • Minor Drainage • Rocky Gorges/gullies • Calcrete Plains • Major Drainage Line	138 vertebrate species • 20 native mammals • 1 introduced mammals • 71 birds • 43 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
56. Biologic (2011b)	Project: Area C to Yandi Fauna Survey. Client: BHP Survey date: 13th – 20th September 2011 Survey type: Basic fauna survey Experience: Senior Zoologist Principle Zoologist	~15km	• Active searching • Targeted searching – transects • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Minor Drainage Line • Major Drainage Line • Valley	74 vertebrate species • 13 native mammals • 3 introduced mammals • 47 birds • 10 reptiles • 1 amphibian	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
57. Ecologia (2005c)	Project: Upper Marillana Exploration Project Biological Survey. 115 Client: BHP Survey date: 13th – 20th April 2005 Survey type: Basic survey Experience: Senior Zoologist Zoologist x2	15km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Stony Plain • Low Ridge Line • Mulga Sandplain • Drainage Line	69 vertebrate species • 11 native mammals • 5 introduced mammals • 37 birds • 16 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Ghost bat recorded adjacent to Study Area at Marillana Creek waterhole.
58. ENV (2007d)	Project: Upper Marillana Exploration Lease Fauna Assessment. Client: BHP Survey date: 5th – 11th May 2007 Survey type: Basic fauna survey Experience: Ornithologist Taxonomist Biologist	15.8km	• Active searching • Bat echolocation recording • Avifauna census • Nocturnal survey • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillcrest/slope • Sand Plain • Flood Plain	118 vertebrate species • 14 native mammals • 5 introduced mammals • 79 birds • 18 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No motion sensitive cameras used.
59. Ecologia (2006a)	Project: Jirridi Terrestrial Vertebrate Fauna Survey. 497 Client: BHP Survey date: Phase 1: 17th – 31st October 2005 Phase 2: 27th March – 5th April 2006 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x 3 Zoologist x3	16.4km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Ridge top and Scree Slope • Minor Drainage Gully • Stony Plain • Alluvial Plain • Rocky Scree Slope • Mesa Top	142 vertebrate species • 18 native mammals • 4 introduced mammals • 70 birds • 48 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
60. ENV (2011)	Project: Upper Marillana and Munjina Flora, Vegetation and Fauna Assessment. Client: BHP Survey date: 31st August – 10th September 2010 Survey type: Basic fauna survey Experience: Senior Zoologist Ornithologist Zoologist Biologist	17.7km	• Active searching • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillcrest/slope • Riverine • Stony Plain • Alluvial Plain	134 vertebrate species • 2 native mammals • 4 introduced mammals • 35 birds • 5 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No trapping, bat echolocation recording, or motion sensitive cameras used.
61. ENV (2010c)	Project: Jinayri Mining Lease Vertebrate Fauna Survey. Client: BHP Survey date: 5th – 18th March 2008 Survey type: Detailed survey Experience: Senior Zoologist Zoologist x3 Ornithologist x2 Biologist Field Assistant x3	18.9km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Breakaways • Alluvial Plains • Hillcrest/slope	149 vertebrate species • 22 native mammals • 4 introduced mammals • 65 birds • 57 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	
62. Biota (2005c)	Project: Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas. 1242 Client: FMG Survey date: Phase 1: 20th March – 7th April 2004 Phase 2: 21st June – 16th July 2004 Survey type: Twp phase Detailed fauna survey Experience: Zoologist x7	18.9km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Low Hills • Stony Plains • Minor creekline and Floodplains • Mulga Wooldlands • Sandy Plains • Cracking Clays • Colluvial Fans	175 vertebrate species • 20 native mammals • 6 introduced mammals • 105 birds • 42 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
63. Biota (2012b)	Project: Koodaideri Project Targeted Fauna Survey. Client: RTIO Survey date: 19th – 27th July 2011 Survey type: Detailed targeted fauna survey Experience: Senior Zoologist Zoologist x3	~20km	• Active searching • Targeted searching • Targeted trapping – medium and large Elliott • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains	16 vertebrate species • 8 native mammals • 2 introduced mammals • 0 birds • 6 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
64. Biota (2012a)	Project: Koodaideri Northern Extension Fauna Survey. Client: RTIO Survey date: 10th – 20th October 2011 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x3	~20km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains • Stony Plain • Calcrete Plain	87 vertebrate species • 15 native mammals • 1 introduced mammals • 31 birds • 40 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
65. Biota (2012c)	Project: Koodaideri Southern Infrastructure Corridor Fauna Survey. Client: RTIO Survey date: Phase 1: 3rd – 13th May 2011 Phase 2: 15th – 25th November 2011 Phase 3: 2nd – 10th May 2012 Survey type: Three phase Detailed fauna survey Experience: Zoologist x12	~20km	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott • Bat echolocation recording • Harp trapping • Avifauna census • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains	166 vertebrate species • 23 native mammals • 4 introduced mammals • 76 birds • 61 reptiles • 2 amphibians	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
66. Rapallo (2012)	Project: Level 2 Fauna Survey and Targeted Northern Quoll Survey of the Lamb Creek. Client: Process Minerals International Pty Ltd. Survey date: Phase 1: 19th – 20th March 2012 Phase 2: 26th – 12th April 2012 Survey type: Two phase Detailed fauna survey Experience: Senior Ecologist Ecologist x5 Field assistant x2	~20km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Harp trapping • Motion sensitive cameras • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/slope • Minor Drainage Line • Alluvial/flood Plain • Stony/sandy Plain	158 vertebrate species • 19 native mammals • 3 introduced mammals • 76 birds • 58 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
67. Biologic (2011d)	Project: Jinidi Vertebrate Fauna Survey. Client: BHP Survey date: 14th - 20th March 2011 6th – 10th April 2011 Survey type: Basic fauna survey Experience: Zoologist x2	21km	• Active searching • Targeted searching – transects • Bat echolocation recording • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Drainage Area • Calcrete Plain • Mulga • Major Drainage Line	92 vertebrate species • 12 native mammals • 3 introduced mammals • 59 birds • 16 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
68. ENV (2008d)	Project: Rapid Growth Project 5: M270SA Fauna Assessment. Client: Calibre Engenium Joint Venture Survey date: 21st, 22nd and 25th May 2008 Survey type: Basic fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x2	21.8km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Rocky Hill • Stony Plain	10 vertebrate species • 1 native mammals • 0 introduced mammal • 6 birds • 3 reptiles • 0 amphibians		No bat echolocation recording or use of motion sensitive cameras

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
69. ENV (2007c)	Project: Mindy North Exploration Lease Fauna Assessment. 411 Client: BHP Survey date: 18th – 24th April 2007 13th -20th April 2007 Survey type: Basic survey Experience: Biologist Ornithologist Taxonomist	23.3km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Riverine • Floodplain • Hillcrest/slope	101 vertebrate species • 6 native mammals • 1 introduced mammal • 57 birds • 37 reptiles • 0 amphibians		Trapping grids were opened within the Coondiner exploration lease, during the same period, to supplement the opportunistic searches.
70. Ecologia (2005a)	Project: Mindy-Coondiner Exploration Project Biological Survey. 413 Client: BHP Survey date: 7th – 11th November 2005 Survey type: Basic survey Experience: Biologist Zoologist	23.6km	• Active searching • Avifauna census • Opportunistic observations • Secondary evidence	• Minor Drainage Gully • Mulga Sandplain	39 vertebrate species • 5 native mammals • 0 introduced mammals • 29 birds • 0 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
71. Ecologia (2009)	Project: Marillana Iron Ore Project Vertebrate Fauna Assessment. Client: Brockman Resources Ltd. Survey date: Phase 1: 25th April – 7th May 2008 Phase 2: 30th August – 10th September 2008 Survey type: Two Phase Detailed survey Experience: Senior Zoologist Zoologist x7	24km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Sandy Spinifex Grassland • Stony Spinifex Plain • Creekline • Longitudinal Sand Dune • Mulga Woodland	152 vertebrate species • 23 native mammals • 4 introduced mammals • 82 birds • 43 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: Fork-tailed swift (*Apus pacificus*)	Potential suitable habitat for night parrots but no acoustic recording equipment used.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
72. Biota (2004)	Project: Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor. Client: FMG Survey date: 20th March – 7th April 2004 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist	27.8km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Stony Plain • Sandy Plain • Mulga Woodland • Drainage Line • Creekline • Hilcrest/slope	178 vertebrate species • 25 native mammals • 5 introduced mammals • 84 birds • 58 reptiles • 6 amphibians	Priority: • Northern short-tailed mouse (*Leggadina lakedownensis*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	Rainfall events during the survey resulted in some trap sites being closed early, and limited access to sites.
73. ENV (2009b)	Project: Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment. Client: Worley Parsons and BHP Survey date: 7th – 16th May 2009 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	33.3km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Riverine • Alluvial Plain • Hillcrest/slope • Stony Plain • Gorge/gully	78 vertebrate species • 8 native mammals • 2 introduced mammal • 59 birds • 9 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
74. Onshore Environmental Consultants and Biologic Environmental Survey (2011).	Project: South Parmelia Exploration Leases. Client: BHP	~35km	• Active searching •	• Medium drainage area •	vertebrate species • 13 native mammals • 4 introduced mammals • 60 birds • 12 reptiles • 0 amphibians		
75. Ninox (2009)	Project: A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Mining Area, Near Newman, Western Australia. 1243 Client: Mattiske Consulting Pty Ltd. Survey date: Phase 1: 6th – 13th May 2008 Phase 2: 12th – 18th September 2008 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x2 Zoologist	39km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Harp trapping • Opportunistic observations • Secondary evidence	• Ridge and Range • Rocky Hill/gully • Creekline • Spinifex with Eucalyptus • Mulga Groves • Stony Plain	112 vertebrate species • 16 native mammals • 1 introduced mammal • 66 birds • 29 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	
76. Biota (2002)	Project:	45.5km	• Active searching • Targeted searching	• Stony Plain • Mulga Woodland • Alluvial Plain	239 vertebrate species • 30 native mammals	Threatened: • Ghost bat (*Macroderma gigas*) • Woma (*Aspidites ramsayi*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey. <u>Client:</u> BHP <u>Survey date:</u> Phase 1: 25th May – 2nd June 2001 Phase 2: 7th – 15th September 2001 Phase 3: 5th – 8th February 2002 <u>Survey type:</u> Three Phase Detailed fauna survey <u>Experience:</u> Senior Zoologist Zoologist		• Systematic trapping – pit, Elliott • Avifauna census • Bat echolocation recording • Harp trapping and Mist netting • Nocturnal surveys • Opportunistic observations • Secondary evidence		• 5 introduced mammals • 125 birds • 73 reptiles • 6 amphibians	• Northern quoll (*Dasyurus hallucatus*) • Greater bilby (*Macrotis lagotis*) <u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*) • Northern short-tailed mouse (*Leggadina lakedownensis*) • Spotted ctenotus (*Ctenotus uber subsp. Johnstonei*) <u>Other specialy protected:</u> • Peregrine falcon (*Falco peregrinus*)	
77. Biota (2008)	<u>Project:</u> Marandoo Mine Phase 2 Seasonal Fauna Survey. <u>Client:</u> RTIO <u>Survey date:</u> Phase 1: 1st – 11th March 2007 and 10th – 15th April 2007 Phase 2: 6th – 12th November 2007 <u>Survey type:</u> Two Phase Detailed fauna survey <u>Experience:</u> Zoologist x7	47.3km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Stony Hillslope • Plain • Rocky Gorge	<u>125 vertebrate species</u> • 17 native mammals • 3 introduced mammals • 54 birds • 48 reptiles • 3 amphibians	<u>Threatened:</u> • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) <u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	Phase 1 broken into two surveys due to rainfall from tropical cyclone. No funnel traps used due to high temperatures.
78. ENV (2007b)	<u>Project:</u> Coondiner and Mindy East Exploration Leases Fauna Assessment. 386 <u>Client:</u> BHP <u>Survey date:</u> 13th – 20th April 2007 <u>Survey type:</u> Detailed fauna survey <u>Experience:</u> Senior Zoologist/Ornithologist Biologist x3 Ornithologist Taxonomist	47.3km	• Active searching • Avifauna census • Systematic trapping – Elliott, cage, funnel, pitfall • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Floodplain • Ridge Crest • Gorge/gully • Breakaway • Scree Slope	<u>125 vertebrate species</u> • 13 native mammals • introduced mammal • 73 birds • 37 reptiles • 1 amphibian	<u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
79. ENV (2008e)	Project: RGP5: Quarry 6 Fauna Assessment. Client: Calibre Engenium Joint Venture Survey date: 24th – 26th May 2008 Survey type: Basic fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x2	48.5km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Plain • Low Rise Floodplain • Cleared/regenerating Area	11 vertebrate species • 0 native mammals • 0 introduced mammal • 9 birds • 2 reptiles • 0 amphibians		
80. Bamford Consulting (2005)	Project: Fauna Survey of Proposed Iron Ore Mine, Cloud Break. 1166 Client: Fortescue Metals Group Ltd. Survey date: Phase 1: 7th – 17th April 2005 Phase 2: 18th – 29th May 2005 Survey type: Two phase Detailed fauna survey and targeted Experience: Senior Zoologist x3 Zoologist x4	49.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Mist netting • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Acacia Woodland • Scattered Eucalypt Woodland • Spinifex and Hummock Grassland • Stony Plain • Rocky hills/slopes • Riverbed/drainage area	153 vertebrate species • 20 native mammals • 5 introduced mammals • 99 birds • 28 reptiles • 1 amphibian	Endangered: • Night parrot (*Pezoporus occidentalis*) Threatened: • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Appendix B – Significant Vertebrate Fauna Recorded in the Desktop Assessment and Field Survey

| Species | | Conservation Status | | | | Database review | | | | | Literature review | | | | |

| Species | | Conservation Status | | | | Database review | | | | | Literature review | | | | |

| Species | | Conservation Status | | | | Literature review | | | |

| Species | | Conservation Status | | | | Literature review | | | |

Appendix C – Vertebrate Fauna Habitat Assessments

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-001	-22.8171	119.1452	05/04/2022	Stony Plain	Stony Plain	South/ West	Low	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-002	-22.9131	118.7276	05/04/2022	Stony Plain	Stony Plain	South/ West	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Eucalypt Woodland	Minor Outcropping	Ironstone	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-003	-22.8510	119.1150	05/04/2022	Major Drainage Line	Gorge	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	1	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-004	-22.8198	118.7462	05/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	North/ West	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-005	-22.8934	119.0668	05/04/2022	Hillcrest/ Hillslope	Stony Plain	Flat	Low	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam Sandy	Few Small Patches	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-006	-22.8686	118.7652	05/04/2022	Stony Plain	Stony Plain	East	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Limited Outcropping	Ironstone	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-007	-22.8299	119.1231	05/04/2022	Hillcrest/ Hillslope	Gully	North	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-008	-22.8881	118.8109	05/04/2022	Drainage Area/ Floodplain	Stony Plain	Sout h/ East	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-009	-22.8654	119.1004	05/04/2022	Hillcrest/ Hillslope	Stony Plain	Nort h/ East	Low	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-010	-22.9030	118.7277	05/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Few Large Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Light Clay	Many Large Patches	Prone to Flooding	0	0.4	Cattle Grazing	Old (6+ yr)		-
VCPH-011	-22.9123	119.0533	05/04/2022	Stony Plain	Stony Plain	Nort h/ West	Low	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Limited Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-012	-22.9133	119.0734	05/04/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible	-	Clay Loam Sandy	Many Small Patches	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-013	-22.8059	119.1424	06/04/2022	Gorge/ Gully	Gully	West	Stee p	Small Rocks (11-20cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcroppin g	Shal e	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-014	-22.8859	119.0830	06/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-015	-22.8345	119.1313	06/04/2022	Major Drainage Line	Drainage Area/ Floodplain	North/ West	Moderate	Boulders (>61cm)	Few Small Patches	Few Large Patches	Eucalypt Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Extensive Outcropping	Ironstone	Light Clay	Few Small Patches	Prone to Pooling	1	0.8	None Discernible	Old (6+ yr)		-
VCPH-016	-22.8847	119.0842	06/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-017	-22.8310	119.1336	06/04/2022	Major Drainage Line	Drainage Area/ Floodplain	East	Moderate	Boulders (>61cm)	Few Small Patches	Few Large Patches	Eucalypt Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Major Outcropping	Ironstone	Light Clay	Few Small Patches	Prone to Pooling	2	0.8	None Discernible	Old (6+ yr)		-
VCPH-018	-22.8685	119.0957	06/04/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-019	-22.8562	119.1166	06/04/2022	Gorge/ Gully	Gorge	South/ West	Steep	Large Rocks (21-60cm)	Scarce	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		Cliff face, water availability in drainage line below.

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-020	-22.8486	119.1111	06/04/2022	Gorge/ Gully	Gorge	Flat	Flat	Boulders (>61cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Permanent	0	1	None Discernible	Old (6+ yr)		-
VCPH-021	-22.8927	118.7977	07/04/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Few Large Patches	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland, Tussock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.6	Cattle Grazing	Old (6+ yr)		-
VCPH-022	-22.8314	119.1311	06/04/2022	Gorge/ Gully	Gorge	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-023	-22.8545	119.1169	06/04/2022	Major Drainage Line	Gorge	Flat	Flat	Large Rocks (21-60cm)	Few Small Patches	Many Large Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		-
VCPH-024	-22.8286	118.7736	07/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-025	-22.8980	119.0722	07/04/2022	Gorge/ Gully	Gorge	West	Steep	Large Rocks (21-60cm)	Scarce	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-026	-22.8116	119.1451	08/04/2022	Gorge/ Gully	Gully	North	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-027	-22.8355	119.1221	08/04/2022	Gorge/ Gully	Gorge	North	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-028	-22.9093	118.8539	08/04/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.6	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-029	-22.8594	118.7656	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-030	-22.8598	118.7705	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-031	-22.8688	118.7579	08/04/2022	Stony Plain	Undulating Low Hills	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-032	-22.8808	118.7486	08/04/2022	Breakaway/ Cliff	Breakaway	West	Steep	Boulders (>61cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-033	-22.8827	118.7487	08/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-034	-22.8842	118.7539	08/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-035	-22.8829	118.7748	08/04/2022	Breakaway/ Cliff	Breakaway	South	Moderate	Large Rocks (21-60cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-036	-22.8819	118.7844	08/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	Weed Invasion	Old (6+ yr)		-
VCPH-037	-22.8856	118.7826	08/04/2022	Hardpan Plain	Drainage Area/ Floodplain	Flat	Flat	Negligible	Evenly Spread	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-038	-22.8850	118.7837	08/04/2022	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Negligible	Many Small Patches	Many Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-039	-22.8844	118.7802	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-040	-22.8822	118.7774	08/04/2022	Hillcrest/ Hillslope	Hillslope	East	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-041	-22.9045	118.7240	09/04/2022	Medium Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Few Large Patches	Permanent	5	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-042	-22.8652	118.7912	09/04/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-043	-22.8472	118.7582	09/04/2022	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-044	-22.8295	118.7704	09/04/2022	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Large Patches	Mulga Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	1	0.6	Weed Invasion	Old (6+ yr)		-
VCPH-045	-22.8194	118.7506	09/04/2022	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Few Small Patches	Prone to Pooling	3	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-046	-22.9220	118.8763	09/04/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	1	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-047	-22.8902	118.7928	09/04/2022	Hardpan Plain	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Scarce	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-048	-22.8916	118.7871	09/04/2022	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Negligible	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-049	-22.9116	118.8386	09/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-

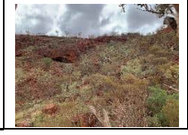
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-050	-22.9052	118.7135	09/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-051	-22.8700	118.7919	10/04/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-052	-22.8506	118.7919	10/04/2022	Gorge/ Gully	Gorge	North	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-053	-22.9158	119.0305	10/04/2022	Minor Drainage Line	Minor Drainage Line	South	Low	Gravel (1-4cm)	Many Small Patches	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland, Scattered Eucalypts	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-054	-22.8083	119.1531	10/04/2022	Gorge/ Gully	Gorge	Flat	Moderate	Large Rocks (21-60cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-055	-22.8111	119.1529	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	South	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

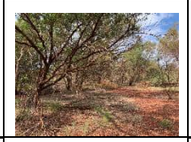
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-056	-22.8049	119.1499	10/04/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-057	-22.8053	118.7125	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	South/ West	Moderate	Small Rocks (11-20cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-058	-22.8075	119.1495	10/04/2022	Gorge/ Gully	Gorge	North	Low	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-059	-22.8856	119.0746	05/04/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sand	Evenly Spread	None	0	0.8	Mining Exploration	Old (6+ yr)		-
VCPH-060	-22.7872	118.6798	10/04/2022	Drainage Area/ Floodplain	Hillslope	North	Moderate	Pebbles (5-10cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Evenly Spread	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		Stony rise with patchy fire, some long unburnt
VCPH-061	-22.8458	119.1122	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-062	-22.8394	119.1208	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-063	-22.8426	119.1160	10/04/2022	Gorge/ Gully	Medium Drainage Line	South	Steep	Large Rocks (21-60cm)	Many Small Patches	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-064	-22.9026	118.7568	11/04/2022	Mulga Woodland	Sand Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-065	-23.0247	118.6427	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-066	-23.0391	118.6769	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-067	-23.0789	118.6668	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-068	-23.0420	118.7365	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-069	-23.0282	118.9216	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-070	-22.9021	118.7582	11/04/2022	Mulga Woodland	Sand Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-071	-22.8055	118.6941	11/04/2022	Breakaway/ Cliff	Cliff	Sout h/ West	Cliff	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-072	-22.7673	118.6481	11/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Large Patches	None	0	0.6	Frequent Fire	Moderate (3 to 5 yr)		Stony spinifex plain with scattered shrubs
VCPH-073	-22.7625	118.6501	11/04/2022	Drainage Area/ Floodplain	Medium Drainage Line	West	Low	Pebbles (5-10cm)	Evenly Spread	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clayey Sand	Evenly Spread	Prone to Flooding	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		Patchy fire
VCPH-074	-23.0882	118.8551	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-075	-23.0930	118.8109	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-076	-23.0910	118.7173	11/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Low	Small Rocks (11-20cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-077	-23.0540	118.6695	11/04/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-078	-23.0710	118.6742	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-079	-22.8468	118.7901	12/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clay Loam	Scarce	None	3	0.8	None Discernible	Old (6+ yr)		-
VCPH-080	-22.8383	118.7541	12/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-081	-22.8404	118.7561	11/04/2022	Gorge/ Gully	Gorge	South	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-082	-22.9137	118.7853	13/04/2022	Hillcrest/ Hillslope	Gully	South/ East	Moderate	Small Rocks (11-20cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-083	-22.8476	118.7650	13/04/2022	Stony Plain	Undulating Low Hills	East	Low	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-084	-22.8428	118.7504	13/04/2022	Gorge/ Gully	Gorge	East	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-085	-23.1060	118.8094	28/04/2022	Gorge/ Gully	Gorge	West	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	1	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-086	-23.0442	118.8541	28/04/2022	Breakaway/ Cliff	Gorge	South	Steep	Boulders (>61cm)	None Discernible	Few Small Patches	*Spinifex* Hummock Grassland, Eucalypt Woodland	Major Outcropping	BIF	Clay Loam	None Discernible	None	1	0.6	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-087	-23.0292	118.7122	29/04/2022	Gorge/ Gully	Gorge	North	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-088	-23.0644	118.7429	29/04/2022	Gorge/ Gully	Gorge	South	Steep	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-089	-23.0403	118.8516	29/04/2022	Gorge/ Gully	Gorge	South/ West	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VCPH-090	-23.0374	118.8401	29/04/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Pooling	1	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-091	-23.0964	118.9056	29/04/2022	Breakaway/ Cliff	Major Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Clay Loam	Many Small Patches	Prone to Pooling	3	0.8	Weed Invasion	Old (6+ yr)		Buffel common. Recent burn where outcropping is minimal but long unburned elsewhere
VCPH-092	-23.0968	118.8454	29/04/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Acacia* Shrubland, Mulga Woodland	Negligible	-	Light Clay	Few Small Patches	None	1	0.6	Cattle Grazing, Weed Invasion and Road/ Access Track	Old (6+ yr)		-
VCPH-093	-23.0685	118.8181	29/04/2022	Gorge/ Gully	Gorge	South/ West	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, *Acacia* Shrubland	Major Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		Recent burning surrounds

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-094	-23.0532	118.8123	29/04/2022	Breakaway/ Cliff	Ironstone Outcrops	North/ East	Moderate	Small Rocks (11-20cm)	Few Small Patches	Scarce	Mulga Woodland, Tussock Grassland	Moderate Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	Cattle Grazing	Old (6+ yr)		-
VCPH-095	-23.0722	118.8226	30/04/2022	Breakaway/ Cliff	Breakaway	South	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-096	-23.0650	118.8211	30/04/2022	Gorge/ Gully	Gorge	West	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-097	-23.0690	118.7791	30/04/2022	Stony Plain	Stony Plain	North	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-098	-23.0677	118.7691	30/04/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-099	-23.0634	118.6912	30/04/2022	Minor Drainage Line	Minor Drainage Line	North	Low	Pebbles (5-10cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clayey Sand	Few Small Patches	Prone to Pooling	0	0.8	Mining Exploration	Old (6+ yr)		-
VCPH-100	-23.0609	118.7099	30/04/2022	Gorge/ Gully	Gorge	North	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-101	-23.0480	118.7424	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-102	-23.0475	118.7359	30/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-103	-23.0567	118.7365	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-104	-23.0581	118.7162	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-105	-23.0617	118.7000	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-106	-23.0935	118.6942	01/05/2022	Hillcrest/ Hillslope	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-107	-22.8504	119.1197	06/04/2022	Major Drainage Line	Major Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	5	1	None Discernible	Old (6+ yr)		-
VCPH-108	-23.0285	118.9135	01/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Limited Outcropping	BIF	Sandy Loam	Many Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-109	-23.0298	118.9094	01/05/2022	Gorge/ Gully	Gorge	East	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-110	-23.0231	118.9118	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-111	-23.0198	118.9084	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-112	-23.0168	118.8981	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-

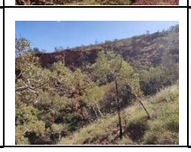
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-113	-23.0164	118.8845	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-114	-23.0174	118.8662	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-115	-23.0175	118.8582	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-116	-23.0922	118.6951	01/05/2022	Gorge/ Gully	Gorge	South	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-117	-23.0461	118.9093	01/05/2022	Breakaway/ Cliff	Ironstone Outcrops	East	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-118	-23.0467	118.9072	01/05/2022	Breakaway/ Cliff	Ironstone Outcrops	East	Moderate	Large Rocks (21-60cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-119	-23.0864	118.6868	01/05/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Many Large Patches	Many Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Loam	Many Large Patches	None	0	1	Frequent Fire	Old (6+ yr)		-
VCPH-120	-23.0857	118.6838	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-121	-23.0335	118.6869	01/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-122	-23.0396	118.8660	01/05/2022	Breakaway/ Cliff	Gorge	Nort h/ East	Stee p	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-123	-23.0369	118.6570	01/05/2022	Gorge/ Gully	Gully	Sout h/ East	Stee p	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcroppin g	BIF	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-124	-23.0366	118.6479	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-125	-23.0376	118.6475	01/05/2022	Gorge/ Gully	Gully	Sout h/ East	Mod erate	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Moderate Outcroppin g	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-126	-23.0456	118.9146	01/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	East	Mod erate	Pebbles (5-10cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcroppin g	BIF	Sandy Clay Loam	None Discernible	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-127	-23.0424	118.9135	01/05/2022	Breakaway/ Cliff	Gorge	Sout h/ West	Stee p	Small Rocks (11-20cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcroppin g	BIF	Sandy Clay Loam	None Discernible	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-128	-23.0590	118.6237	02/05/2022	Gorge/ Gully	Gorge	Sout h/ East	Mod erate	Large Rocks (21-60cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcroppin g	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-129	-23.0937	118.7026	02/05/2022	Gorge/ Gully	Gully	Sout h	Stee p	Large Rocks (21-60cm)	None Discernible	Few Large Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcroppin g	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-130	-23.0383	118.6552	02/05/2022	Gorge/ Gully	Breakaway	Nort h	Stee p	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-131	-23.0170	118.6490	02/05/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Scarce	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-132	-23.0870	118.6405	02/05/2022	Gorge/ Gully	Gorge	South	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-133	-23.0815	118.6608	02/05/2022	Gorge/ Gully	Gorge	North/ East	Steep	Large Rocks (21-60cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-134	-23.0323	118.8336	03/05/2022	Stony Plain	Stony Plain	North/ West	Low	Pebbles (5-10cm)	Scarce	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Recent (0 to 2 yr)		Patchy recent burn
VCPH-135	-23.0463	118.8309	03/05/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-136	-23.0508	118.8236	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-137	-23.0662	118.8065	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-138	-23.0332	118.8385	03/05/2022	Gorge/ Gully	Footslope	North/ West	Steep	Small Rocks (11-20cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-139	-23.0701	118.8124	03/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-140	-23.0417	118.8684	03/05/2022	Breakaway/ Cliff	Gorge	South/ West	Steep	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-141	-23.0822	118.8164	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-142	-23.0408	118.8755	03/05/2022	Gorge/ Gully	Gorge	North/ West	Moderate	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	4	1	None Discernible	Old (6+ yr)		-
VCPH-143	-23.0755	118.8043	03/05/2022	Gorge/ Gully	Gully	South/ East	Steep	Boulders (>61cm)	None Discernible	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	None Discernible	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-144	-23.0396	118.8741	03/05/2022	Gorge/ Gully	Gorge	North/ West	Moderate	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	2	1	None Discernible	Old (6+ yr)		-
VCPH-145	-23.0726	118.7952	03/05/2022	Hillcrest/ Hillslope	Footslope	North	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-146	-23.0652	118.7555	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-147	-23.0751	118.7935	03/05/2022	Breakaway/ Cliff	Gully	North	Steep	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-148	-23.0579	118.7215	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-149	-23.0674	118.7169	03/05/2022	Gorge/ Gully	Gully	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-150	-23.0662	118.7197	03/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	West	Steep	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

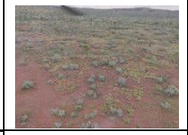
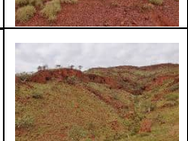
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-151	-23.0649	118.7202	03/05/2022	Gorge/ Gully	Gully	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-152	-23.0587	118.7148	03/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-153	-23.0671	118.6946	03/05/2022	Gorge/ Gully	Gorge	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	1	0.8	Frequent Fire	Old (6+ yr)		-
VCPH-154	-23.0377	118.7311	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-155	-23.0359	118.7138	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-156	-23.0328	118.6990	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-157	-23.0352	118.6983	03/05/2022	Mulga Woodland	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Limited Outcropping	BIF	Light Clay	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-158	-23.0266	118.7039	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-159	-23.0921	118.8676	04/05/2022	Minor Drainage Line	Medium Drainage Line	North/ West	Low	Gravel (1-4cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Flooding	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-160	-23.0838	118.6219	04/05/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

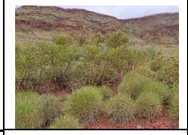
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-161	-23.0889	118.9101	04/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Loam	Many Small Patches	Prone to Flooding	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-162	-23.0896	118.9138	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-163	-23.0994	118.9219	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-164	-23.1018	118.9203	04/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-165	-23.1009	118.9105	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-166	-23.1007	118.9013	04/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Large Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Moderate Outcropping	BIF	Silty Loam	Many Large Patches	Prone to Flooding	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-167	-23.1047	118.9028	04/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-168	-23.0962	118.8878	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-169	-23.0943	118.8738	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-170	-23.0574	118.6345	04/05/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-

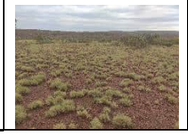
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-171	-23.0571	118.6769	04/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-172	-23.0442	118.6837	04/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-173	-23.0236	118.6978	05/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	Prone to Flooding	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-174	-23.0383	118.6805	05/05/2022	Hardpan Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Flooding	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-175	-23.0197	118.8665	06/05/2022	Stony Plain	Stony Plain	North	Low	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-176	-22.9062	118.7242	26/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.6	Weed Invasion	Old (6+ yr)		-
VCPH-177	-23.0545	118.8860	25/05/2022	Minor Drainage Line	Minor Drainage Line	West	Low	Gravel (1-4cm)	Scarce	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	CID	Clay Loam	Scarce	Prone to Pooling	1	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-178	-23.0977	118.7020	26/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-179	-23.0427	118.6814	26/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-180	-23.0133	118.6869	26/05/2022	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	Conglomerate	Clay Loam	Scarce	Scarce	0	1	None Discernible	Moderate (3 to 5 yr)		-

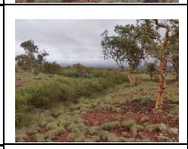
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-181	-23.0901	118.7062	26/05/2022	**Breakaway/ Cliff**	Breakaway	North / East	Mode rate	Large Rocks (21-60cm)	Scarce	Scarce	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	Moderate Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-182	**-23.0969**	**118.7851**	**26/05/2022**	**Hardpan Plain**	**Hardpan Plain**	**Flat**	**Flat**	**Negligible**	**Evenly Spread**	**Few Small Patches**	**Mulga Woodland, Tussock Grassland**	**Negligible**	**-**	**Clay Loam**	**Evenly Spread**	**Prone to Flooding**	**0**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-183	**-23.0857**	**118.6830**	**26/05/2022**	**Stony Plain**	**Stony Plain**	**Sout h**	**Low**	**Pebbles (5-10cm)**	**Scarce**	**Few Small Patches**	***Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Clay Loam**	**Scarce**	**None**	**0**	**0.8**	**None Discernible**	**Moderate (3 to 5 yr)**		-
VCPH-184	**-23.0236**	**118.8872**	**26/05/2022**	**Drainage Area/ Floodplain**	**Drainage Area/ Floodplain**	**Nort h**	**Low**	**Pebbles (5-10cm)**	**Few Small Patches**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Minor Outcroppin g**	**BIF**	**Clay Loam**	**Few Small Patches**	**Prone to Flooding**	**1**	**0.8**	**None Discernible**	**Old (6+ yr)**		-
VCPH-185	**-23.0261**	**118.8710**	**26/05/2022**	**Gorge/ Gully**	**Gully**	**Nort h**	**Mod erate**	**Pebbles (5-10cm)**	**Scarce**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Major Outcroppin g**	**BIF**	**Clay Loam**	**Scarce**	**None**	**3**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-186	**-23.0269**	**118.8513**	**26/05/2022**	**Undulating Low Hills**	**Undulating Low Hills**	**East**	**Low**	**Pebbles (5-10cm)**	**Scarce**	**Scarce**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Limited Outcroppin g**	**CID**	**Clay Loam**	**Scarce**	**None**	**4**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-187	**-23.0788**	**118.8579**	**26/05/2022**	**Drainage Area/ Floodplain**	**Stony Plain**	**Flat**	**Flat**	**Gravel (1-4cm)**	**Evenly Spread**	**Few Small Patches**	**Mulga Woodland**	**Negligible**	**-**	**Clay Loam**	**Evenly Spread**	**None**	**0**	**0.8**	**Cattle Grazing**	**Old (6+ yr)**		-
VCPH-188	**-22.8818**	**118.8084**	**26/05/2022**	**Stony Plain**	**Stony Plain**	**Flat**	**Flat**	**Gravel (1-4cm)**	**Few Small Patches**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Clay Loam**	**Few Small Patches**	**None**	**0**	**0.8**	**Mining Exploration**	**Moderate (3 to 5 yr)**		-
VCPH-189	**-22.8095**	**118.7112**	**27/05/2022**	**Breakaway/ Cliff**	**Breakaway**	**Sout h**	**Stee p**	**Large Rocks (21-60cm)**	**Few Small Patches**	**Many Small Patches**	***Acacia* Shrubland, *Spinifex* Hummock Grassland**	**Moderate Outcroppin g**	**BIF**	**Sandy Loam**	**Few Small Patches**	**None**	**0**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-190	**-22.7357**	**118.7097**	**27/05/2022**	**Stony Plain**	**Stony Plain**	**Flat**	**Flat**	**Pebbles (5-10cm)**	**Few Small Patches**	**Scarce**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Sandy Clay Loam**	**Few Small Patches**	**None**	**0**	**0.8**	**Frequent Fire**	**Old (6+ yr)**		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-191	-22.7339	118.7098	27/05/2022	Mulga Woodland	Medium Drainage Line	Flat	Flat	Negligible	Many Large Patches	Many Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	Prone to Pooling	0	0.8	Frequent Fire	Old (6+ yr)		-
VCPH-192	-22.9032	118.7439	10/04/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Large Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-193	-23.0465	118.9035	27/05/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-194	-23.0512	118.9018	27/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Moderate Outcropping	Conglomerate	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-195	-23.0349	118.6186	27/05/2022	Gorge/ Gully	Gorge	North	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	Conglomerate	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-196	-23.0499	118.9026	27/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Moderate	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-197	-22.8052	118.6949	27/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Large Rocks (21-60cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-198	-22.7967	118.6913	27/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Large Rocks (21-60cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-199	-22.8981	118.7781	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-200	-23.0733	118.6925	27/05/2022	Breakaway/ Cliff	Breakaway	South	Cliff	Boulders (>61cm)	None Discernible	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Clay Loam	None Discernible	None	5	0.8	Mining Exploration	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-201	-23.0885	118.7284	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-202	-22.7272	118.6606	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-203	-22.7335	118.6680	27/05/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-204	-22.7501	118.6955	27/05/2022	Undulating Low Hills	Undulating Low Hills	West	Low	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-205	-22.7611	118.6981	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-206	-22.7829	118.6941	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-207	-23.0229	118.8673	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-208	-23.0238	118.8667	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-209	-23.0276	118.8673	28/05/2022	Gorge/ Gully	Gorge	North	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-210	-23.0261	118.8689	28/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

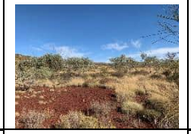
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-211	-23.0246	118.8654	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-212	-23.0237	118.8644	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-213	-23.0240	118.8613	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-214	-23.0240	118.8594	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-215	-23.0819	118.8926	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-216	-23.0206	118.8637	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-217	-23.0790	118.8718	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-218	-23.1008	118.8129	28/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-219	-23.0780	118.8836	28/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Gravel (1-4cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-220	-23.1026	118.8023	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-

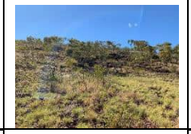
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-221	-23.0712	118.8543	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-222	-23.0896	118.8480	28/05/2022	Stony Plain	Hardpan Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-223	-23.0950	118.8354	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-224	-23.0885	118.7918	28/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-225	-23.0835	118.8338	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-226	-23.0205	118.8846	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-227	-23.0214	118.8836	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-228	-23.0263	118.8979	28/05/2022	Gorge/ Gully	Gully	North	Low	Gravel (1-4cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Scarce	None	4	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-229	-23.0290	118.8980	28/05/2022	Hillcrest/ Hillslope	Hillslope	North/ West	Very Steep	Boulders (>61cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	BIF	Clay Loam	None Discernible	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-230	-23.0196	118.8984	28/05/2022	Stony Plain	Stony Plain	North	Low	Gravel (1-4cm)	Many Small Patches	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-231	-23.1031	118.7768	28/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-232	-23.1002	118.7854	26/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		-
VCPH-233	-23.0195	118.8878	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-234	-23.0160	118.8754	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-235	-23.0228	118.8554	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-236	-23.0247	118.8557	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-237	-23.0254	118.8544	29/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-238	-23.0258	118.8530	29/05/2022	Stony Plain	Undulating Low Hills	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-239	-23.0582	118.8841	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-240	-23.0652	118.8902	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-241	-23.0679	118.8918	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-242	-23.1009	118.7020	29/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	CID	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-243	-23.0274	118.6893	29/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Medium Heavy Clay	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-244	-23.0879	118.7670	29/05/2022	Cleared/ Disturbed	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Scarce	*Acacia* Shrubland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-245	-23.0839	118.7482	29/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Tussock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-246	-23.0778	118.7325	29/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Tussock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-247	-23.0823	118.7317	29/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Tussock Grassland	Negligible	-	Medium Heavy Clay	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-248	-23.0805	118.7331	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-249	-23.0859	118.7305	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-250	-23.0884	118.7335	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-251	-23.0516	118.8597	30/05/2022	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-252	-23.0554	118.8719	30/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	Prone to Flooding	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-253	-23.0567	118.8769	30/05/2022	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	1	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VPIH-01	-22.7640	118.5966	11/11/2021	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Negligible	Evenly Spread	Many Large Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-02	-22.7449	118.5839	12/11/2021	Gorge/ Gully	Gorge	Sout h/ East	Mod erate	Boulders (>61cm)	Few Large Patches	Many Large Patches	Scattered Eucalypts	Extensive Outcroppin g	BIF	Clay Loam	Few Large Patches	Prone to Pooling	10	1	None Discernible	Old (6+ yr)		-
VPIH-03	-22.7756	118.5850	12/11/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Negligible	Evenly Spread	Many Small Patches	Eucalypt Woodland, Tussock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-04	-22.7751	118.6330	12/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-05	-22.7208	118.6935	12/11/2021	Gorge/ Gully	Gully	Nort h	Mod erate	Small Rocks (11-20cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Eucalypt Woodland	Minor Outcroppin g	BIF	Silty Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-06	-22.8029	118.7529	12/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-07	-22.7703	118.7010	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VPIH-08	-22.7821	118.6602	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-09	-22.7864	118.5806	13/11/2021	Gorge/ Gully	Gully	Sout h/ East	Mod erate	Boulders (>61cm)	Scarce	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcroppin g	BIF	Clay Loam	Scarce	Scarce	3	0.8	None Discernible	Old (6+ yr)		-
VPIH-10	-22.7720	118.6083	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-11	-22.8006	118.6525	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-12	-22.7474	118.6760	24/11/2021	Hardpan Plain	Hardpan Plain	Flat	Flat	Pebbles (5-10cm)	Many Large Patches	Few Large Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible		Clay Loam	Many Large Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VPIH-13	-22.7472	118.6515	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-14	-22.7734	118.7467	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland,*Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-15	-22.7482	118.6333	14/11/2021	Gorge/ Gully	Gully	Sout h/ East	Stee p	Large Rocks (21-60cm)	Scarce	Scarce	Eucalypt Woodland, Tussock Grassland	Moderate Outcroppin g	BIF	Clay Loam	Scarce	Scarce	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-16	-22.7479	118.6429	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-17	-22.7661	118.5847	24/11/2021	Medium Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Evenly Spread	Few Small Patches	Eucalypt Woodland, Tussock Grassland	Negligible		Clay Loam	Evenly Spread	Prone to Flooding	6	0.8	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VPIH-18	-22.7511	118.6809	24/11/2021	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Flooding	5	0.6	None Discernible	Old (6+ yr)		-
VPIH-19	-22.8064	118.7418	23/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-20	-22.7405	118.5952	25/11/2021	Gorge/ Gully	Gorge	South	Steep	Negligible	Scarce	Few Small Patches	-	Extensive Outcropping	BIF	Clay Loam	Scarce	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VPIH-21	-22.7507	118.6042	25/11/2021	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts, Tussock Grassland	Major Outcropping	BIF	Silty Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-22	-22.7763	118.6143	25/11/2021	Gorge/ Gully	Gully	West	Moderate	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Moderate Outcropping	BIF	Silty Clay Loam	Scarce	None	0	0.6	None Discernible	Moderate (3 to 5 yr)		-
VPIH-23	-22.7382	118.6259	27/11/2021	Gorge/ Gully	Gully	East	Steep	Boulders (>61cm)	Scarce	Many Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Major Outcropping	BIF	Silty Loam	Scarce	Scarce	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-24	-22.7953	118.6074	27/11/2021	Gorge/ Gully	Gully	East	Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Silty Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-25	-22.8137	118.5848	29/11/2021	Gorge/ Gully	Gorge	North	Steep	Boulders (>61cm)	Few Small Patches	Many Large Patches	-	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VPIH-26	-22.8093	118.7542	25/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VYAN-31	-22.7864	119.1484	15/05/2022	Major Drainage Line	Major Drainage Line	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Evenly Spread	Eucalypt Woodland	Negligible		Clay Loam	Evenly Spread	Permanent	20	1	Dewatering	Old (6+ yr)		-
VYAN-41	-22.7791	119.1446	16/05/2022	Hillcrest/ Hillslope	Hillslope	North	Low	Gravel (1-4cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Limited Outcropping	BIF	Clay Loam	Scarce	None	0	1	Mining Dust/Noise	Old (6+ yr)		-

Appendix D – Fauna Species Recorded During the Current Survey

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Birds					
Acanthizidae					
Acanthiza uropygialis	Chestnut-rumped thornbill				•
Acanthiza apicalis	Inland thornbill	•			•
Gerygone fusca	Western gerygone				•
Smicrornis brevirostris	Weebill	•			•
Accipitridae					
Aquila audax	Wedge-tailed eagle			•	
Elanus caeruleus subsp. axillaris	Black-shouldered kite				•
Haliastur sphenurus	Whistling kite				•
Lophoictinia isura	Square-tailed kite				•
Hamirostra melanosternon	Black-breasted buzzard				•
Milvus migrans	Black kite				•
Aegothelidae					
Aegotheles cristatus	Australian owlet-nightjar	•			•
Alaudidae					
Mirafra javanica	Horsfield's bushlark				•
Alcedinidae					
Dacelo leachii	Blue-winged kookaburra	•			•
Todiramphus pyrrhopygius	Red-backed kingfisher	•			•
Todiramphus sanctus	Sacred kingfisher				•
Anatitdae					
Anas gracilis	Grey teal	•			•
Artamidae					
Artamus cinereus	Black-faced woodswallow				•
Artamus minor	Little woodswallow				•
Artamus personatus	Masked woodswallow				•
Cracticus tibicen	Australian Magpie	•		•	•
Burhinidae					
Burhinus grallarius	Bush stone-curlew	•			
Cacatuidae					
Cacatua sanguinea	Little corella	•			•
Cacatua roseicapilla	Galah	•			•
Nymphicus hollandicus	Cockatiel				•
Campephagidae					
Coracina maxima	Ground cuckoo-shrike				•
Coracina novaehollandiae	Black-faced cuckoo-shrike				•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Caprimulgidae					
Eurostopodus argus	Spotted nightjar	•			
Columbidae					
Geopelia cuneata	Diamond dove				•
Geopelia placida	Peaceful dove				•
Geophaps plumifera	Spinifex pigeon				•
Ocyphaps lophotes	Crested pigeon			•	•
Corvidae					
Corvus bennetti	Little crow				•
Corvus orru	Torresian crow	•		•	•
Cracticidae					
Cracticus nigrogularis	Pied butcherbird	•		•	•
Cracticus torquatus	Grey butcherbird	•			•
Cuculidae					
Chrysococcyx basalis	Horsfield's bronze cuckoo	•			
Chrysococcyx osculans	Black-eared cuckoo	•			
Cacomantis pallidus	Pallid cuckoo	•			•
Dicaeidae					
Dicaeum hirundinaceum	Mistletoe bird				•
Estrildidae					
Emblema pictum	Painted finch	•			•
Taeniopygia guttata	Zebra finch				•
Falconidae					
Falco berigora	Brown falcon	•			•
Falco cenchroides	Nankeen kestrel				•
Falco longipennis	Australian hobby				•
Locustellidae					
Cincloramphus mathewsi	Rufous songlark			•	•
Eremiornis carteri	Spinifexbird	•			•
Maluridae					
Amytornis striatus	Striated grasswren				•
Malurus assimilis subsp. assimilis	Purple-backed fairy-wren	•			•
Malurus leucopterus	White-winged fairy-wren	•			•
Stipiturus ruficeps	Rufous-crowned emu-wren	•			
Meliphagidae					
Acanthagenys rufogularis	Spiny-cheeked honeyeater	•			•
Epthianura tricolor	Crimson chat				•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Gavicalis virescens subsp. virescens	Singing honeyeater	•		•	•
Lichmera indistincta	Brown honeyeater				•
Manorina flavigula	Yellow-throated miner				•
Ptilotula keartlandi	Grey-headed honeyeater	•			•
Ptilotula penicillata	White-plumed honeyeater				•
Meropidae					
Merops ornatus	Rainbow bee-eater				•
Oreoicidae					
Oreoica gutturalis	Crested bellbird	•			•
Otididae					
Ardeotis australis	Australian bustard				•
Pachycephalidae					
Colluricincla harmonica	Grey shrike-thrush			•	•
Pachycephala rufiventris	Rufous whistler	•			•
Pardalotidae					
Pardalotus rubricatus	Red-browed pardalote				•
Petroicidae					
Melanodryas cucullata	Hooded robin	•			•
Petroica goodenovii	Red-capped robin				•
Phasianidae					
Synoicus ypsilophora	Brown quail	•			•
Pomatostomidae					
Pomatostomus superciliosus	White-browed babbler				•
Pomatostomus temporalis	Grey-crowned babbler				•
Psittacidae					
Barnardius zonarius	Australian ringneck/ Port Lincoln parrot				•
Melopsittacus undulatus	Budgerigar	•			•
Ptilinorhynchidae					
Ptilonorhynchus maculatus subsp. guttatus	Western bowerbird				•
Rhipiduridae					
Rhipidura albiscapa	Grey fantail				•
Rhipidura leucophrys	Willie wagtail	•		•	•
Strigidae					
Ninox boobook	Boobook owl	•			•
Ninox connivens	Barking owl	•			
Turnicidae					
Turnix velox	Little button quail	•		•	•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Tytonidae					
Tyto javanica	Eastern barn owl	•			
Mammals					
Bovidae					
Bos taurus	European cattle			•	•
Canidae					
Canis familiaris	Dingo, dog			•	•
Dasyuridae					
Ningaui timealeyi	Pilbara ningaui			•	
Pseudomys chapmani	Western pebble-mound mouse				•
Pseudantechinus woolleyae	Woolley's pseudantechinus			•	
Felidae					
Felis catus	Domestic cat			•	•
Emballonuridae					
Taphozous georgianus	Common sheath-tailed bat				•
Leporidae					
Oryctolagus cuniculus	European rabbit				•
Macropodidae					
Osphranter robustus	Euro, biggada			•	•
Osphranter rufus	Red kangaroo			•	•
Petrogale rothschildi	Rothschild's rock-wallaby			•	•
Megadermatidae					
Macroderma gigas	Ghost bat **– Vulnerable***		•		
Molossidae					
Austronomus australis	White-striped free-tailed bat		•		
Chaerephon jobensis colonicus	Greater northern free-tailed bat		•		
Ozimops lumsdenae	Northern free-tailed bat		•		
Muridae					
Zyzomys argurus	Common rock-rat			•	
Rhinonycteridae					
Rhinonicteris aurantia Pilbara form	Pilbara leaf-nosed bat **- Vulnerable**		•		
Tachyglossidae					
Tachyglossus aculeatus subsp. acanthion	Short-beaked echidna			•	
Vespertilionidae					
Chalinolobus gouldii	Gould's wattled bat		•		
Nyctophilus geoffroyi subsp. geoffroyi	Lesser long-eared bat		•		
Scotorepens greyii	Little broad-nosed bat		•		

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Vespadelus finlaysoni	Finlayson's cave-bat		•		•
Reptiles					
Agamidae					
Ctenophorus caudicinctus	Western ring-tailed dragon				•
Ctenophorus isolepis	Central military dragon				•
Gowidon longirostris	Long-nosed dragon			•	•
Pogona minor subsp. minor	Dwarf bearded dragon				•
Diplodactylidae					
Oedura fimbria	Western marbled velvet gecko				•
Elapidae					
Demansia psammophis subsp. cupreiceps	Yellow-faced whipsnake				•
Furina ornata	Moon snake				•
Pseudechis australis	Mulga snake				•
Pseudonaja mengdeni	Western brown snake				•
Vermicella snelli	Pilbara bandy bandy				•
Gekkonidae					
Heteronotia binoei	Binoe’s gecko				•
Myobatrachidae					
Pseudophryne douglasi	Gorge toadlet				•
Pelodryadidae					
Litoria rubella	Little red tree frog				•
Lialis burtonis	Burton's legless lizard				•
Pythonidae					
Antaresia childreni	Children’s python				•
*Liasis olivaceus subsp. barroni**	Pilbara olive python				•
Scincidae					
Cryptoblepharus ustulatus	Russet snake-eyed skink				•
Ctenotus inornatus	-				•
Ctenotus pantherinus	Leopard skink				•
Ctenotus rubicundus	Ruddy ctenotus				•
Lerista flammicauda	Pilbara flame-tailed slider				•
Menetia greyii	Common dwarf skink				•
Varanidae					
Varanus acanthurus	Spiny-tailed goanna			•	
Varanus giganteus	Perentie			•	
Varanus gouldii	Bungarra			•	

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Varanus hamersleyensis	Southern Pilbara rock goanna				•
Varanus tristis	Racehorse goanna			•	•
Total		**39**	**9**	**7**	**54**

* Located just outside Study Area

Appendix E – Night Parrot Acoustic Analysis Report

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at Central Pilbara Hub – April/May 2022

Report to:

Biologic Environmental Survey

Prepared by:

Nigel Jackett

Adaptive NRM

18 July 2022

1. Summary

During April and May 2022, autonomous recording units (ARUs) were deployed at Central Pilbara Hub, Western Australia, to survey for Night Parrots (*Pezoporus occidentalis*). Resulting acoustic data was analysed using signal parameters optimised for detecting Night Parrot calls. No Night Parrot calls were detected during the analysis.

2. Survey effort

Research in western Queensland has demonstrated Night Parrots occupy long-term stable roost sites for periods of up to several years. These long-term stable roost sites support both roosting and breeding. The birds also have predictable year-round calling periods at dusk and dawn (Murphy *et al.* 2017a; Leseberg *et al.* 2019). This ensures that if Night Parrots are roosting at a particular site, the likelihood of detecting them using ARUs is very high, provided the ARU is placed for a minimum of four nights in calm weather, and the recorder is set to record during the peak calling periods. During breeding, and following large rain events, calling is more frequent, extends throughout the night (Murphy *et al.* 2017a), and the likelihood of detection is increased. Preliminary results from research in central Western Australia suggest patterns of behaviour in that region are similar (Jackett *et al.* 2017).

Night Parrots are also known to call during the night at feeding and drinking sites (S. Murphy, N. Leseberg, N. Jackett unpubl. data). Anecdotal evidence suggests they may call when moving between these sites (N. Leseberg, N. Jackett, S. Murphy unpubl. data). However, the detection of birds away from roosting sites is likely to be a chance event given the large area over which birds range at night (Murphy *et al.* 2017b). Night Parrots are known to drink, and modelling suggests they may be reliant on free-standing water (or succulent food containing >55% water) during hot weather (Kearney *et al.* 2016). Birds have been detected in the Great Sandy Desert by focusing survey effort at water sources (J. Brown pers. comm.). It is likely this technique will be most effective during periods of water scarcity, when survey effort can focus on just a few possible locations.

The likelihood of detection is also influenced by the type of ARU being used. In calm conditions, Song Meter 4s are known to be capable of reliably detecting 95% of Night Parrot calls out to a range of around 205 m (Leseberg *et al.* 2021).

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in April and May 2022. Thirteen Song Meter Mini (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across 24 sites and recorded a combined total of 206 nights of data (Table 1). The analysed dataset comprised 2,289 sound files (wav format) totalling 366.5 GB. Each unit recorded continuously from sunset until sunrise (approx. 12 hours).

Table 1. Bioacoustic recordings analysed from the Central Pilbara Hub surveys

Site	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
VCPH-01	05/04/22	11/04/22	6	6
VCPH-02	05/04/22	11/04/22	6	6
VCPH-04	05/04/22	06/04/22	1	1
VCPH-05	05/04/22	11/04/22	6	6
VCPH-06	05/04/22	11/04/22	6	6
VCPH-07	05/04/22	11/04/22	6	5
VCPH-08	05/04/22	11/04/22	6	4
VCPH-09	05/04/22	11/04/22	6	6
VCPH-11	05/04/22	11/04/22	6	6
VCPH-19	06/04/22	12/04/22	6	6
VCPH-20	07/04/22	13/04/22	6	6
VCPH-22	07/04/22	13/04/22	6	6
VCPH-50	11/04/22	28/04/22	17	15
VCPH-52	11/04/22	28/04/22	17	16
VCPH-54	11/04/22	16/04/22	5	5
VCPH-56	11/04/22	29/04/22	18	17
VCPH-58	11/04/22	28/04/22	17	15
VCPH-60	11/04/22	25/04/22	14	14
VCPH-73	11/04/22	13/04/22	2	2
VCPH-73	30/04/22	06/05/22	6	6
VCPH-75	11/04/22	23/04/22	12	11
VCPH-77	11/04/22	28/04/22	17	16
VCPH-79*	11/04/22	11/04/22	0	0
VCPH-81	12/04/22	13/04/22	1	1
VCPH-175	06/05/22	19/05/22	13	12
* recordings end first evening		Total	206	194

3. Data analysis

The analysis was undertaken using the software Kaleidoscope Pro v5.4.2, targeting the frequency range of 1000 – 4000 Hz for which all known calls of the Night Parrot are distributed within (Leseberg *et al.* 2019). Searching for calls over a large frequency range such as this is likely to produce a high number of false-positive results due to many other bird species calling at similar frequencies but is a necessary procedure in order to capture the potential repertoire of Night Parrot.

Potential Night Parrot calls detected during the analysis were compared to a reference library comprising 897 Night Parrot calls from Western Australia. This library consists of calls recorded at sites where Night Parrots have been confirmed using visual means and is therefore considered of high reliability. The library also comprises multiple examples of all known call types from Western Australia (Leseberg *et al.* 2019).

Kaleidoscope Pro search parameters were optimised using a random selection of 250 Night Parrot call examples manually detected from both Great Sandy Desert and East Murchison datasets, of which 205 (82.0%) were automatically detected. Calls not detected were typically extremely faint. The probability of non-detection of a true-positive call was 18.0%; two true-positive calls was 3.2%; three true-positive calls was 0.6%; etc. Of the data tested, the median number of consecutive (spaced at <5 minutes apart) calls in a sequence when Night Parrots were recorded was 5 (1–34, n=29). The probability of at least one call being detected within a sequence of median length, assuming there was variation in the location of the source of the call, was >99.9%.

4. Survey results

A total of 65,482 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

Recording conditions were considered good, with minimal noise interference from wind across most sites. Occasional noise interference from heavy machinery was detected at sites VCPH-20 and VCPH-22, and constant calls from *Uperoleia saxatilis* was detected at site VCPH-19. Noise interference at these sites may have masked any coinciding Night Parrot calls.

A total of 37 non-target species were detected during the analysis and are shown for each site in Appendix 1.

5. Conclusion

It is very unlikely a long-term stable Night Parrot roost exists within two hundred metres of any of the surveyed points where four or more non-windy recording nights were made. Additionally, it is unlikely that Night Parrots were foraging in proximity to these surveyed points during the survey. It is important to note that these results pertain specifically to that area immediately surrounding the survey points, and do not necessarily support conclusions about the presence or absence of Night Parrots in the wider landscape.

6. References

Jackett, N. A., Greatwich, B. R., Swann, G., & Boyle, A. (2017). A nesting record and vocalisations of the Night Parrot *Pezoporus occidentalis* from the East Murchison, Western Australia. *Australian Field Ornithology, 34*, 144–150.

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Murphy, S. A., Silcock, J. L., Murphy, R., Reid, J., & Austin, J. J. (2017b). Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland. *Austral Ecology, 42*, 858–868.

Appendix 1 – Species detected during the analysis

Species	Site VCPH-																							
	1	2	4	5	6	7	8	9	11	19	20	22	50	52	54	56	58	60	73	75	77	79	81	175
Grey Teal *Anas gracilis*																			•					
Brown Quail *Coturnix ypsilophora*	•	•			•		•	•						•	•	•	•	•		•	•			
Black-eared Cuckoo *Chalcites osculans*						•										•	•		•					•
Horsfield's Bronze Cuckoo *Chalcites basalis*	•	•		•	•	•	•	•	•		•		•	•	•	•	•	•	•	•	•			•
Pallid Cuckoo *Heteroscenes pallidus*			•	•		•		•	•		•		•	•		•	•	•	•	•	•			•
Spotted Nightjar *Eurostopodus argus*		•		•	•								•	•							•			
Australian Owlet-nightjar *Aegotheles cristatus*	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•		•	•
Bush Stone-curlew *Burhinus grallarius*		•														•		•						
Little Buttonquail *Turnix velox*				•	•	•			•				•	•		•		•	•	•	•			•
Eastern Barn Owl *Tyto javanica*		•	•					•						•		•		•						
Barking Owl *Ninox connivens*	•																							
Boobook Owl *Ninox boobook*		•	•					•		•					•	•				•	•			
Blue-winged Kookaburra *Dacelo leachii*																								•
Red-backed Kingfisher *Todiramphus pyrrhopygius*		•							•				•				•			•				
Brown Falcon *Falco berigora*									•				•		•	•						•		
Galah *Eolophus roseicapilla*													•	•		•								
Little Corella *Cacatua sanguinea*																•								
Budgerigar *Melopsittacus undulatus*	•	•												•		•				•	•			
Rufous-crowned Emu-wren *Stipiturus ruficeps*																			•					

Species	Site VCPH-																							
	1	2	4	5	6	7	8	9	11	19	20	22	50	52	54	56	58	60	73	75	77	79	81	175
Purple-backed Fairywren *Malurus assimilis*																			•					
White-winged Fairywren *Malurus leucopterus*	•							•			•		•	•		•								
Spiny-cheeked Honeyeater *Acanthagenys rufogularis*		•			•		•				•		•	•	•	•		•	•	•	•	•		
Singing Honeyeater *Gavicalis virescens*		•			•		•		•		•		•	•	•	•			•	•		•		•
Grey-headed Honeyeater *Ptilotula keartlandi*					•																			•
Inland Thornbill *Acanthiza apicalis*																			•					
Weebill *Smicrornis brevirostris*																			•					
Crested Bellbird *Oreoica gutturalis*																			•			•		
Rufous Whistler *Pachycephala rufiventris*													•									•		
Grey Butcherbird *Cracticus torquatus*													•					•						
Pied Butcherbird *Cracticus nigrogularis*					•								•						•					•
Australian Magpie *Gymnorhina tibicen*						•							•			•	•	•						•
Willie Wagtail *Rhipidura leucophrys*		•			•	•	•	•					•	•	•	•	•	•	•	•	•	•	•	•
Torresian Crow *Corvus orru*																			•					
Hooded Robin *Melanodryas cucullata*		•						•						•										
Horsfield's Bush Lark *Mirafra javanica*														•		•								
Spinifexbird *Poodytes carteri*	•	•	•		•		•	•	•		•				•		•				•			•
Painted Finch *Emblema pictum*				•																				
Total	7	14	5	6	11	7	7	10	8	2	6	0	16	15	9	19	9	11	16	11	11	6	2	12

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at Pineapple Hill

Report to:

Biologic Environmental Survey

Prepared by:

Nigel Jackett

Adaptive NRM

12 May 2022

1. Summary

During November 2021, autonomous recording units (ARUs) were deployed at Pineapple Hill, Western Australia, to survey for Night Parrots (*Pezoporus occidentalis*). Resulting acoustic data was analysed using signal parameters optimised for detecting Night Parrot calls. No Night Parrot calls were detected during the analysis.

2. Survey effort

Research in western Queensland has demonstrated Night Parrots occupy long-term stable roost sites for periods of up to several years. These long-term stable roost sites support both roosting and breeding. The birds also have predictable year-round calling periods at dusk and dawn (Murphy *et al.* 2017a; Leseberg *et al.* 2019). This ensures that if Night Parrots are roosting at a particular site, the likelihood of detecting them using ARUs is very high, provided the ARU is placed for a minimum of four nights in calm weather, and the recorder is set to record during the peak calling periods. During breeding, and following large rain events, calling is more frequent, extends throughout the night (Murphy *et al.* 2017a), and the likelihood of detection is increased. Preliminary results from research in central Western Australia suggest patterns of behaviour in that region are similar (Jackett *et al.* 2017).

Night Parrots are also known to call during the night at feeding and drinking sites (S. Murphy, N. Leseberg, N. Jackett unpubl. data). Anecdotal evidence suggests they may call when moving between these sites (N. Leseberg, N. Jackett, S. Murphy unpubl. data). However, the detection of birds away from roosting sites is likely to be a chance event given the large area over which birds range at night (Murphy *et al.* 2017b). Night Parrots are known to drink, and modelling suggests they may be reliant on free-standing water (or succulent food containing >55% water) during hot weather (Kearney *et al.* 2016). Birds have been detected in the Great Sandy Desert by focusing survey effort at water sources (J. Brown pers. comm.). It is likely this technique will be most effective during periods of water scarcity, when survey effort can focus on just a few possible locations.

The likelihood of detection is also influenced by the type of ARU being used. In calm conditions, Song Meter 4s are known to be capable of reliably detecting 95% of Night Parrot calls out to a range of around 205 m (Leseberg *et al.* 2021).

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in November 2021. Five Song Meter Mini (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across seven sites and recorded a combined total of 38.25 nights of data (Table 1). The analysed dataset comprised 421 sound files (wav format) totalling 133.6 GB. Each unit recorded continuously from sunset until sunrise (approx. 12 hours).

Table 1. Bioacoustic recordings analysed from the Pineapple Hill survey

Site	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
VPIN-07	13/11/21	17/11/21	4	4
VPIN-08	13/11/21	21/11/21	8.25	8.25
VPIN-10	13/11/21	19/11/21	6	6
VPIN-13	13/11/21	24/11/21	11	11
VPIN-14	13/11/21	19/11/21	6	6
VPIN-19	24/11/21	26/11/21	2	2
VPIN-26	25/11/21	26/11/21	1	1
		Total	38.25	38.25

3. Data analysis

The analysis was undertaken using the software Kaleidoscope Pro v5.4.2, targeting the frequency range of 1000 – 4000 Hz for which all known calls of the Night Parrot are distributed within (Leseberg *et al.* 2019). Searching for calls over a large frequency range such as this is likely to produce a high number of false-positive results due to many other bird species calling at similar frequencies but is a necessary procedure in order to capture the potential repertoire of Night Parrot.

Potential Night Parrot calls detected during the analysis were compared to a reference library comprising 897 Night Parrot calls from Western Australia. This library consists of calls recorded at sites where Night Parrots have been confirmed using visual means and is therefore considered of high reliability. The library also comprises multiple examples of all known call types from Western Australia (Leseberg *et al.* 2019).

Kaleidoscope Pro search parameters were optimised using a random selection of 250 Night Parrot call examples manually detected from both Great Sandy Desert and East Murchison datasets, of which 205 (82.0%) were automatically detected. Calls not detected were typically

extremely faint. The probability of non-detection of a true-positive call was 18.0%; two true-positive calls was 3.2%; three true-positive calls was 0.6%; etc. Of the data tested, the median number of consecutive (spaced at <5 minutes apart) calls in a sequence when Night Parrots were recorded was 5 (1–34, n=29). The probability of at least one call being detected within a sequence of median length, assuming there was variation in the location of the source of the call, was >99.9%.

4. Survey results

A total of 46,385 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

The recordings were of excellent quality, with minimal interference from wind or insects. Site VPIN-08 had near-constant background water noise, which may have masked any Night Parrot vocalisations had they been recorded.

5. Conclusion

It is very unlikely a long-term stable Night Parrot roost exists within two hundred metres of any of the surveyed points where four or more non-windy recording nights were made. Additionally, it is unlikely that Night Parrots were foraging in proximity to these surveyed points during the survey. It is important to note that these results pertain specifically to that area immediately surrounding the survey points, and do not necessarily support conclusions about the presence or absence of Night Parrots in the wider landscape.

6. References

Jackett, N. A., Greatwich, B. R., Swann, G., & Boyle, A. (2017). A nesting record and vocalisations of the Night Parrot *Pezoporus occidentalis* from the East Murchison, Western Australia. *Australian Field Ornithology, 34*, 144–150.

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Appendix F – Records of Western Pebble Mound Mouse During Current Survey

Date	Latitude	Longitude	Observation	Habitat Type
25/11/2021	-22.7769	118.7186	Mound (inactive)	Stony Plain
8/04/2022	-22.8157	119.1440	Mound (active)	Cleared/ Disturbed
8/04/2022	-22.8155	119.1450	Mound (active)	Stony Plain
8/04/2022	-22.8151	119.1469	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8151	119.1467	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8149	119.1479	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8108	119.1462	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8827	118.7774	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8155	119.1445	Mound (recently inactive)	Stony Plain
8/04/2022	-22.8150	119.1466	Mound (recently inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8631	118.7863	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8481	118.7967	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8473	118.7923	Mound (active)	Stony Plain
10/04/2022	-22.8463	118.7856	Mound (active)	Stony Plain
10/04/2022	-22.8091	119.1482	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8635	118.7952	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8632	118.7947	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8591	118.7922	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8590	118.7867	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8590	118.7931	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8581	118.7901	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8499	118.7922	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8479	118.7880	Mound (active)	Stony Plain
10/04/2022	-22.8605	118.7854	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8465	118.7860	Mound (inactive)	Stony Plain
10/04/2022	-22.8663	118.7893	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8626	118.7861	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8589	118.7919	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8585	118.7875	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8498	118.7923	Mound (inactive)	Hillcrest/ Hillslope
11/04/2022	-23.0911	118.7179	Mound (inactive)	Hillcrest/ Hillslope
12/04/2022	-22.8659	118.7892	Mound (active)	Hillcrest/ Hillslope
12/04/2022	-22.8385	118.7555	Mound (active)	Hillcrest/ Hillslope
13/04/2022	-22.8480	118.7633	Mound (recently inactive)	Stony Plain
28/04/2022	-23.0441	118.8525	Mound (active)	Hillcrest/ Hillslope
28/04/2022	-23.0441	118.8530	Mound (inactive)	Hillcrest/ Hillslope
28/04/2022	-23.0438	118.8516	Mound (recently inactive)	Hillcrest/ Hillslope
29/04/2022	-23.0716	118.8183	Mound (active)	Hillcrest/ Hillslope
29/04/2022	-23.0547	118.8132	Mound (active)	Hillcrest/ Hillslope
29/04/2022	-22.9167	118.7860	Mound (active)	Stony Plain
29/04/2022	-22.8430	118.7467	Mound (recently inactive)	Hillcrest/ Hillslope
29/04/2022	-22.8381	118.7529	Mound (recently inactive)	Hillcrest/ Hillslope
30/04/2022	-23.0694	118.7792	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
30/04/2022	-23.0716	118.8183	Mound (inactive)	Hillcrest/ Hillslope
30/04/2022	-23.0601	118.7096	Mound (inactive)	Hillcrest/ Hillslope
30/04/2022	-22.8385	118.7549	Mound (inactive)	Hillcrest/ Hillslope
1/05/2022	-23.0474	118.9138	Mound (active)	Minor Drainage Line
1/05/2022	-23.0274	118.9141	Mound (inactive)	Hillcrest/ Hillslope
1/05/2022	-23.0268	118.9226	Mound (inactive)	Stony Plain
2/05/2022	-23.0177	118.6490	Mound (active)	Hillcrest/ Hillslope
2/05/2022	-23.0274	118.9141	Mound (inactive)	Hillcrest/ Hillslope
2/05/2022	-23.0695	118.8153	Mound (recently inactive)	Hillcrest/ Hillslope
3/05/2022	-23.0446	118.8656	Mound (active)	Stony Plain
3/05/2022	-23.0326	118.8378	Mound (active)	Hillcrest/ Hillslope
3/05/2022	-23.0639	118.6941	Mound (inactive)	Stony Plain
3/05/2022	-23.0438	118.8660	Mound (inactive)	Stony Plain
3/05/2022	-23.0325	118.8346	Mound (inactive)	Minor Drainage Line
3/05/2022	-23.0322	118.8377	Mound (inactive)	Stony Plain
3/05/2022	-23.0458	118.8649	Mound (recently inactive)	Minor Drainage Line
4/05/2022	-23.0837	118.6220	Mound (inactive)	Hillcrest/ Hillslope
4/05/2022	-23.0597	118.7096	Mound (recently inactive)	Hillcrest/ Hillslope
5/05/2022	-23.0159	118.6468	Mound (active)	Hillcrest/ Hillslope
5/05/2022	-23.0376	118.6548	Mound (inactive)	Hillcrest/ Hillslope
6/05/2022	-23.0328	118.8382	Mound (active)	Hillcrest/ Hillslope
16/05/2022	-22.7806	119.1444	Mound (recently inactive)	Hillcrest/ Hillslope
25/05/2022	-23.0608	118.8837	Mound (active)	Stony Plain
26/05/2022	-23.0226	118.8716	Mound (active)	Stony Plain
26/05/2022	-23.0259	118.8508	Mound (inactive)	Stony Plain
26/05/2022	-23.0237	118.8716	Mound (inactive)	Stony Plain
26/05/2022	-23.0227	118.8869	Mound (inactive)	Minor Drainage Line
26/05/2022	-23.0218	118.8713	Mound (inactive)	Stony Plain
26/05/2022	-23.0210	118.8711	Mound (inactive)	Stony Plain
26/05/2022	-23.0189	118.8710	Mound (inactive)	Stony Plain
26/05/2022	-23.0182	118.8712	Mound (inactive)	Minor Drainage Line
26/05/2022	-23.0877	118.7071	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0872	118.7009	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0870	118.7072	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0127	118.6859	Mound (recently inactive)	Hillcrest/ Hillslope
27/05/2022	-22.7990	118.6906	Mound (active)	Hillcrest/ Hillslope
28/05/2022	-23.0235	118.8633	Burrow (inactive)	Stony Plain
28/05/2022	-23.0244	118.8648	Mound (active)	Stony Plain
28/05/2022	-23.0242	118.8978	Mound (active)	Hillcrest/ Hillslope
28/05/2022	-23.0221	118.8981	Mound (active)	Stony Plain
28/05/2022	-23.0209	118.8985	Mound (active)	Stony Plain
28/05/2022	-23.0205	118.9045	Mound (active)	Stony Plain
28/05/2022	-23.0203	118.9041	Mound (active)	Stony Plain
28/05/2022	-23.0202	118.9041	Mound (active)	Stony Plain
28/05/2022	-23.0199	118.8984	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
28/05/2022	-23.0192	118.8983	Mound (active)	Minor Drainage Line
28/05/2022	-23.0187	118.8998	Mound (active)	Stony Plain
28/05/2022	-23.0184	118.8983	Mound (active)	Stony Plain
28/05/2022	-23.0174	118.8988	Mound (active)	Stony Plain
28/05/2022	-23.0196	118.8990	Mound (active)	Stony Plain
28/05/2022	-23.0216	118.9052	Mound (active)	Stony Plain
28/05/2022	-23.0212	118.9048	Mound (active)	Stony Plain
28/05/2022	-23.0209	118.9039	Mound (active)	Stony Plain
28/05/2022	-23.0208	118.9038	Mound (active)	Minor Drainage Line
28/05/2022	-23.0198	118.9015	Mound (active)	Stony Plain
28/05/2022	-23.0196	118.9000	Mound (active)	Stony Plain
28/05/2022	-23.0245	118.8648	Mound (inactive)	Stony Plain
28/05/2022	-23.0240	118.8611	Mound (inactive)	Minor Drainage Line
28/05/2022	-23.0240	118.8645	Mound (inactive)	Stony Plain
28/05/2022	-23.0239	118.8609	Mound (inactive)	Stony Plain
28/05/2022	-23.0237	118.8633	Mound (inactive)	Stony Plain
28/05/2022	-23.0236	118.8625	Mound (inactive)	Minor Drainage Line
28/05/2022	-23.0204	118.9021	Mound (inactive)	Stony Plain
28/05/2022	-23.0193	118.9026	Mound (inactive)	Stony Plain
28/05/2022	-23.0200	118.9025	Mound (inactive)	Stony Plain
28/05/2022	-23.0239	118.8622	Mound (recently inactive)	Stony Plain
28/05/2022	-23.0207	118.8637	Mound (recently inactive)	Stony Plain
28/05/2022	-23.0202	118.8647	Mound (recently inactive)	Stony Plain
29/05/2022	-23.1009	118.7020	Mound (active)	Hillcrest/ Hillslope
29/05/2022	-23.0984	118.7026	Mound (active)	Stony Plain
29/05/2022	-23.0651	118.8902	Mound (active)	Stony Plain
29/05/2022	-23.0650	118.8919	Mound (active)	Stony Plain
29/05/2022	-23.0645	118.8919	Mound (active)	Stony Plain
29/05/2022	-23.0587	118.8840	Mound (active)	Stony Plain
29/05/2022	-23.0583	118.8826	Mound (active)	Stony Plain
29/05/2022	-23.0556	118.8849	Mound (active)	Stony Plain
29/05/2022	-23.0264	118.8518	Mound (active)	Minor Drainage Line
29/05/2022	-23.0236	118.8556	Mound (active)	Stony Plain
29/05/2022	-23.0219	118.8846	Mound (active)	Stony Plain
29/05/2022	-23.0214	118.8840	Mound (active)	Stony Plain
29/05/2022	-23.0208	118.8849	Mound (active)	Stony Plain
29/05/2022	-23.0203	118.8870	Mound (active)	Stony Plain
29/05/2022	-23.0597	118.8836	Mound (inactive)	Stony Plain
29/05/2022	-23.0573	118.8828	Mound (inactive)	Stony Plain
29/05/2022	-23.0251	118.8556	Mound (inactive)	Stony Plain
29/05/2022	-23.0218	118.8873	Mound (inactive)	Drainage Area/ Floodplain
29/05/2022	-23.0208	118.8841	Mound (inactive)	Stony Plain
29/05/2022	-23.0198	118.8875	Mound (inactive)	Stony Plain
29/05/2022	-23.0214	118.8843	Mound (recently inactive)	Stony Plain
30/05/2022	-23.0245	118.8704	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
30/05/2022	-23.0257	118.8710	Mound (inactive)	Hillcrest/ Hillslope
30/05/2022	-23.0239	118.8698	Mound (inactive)	Stony Plain
30/05/2022	-23.0218	118.8681	Mound (recently inactive)	Stony Plain
30/05/2022	-23.0195	118.8663	Mound (recently inactive)	Stony Plain