Jinidi Targeted Vertebrate Fauna Survey

Report to BHP WAIO

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Executive Summary

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake targeted vertebrate fauna survey of the Jinidi, Northeast Corner and South Parmelia project areas, and the Weeli Wolli Spring Priority Ecological Community, including Ben's Oasis (hereafter referred to as the Survey Area). The Survey Area is located approximately 70 kilometres (km) north-west of Newman and covers an area of approximately 21,606.67 hectares (ha).

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Survey 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*), including ten target species These species are: northern quoll (*Dasyurus hallucatus*) – Endangered, greater bilby (*Macrotis lagotis*) – Vulnerable, ghost bat (*Macroderma gigas*) – Vulnerable, Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable, night parrot (*Pezoporus occidentalis*) – Endangered, grey falcon (*Falco hypoleucos*) – Vulnerable, princess parrot *(Polytelis alexandrae*) – Vulnerable, southern whiteface *(Aphelocephala leucopsis*) – Vulnerable, Pilbara olive python *(Liasis olivaceus* subsp. *barroni*) – Vulnerable, and great desert skink *(Liopholis kintorei*) – Vulnerable. In addition, the field assessments also considered species classified as Priority by the Department of Biodiversity, Conservation, and Attractions (DBCA), such as the western pebble mound mouse (*Pseudomys chapmani*) – P4, and brush-tailed mulgara (*Dasycercus blythi*) – P4. Field surveys were undertaken during March, May, and September-October 2023, with species specific sampling comprising habitat and habitat feature assessments, ultrasonic and acoustic recordings, camera trap transects, targeted searches, and eDNA sampling. A comprehensive desktop assessment was conducted prior to the field surveys to identify previous records of the target species within the Survey Area and the local region.

Eleven broad fauna habitat types were recorded and mapped across the Survey Area, comprising Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Stony Plain (5.62%, 1,214.52 ha), Mulga Woodland (2.61%, 564.78 ha), Gorge/ Gully (2.28%, 491.71 ha), Minor Drainage Line (2.15%, 463.72 ha), Major Drainage Line (1.94%, 419.49 ha), Cleared/ Disturbed (1.90%, 411.53), Rehabilitated Areas (1.62%, 349.44 ha), Calcrete Plain (3.40%, 734.64 ha), and Breakaway/ Cliff (0.81%, 174.27 ha). Seven of these provide critical habitat for significant species; Drainage Area/ Floodplain, Stony Plain, Mulga Woodland, Gorge/ Gully, Minor Drainage Line, Major Drainage Line, and Breakaway/ Cliff.

Three MNES species were recorded within the Survey Area during the current survey, northern quoll, ghost bat, and Pilbara olive python. Two additional significant fauna species, not listed as MNES, were recorded from secondary evidence, brush-tailed mulgara (*Dasycercus blythi*) and western pebble-mouse mound (*Pseudomys chapmani*); both are listed as Priority 4 on the Department of Biodiversity, Conservation, and Attractions list.

Northern quoll was recorded on 12 occasions from secondary evidence (scats) in the Northeast Corner project area within the Survey Area. The Gorge/ Gully, Breakaway/ Cliff, and Major Drainage Line habitats provide critical habitat for the species within the Survey Area. Potential supporting habitat for the northern quoll occurs in the Hillcrest/ Hillslope, Drainage Area/ Floodplain, and Minor Drainage Line habitats, that are proximal (within 35 hectares (ha), as defined in BHP's Vertebrate Fauna Survey guidance) to critical habitat. Within the local area, the species is only known from a small number of records, primarily within the vicinity of Rio Tinto's Gudai-Darri mine, approximately 21.5 km north-east of the Survey Area, and in the Hope Downs mine area approximately 5 km to the west. It is possible the species occurs at low abundance and its occurrence may be restricted to Northeast Corner. The scarcity and concentration of records suggests the species on a regional scale is unlikely to be reliant on the habitats within the Survey Area for long-term persistence; however, the habitat is considered critical for individual persistence within the Survey Area. Based on the results of the current survey, the occurrence of northern quoll within Survey Area is unlikely to represent or contribute to an important population.

Ghost bat was recorded on 18 occasions during the current survey, including a single active individual recorded in cave CJIN-33, scat records from 13 caves, three records from ultrasonic recorders, and one detection from eDNA sampling. Thirty-four caves were recorded in the Survey Area, of which three (CJIN-13, CJIN-14, and CJIN-33) were classified as Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts, eight as Category 3 (diurnal roost caves with occasional occupancy), and 14 as Category 4 (nocturnal roost caves with opportunistic usage). The remaining nine caves are unlikely to be used by ghost bat. Additional caves recorded in historic surveys were unable to be located due to inaccurate site locations and/or location in unsuitable habitat and were not verified using current guidance. Critical foraging and dispersal habitat within the Survey Area is provided by Drainage Area/ Floodplain, Hillcrest/ Hillslope, Mulga Woodland, Stony Plain, Gorge/ Gully, Minor Drainage Line, and Major Drainage Line, when proximal (<12 km) to critical (i.e. Category 1–2, and 3 when occurring as part of an apartment block) roosting caves. Records of ghost bat were made in Drainage Area/ Floodplain and Major Drainage Line (via ultrasonic and eDNA records) and indicates foraging and/or dispersal potential where foraging structures (tree perches) and suitable vegetation structure and density occurs. Due to the presence of three Category 2 roosts and critical foraging habitat, the individuals present in

the Survey Area contribute to a key population for breeding, and form part of the broader meta-population of ghost bats in the Pilbara. The individuals present likely contribute to the high genetic diversity present in the region, potentially linking larger groupings at South Flank/Mining Area C and Western Ridge and Jimblebar through dispersing individuals. As such, the individuals present in the Survey Area contribute to a population aligning with the DoE (2013b) definition of 'important'.

Pilbara olive python was recorded on eight occasions during the current surveys, comprising two active individuals, five records of scats, and one detection from eDNA sampling. Thirty-five water features (historical and current survey) are recorded in the Survey Area; the permanent water features of Weeli Wolli Springs, including Ben's Oasis, and Weeli Wolli Creek downstream of the Hope Downs discharge point is considered critical habitat, with the ephemeral pools in Gorge/ Gully habitat considered supporting habitat. Overall, the Gorge/ Gully, Breakaway/ Cliff, and Major Drainage Line provide critical habitat for the Pilbara olive python; areas of Major Drainage Line, and Minor Drainage Line areas that don't contain permanent or ephemeral water features are classified as supporting habitat, particularly in areas where they provide connectivity between areas of critical habitat (i.e. Gorge/ Gully). Hillcrest/Hillslope and Drainage Area/ Floodplain is considered supporting habitat where in the home range (88 – 450 ha) of critical habitat and where important microhabitats are present. The Pilbara olive python has been recorded multiple times within the Survey Area across its extent, and the Survey Area contains both critical and supporting habitat. Based on this, the individuals present would be considered to contribute to an 'important population'.

No grey falcons were recorded during the current survey. The Major Drainage Line is considered critical habitat for grey falcon, with supporting habitat within the Drainage Area/ Floodplain and Minor Drainage Line. The grey falcon is considered a single interbreeding population across its distribution, therefore if present, grey falcon occurrence within the Survey Area would contribute to an important population.

Pilbara leaf-nosed bat has been previously recorded from ultrasonic recording in the Survey Area; however, no Pilbara leaf-nosed bat or evidence of the species' occurrence was recorded during the current survey. Of the 34 caves recorded in the Survey Area, only eight are classified as suitable for use by the species (all classified as non-critical Category 4 nocturnal refuges). Currently, no habitat within the Survey Area is considered critical foraging habitat for the Pilbara leaf-nosed bat, as it is not within 20 km of any currently known diurnal roosts. Presently, the Gorge/ Gully, Breakaway/ Cliff, and Major Drainage Line habitats provide potential supporting foraging and dispersal habitat for the species and tend to contain important habitat features such as nocturnal refuges and water features.

Other supporting foraging and dispersal habitat for Pilbara leaf-nosed bat within the Survey Area is provided by Hillcrest/ Hillslope, Stony Plain, Drainage Area/ Floodplain, and Mulga Woodland. The Pilbara population is regarded as a single interbreeding population and therefore, the entire population of Pilbara leaf-nosed bat is classified as an 'important population'. Based on the results of the current surveys, the Survey Area is considered unlikely to represent a significant area for Pilbara leaf-nosed bats due to the absence of Category 1, 2 and 3 roosts.

No southern whiteface records were made during the current survey and there is a scarcity of records in the broader vicinity due to the location on the northern edge of its distribution within the "species or species habitat may occur". Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Minor Drainage Line (2.15%, 463.72 ha), Mulga Woodland (2.61%, 564.76 ha), and Stony Plain (5.62%, 1,214.52 ha) habitats within the Survey Area are likely to provide suitable nesting, foraging and dispersal for the species. As the Survey Area currently occurs on the periphery of southern whiteface distribution, any records present may contribute to an important population of the species; however, the distribution of southern whiteface in the Pilbara may not be well defined.

The habitat present in the Survey Area is considered supporting or marginal for both the greater bilby (lack of extensive sand plain) and night parrot (lack of large, long-unburnt hummocks and chenopod shrubland). The Survey Area is outside the modelled distribution for both the princess parrot and great desert skink and there is an absence of records in the local vicinity. As such, these species are not reliant on the habitats present in the Survey Area and are considered unlikely to occur.

Two other significant species were recorded in the Survey Area, the western pebble-mound mouse and brush-tailed mulgara. Thirty-seven pebble-mounds were recorded, including 29 classified as active mounds, four as recently inactive mounds, and five as inactive mounds. The species is likely to occur as a resident throughout the Survey Area, in Hillcrest/ Hillslope and Stony Plain habitats. Three brush-tailed mulgara burrows (one active and two inactive) were recorded in a sandy area of Drainage Area/ Floodplain habitat within the Jinidi part of the Survey Area. These are the first records of this species from the Survey Area. The species may occur as a resident in small sections of the Survey Area, in Drainage Area/ Floodplain and Stony Plain habitats. These species occurrences within the Survey Area are unlikely to represent or form part of important populations and the species are not likely to be reliant upon the Survey Area, or habitat within, for the long-term persistence at a local or regional scale. Other significant species are identified in the desktop assessment as recorded within the vicinity of the Survey Area (e.g. peregrine falcon, eastern osprey, fork-tailed swift, Pilbara barking gecko, and Gane's blind snake); however, the Survey Area and habitats within are

unlikely to be relied upon for long-term persistence of these species at a local and/or regional scale.

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1 Introduction

1.1 Background

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake targeted significant vertebrate fauna surveys. These surveys were undertaken within the Jinidi, Northeast Corner and South Parmelia project areas, and the Weeli Wolli Spring Priority Ecological Community (PEC), including Ben's Oasis (hereafter referred to as the Survey Area; Figure 1.1). The Survey Area is located approximately 70 kilometres (km) north-west of Newman and covers an area of approximately 21,606.67 hectares (ha).

1.2 Survey Objectives

The overarching objective of this assessment was to determine the presence, or likely presence of significant vertebrate fauna species within the Survey 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)), and species listed under the Biodiversity Conservation Act 2016 (BC Act) and as Priority by the Department of Biodiversity, Conservation, and Attractions (DBCA) (Appendix A). The MNES species targeted for this survey were:

- northern quoll (*Dasyurus hallucatus*) – Endangered;
- greater bilby (*Macrotis lagotis*) – Vulnerable;
- ghost bat (*Macroderma gigas*) – Vulnerable;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable;
- night parrot (*Pezoporus occidentalis*) – Endangered/ Critically Endangered;
- princess parrot (*Polytelis alexandreae*) – Vulnerable;
- southern whiteface (*Aphelocephala leucopsis*) – Vulnerable;
- grey falcon (*Falco hypoleucos*) – Vulnerable;
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable; and
- Great desert skink (*Liopholis kintorei*) – Vulnerable.

1.3 Compliance

This assessment was carried out in accordance with the following guidelines and recommendations developed by the relevant state and federal regulatory bodies, relevant survey-specific license conditions and, where relevant, BHP WAIO procedures:

- BHP WAIO (2023d) Vertebrate fauna surveys in Western Australia procedure (Document Number: SPR-IEN-EMS-012) Version: 12.0
- BHP WAIO (2023c) Biological survey spatial data requirements (SPR-IEN-EMS-015) Version 12.0
- Department of Biodiversity, Conservation and Attractions [DBCA] (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia
- Department of Environment, Water, Heritage and the Arts [DEWHA] (2010a) Survey guidelines for Australia's threatened bats
- DEWHA (2010b) Survey guidelines for Australia's threatened birds
- Department of the Environment (2016) EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus)*
- Department of Parks and Wildlife (2017) Interim guidelines for the preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia
- DoE (2013a) Significant impact guidelines 1.1: Matters of National Environmental Significance
- Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] (2011a) Survey guidelines for Australia's threatened mammals
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles
- DEWHA (2010c) Survey guidelines for Australia's threatened frogs
- Environmental Protection Authority [EPA] (2020b) Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment
- EPA (2020a) Statement of environmental principles, factors and objectives
- EPA (2016) Environmental factor guideline: Terrestrial fauna
- TSSC (2016b) Conservation advice: *Macroderma gigas*, ghost bat
- TSSC (2020) Conservation advice: Falco hypoleucos, grey falcon
- TSSC (2016c) Conservation advice: *Rhinonicteris aurantia* (Pilbara form), Pilbara leaf-nosed bat
- TSSC (2016b) Conservation advice: *Macroderma gigas*, ghost bat
- TSSC (2008) Approved conservation advice for *Liasis olivaceus barroni* (Olive Python – Pilbara subspecies).

700000 712000 724000 736000 748000

7464000

7452000

7440000

AM 7000266

E 4700628

L 4700095

AML7000281

AML7000249

P 4701611

E 4701540

Weeli Wolli Creek PEC

Northeast Corner

AML7000244

Jinidi

South Parmelia

L 4700092

Ben's Oasis

Ben's Oasis

Great Northern Hwy

West Angelas Rd

Wee/ Wolli Rd

Eagle Pool Rd

IBRA Region
Pilbara

IBRA Subregion
Chichester
Fortescue

Hamersley
Roebourne

Port Hedland
Karratha
Karijini National Park
Newman

LEGEND

Survey Area
Live Mining Tenement
PEC Boundary

Local Road
State Road
Rail

Pastoral Station or Lease
Juna Downs Station
Marillana Station

Biologic

Scale 1:150,000

0 2 4 6 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024

Port Hedland
Karratha
Exmouth
Newman
Carnarvon

BHP WAIO
Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 1.1: Survey Area and regional context

2 Existing Environment

2.1 Biogeography

The Survey Area is located within the Hamersley (PIL03) subregion of the Pilbara bioregion (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, 2003). Vegetation comprises mulga low woodland over bunch grasses on fine-textured soils dominant in valley floors, while skeletal soils of the ranges are dominated by snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* (Kendrick, 2003). Drainage is typically into the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick, 2003).

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, 2023; 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, 2003). The Survey Area occurs across nine regolith (1:500,000) geology units (Figure 2.1). The Marra Mamba Iron Formation is the bedrock geology most predisposed to forming deep caves in the Pilbara suitable for use by ghost bats and Pilbara leaf-nosed bats; however, the larger hills of Brockman Iron Formation also form suitable caves (Armstrong & Anstee, 2000; Cramer *et al.*, 2022). Both of these bedrock geologies are present within the Survey Area.

710000 720000 730000 740000

7460000 7450000

Rr-fh-PIP X-PIP Rt-PIP Rt-PIP Rr-kc-PIP Rt-PIP X-PIP Rt-PIP W-PIP X-PIP West Angelas Rd A-PIP Ac-PIP C-PIP Rr-kc-PIP C-PIP Aa-PIP X-PIP Rr-f-PIP C-PIP Rr-f-PIP Rt-PIP X-PIP C-PIP A-PIP X-PIP C-PIP Rr-f-PIP

Regolith Geology

- A-PIP; Alluvial/fluvial unit, PIP
- Aa-PIP; Alluvial/fluvial unit, PIP
- Ac-PIP; Alluvial/fluvial unit, PIP
- C-PIP; Colluvial unit, PIP
- Rr-f-PIP; Residual or relict unit, PIP
- Rr-fh-PIP; Residual or relict unit, PIP
- Rr-kc-PIP; Residual or relict unit, PIP
- Rt-PIP; Residual or relict unit, PIP
- Rt-fl-PIP; Residual or relict unit, PIP
- W-PIP; Sheetwash unit, PIP
- X-PIP; Exposed unit, PIP

LEGEND

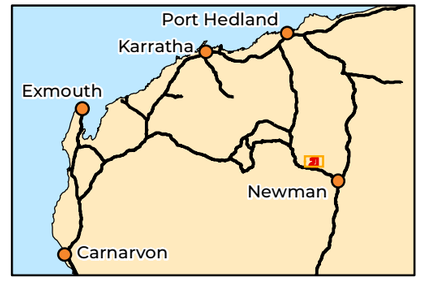
- Survey Area
- Local Road
- Rail

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 2.1: Geology of the Survey Area

2.4 Soils

The CSIRO (2009) Atlas of Australian Soils described and mapped the soils of Australia following Bettany *et al.* (1967). The Survey Area occurs over two soil units, Fa13 (16,844.64 ha, 77.96%), and Fa14 (4,762.02 ha, 22.04%) (Figure 2.2). The dominant soil unit, 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 unit is Fa14, is 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).

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.

Eleven land systems occur within the Survey Area, the dominant being the Newman land system, which covers approximately 60.02% (12,967.25 ha) of the Survey Area (Figure 2.3; Table 2.1). The Newman land system is defined as “rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands” (van Vreeswyk *et al.*, 2004). The second most dominant system is the Platform land system, accounting for 22.97% (4,962.61 ha) of the Survey Area and characterised as “dissected slopes and raised plains supporting shrubby hard spinifex grasslands”. The remaining nine land systems account for the remaining 17.02% (3,676.81 ha) and include Boolgeeda, Oakover, Egerton, Mckay, River, Rocklea, Spearhole, Robe, and Calcrete (Figure 2.3; Table 2.1).

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.

Table 2.1: Land systems of the Survey Area

Land system	Land type	Description	Extent in Survey Area	
			Ha	%
Newman (New)	Hills and ranges with spinifex grasslands	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	12,967.25	60.02
Platform (Pla)	Stony plains with spinifex grasslands	Dissected slopes and raised plains supporting hard spinifex grasslands.	4,962.61	22.97
Boolgeeda (Bgd)	Stony plains with spinifex grasslands	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	1,162.02	5.38
Oakover (Oak)	Hills and ranges with spinifex grasslands	Breakaways, mesas, plateaux, and stony plains of calcrete supporting hard spinifex shrubby grasslands.	862.93	3.99
Egerton (Ege)	Stony plains with spinifex grasslands	Highly dissected hardpan plains supporting mulga shrublands and hard spinifex hummock grasslands.	782.84	3.62
Mckay (Mck)	Hills and ranges with spinifex grasslands	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.	415.32	1.92
River (Riv)	Water course and drainage systems	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.	234.03	1.08
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.	167.85	0.78
Spearhole (Sph)	Stony plains with spinifex grasslands	Gently undulating gravelly hardpan plains and dissected slopes supporting groved mulga shrublands and hard spinifex.	31.24	0.14
Robe (Rob)	Hills and ranges with spinifex grasslands	Low plateaux, mesas and buttes of limonite supporting soft spinifex and occasionally hard spinifex grasslands.	20.58	0.10
Calcrete (Ca)	Low calcrete platforms and plains	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	<0.1	<0.1
Total			**21,606.67**	**100**

710000
720000
730000
740000
7460000
7450000
West Angelas Rd

LEGEND

Survey Area
Local Road
Rail

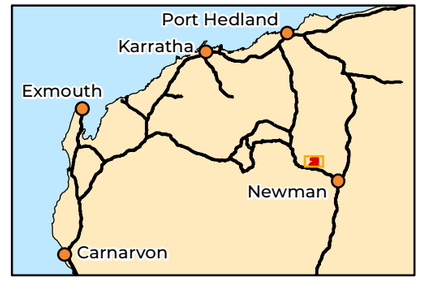
Soil Unit
Fa13
Fa14

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 2.2: Soils of the Survey Area

710000
720000
730000
740000
7460000
7450000
West Angelas Rd

LEGEND

Survey Area
Local Road
Rail

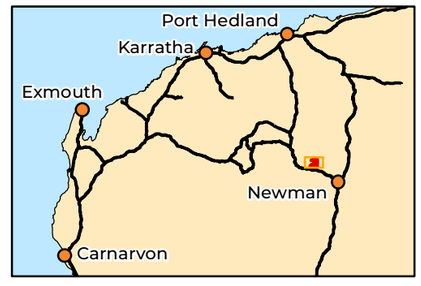
Land System
Boolgeeda System
Calcrete System
Egerton System
Kumina System
McKay System
Newman System
Oakover System
Pindering System
Platform System
River System
Robe System
Rocklea System
Spearhole System
Wannamunna System

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 2.3: Land systems of the Survey Area

2.6 Surface Hydrology

Weeli Wolli Creek crosses the Survey Area in the north-west and south-west corners. Under natural conditions, Weeli Wolli Creek had permanent surface water at Weeli Wolli Springs and would otherwise flow after large rainfall events (typically twice per year), followed by some years of no flow (EPA, 2018). Since 2007, these hydrological processes have changed due to cumulative dewatering and discharge of surplus dewater to the creek from adjacent mining operations in the catchment (EPA, 2018). Sections of Weeli Wolli Creek downstream of the Gabion discharge point associated with Hope Downs 1 operations now experience perennial flows due to discharge of mine dewatering, that drain into the Fortescue River Valley to the north (EPA, 2018). Although Weeli Wolli Springs historically had permanent water, the extent of permanent water has increased in extent due to this discharge. A series of irrigation spurs within the initial parts of the Weeli Wolli Springs (prior to the gabion) also occur (Rio Tinto, 2023). The area of historically permanent flow and pools in Weeli Wolli Creek is classified as a Priority Ecological Community (PEC) (EPA, 2018), due to the unique groundwater dependent vegetation and habitat for faunal communities of high biodiversity value (including stygofauna and microbats) . This PEC also occurs at a water pool called Ben's Oasis, located 20 km upstream to Weeli Wolli Spring, included in the current Survey Area. Ben's Oasis is maintained by groundwater aquifer.

Two other major watercourses, Marillana Creek and Yandicoogina Creek are located approximately 12 km directly north of the Survey Area (Figure 2.4). Marillana Creek and Yandicoogina Creek are important sources of surface water runoff to Weeli Wolli Creek. Both 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 is also influenced by dewatering and discharge from BHP and Rio Tinto Iron Ore's mining operations.

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.

Two vegetation associations occur within the Survey Area (Figure 2.5; Table 2.2). The dominant vegetation association is HAMMERSLEY-82 which covers approximately 66.40% (14,347.89 ha) of the Survey Area and comprises hummock grasslands and low snappy gum (*Eucalyptus leucophloia*) trees. The mulga woodlands of the HAMMERSLEY-18 vegetation association largely occur on the flats between the ranges and can be sheet flow dependent.

Table 2.2: Vegetation associations within the Survey Area

Vegetation Association	Description	Extent in Survey Area	
		Ha	%
HAMMERSLEY-82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	14,347.89	66.40
HAMMERSLEY-18	Low woodland; mulga (*Acacia aneura*)	7,258.78	33.60
Total		**21606.67**	**100**

2.8 Land Use and Tenure

The dominant land uses in the subregion including grazing, native pastures, conservation, urban areas, and mining (Kendrick, 2003), as well as recreation and tourism. Several mines and their associated infrastructure are currently active in the central Pilbara in proximity to the Survey Area e.g. Hope Downs 1, 2 and 4, South Flank, and Mining Area C. The BHP WAIO-managed Marillana pastural lease occurs immediately adjacent to the north of the Survey Area (excluding Weeli Wolli Creek). Railway infrastructure associated with these mines run through South Parmelia in the southern part of the Survey Area. Karijini National Park occurs approximately 60 km to the west of the Survey Area.

710000
720000
730000
740000
7460000
7450000
West Angelas Rd

LEGEND

Survey Area
Local Road
Rail

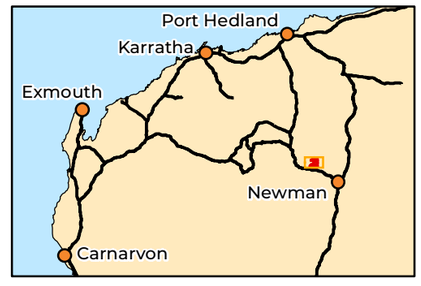
Land System
Boolgeeda System
Calcrete System
Egerton System
Kumina System
McKay System
Newman System
Oakover System
Pindering System
Platform System
River System
Robe System
Rocklea System
Spearhole System
Wannamunna System

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 2.3: Land systems of the Survey Area

710000
720000
730000
740000
7460000
7450000
West Angelas Rd

LEGEND

Survey Area
Local Road
Rail

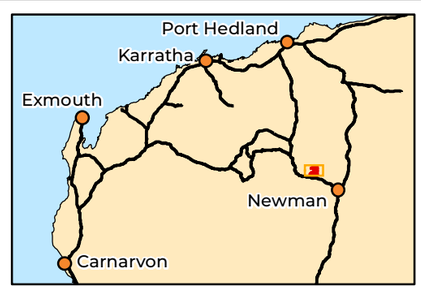
System Association
Hamersley 18
Hamersley 29
Hamersley 82

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 2.5: Pre-European vegetation associations of the Survey Area

3 Desktop Assessment

3.1 Methods

A desktop assessment comprising database searches and a literature review was undertaken to determine current distribution and records of the ten target MNES species and other significant vertebrate fauna potentially occurring within the Survey Area (Table 3.1; Table 3.2).

Five fauna databases were searched (Table 3.1), three contain information on all vertebrate species previously recorded (ALA, 2023a; BirdLife Australia, 2023; DBCA, 2023a), one identifies species of significance previously recorded (DBCA, 2023b), and one identifies species of significance known or likely to occur within the region based on modelled distribution (DCCEEW, 2023b).

Thirty-three reports were reviewed (18 detailed surveys, seven targeted surveys, six basic surveys, one desktop, and one monitoring report) (Table 3.2; Figure 3.1; Appendix B). Sixteen of these overlapped with a portion of the Survey Area, and 17 assessments were undertaken within 20 km of it (Table 3.2; Figure 3.1).

Table 3.1: Databases searched

Database	Data Access/ Receival Date	Search Area
DBCA (2023b) NatureMap	March 2023	Approximate central point of the Survey Area (-22.9926 S, 119.2674 E) with a 40 km buffer
DBCA (2023b) Threatened and Priority Fauna Database	Feb 2023	
BirdLife Australia (2023) Birdata	March 2023	
DCCEEW (2023b)Protected Matters Search Tool	March 2023	
ALA (2023a) Atlas of Living Australia	March 2023	

Table 3.2: Literature reviewed

Report	BHP WAIO Survey ID	Survey Type	Distance from Survey Area
Biologic (2011b) Jinidi targeted northern quoll survey	-	Targeted	Within Survey Area
Biologic (2011c) Jinidi vertebrate fauna survey	1001	Targeted	Within Survey Area
Biota (2013b) South Parmelia Level 2 vertebrate fauna survey	1224	Detailed	Within Survey Area
Ecologia (2006a) Jirridi biological survey summary report	-	Basic	Within Survey Area

Report	BHP WAIO Survey ID	Survey Type	Distance from Survey Area
Ecologia (2006b) Jirridi terrestrial vertebrate fauna survey.	497	Detailed	Within Survey Area
ENV (2010b) Jinayri access road vertebrate fauna survey	499	Detailed	Within Survey Area
Onshore and Biologic (2009) South Parmelia exploration leases biological survey	121	Basic	Within Survey Area
Ecologia (1998b) Weeli Wolli creek biological assessment survey	101	Detailed	Intersects Survey Area
Biota (2013a) Jinidi to Mindy level 1 fauna survey	1122	Basic	Intersects Survey Area NE
Ecologia (1998b) Weeli Wolli Creek biological assessment survey.	101	Detailed	Intersects Survey Area W
ENV (2008b) Jinayri vertebrate fauna assessment.	1010	Detailed	Intersects Survey Area W
ENV (2009) Newman to Yandi transmission line terrestrial vertebrate fauna assessment	444	Basic	Intersects Survey Area
ENV (2010a) Jinayri Access Road vertebrate fauna survey.	499	Detailed	Intersects Survey Area
Biologic (2010) East Packsaddle Level 1 vertebrate fauna study	354	Basic	Intersects Survey Area N
Biologic (2011a) Area C and surrounds vertebrate fauna survey	1008	Detailed	Intersects Survey Area N
Outback Ecology (2010) Area C to Jinayri to Mount Newman railway terrestrial vertebrate fauna survey.	366	Detailed	Intersects Survey Area
Biologic (2012) Jinidi to Mainline vertebrate fauna survey.	1065	Detailed	Borders Survey Area N
Biota (2012) South Flank to Jinidi level 2 fauna survey.	1093	Detailed	Borders Survey Area W
Onshore (2017) Flora and Vegetation and Vertebrate fauna survey of the Newman to MAC powerline corridor.	10137	Basic	Borders Survey Area S and W
Astron (2019) Hope Downs 2 Proposal fauna survey.	-	Detailed	5 km E

Report	BHP WAIO Survey ID	Survey Type	Distance from Survey Area
Biota (2005) Fauna habitats and fauna assemblage of the FMG stage B rail corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas mine areas	1242	Detailed	10 km NE
ENV (2007) Area C R-Deposit fauna assessment	349	Detailed	10 km W
Outback Ecology (2008) Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial vertebrate fauna assessment	344	Detailed	10 km W
Specialised Zoological (2008) Area C R-Deposit fauna assessment	340	Targeted	10 km W
Ninox (2009) A fauna survey of the proposed Hope Downs 4 Mining Area, near Newman, Western Australia	1243	Detailed	10 km SE
Biota (2015) Hope Downs Deposit targeted fauna survey.	-	Targeted	10 km W
Ecologia (1998a) Mining Area C Biological Survey	336	Detailed	15 km W
Biota (2010) Yandicoogina Junction South West and Oxbow fauna survey.	1187	Detailed	15 km N
Biologic (2013e) South Flank Targeted Northern Quoll Survey	1048	Targeted	15 km W
Biologic (2013b) Central Pilbara ghost bat population and roost assessment.	10037	Monitoring	15 km W
Biologic (2014) Mining area C desktop review of baseline information on vertebrate fauna	1269	Desktop	15 km W
Biologic (2013c) Marillana and surrounds targeted mulgara survey.	1226	Targeted	20 km N
Biologic (2017) Hamersley subregion ghost bat population and roost assessment: 2015 – 2016.	-	Targeted	20 km W

3.2 Results

The desktop assessment identified 349 vertebrate fauna species (50 mammals, 156 birds, 135 reptiles, and 8 amphibians). Twenty-nine are classified as significant species, including the ten target MNES species (Figure 3.2; Appendix B). The following eight species have previously been recorded within the Survey Area (including Weeli Wolli PEC) prior to the current survey:

- ghost bat (*Macroderma gigas*) – Vulnerable (EPBC Act and BC Act): 27 records;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable (EPBC Act and BC Act): one record;
- western pebble-mound mouse (*Pseudomys chapmani*) – Priority 4 (DCBA): 213 records;
- peregrine falcon (*Falco peregrinus*) – Specially Protected (BC Act): one record;
- fork-tailed swift (Apus pacificus) – Migratory (EPBC Act and BC Act): eight records;
- southern whiteface (*Aphelocephala leucopsis*) – Vulnerable (EPBC Act): one record;
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable (EPBC Act and BC Act): four records; and
- blind-snake (*Anilios ganei*) – Priority 1 (DCBA): two records.

680000

720000

760000

7480000

7440000

LEGEND

Survey Area

Biologic (2012) Jinidi to Mainline Vertebrate Fauna Survey

- Habitat Assessment
- Targeted Search
- Trapping Site

Biologic (2011b)

- Targeted Search

Biologic (2011a) Jinidi Northern Quoll Survey

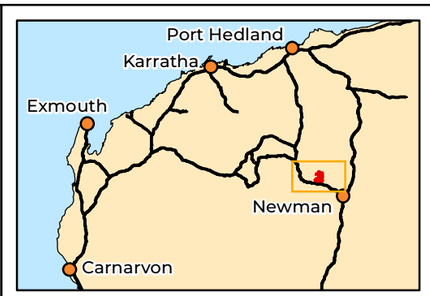
- Cage trap
- Camera trap
- Targeted Search
- Ultrasonic Recorder

Biologic

Scale 1:300,380

0 5 10 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO

Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 3.1: Previous surveys in the Survey Area

Citation

- Onshore Environmental Consultants (2017) Flora and Vegetation and Vertebrate fauna survey of the Newman to MAC powerline corridor
- 2015 - Biologic (2015) - Central Pilbara Ghost Bat Population and Roost Assessment: 2014
- 2014 - Biologic Environmental Survey (2014b) - Pilbara Regional Ghost Bat Review
- 2014 - Biologic Environmental Survey (2014a) - Mining Area C Desktop Review of Baseline Information on Vertebrate Fauna
- 2013 - Biota Environmental Sciences (2013c) - South Parmelia Level 2 Vertebrate Fauna survey
- 2013 - Biologic Environmental Survey (2013a) - Marillana and Surrounds Targeted Mulgara Survey
- 2013 - Biologic Environmental Survey (2013b) - South Flank Targeted Northern Quoll Survey
- 2012 - Biota Environmental Sciences (2012b) - South Flank to Jinidi Level 2 Vertebrate Fauna Survey
- 2012 - Biota Environmental Sciences (2012a) - Jinidi to Mindy Level 1 Fauna Survey
- 2011 - Biologic Environmental Survey (2011c) - Jinidi Vertabrate Fauna Survey
- 2011 - Biologic Environmental Survey (2011b) - Jinidi to Mainline Vertebrate Fauna Survey
- 2011 - Biologic Environmental Survey (2011a) - Area C and Surrounds Vertebrate Fauna Survey
- 2010 - ENV Australia (2010a) - Jinayri Access Road Vertebrate Fauna Survey
- 2009 - Onshore Environmental Consultants, Biologic Environmental Survey (2009) - Biological Survey South Parmelia Exploration Leases
- 2009 - ENV Australia (2009) - Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment
- 2009 - Outback Ecology Services (2009) - Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey
- 2009 - Ninox Wildlife Consulting (2009) - Fauna Survey of Proposed Hope Downs 4 Mining Area
- 2008 - Outback Ecology Services (2008) - Area C Deposit A, D, P1 and P3 Vertebrate Fauna Survey Outback Ecology
- 2008 - Specialised Zoological (2008) - Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment
- 2008 - ENV Australia (2008b) - Jinayri Vertebrate Fauna Assessment
- 2007 - ENV Australia (2007) - Area C Deposit R Fauna Assessment
- 2006 - Ecologia Environment (2006) - Jirridi Terrestrial Fauna Survey
- 2005 - Biota Environmental Sciences (2005) - 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.
- 2001 - Biologic Environmental Survey (2001) - Area C Packsaddle Vertebrate Fauna Assesssment
- 1998 - Ecologia Environment (1998a) - Mining Area C Biological Survey
- 1998 - Ecologia Environment (1998b) - Weeli Wolli Creek Biological Assessment Survey

Biologic

Table 3.3: Species of significance with the potential to occur over the Survey Area (records prior the current survey)

Species		Conservation Status				Recorded within Survey Area
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	
MAMMALS						
DASYURIDAE						
Dasycercus blythi	Brush-tailed mulgara			P4		
Dasyurus hallucatus	Northern quoll	EN	EN		EN	
MEGADERMATIDAE						
Macroderma gigas	Ghost bat	VU	VU		VU	•
MURIDAE						
Pseudomys chapmani	Western pebble-mound mouse			P4		•
RHINONYCTERIDAE						
Rhinonicteris aurantia	Pilbara leaf-nosed bat	VU	VU			•
THYLACOMYIDAE						
Macrotis lagotis	Greater bilby	VU	VU		VU	
BIRDS						
ACANTHIZIDAE						
Aphelocephala leucopsis	Southern whiteface	VU				•
ACCIPITRIDAE						
Elanus scriptus	Letter-winged kite			P4	NT	
Pandion haliaetus	Eastern osprey	MI	MI			
APODIDAE						
Apus pacificus	Fork-tailed swift	MI	MI			•
CHARADRIIDAE						
Charadrius veredus	Oriental plover	MI	MI			
FALCONIDAE						
Falco hypoleucos	Grey falcon	VU	VU		VU	
Falco peregrinus	Peregrine falcon		OS			•
HIRUNDINIDAE						
Hirundo rustica	Barn swallow	MI	MI			
LARIDAE						
Sterna anaethetus	Bridled tern	MI	MI			
Sterna nereis subsp. Nereis	Australian fairy tern	VU	VU		VU	•
MOTACILLIDAE						
Motacilla flava	Yellow wagtail	MI	MI			
PSITTACIDAE						

Species		Conservation Status				Recorded within Survey Area
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	
Pezoporus occidentalis	Night parrot	EN	CR		EN	
ROSTRATULIDAE						
Rostratula australis	Australian painted snipe	EN	EN		EN	
SCOLOPACIDAE						
Actitis hypoleucos	Common sandpiper	MI	MI			
Calidris acuminata	Sharp-tailed sandpiper	MI	MI		VU	
Calidris ferruginea	Curlew sandpiper	CR/MI	CR/MI		NT	
Calidris melanotos	Pectoral sandpiper	MI	MI			
Tringa glareola	Wood sandpiper	MI	MI			
Tringa nebularia	Common greenshank	MI	MI			
REPTILES						
CARPHODACTYLIDAE						
Underwoodisaurus seorsus	Pilbara barking gecko			P2		
PYTHONIDAE						
Liasis olivaceus subsp. barroni	Pilbara olive python	VU	VU			•
SCINCIDAE						
Liopholis kintorei	Great desert skink	VU	VU		VU	
TYPHLOPIDAE						
Anilios ganei	Gane's blind-snake			P1		•

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

Newman

ALA (2023) - Bird
- Southern Whiteface - VU

BHP (2023)

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

Reptile
- Pilbara olive python - VU

DBCA (2023)

Bird
- Grey falcon - VU

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

Reptile
- Pilbara olive python - VU

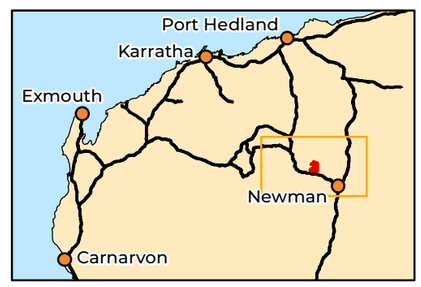
LEGEND
- Survey Area
- Desktop Assessment Area

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 3.2: Targeted MNES fauna records from the desktop assessment

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

DBCA (2023)

Bird
- Barking owl (southwest subpop.) - P3
- Letter-winged kite - P4
- Common greenshank - MI
- Common sandpiper - MI
- Fork-tailed swift - MI
- Osprey - MI
- Southern giant petrel - MI
- Peregrine falcon - MI

Mammal
- Brush-tailed mulgara - P4
- Western pebble-mound mouse - P4

Reptile
- Gane's blind snake (Pilbara) - P1
- Pilbara barking gecko - P2
- Unpatterned robust slider (Robertson Range) - P2

BHP (2023)

Bird
- Common greenshank - MI
- Common sandpiper - MI
- Eastern Osprey - MI
- Fork-tailed swift - MI
- Peregrine falcon - MI

Mammal
- Northern brushtail possum - VU
- Brush-tailed mulgara - P4
- Long-tailed dunnart - P4
- Western pebble-mound mouse - P4

Reptile
- Gane's blind snake (Pilbara) - P1
- Pilbara barking gecko - P2
- Spotted ctenotus - P2

Newman

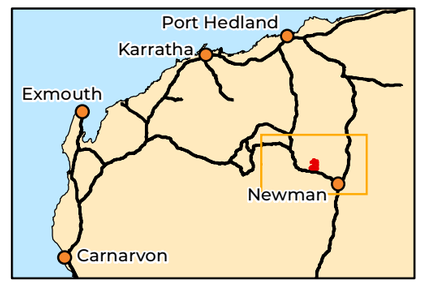
LEGEND
- Survey Area
- Desktop Assessment Area

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 3.3: Other significant fauna records from the desktop assessment

4 Methods

4.1 Survey Timing and Weather

Three targeted field surveys were undertaken from 21–31 March, 11–19 May, and 27 September – 3 October 2023 (Table 4.1). Observed weather conditions prior to and during all surveys are shown in Figure 4.1. Current and long-term climatic data is available from the Bureau of Meteorology (BoM) weather station at Newman Aero (Station 007176), located approximately 70 km south-west of the Survey Area (BoM, 2023). In the six months prior to trip 1 (March 2023), minimum and maximum temperatures recorded at Newman Aero were similar to or slightly higher than long-term averages for most months, with above average temperatures recorded in the two months prior to the trip (Figure 4.1). Temperatures during trip 1 were slightly higher than the long-term minimum and maximum averages, recording 1.6°C above and 2.8°C above respectively. Trip 2 recorded slightly lower minimum and maximum temperatures of 1°C and 2.9°C below the long-term averages for the month of May (Figure 4.1; Table 4.1). Trip 3 recorded slightly higher minimum and maximum temperatures of 0.5°C and 3.5°C above the long-term averages for September and October (Table 4.1).

Overall, rainfall was significantly lower for the six months prior to the survey with an average of 18 mm compared to the long-term average of 38.7 mm (Figure 4.1). March recorded 118.4mm total rainfall, including 108.6 mm during the last three days of the survey (Table 4.1). This is well above the long-term average of 40.8 mm for March. No rain was recorded during the trip 2 and 3 survey months which is well below the long-term averages of 19 mm for May, 4.7 mm for September and 5.7 mm for October (Figure 4.1; Table 4.1).

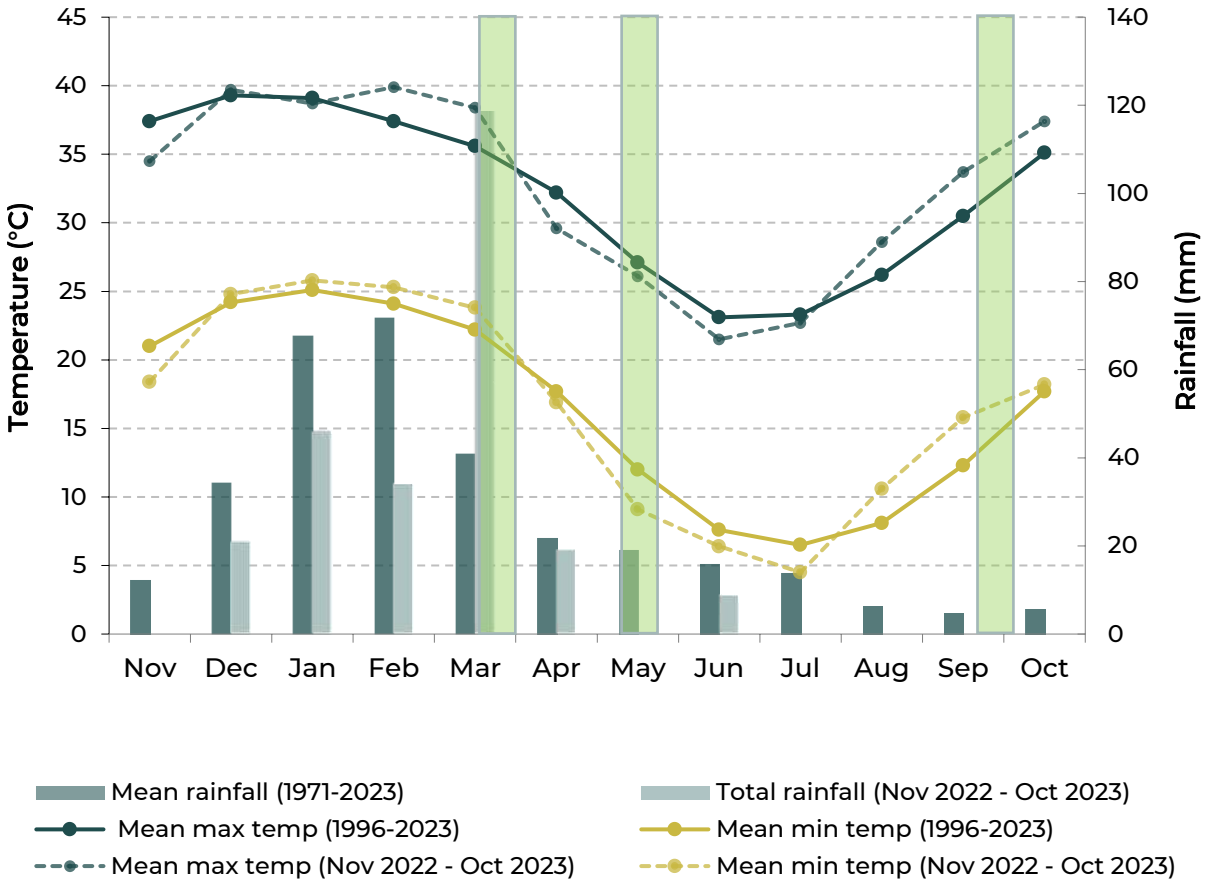


Figure 4.1: Current and long-term climatic data for Newman Airport (BoM, 2023) with approximate survey timing of the five trips shown in green shaded box

Table 4.1: Climatic conditions recorded at Newman Aero (BoM, 2023) during the three field surveys

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Trip 1			
21/03/2023	26.0	40.7	0
22/03/2023	24.2	39.3	0
23/03/2023	27.5	38.1	0
24/03/2023	24.2	39.3	0
25/03/2023	22.8	34.9	0
26/03/2023	21.4	34.8	2.0
27/03/2023	22.6	33.7	6.2
28/03/2023	23.7	34.0	0
29/03/2023	21.2	28.1	13.2
30/03/2023	21.5	29.7	85.6
31/03/2023	19.9	30.5	9.8
Trip 2			
11/05/2023	14.8	28.3	0

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
12/05/2023	9.2	28.6	0
13/05/2023	9.4	28.9	0
14/05/2023	12.8	23.1	0
15/05/2023	7.5	22.8	0
16/05/2023	6.3	27.8	0
17/05/2023	8.5	26.4	0
18/05/2023	7.2	25.2	0
19/05/2023	12.5	22.4	0
Trip 3			
27/09/2023	18.5	36.9	0
28/09/2023	18.3	37.2	0
29/09/2023	15.0	38.1	0
30/09/2023	18.5	37.7	0
01/10/2023	17.7	38.0	0
02/10/2023	15.9	33.0	0
03/10/2023	18.2	34	0

4.2 Personnel and Licences

The field surveys were completed by zoologists with extensive experience undertaking vertebrate fauna surveys in the Pilbara region. Personnel involved in the field survey are shown in Table 4.2.

The survey was conducted under the following licences and permits; Department of Primary Industries and Regional Development (DPIRD) *Animal Welfare Act 2002's* Licence to use animals for scientific purposes (Licence No. U244/2022-2024); Department Of Biodiversity, Conservation and Attractions Regulation 27 "Fauna Taking (Biological Assessment) Licence", issued to Chris Knuckey (licence number BA27000783); Department Of Biodiversity, Conservation and Attractions "Authorisation to Take or Disturbed Threatened Species" issued to Chris Knuckey (authorisation number TFA 2223-0170); and Murdoch University Animal Ethics Committee permit RW3354/21.

Table 4.2: Survey personnel and experience

Name	Qualification	Experience	Trip 1	Trip 2	Trip 3
Claire Brooks	BSc (Hons) Conservation Biology and Zoology	11 years' EIA (consulting) 14 years' field survey 14 years' vertebrate zoology/ ecology	•	•	•

Name	Qualification	Experience	Trip 1	Trip 2	Trip 3
Thomas Rasmussen	-	18 years' EIA (consulting) 18 years' field survey 18 years' vertebrate zoology/ ecology		•	
Samantha Lostrom	BSc (Hons) Marine Biology and Zoology	5 years' EIA (consulting) 7 years' field survey 7 years' vertebrate zoology/ ecology	•		
Aleesha Turner	BSc Applied Science (Wildlife Biology) (Hons)	3 years' EIA (consulting) 5 years' field survey 5 years' vertebrate zoology/ ecology	•	•	•
Georgina Mattner	BSc Animal Ecology	2 years' EIA (consulting) 3 years' field survey 3 years' vertebrate zoology/ ecology		•	
Emma de Mamiel	BSc (Hons) Zoology & Marine Science	2 years' EIA (consulting) 4 years' field survey 9 years' vertebrate zoology/ ecology	•		
Stephen McGrath	BSc Environmental Science and Conservation Biology	7 years' EIA (consulting) 5 years' field survey 1 years' vertebrate zoology/ ecology		•	
Judy Dunlop	BSc Zoology	2 years' EIA (consulting) 18 years' field survey 18 years' vertebrate zoology/ ecology		•	

4.3 Habitat Assessments and Mapping

A total of 113 habitat assessments were undertaken in representative habitats across the Survey Area. The aim of these were 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 or variation in habitats occurred. The assessment were conducted using methodology and terminology prescribed by BHP WAIO (2023d). The characteristics recorded during the habitat assessments included:

- site information: location and photo;
- habitat: broad habitat type, landform, aspect, slope, soil type and availability, rocky outcropping presence and type;
- ground cover: rock size, vegetation litter and woody debris;
- vegetation: broad vegetation type, structure and dominant species;
- microhabitat: rocky cracks/ crevices, burrowing suitability, hollow presence and abundance, water presence; and
- condition: time since fire, disturbance, and overall habitat condition.

Fauna habitats were mapped at a scale of approximately 1:10,000 using data collected from the habitat assessments, previously completed fauna habitat and vegetation mapping within and adjacent to the Survey Area, disturbance and rehabilitation mapping (provided by BHP WAIO), and high-resolution aerial imagery, vegetation, topographical, geology and soil mapping as relevant.

4.3.1 Cave Assessments

Cave searching survey effort focussed on areas of habitat (i.e. Gorge/ Gully) most suitable for cave formation. Information recorded during each cave assessment was consistent with those attributes required by BHP WAIO (2023c), and included:

- entrance location and photograph;
- entrance shape, dimensions, position in the landscape, aspect and level of sun exposure;
- internal structure and dimensions including depth, floor slope, number and size of chambers;
- presence of water either within the cave or near its entrance; and
- presence or signs of bat use (such as remains, scats or feeding signs).

Each cave was categorised based on data from the cave assessments, including the presence of any target bat species via primary or secondary evidence (i.e. calls, scats and individual remains). The categories of cave significance for ghost bats followed the classifications defined by Bat Call (2021a) and as specified in BHP's guidance for Vertebrate Fauna Surveys in Western Australia (v12, BHP WAIO, 2023d):

- **Category 1** (maternity/ diurnal roost with permanent occupancy): Permanently occupied roost tending to have large fluctuating populations. Due to permanent presence maternity usage is assumed. Structurally, caves are often deep and dark with one or more elevated roosting chambers that provide a stable microhabitat. Critical for the ongoing presence of ghost bat in the area.
- **Category 2** (maternity/ diurnal roost with regular occupancy): Ghost bat presence regular, but not permanent/ continuous over long periods. Pregnant or pup-carrying individuals may be present. Similar to Category 1 caves, but often less complex, with only a single inner chamber and are often in less productive areas only used by the species periodically. Bats present for 25% to 75% but may be abandoned for weeks or months. Typically have several other caves, shelters and overhangs within a few hundred meters, which together make up an 'apartment block' grouping that supports the ongoing presence of the species. Critical for the ongoing presence of the species in the area.

- **Category 3** (diurnal roost with occasional occupancy): Diurnal roosts where the species roosts occasionally, or rarely. Structurally, less well-developed and often used as feeding sites (as evidenced by middens with food scraps) or temporary refuges. Scats and/or small food middens present but may be no evidence of roosting bats or observations of roosting not consistent. May facilitate long-distance movements of individuals more broadly across the landscape. When adjacent to Category 2 roosts, Category 3 caves are considered part of an 'apartment block' and therefore critical habitat for the ongoing presence of the species in the area. Where occurring in isolation, Category 3 caves are not considered critical habitat essential for the long-term viability of a local population.
- **Category 4** (nocturnal roost with opportunistic usage): Roosts used in at least an opportunistic manner by itinerant individuals and may comprise single visitations to longer periods including periods of rest or feeding during foraging. Includes majority of shallow caves, shelters and deep overhangs in the Pilbara. Not considered critical habitat.
- **Category 5** No usage by ghost bat.

For Pilbara leaf-nosed bats, cave significance followed the classifications defined by Bat Call (2021b):

- **Category 1** (permanent diurnal/ maternity roost): Maternity roosts where seasonal presence of young is proven. Often supporting presence of a large colony. Critical habitat for the daily and long-term survival of the species.
- **Category 2** (permanent diurnal roost): Diurnal roosts occupied year-round, often by smaller colonies to Category 1 roosts, without confirmed maternity usage (presence of young). Critical habitat for the daily and long-term survival of the species.
- **Category 3** (semi-permanent diurnal roost): Diurnal roost with occasional/ intermittent occupancy, not occupied year-round. May be used during the breeding cycle and may also facilitate long distant distance dispersal, particularly around autumn. Often occurring as a 'satellite' roost associated with nearby Category 1 and/or Category 2 roosts. Critical habitat for the long-term survival of the species.
- **Category 4** (nocturnal refuge): Roosts occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Not considered critical habitat for the species; however, important for persistence in a local area.

Further information on survey methods and categorisation is provided in Sections 6.2 and 6.4

4.3.2 Water Feature Assessment

Water feature assessments were conducted for any water features that were found within the Survey Area. The assessments were aimed to define and characterise the water features and identify their likelihood of supporting significant species (i.e. critical habitat for Pilbara olive python or water sources for Pilbara leaf-nosed bat). Water feature assessments were conducted and attributes assessed using attribute terminology prescribed by BHP WAIO (2023d). The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- dimensions: length, width, depth;
- water presence: above the surface, in the intermediate zone; and
- vegetation: obligate phreatophytes, emergent macrophytes.

Water features were assessed, and their persistence classified into three categories, comprising:

- permanent – fed by ground water and/or surface drainage, persisting year-round;
- ephemeral – fed by rainfall/ surface drainage following rainfall, persisting for long periods (i.e. several months) after rainfall; and
- temporary ephemeral – fed by rainfall/ surface drainage following rainfall, persisting for short periods (i.e weeks or less than three months) after rainfall.

The assessment of persistence was made at time of survey and is not based on long-term data, as such there is uncertainty in the categorisation.

Historical water features were assessed where water was present; some historical features are presumed incorrect due to the recorded habitat type and location and could not be located. Additional water features recorded by Biologic during targeted aquatic surveys (Biologic, in prep.) are included.

4.4 Targeted Searching and Sampling

Targeted searches were undertaken within areas considered to provide suitable habitat for significant species. Sampling methods undertaken during the survey were specific to each targeted species and comprised:

- targeted searches (including cave searches) for northern quoll, Pilbara leaf-nosed bat, ghost bat and Pilbara olive python;
- plot searches for greater bilby;
- ultrasonic recorders targeting Pilbara leaf-nosed bat and ghost bat;
- acoustic recorders targeting night parrot and other significant birds; and

- eDNA sampling of water features targeting primarily Pilbara olive python (Figure 4.2).

Detailed information on species-specific methods is provided in Section 6.

4.5 Opportunistic Fauna Records

Opportunistic fauna observations from direct observation or secondary evidence (e.g. burrows, scratchings, diggings, and scats) were documented for all species not previously recorded during the survey, rare species, significant species, or other fauna of interest.

4.6 Assessment of Significance

4.6.1 Fauna Habitats

For each MNES species, habitat was categorised as either providing critical (foraging, breeding, or roosting) habitat or supporting (foraging, roosting or dispersal) habitat, as per the DoE (2013b) definitions. The categorisation of critical and supporting habitat followed that of BHP WAIO (2023d). The presence or absence of habitat features, suitable connecting habitat (e.g. movement corridors), the influence of other habitats (i.e. caves, water features) occurring within and adjacent to the Survey Area and species records was also considered.

4.6.1.1 Bat foraging habitat classification

4.6.1.1.1 Ghost bat

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

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, 2020a).

As such, habitats within the Survey Area were classified as Critical, Supporting or Nil for ghost bat based on the following criteria:

1. Critical:
    a. Roosting habitat: Caves classified as Category 1 or 2.

b. Foraging habitat: Stony Plain, Mulga Woodland, Drainage Area/ Floodplain, Minor Drainage Line and Medium Drainage Line within 12 km of Category 1 or 2 caves.

2. Supporting: caves classified as Category 3 or 4 and Undulating Low Hills and Gorge/ Gully habitats.

4.6.1.1.2 Pilbara leaf-nosed bat

For Pilbara leaf-nosed bat, foraging habitat was classified according to Bat Call (2021b) Habitat Ratings (HR):

- **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).

4.6.2 Significances 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 Survey Area formed part of or contributed to "populations important for the long-term survival of the northern quoll". These are populations that are (DoE, 2016):

- 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, southern whiteface, grey falcon, princess parrot, Pilbara olive python and great desert skink (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 (2013a), specifically whether their occurrence in the Survey 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, 2013a):

- 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 and ghost bat, the entire Pilbara is suggested to represent an 'important population' (Bat Call, 2021a, 2021b; TSSC, 2016c). Thus, the significance of occurrence was based on the presence of critical roosting (i.e. Category 1–3 roosts) habitat.

For the night parrot, the significance of occurrence was based on definitions by the DoE (2013a), 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.

4.7 Constraints and Limitations

The EPA (2020b) outlines several potential limitations to vertebrate fauna surveys. These aspects are assessed and discussed in Table 4.3 below. No major limitations or constraints were identified for the three survey stages.

Table 4.3: 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 surrounding region (e.g. Mining Area C, South Flank, Hope Downs mines) which provided context for the current surveys. Sixteen surveys have been undertaken within or intersecting the Survey Area. These surveys were undertaken more than 10 years ago; however, they provide additional context on habitat suitability for significant species and previous records. Most previous survey results were available for review.

Potential limitation or constraint	Constraint	Applicability to this survey
Competency/ experience of the survey team	No	The field personnel involved in the survey and analyses are experienced in undertaking fauna surveys of similar nature, including with the significant species targeted during the survey.
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). Sampling for target species was undertaken in accordance with relevant guidelines and recommendations.
		Northern quoll – DoE (2016)
		Greater bilby – DoE (2013a)
		Ghost bat – Bat Call (2021a)
		Pilbara leaf-nosed bat – Bat Call (2021b)
		Night parrot – DoE (2013a)
		Southern whiteface - DoE (2013a)
		Princess parrot - DoE (2013a)
		Grey falcon - DoE (2013a)
		Pilbara olive python – DoE (2013a), no nocturnal searches (optimal sampling method) were undertaken due to safety limitations (distance to both the Survey Area (driving risk) and emergency services).
		Great desert skink - DoE (2013a)
Timing, weather, and season	No	Field surveys occurred over appropriate or optimal periods for sampling the target species.
Disturbances (e.g. fire or flood)	No	No disturbances were observed during the survey periods that may have impacted the outcomes of the survey.
Proportion of fauna identified	No	Most fauna observed during the field surveys were identified to species level. The grey falcon record remain unconfirmed from the brief visual observation in the field. Fauna recorded via camera traps and ultrasonic and acoustic recorders were identified by technical personnel with relevant expertise.
Adequacy of the survey intensity and proportion of the survey achieved	Partial	The sampling methods and survey intensity was high and focussed on the species of interest. Some access restrictions were experienced during trip 1 and trip 3 due to heritage exclusion areas, particularly in the Northeast Corner and some areas of Jinidi. No nocturnal searches for Pilbara olive python were undertaken due to safety limitations (distance to Survey Area and emergency services). Several low-value caves from the database searches could not be located or were in habitat unsuitable to support caves (e.g. low Hillcrest/ Hillslope).

Potential limitation or constraint	Constraint	Applicability to this survey
Remoteness or access issues	No	The majority of the Survey Area was accessible either by vehicle or on foot. A helicopter was utilised during two surveys (trip 2 and 3) to access more remote sampling sites (particularly Northeast Corner) and for ease of access across the Survey Area.
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.

720000 724000 728000 732000 736000 740000

7468000 7464000 7460000 7456000

VJIN-19 VJIN-100 VJIN-70 VJIN-62
VJIN-21 VJIN-01 VJIN-66 VJIN-78 VJIN-72
VJIN-02 VJIN-03 VJIN-60
VJIN-61
VJIN-05 VJIN-71
VJIN-22 VJIN-74 VJIN-64
VJIN-09 VJIN-07 VJIN-79 VJIN-77 VJIN-63
VJIN-90 VJIN-95 VJIN-65
VJIN-73 VJIN-105
VJIN-69
VJIN-04 VJIN-98 VJIN-68 VJIN-91
VJIN-99
VJIN-96
VJIN-06 VJIN-59
VJIN-57
VJIN-11 VJIN-82 VJIN-58
VJIN-56
VJIN-08
VJIN-10 VJIN-55
VJIN-89
VJIN-13 VJIN-17 VJIN-92
VJIN-81 VJIN-110
VJIN-111 VJIN-28 VJIN-107

LEGEND

Survey Area

Site Type

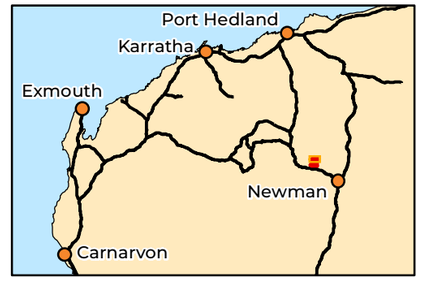
- Acoustic Recorder
- Camera Trap
- Habitat Assessment
- Ultrasonic Recorder
- eDNA
- Traverse

Biologic

Scale 1:60,000

0 1 2 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 4.2a: Sample sites and traverses

720000 724000 728000 732000 736000 740000

7456000 7452000 7448000 7444000

West Angelas Rd

VJIN-13 VJIN-111 VJIN-112 VJIN-24 VJIN-15 VJIN-37 VJIN-12 VJIN-30 VJIN-47 VJIN-18 VJIN-16 VJIN-86 VJIN-88 VJIN-102 VBEN-01 VJIN-52 VJIN-106 VJIN-75 VJIN-49 VJIN-97 VJIN-39 VJIN-43 VJIN-41 VJIN-85 VJIN-84 VJIN-87 VJIN-80 VJIN-101 VJIN-45 VJIN-34 VJIN-31 VJIN-32 VJIN-42 VJIN-50 VJIN-14 VJIN-27 VJIN-94 VJIN-38 VJIN-29 VJIN-40 VJIN-33 VJIN-44 VJIN-53 VJIN-54 VJIN-51 VJIN-36 VJIN-48 VJIN-46

VJIN-81 VJIN-17 VJIN-92 VJIN-110 VJIN-107 VJIN-28 VJIN-26 VJIN-108 VJIN-109 VJIN-93 VJIN-83 VJIN-20 VJIN-103 VJIN-25 VJIN-35 VJIN-23 VJIN-104

LEGEND

- Survey Area
- Rail
- Local Road

Site Type

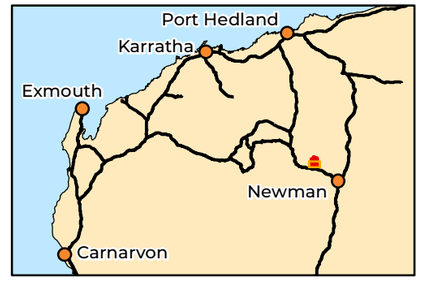
- Acoustic Recorder
- Camera Trap
- Habitat Assessment
- Ultrasonic Recorder
- eDNA
- Traverse

Biologic

Scale 1:60,000

0 1 2 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 4.2b: Sample sites and traverses

5 Fauna Habitats

5.1 Fauna Habitats of the Survey Area

A total of eleven broad fauna habitat types were recorded and mapped across the Survey Area, comprising, in decreasing extent (Table 5.1, Figure 5.1):

- Hillcrest/ Hillslope (57.46%, 12,415.13 ha),
- Drainage Area/ Floodplain (20.21%, 4,367.47 ha),
- Stony Plain (5.62%, 1,214.52 ha),
- Mulga Woodland (2.61%, 564.76 ha),
- Gorge/ Gully (2.28%, 491.71 ha),
- Minor Drainage Line (2.15%, 463.72 ha),
- Major Drainage Line (1.94%, 419.49 ha)
- Cleared/ Disturbed areas (1.90%, 411.53 ha),
- Rehabilitated Area (1.62%, 349.44 ha),
- Calcrete Plain (3.40%, 734.64 ha), and
- Breakaway/ Cliff (0.81%, 174.27 ha).

Descriptions of the distinguishing characteristics and the occurrence within the Survey Area for each of habitat type is presented in Table 5.1. Data from on-site habitat assessments is presented in Appendix C.

Drainage Area/ Floodplain, Gorge/ Gully, Major Drainage Line, and Breakaway/ Cliff provide critical habitat for significant species, including northern quoll and Pilbara olive python (Table 5.1). Within this habitat, potential critical breeding (Pilbara olive python), denning (northern quoll), foraging and dispersal habitat for the species occurs, particularly in areas with caves and overhangs (i.e. Gorge/ Gully and Breakaway/ Cliff) and where pooling water remains for prolonged periods following rainfall events (i.e. Major Drainage Line). Although Gorge/ Gully and Breakaway/ Cliff habitats are not classified as critical habitat for ghost bat or Pilbara leaf-nosed bat, they have the potential to contain critical habitat in the form of Category 1–2 and Category 3 (when found in an apartment block with Category 2 caves) caves (ghost bat), or Category 1–3 caves (Pilbara leaf-nosed bat).

Critical foraging and dispersal habitat for ghost bat within the Survey Area is provided by Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Major Drainage Line, Minor Drainage Line and Gorge/ Gully habitats where proximal (<12 km) to Category 1–2 and Category 3 caves when in an apartment block with Category 2 caves (Table 5.1). As three Category 2 roosts occur in the southern extent of the Survey Area (CJIN-13, CJIN-14, and CJIN-33; all in Gorge/ Gully habitat), most of the occurrence of the aforementioned habitats within

the Survey Area provides critical foraging habitat for the species (i.e. occurs within 12km of the Category 2 caves).

Drainage Area/ Floodplain, Minor Drainage Line, and to a lesser extent, Mulga Woodland, and Stony Plain, may provide suitable nesting and foraging for southern whiteface (Table 5.1). The species occurrence, however, is likely to be dependent on the presence of suitable vegetation structure and cover, which is variable throughout all habitats occurring within the Survey Area.

For grey falcon, the Major Drainage Line is considered critical habitat, with the Drainage Area/ Floodplain, and Minor Drainage Line habitat provide supporting habitat for foraging and dispersal functions; however, the species' occurrence is likely to be dependent on the proximity of nesting (Table 5.1).

Suitable supporting habitat for the northern quoll, Pilbara leaf-nosed bat and Pilbara olive python is provided by Hillcrest/ Hillslope and Minor Drainage Line habitat, particularly when occurring near suitable denning/ roosting habitat (i.e. Gorge/ Gully and Breakaway/ Cliff habitats) (Table 5.1). Other supporting foraging and dispersal habitat for Pilbara leaf-nosed bat within the Survey Area is provided by Stony Plain, Drainage Area/ Floodplain, Major Drainage Line, Mulga Woodland, Gorge/ Gully and Breakaway/ Cliff habitat (Table 5.1).

Possible supporting habitat for night parrot in Stony Plain habitat may be suitable for foraging where *Triodia* is suitably sized (Table 5.1). Habitats within the Survey Area are unlikely to support greater bilby, due to the absence of suitable critical and/or supporting habitats. Potential supporting habitat for princess parrot occurs in the Mulga Woodland, Drainage Area/ Floodplain, Minor Drainage Line, Major Drainage Line, and Stony Plain. For great desert the habitats present are unlikely to provide critical habitat for the species due to the lack of large sand plain areas.

Although critical and/or supporting habitat for numerous significant species was identified within the Survey Area, the occurrence of suitable habitat doesn't necessarily indicate species presence. Many of the 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. However, some habitats, such as the Weeli Wolli Creek PEC (including Ben's Oasis) comprising Major Drainage Line, are significant on a regional scale. The creek provides permanent pools and unique vegetation communities (EPA, 2018), and as such is important in supporting the fauna assemblages present, particularly those reliant on water resources. The condition of habitats within the Survey Area ranged from 'very good' to 'good'. The greatest disturbance was caused by tracks and cleared areas, as a result of exploration activity throughout parts of the Survey Area.

Table 5.1: Broad fauna habitats within the Survey Area

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Hillcrest/ Hillslope 12,415.13 ha 57.46%	Comprises 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 Survey Area and greater Pilbara region, Hillcrest/ Hillslope habitat is common and widespread. The vegetation and substrate which make up this habitat type are characteristic features of the region.	**Critical habitat for:** • **ghost bat –** foraging and dispersal, where proximal (<12 km) to Category 1–2 caves and Category 3 caves when in an apartment block with Category 2 caves, otherwise supporting habitat **Supporting habitat for:** • **northern quoll** – foraging and dispersal habitat where proximal to breeding habitat • **Pilbara leaf-nosed bat** — foraging (*HR=2) and dispersal • **Pilbara olive python** — foraging and dispersal **Important habitat for:** • **western pebble-mound mouse** - breeding, foraging and dispersal	
Drainage Area/ Floodplain 4367.47 ha 20.21%	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 with heavy clays and gravel. Tussock grasses can be dominant within Drainage Area/ Floodplain habitat as a result of high rainfall events.	Within the Survey Area, Drainage Area/ Floodplain habitat occurs primarily within the Northeast Corner and northern region of Jinidi. 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 and dispersal, where proximal (<12 km) to Category 1–2 caves and Category 3 caves when in an apartment block with Category 2 caves, otherwise supporting habitat • **southern whiteface –** breeding, foraging and dispersal **Supporting habitat for:** • **northern quoll -** foraging and dispersal • **Pilbara leaf-nosed bat –** foraging (HR=2) and dispersal • **grey falcon –** foraging and dispersal habitat where proximal to breeding habitat • **princess parrot –** foraging and dispersal • **Pilbara olive python –** foraging and dispersal **Important habitat for:** • **brush-tailed mulgara –** breeding, foraging, and dispersal	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Stony Plain 1,214.52 ha 5.62%	Comprises 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* and scattered Mulga, eucalpyt and *Acacia* trees, with patches of various small to medium shrub species.	Stony Plain habitat occurs throughout a large portion of the Survey Area, often occurring as the intervening area between other habitats. 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, where proximal (<12 km) to Category 1–2 caves and Category 3 caves when in an apartment block with Category 2 caves, otherwise supporting habitat **Supporting habitat for:** • **Pilbara leaf-nosed bat –** foraging (HR=2) and dispersal • **night parrot –** foraging, where *Triodia* is suitably sized • **southern whiteface –** foraging and dispersal • **princess parrot -** foraging and dispersal **Important habitat for:** • **western pebble-mound mouse** - breeding, foraging and dispersal • **brush-tailed mulgara -** breeding, foraging and dispersal	
Mulga Woodland 564.76 ha 2.61%	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 Survey Area, Mulga Woodland habitat primarily occurs within low lying and rocky areas, in the northern region of Jinidi, with little or no connectivity between small areas of habitat. This habitat is relatively common throughout the Pilbara region, usually occurring in areas of drainage or sheet flow.	**Critical habitat for:** • **ghost bat –** foraging and dispersal habitat where proximal (<12 km) to roosting habitat **Supporting habitat for:** • **Pilbara leaf-nosed bat -** foraging (HR=2) and dispersal • **southern whiteface -** foraging and dispersal • **princess parrot -** foraging and dispersal	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Gorge/ Gully 491.71 ha 2.28%	Characterised by rugged, steep-sided valleys incised into the surrounding landscape. Gorges are 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.	Gorge/ Gully habitat occurs throughout the Survey Area, primarily along the Northeast Corner and South Parmelia Ranges. 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 –** breeding, denning, foraging and dispersal • **Pilbara olive python –** breeding, foraging and dispersal • **ghost bat -** only Category 1,2 and 3 (when found in an apartment block) caves associated with this habitat type are considered critical; the broad habitat itself is not critical **Supporting habitat for:** • **Pilbara leaf-nosed bat –** foraging (HR=4) and dispersal. Only Category 1-3 caves associated with this habitat type are consider critical; the broad habitat itself is not considered critical	
Minor Drainage Line 463.72 ha 2.15%	Usually lacks 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 Survey Area Minor Drainage Line habitat occurs throughout the Survey Area, surrounding areas of higher elevation, particularly the Hillcrest/ Hillslope habitat. It 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 and dispersal habitat where proximal (<12 km) to roosting habitat • **southern whiteface –** breeding, foraging and dispersal **Supporting habitat for:** • **grey falcon** – foraging and dispersal habitat where proximal to breeding habitat • **northern quoll** – foraging and dispersal habitat where proximal to breeding habitat • **Pilbara olive python** – foraging and dispersal habitat where proximal to breeding habitat	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Major Drainage Line 419.49 ha 1.94%	Comprises 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. Also supports the Weeli Wolli PEC, which has groundwater dependent vegetation species including silver cadjeput (*Melaleuca argentea*).	Within the Survey Area, Major Drainage Line habitat occurs in discrete linear areas within the Northeast Corner block, and South Parmelia where Weeli Wolli Creek intersects the Survey Area. 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. Permanent spring fed pools are uncommon habitat features, and these areas are significant habitat in the Pilbara.	**Critical habitat for:** • **northern quoll –** denning, foraging and dispersal • **ghost bat –** foraging and dispersal habitat where proximal (<12 km) to roosting habitat, otherwise supporting habitat • **Pilbara olive python –** breeding, foraging, dispersal • **grey falcon –** breeding, foraging and dispersal **Supporting habitat for:** • **Pilbara leaf-nosed bat –** foraging (HR=4) and dispersal • **princess parrot -** foraging and dispersal	
Cleared/ Disturbed 411.53 ha 1.90%	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 Survey Area Cleared/ Disturbed areas are primarily restricted to discrete linear corridors, including roads and access tracks.	**N/A**	No photo
Rehabilitated Area 349.52 ha 1.62%	Rehabilitated Areas are previously cleared or disturbed areas (e.g. tracks, laydown areas, drill pads) that have been seeded or prepared for natural vegetation colonization, but is not yet regenerated. The habitat resembles Cleared/ Disturbed areas in the early stages of rehabilitation.	Within the Survey Area, Rehabilitated Areas are concentrated within the central and western areas of Jinidi.	**N/A**	No photo
Calcrete Plain 734.64 ha 3.40%	The Calcrete Plain fauna habitat includes areas where some solid sheets of calcrete were present, but more commonly soils in this habitat were shallow red loams with calcrete rubble. The vegetation occurring differs from that of the surroundings, presumably due to the differences in soil type. Trees are isolated and the shrub layer tends to be sparse, with a low hummock grassland (*Triodia* sp.) dominant.	Calcrete Plain habitat occurs within the Northeast corners of Central Jinidi near Weeli Wolli Creek, and in South Parmelia. Although this habitat is uncommon in the region, there are no significant fauna that are solely reliant on it, and it does not appear to support a unique vertebrate faunal assemblage despite having different vegetation.	**N/A**	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Breakaway/ Cliff 174.27 ha 0.81%	Comprises single sided rock faces within steep mid-upper slopes with bare rock outcrops or cliffs (not the entire slope).	Within the Survey Area Breakaway/ Cliff habitat occurs primarily in the northern section of Northeast Corner and South Pamelia. 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 –**breeding, denning, foraging and dispersal • **Pilbara olive python –**breeding, foraging and dispersal **Supporting habitat for:** • **ghost bat -** only Category 1,2 and 3 (when found in an apartment block) caves associated with this habitat type are considered critical; the broad habitat itself is not critical • **Pilbara leaf-nosed bat –** foraging (HR=4) and dispersal. Only Category 1-3 caves associated with this habitat type are consider critical; the broad habitat itself is not considered critical	

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

- Survey Area
- Rail
- Local Road

Habitat Type

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

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024

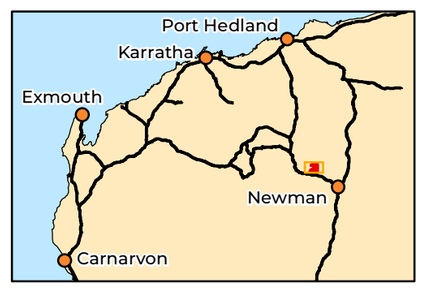


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Figure 5.1: Fauna habitats in the Survey Area

5.2 Habitat Features of the Survey Area

5.2.1 Caves

Thirty-four caves were assessed within the Survey Area during the current surveys (Figure 5.2; Appendix D), including some caves previously recorded in Biologic (2011c) and Biota (2013b). Twenty-seven caves occurred within Gorge/ Gully habitat and seven within the Hillcrest/ Hillslope habitat (Appendix D). Several caves from the database searches (BHP WAIO, 2023a) and historic reports (Biologic, 2011c)) could not be located during the current surveys or were in habitat unsuitable to support caves (e.g. Cave 16394 in low Hillcrest/ Hillslope and Drainage Area/ Floodplain) (Table 5.2). These caves were assessed as likely not significant or suitable for ghost bat or Pilbara leaf-nosed bat by Biologic (2011c); however, as they were not assessed by the current surveys this is not verified with current guidance. In addition, the database records have many partially overlapping/proximate caves that were assumed to be the same record.

Table 5.2: Previous caves from historic report or database searches that were not located during the current surveys

Cave ID	Survey	Notes
Cave 1	Biologic (2011c)	Could not be located. Cave location is in the vicinity of CJIN-06 and CJIN-09, and Cave 4. Cave is in moderately suitable habitat. Multiple database records exist at this location (e.g. Cave ID "10011_11_00291" and "1001_11-00171") and are presumed to represent the same cave. Lack of use recorded by Biologic (2011c), and presumed to be low-value feeding roost only; however, this is not verified by the current survey.
Cave 2	Biologic (2011c); (ENV, 2010a)	Could not be located. Cave location is in the vicinity of CJIN-06 and CJIN-09. Cave is in moderately suitable habitat. Assessed as not suitable by Biologic (2011c); however, this is not verified by the current survey. Multiple database records exist at this location (e.g. Cave ID "10011_11_00288" and "1001_11-00044") and are presumed to represent the same cave.
Cave 3	Biologic (2011c)	Could not be located. Cave location is in the vicinity of CJIN-09. Cave is in moderately suitable habitat. Assessed as unlikely to be suitable by Biologic (2011c); however, this is not verified by the current survey. Multiple database records exist at this location (e.g. Cave ID "10011_11_00285" and "1001_11-00172") and are presumed to represent the same cave.
Cave 4	Biologic (2011c)	Could not be located. Cave location is in the vicinity of CJIN-06 and CJIN-09, and Cave 1. Cave is in moderately suitable habitat. Assessed as not suitable by Biologic (2011c); however, this is not verified by the

Cave ID	Survey	Notes
		current survey. Multiple database records exist at this location (e.g. Cave ID "10011_11_00173" and "1001_11-00293") and are presumed to represent the same cave.
Cave 5	Biologic (2011c)	Could not be located. Cave location is in the vicinity of CJIN-06 and CJIN-09, and Cave 1. Cave is in moderately suitable habitat. Assessed as not suitable by Biologic (2011c); however, this is not verified by the current survey. Multiple database records exist at this location and are presumed to represent the same cave.
Cave 7	Biologic (2011c); (ENV, 2010a)	Could not be located. Cave is in low-quality habitat for cave formation. Assessed as not suitable by Biologic (2011c); however, this is not verified by the current survey. Multiple database records exist at this location (e.g. Cave ID "10011_11_00278" and "1001_11-0047") and are presumed to represent the same cave.
Cave 8	Biologic (2011c); (ENV, 2010a)	Could not be located. Cave is in suitable habitat. Assessed as not suitable by Biologic (2011c); however, this is not verified by the current survey.
Cave 12	Biologic (2011c)	Was not located during current survey; cave is in suitable habitat. No usage recorded by Biologic (2011c); however, this is not verified by the current survey.
Cave 16	Biologic (2011c)	Could not be located. Cave is in moderately suitable habitat. Assessed as unlikely to be suitable by Biologic (2011c); however, this is not verified by the current survey.
Cave ID 10011_11_00301	(BHP WAIO, 2023a)	Could not be located. Location is in unsuitable habitat (low Hillcrest/Hillslope next to Drainage Area/ Floodplain)

Of the 34 caves located and assessed within the Survey Area, three caves (CJIN-13, CJIN-14, CJIN-33) were classified as Category 2 roost (maternity/ diurnal roost caves with regular occupancy) for ghost bats (Appendix D). Eight caves (CJIN-15, CJIN-26, CJIN-29, CJIN-30, CJIN-32, CJIN-36, CJIN-37, CJIN-38) in the Survey Area were identified as Category 3 (diurnal roost caves with occasional occupancy) and 14 caves were identified as Category 4 (nocturnal roost caves with opportunistic usage) (Appendix D). The remaining nine caves were classified as Category 5 for ghost bats) (Appendix D). One Category 3 cave (CJIN-32) occurs as part of an apartment block with a Category 2 cave (CJIN-33) and is considered critical habitat for the species (Figure 5.2).

None of the caves in the Survey Area were assessed as likely or potentially suitable as Category 1, 2 or 3 (permanent or semi-permanent diurnal) roosts for Pilbara leaf-nosed bats (Appendix D). Eight caves were classified as Category 4 (nocturnal refuge) and the remaining 26 as Category 5 by Pilbara leaf-nosed bats (Appendix D).

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

5.2.2 Water Features

Thirty-eight water features were historically recorded or recorded in the Survey Area during the current surveys (Figure 5.2, Appendix E). Five are classified as permanent or likely permanent (Weeli Wolli Spring – pools both upstream and downstream of the gabion discharge, and Ben's Oasis), twenty-six as likely ephemeral, and seven as likely temporary ephemeral, noting that the classification and location of some of the historical features is not confirmed. The majority of water features occurring in the Survey Area were recorded in Gorge/ Gully habitat (*n* = 32), with the remaining water features recorded in Major Drainage Line (*n* = 5) and Minor Drainage Line (*n* = 1) habitat. WJIN-14 and WJIN-02 were previously recorded in Biologic (2011c), and Onshore and Biologic (2009) reports a Pilbara olive python individual within a rock pool in the vicinity of WJIN-11.. Several water features have been assessed in full by (Biologic, in prep.) (Appendix E). Some historic water features were not located during the current surveys and were assumed ephemeral pools (Appendix E, Figure 5.2)

With consideration of overall survey effort for water features and Survey Area coverage, it is possible that additional water features occur within the Survey Area, particularly within Gorge/ Gully and Major Drainage Line, and Minor Drainage Line habitats following rainfall events. However, due to survey effort over multiple surveys including aerial searches via helicopter, the possibility of additional significant (i.e. persisting for long periods) water features being undetected is low.

The significant permanent water features recorded during the surveys were at Weeli Wolli Spring (WJIN-01, WJIN 16 - 19), recognised as an important water feature in the Pilbara. Due to discharge of surplus dewater from adjacent mining operations in the catchment (i.e. Rio Tinto's Hope Downs and, at times, Yandi operations), the extent of permanent surface water now occurs further downstream of Weeli Wolli Springs than occurred historically, i.e., almost to the union of Marillana Creek (approximately 19 km compared to the pre-mining extent of approximately 2 km), and drains into the Fortescue River Valley (EPA, 2018). Limited pools of water were present in Weeli Wolli creek immediately upstream of the gabion discharge point during the dry season surveys. However, during the wet season survey (March 2023), heavy flow in Weeli Wolli creek was observed throughout the Survey Area, including in the north-western corner of South Parmelia where the drainage line occurs.

All water features known from within the Survey Area are considered to provide supporting foraging habitat for the northern quoll, and Pilbara leaf-nosed bat and Pilbara olive python. For northern quolls, they often represent areas of high productivity, and therefore may contain a relatively high abundance of feeding resources (Braithwaite & Griffiths, 1994; Oakwood, 2000), particularly when occurring within rocky habitats, and to a lesser degree, drainage lines. For Pilbara leaf-nosed bats they 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). For Pilbara olive pythons, these features can often act as primary 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 extent within drainage line habitats (Pearson, 1993). This occurrence is likely to be seasonal and irregular, dependent on the permanency of the feature.

720000 724000 728000 732000 736000 740000

7468000 7464000 7460000 7456000

WJIN-19 WJIN-01 WJIN-09 CJIN-34 WJIN-06 WJIN-07
WJIN-16 WJIN-18
WJIN-17
CJIN-30 CJIN-35
CJIN-38 WJIN-08 CJIN-41
CJIN-27
CJIN-44 CJIN-43

1001_11_0016 1001_11_0015
1001_11_0018 WJIN-14 1001_11_0022
1001_11_0019 1001_11_0021 1001_11_0020

1001_11_0016 1001_11_0015
1001_11_0018 CJIN-31
1001_11_0019 1001_11_0022
1001_11_0020

LEGEND

Survey Area
Discharge Point

Ghost Bat Roost Type
Category 3
Category 4
Category 5

Water Feature This Survey
Permanent
Ephemeral
Temporary

Other Survey
Ephemeral

Biologic

Scale 1:60,000
0 1 2 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024

Port Hedland
Karratha
Exmouth
Newman
Carnarvon

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Figure 5.2a: Fauna habitat features recorded in the Survey Area

720000 724000 728000 732000 736000 740000

7456000 7452000 7448000 7444000

1001_11_0016 1001_11_0015 1001_11_0018 1001_11_0019 1001_11_0022 1001_11_0020 CJIN-31

CJIN-20 Jinidi 4 1001_11_0025

WJIN-03

CJIN-29 CJIN-14 1001_11_0008 Jinidi 3 CJIN-13 CJIN-15

Jinidi 7 Jinidi 2 1001_11_0012 CJIN-40 CJIN-23 Jinidi 6 WJIN-02 CJIN-22 1001_11_0014 1001_11_0013

CJIN-06 CJIN-24 WJIN-04 CJIN-18 CJIN-09 1001_11_0011

CJIN-11 CJIN-10

West Angelas Rd

WBEN-01

JINSP2 WJIN-13 CJIN-28 WJIN-12 CJIN-32 WJIN-15 CJIN-39 CJIN-21 CJIN-33 WJIN-10 CJIN-37 CJIN-42 WJIN-11 CJIN-36 CJIN-19

WJIN-05 CJIN-26 CJIN-25

LEGEND

- Survey Area
- Local Road
- Rail

Ghost Bat Roost Type
- Category 2
- Category 3
- Category 4
- Category 5

Water Feature This Survey
- Permanent
- Ephemeral
- Temporary

Other Survey
- Ephemeral

Biologic

Scale 1:60,000

0 1 2 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024

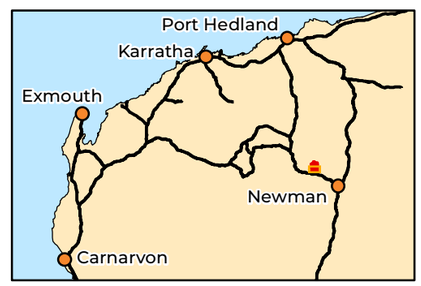

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Figure 5.2b: Fauna habitat features recorded in the Survey Area

6 Target Species

6.1 Northern Quoll (*Dasyurus hallucatus*) – Endangered EPBC Act & BC Act

6.1.1 Species Profile

The northern quoll was once widely distributed across northern Australia, however, it is now restricted to three isolated populations in the Pilbara, Kimberley and Northern Territory, and Queensland (DoE, 2016). 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). 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 (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).

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). They 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). 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).

6.1.2 Previous Records

The Survey Area falls within the current modelled distribution of the northern quoll; however, there are no prior records from within it. Previous survey effort within the Survey Area includes 3,896 trap nights and 83 camera nights; however, this previous targeted survey effort did not include the Northeast corner (Table 6.1, Figure 3.1). Within 40 km of the Survey Area, there are

33 previous northern quoll records (BHP WAIO, 2023b; DBCA, 2023b)(Figure 6.1). Most of these records (76%, 25 records) occur in the vicinity of Rio Tinto's Gudai-Darri mine, approximately 21.5 km north-east of the Survey Area. The remaining database records are within the vicinity of the Rio Tinto's Hope Downs 2 mine (~5 km west of the Survey Area) (Astron (2019, 2020), from camera trap, scat and cage trapping records. Northern quoll was detected from eDNA sampling during a concurrent survey to the March 2023 trip approximately 20 km northeast of the Survey Area (Biologic, 2023).

Table 6.1: Previous survey effort for northern quoll in the Survey Area

Survey	Survey effort	Notes
Biologic (2011c)	75.2 person hours targeted searches	Jinidi, excluding Northeast Corner
Biologic (2011b)	64.8 person hours targeted searches 83 camera trap nights 2,380 cage trap nights • Additional 420 nights (three sites) outside Survey Area boundary	Jinidi, excluding Northeast Corner
Ecologia (2006b)	216 cage trap nights	Jinidi
ENV (2010a)	670 cage trap nights	Jinidi
Outback Ecology (2010)	70 cage trap nights	Jinidi
Biota (2013b)	560 Elliot trap nights (over two seasons)	South Parmelia
Total	**3,896 cage trap/Elliot nights** **83 camera trap nights** **140 person hours targeted searches**	

6.1.3 Survey Methods

6.1.3.1 Targeted Searches

Targeted searches for direct or secondary evidence were undertaken in suitable habitat for northern quoll along 62 transects, equating to approximately 213 person hours (Appendix F). Scats were aged based on visual assessment of colour, level of moisture, and structure.

6.1.3.2 Camera Trap Transects

Twelve camera trap transects were deployed in suitable northern quoll breeding, foraging and dispersal habitat (e.g. Gorge/ Gully) (Table 6.2; Figure 6.2). Where possible, survey effort followed methods recommended by DoE (2016). Up to 10 cameras were deployed across each transect with an approximate spread of one camera every 50–100 m (Table 6.2). Cameras were deployed for between four and 51 consecutive nights, for a total of 2,189 camera trap sampling nights (Table 6.2). Cameras transects at sites VJIN-012, VJIN-014, VJIN-017, and VJIN-021 were deployed during trip 1 and collected at the start of trip 2 for re-deployment during that survey period (Table 6.2).

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

Table 6.2: Camera transects sampled for northern quoll

Site	Habitat	Deployment	Retrieval	No. Cameras	Total Trap Nights
Trip 1					
VJIN-012	Hillcrest/ Hillslope	24/03/2023	12/05/2023	10	400
VJIN-014	Hillcrest/ Hillslope	23/03/2023	12/05/2023	9	441
VJIN-017	Hillcrest/ Hillslope	23/03/2023	13/05/2023	10	500
VJIN-019	Major Drainage Line	23/03/2023	29/03/2023	10	60
VJIN-021	Major Drainage Line	24/03/2023	13/05/2023	10	510
VJIN-023	Hillcrest/ Hillslope	24/03/2023	29/03/2023	10	50
Trip 2					
VJIN-065	Gorge/ Gully	14/05/2023	18/05/2023	10	40
VJIN-066	Gorge/ Gully	14/05/2023	18/05/2023	9	36
VJIN-074	Hillcrest/ Hillslope	14/05/2023	18/05/2023	10	40
VJIN-075	Hillcrest/ Hillslope	14/05/2023	18/05/2023	9	36
VJIN-083	Gorge/ Gully	14/05/2023	18/05/2023	10	40
VJIN-085	Hillcrest/ Hillslope	14/05/2023	18/05/2023	9	36
Total camera transects deployed					**12**
Total trap nights					**2189**

6.1.4 Survey Results

Northern quoll was recorded from scats at 12 locations within Northeast Corner of the Survey Area in Gorge/ Gully and Hillcrest/ Hillslope habitats (Table 6.3; Figure 6.2). The scats varied in age from recent to very old (greater than 3 years). No other evidence of the species occurrence was recorded in the Survey Area.

Table 6.3: Northern Quoll scat recorded within the Survey Area

Site	Habitat	Date	Scat Age
Trip 2			
VJIN-60	Gorge/ Gully	16/05/2023	Recent (1–6 mths)
VJIN-66	Gorge/ Gully	17/05/2023	Very Old (3 to 10 yrs)
VJIN-66	Gorge/ Gully	17/05/2023	Old (6 mths to 3 yrs)
VJIN-77	Gorge/ Gully	17/05/2023	Recent (1–6 mths)
VJIN-77	Gorge/ Gully	17/05/2023	Old (6 mths to 3 yrs)
VJIN-78	Hillcrest/ Hillslope	15/05/2023	Old (6 mths to 3 yrs)
VJIN-78	Hillcrest/ Hillslope	15/05/2023	Recent (1–6 mths)
VJIN-79	Gorge/ Gully	15/05/2023	Recent (1–6 mths)
VJIN-90	Gorge/ Gully	17/05/2023	Old (6 mths to 3 yrs)
VJIN-91	Gorge/ Gully	17/05/2023	Recent (1–6 mths)
VJIN-98	Hillcrest/ Hillslope	28/09/2023	Old (6 mths to 3 yrs)
VJIN-100	Hillcrest/ Hillslope	28/09/2023	Old (6 mths to 3 yrs)

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

Banjima Dr
Karijini Dr
Juna Downs Rd
Packsaddle Rd
Munjina - Roy Hill Rd
Roy Hill - Noreena Downs Rd
Marble Bar Rd
Jigalong Rd
West Angelas Rd
Eagle Pool Rd
Great Northern Hwy
Kalgan Pool Rd
Newman
Turee Creek Rd

14
5
3

LEGEND

Survey Area
Desktop Assessment Area
Local Road
State Road
Rail

BHP (2023)
Individual (alive)
Scat
Unknown

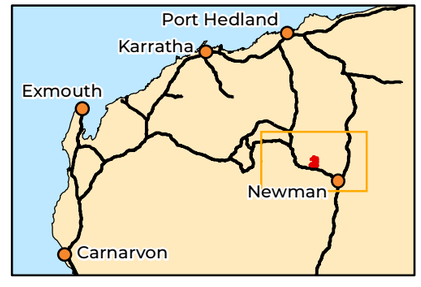
DBCA (2023)
Unknown
Specimen
Camera Trap

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 01/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

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

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Critical
Supporting
Nil

Sampling Method
Camera Trap
Traverse

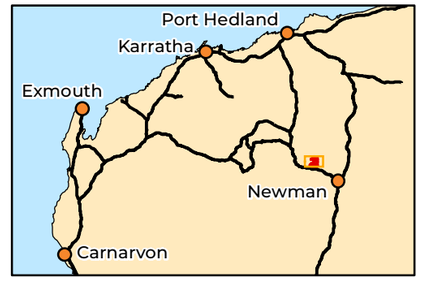
Scat
Recent (1 to 6 mths)
Old (6 mths to 3 yrs)
Very Old (3 to 10 yrs)

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



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Vertebrate Fauna Survey

Figure 6.2: Northern quoll sampling, records and habitat in the Survey Area

6.1.5 Discussion

There were no previous records of northern quoll within the Survey Area, and it is only known in the vicinity from records at Gudai-Darri mine (approximately 21.5 km north-east), and Hope Downs mine (approximately 5 km west). Previous survey effort did not target the Northeast Corner where scats from the current surveys were recorded.

The Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.8%, 174.27 ha), and Major Drainage Line (1.94%, 419.49 ha) habitats meet the definition of critical habitat (i.e. denning/ foraging habitat within the home range (<35 ha, up to 100 ha in breeding season) of low rocky hills, gorges, escarpments, ranges, breakaways, boulder fields, major drainage lines) for northern quoll (BHP WAIO, 2023d; DoE, 2016) (Figure 6.2). These habitats also provide critical foraging and dispersal habitat for the species. Potential supporting habitat for the northern quoll occurs in the Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Drainage Area/ Floodplain (20.21%, 4367.47 ha), and Minor Drainage Line (2.15%, 463.72 ha) habitats, where proximal (<35 ha, BHP WAIO (2023d)) to critical habitat (Gorge/ Gully, Breakaway/ Cliff, and Major Drainage Line). The extent of critical habitat within the Survey Area is limited; however, they form part of larger continuations of the habitat beyond the extent of the Survey Area and may therefore potentially act as foraging and dispersal corridors where connectivity to other areas of critical habitat is provided.

In consideration of the overall scarcity and concentration of records, the species is unlikely to be reliant on the habitats within the Survey Area for long-term persistence at a regional scale, however the habitat is considered critical for individual persistence within the Survey Area. The current survey results suggest that the northern quoll presence within Survey Area is unlikely to represent part of or contribute to an important population (DoE (2013a, 2016). A targeted northern quoll survey by Biologic (2011b) in the Survey Area recorded no evidence of the species despite extensive survey effort and suggested that if present, the species would likely occur in low densities. However, the previous survey effort did not include Northeast Corner; the presence of scats in this section of the Survey Area during the current surveys, ranging in age from recent to very old, suggests a potentially recent, low abundance population or possible transient individuals in this northern section. The proximity to Weeli Wolli creek may support this, as the drainage line may act as a dispersal corridor in the local region to other critical denning and foraging habitat (BHP WAIO, 2023d). Further monitoring would be required to confirm the presence of a resident population and as such importance of connecting habitats to other populations.

6.2 Greater Bilby (*Macrotis lagotis*) – Vulnerable EPBC Act & BC Act

6.2.1 Species Profile

The greater bilby is 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), and may move in response to foraging potential (Southgate, 1990a; Southgate *et al.*, 2019).

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 their habitat as they support shrub species, such as *Acacia kempeana*, *A. hilliana* and *A. rhodophylla*, which have root-dwelling larvae prone that support 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 desktop assessment identified 11 previous records of greater bilby within 40 km of the Survey Area (BHP WAIO, 2023b; DBCA, 2023b) (Figure 6.3). Of these, eight records of secondary

evidence attributed to the species (two burrows and six diggings, classified between 'possible' to 'uncertain') were recorded in 2020 and 2013 from a site approximately 20–35 km northeast of the Survey Area in the Fortescue Valley. The other three records are located approximately 10 km south to southeast of the Survey Area from 1984. There are no previous records of the species within the Survey Area.

6.2.3 Survey Methods

6.2.3.1 Greater Bilby Plots Searches

One 2-hectare survey plot (plot search) was surveyed in Drainage Area/ Floodplain habitat in the north-east corner of the Jinidi portion of the Survey Area (Appendix F). This area was considered the only suitable habitat, although marginal and small in size. The targeted search focused on identifying signs of secondary evidence (burrows, diggings, tracks and scats, as described by Southgate *et al.* (2019)). The plot was sampled for one person hour (Appendix F).

6.2.4 Survey Results

No evidence of occurrence of greater bilby was recorded within the Survey Area.

6.2.5 Discussion

Based on the limited number of nearby recent records, and lack of suitable Sand Plain habitat or evidence of species occurrence, the greater bilby is considered unlikely to occur in the Survey Area. Although the species is known to utilise broad habitats occurring within the Survey Area in other parts of its distribution (i.e. Major Drainage Line (1.94%, 419.49 ha), Mulga Woodland (2.61%, 564.76 ha) and Drainage Area/ Floodplain (20.21%, 4,367.47 ha)), these habitats are rarely utilised by the species within the Pilbara region, likely due to the high amount of alluvial material making substrates less suitable for burrowing activity compared to sand-plain habitats (Cramer *et al.*, 2017). The likelihood of these habitats being utilised by the species may also increase when larger areas of suitable habitat (e.g. Sand Plain) are present adjacent to or in the vicinity.

640000
680000
720000
760000
800000
840000
7520000
7480000
7440000
7400000
Newman
LEGEND
Survey Area
Desktop Assessment Area
BHP (2023)
Burrow (inactive)
Digging
DBCA (2023)
Burrow
Digging
Unspecified
Biologic
Scale 1:600,000
0
10
20
Km
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Created 29/04/2024
Port Hedland
Karratha
Exmouth
Newman
Carnarvon
BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey
Figure 6.3: Previous greater bilby records in the Survey Area and region

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Nil

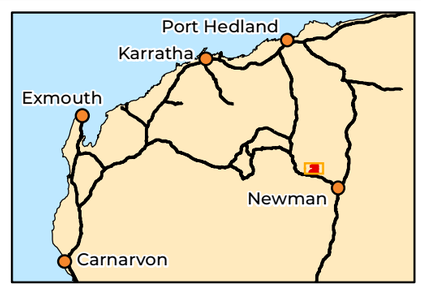
Sampling Method
Targeted Search

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



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Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.4: Greater bilby sampling and habitat in the Survey Area

6.3 Ghost Bat (*Macroderma gigas*) – Vulnerable EPBC Act & BC Act

6.3.1 Species Profile

The ghost bat occurs in disjunct colonies across northern Australia (TSSC, 2016b) and the Pilbara region. The Pilbara population is estimated to comprise between 1,300 and 2,000 individuals, the largest occurring within the Chichester subregion (estimated at approximately 1,500 individuals) where known populations are largely restricted to disused mines (TSSC, 2016b).

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). To date, breeding has been documented in natural caves at Mining Area C (including South Flank), Mt Brockman and West Angeles in the Hamersley subregion, and at Callawa and Tambrey Station in the Chichester sub-region (Armstrong and Anstee, 2000; Biologic 2013; 2015; M. O'Connell, pers. obs.). 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).

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, studies using VHF tracking and GPS/satellite tracking technologies show that ghost bats, both male and female, may forage over much larger areas (up to 17 km) from their diurnal roost, with an average radial distance of 8.5 km (Augusteyn *et al.*, 2018; Bat Call, 2021a; Biologic, 2020a; Bullen *et al.*, 2023). Ghost bats will utilise the majority of an available foraging area, spending on average 116 minutes at particular foraging sites (Bullen *et al.*, 2023). 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).

Ghost bats have been confirmed as foraging across a variety of habitat types, however generally thinly wooded areas of mulga, other *Acacia* or *Eucalypt* sp. or linear woodland features are preferred in areas with a moderate percentage of open ground (typically 30–70%)

(Bullen *et al.*, 2023). Tracking studies at BHP WAIO's South Flank mine have observed a ghost bat exiting a cave and moving immediately towards broad drainage plains with Mulga Woodland and Major Drainage Line (Biologic, 2020a). Such areas are often highly productive and contain an abundance of foraging structures (Biologic, 2020a).

6.3.2 Previous Records

Previous survey effort for significant bat species within the Survey Area includes ultrasonic recorders deployed at twenty locations within Jinidi and South Parmelia between 2006 and 2011 (Table 6.4) and targeted searches; no ultrasonic survey effort has been previously undertaken in Northeast corner. A total of 283 records of ghost bat occur within 40 km of the Survey Area (Figure 6.5), with 27 records occurring within the Survey Area (BHP WAIO, 2023b; DBCA, 2023b). Long term annual monitoring of the ghost bat population at important nearby roosts at South Flank/Mining Area C and West Angelas occurs (Bat Call, 2021a). Biologic (2011c), recorded one individual within the Jinidi area (shallow overhang), and scats were recorded at two locations within the Jinidi area (caves CJIN-13 and CJIN-09) (Figure 6.5). Ultrasonic calls were also recorded at multiple locations near CJIN-09. Biota (2013b) recorded an extensive scat pile in a cave in South Parmelia (renamed CJIN-33 during the current survey) (Figure 6.5). Biologic and Bat Call WA (2014), collected scats from CJIN-14 for regional roost assessment (Figure 6.5). ENV (2010b), recorded ghost bats three times from an ultrasonic recorder near cave CJIN-09 (Figure 6.5). Ecologia (2006b), recorded a ghost bat from an ultrasonic recorder deployed at a cave overlooking a gully (near CJIN-09) (Figure 6.5). There are no previous records from Northeast Corner; however, this area has not previously been surveyed for ghost bats.

Table 6.4: Survey effort for bats within the Survey Area

Survey	Survey effort	Notes
Biologic (2011c)	Three ultrasonic locations (174.3 hours)	Jinidi
Onshore and Biologic (2009)	One ultrasonic location (5 nights)	South Parmelia
Biota (2013b)	Five ultrasonic locations (12 nights)	South Parmelia
Ecologia (2006b)	Seven ultrasonic locations (995 mins)	Jinidi
ENV (2010a)	Four ultrasonic locations (13 nights)	Jinidi

640000
680000
720000
760000
800000
840000
7520000
7480000
7440000
7400000
Newman

LEGEND

Survey Area
Desktop Assessment Area

BHP (2023)
- Individual (alive)
- Scat
- Unknown

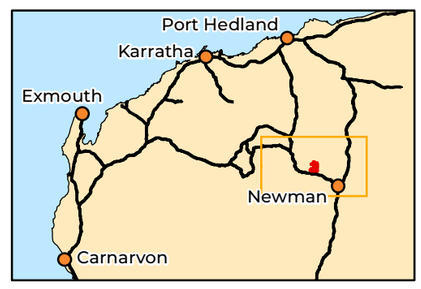
DBCA (2023)
- Acoustic Recorder
- Bat Trap
- Individual (alive)
- Scat
- Specimen
- Unknown

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



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Vertebrate Fauna Survey

Figure 6.5: Previous ghost bat records in the Survey Area and region

6.3.3 Survey Methods

6.3.3.1 Targeted Searches

Targeted searches for significant bat species were undertaken at 70 locations across the Survey Area in habitats with rocky outcropping (i.e. Gorge/ Gully). The searches were conducted on foot to determine the presence of caves likely to be used by ghost bats and/or Pilbara leaf-nosed bats (Appendix F; Figure 6.6). Where suitable caves or overhangs were located, detailed cave assessments were undertaken to search for evidence of occurrence and determine the cave classification as detailed in Bat Call (2021a). Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 165.5 person hours of search effort for significant bat species was undertaken during the surveys (Appendix F; Figure 6.6).

6.3.3.2 Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter ultrasonic bat recorder at 36 sites across the three surveys (Table 6.5; Figure 6.6). Recorders were placed in critical habitat near water features, caves, and foraging/ dispersal corridors. Recorders were deployed for three consecutive nights at each site, resulting in a total of 108 Recording nights (Table 6.5; Figure 6.6). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of ghost bat and Pilbara leaf-nosed bat calls.

Table 6.5: Ultrasonic sampling for ghost bat and Pilbara leaf-nosed bat

Site	Habitat Feature	Habitat	Deployment	Retrieval	Sampling Nights
Trip 1					
VJIN-01	Weeli Wolli creek (WJIN-01)	Major Drainage Line	22/03/2023	25/03/2023	3
VJIN-02		Major Drainage Line	22/03/2023	25/03/2023	3
VJIN-09		Major Drainage Line	22/03/2023	25/03/2023	3
VJIN-10		Mulga Woodland	22/03/2023	25/03/2023	3
VJIN-12	WJIN-04	Hillcrest/ Hillslope	25/03/2023	28/03/2023	3
VJIN-13		Drainage Area/ Floodplain	22/03/2023	25/03/2023	3
VJIN-15	WJIN-03	Gorge/ Gully	22/03/2023	25/03/2023	3
VJIN-18		Major Drainage Line	23/03/2023	26/03/2023	3
VJIN-24		Hillcrest/ Hillslope	25/03/2023	28/03/2023	3
VJIN-25		Drainage Area/ Floodplain	25/03/2023	28/03/2023	3
VJIN-26		Gorge/ Gully	25/03/2023	28/03/2023	3
VJIN-27		Gorge/ Gully	25/03/2023	28/03/2023	3
VJIN-28		Drainage Area/ Floodplain	26/03/2023	29/03/2023	3

Site	Habitat Feature	Habitat	Deployment	Retrieval	Sampling Nights
VJIN-33		Minor Drainage Line	26/03/2023	29/03/2023	3
VJIN-39		Hillcrest/ Hillslope	28/03/2023	31/03/2023	3
Trip 2					
VJIN-32	CJIN-26	Hillcrest/ Hillslope	16/05/2023	15/05/2023	3
VJIN-50		Hillcrest/ Hillslope	12/05/2023	15/05/2023	3
VJIN-52		Drainage Area/ Floodplain	12/05/2023	15/05/2023	3
VJIN-54		Drainage Area/ Floodplain	12/05/2023	16/05/2023	3
VJIN-55		Drainage Area/ Floodplain	13/05/2023	16/05/2023	3
VJIN-59		Drainage Area/ Floodplain	13/05/2023	16/05/2023	3
VJIN-60	WJIN-07	Gorge/ Gully	13/05/2023	16/05/2023	3
VJIN-61		Gorge/ Gully	13/05/2023	16/05/2023	3
VJIN-63		Gorge/ Gully	13/05/2023	19/05/2023	3
VJIN-68		Gorge/ Gully	16/05/2023	19/05/2023	3
VJIN-69		Hillcrest/ Hillslope	16/05/2023	19/05/2023	3
VJIN-71		Hillcrest/ Hillslope	13/05/2023	19/05/2023	3
VJIN-79	CJIN-30, CJIN-38	Gorge/ Gully	16/05/2023	18/05/2023	3
VJIN-86		Hillcrest/ Hillslope	15/05/2023	18/05/2023	3
VJIN-87		Hillcrest/ Hillslope	15/05/2023	18/05/2023	3
VJIN-88		Gorge/ Gully	15/05/2023	19/05/2023	3
Trip 3					
VJIN-42	CJIN-37	Gorge/ Gully	29/09/2023	2/10/2023	3
VJIN-98		Gorge/ Gully	28/09/2023	1/10/2023	3
VJIN-101		Gorge/ Gully	29/09/2023	2/10/2023	3
	Total ultrasonic recorders deployed				**36**
	Total recording nights				**108**

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Critical
Supporting
Nil

Sampling Method
Ultrasonic Recorder
Targeted Search

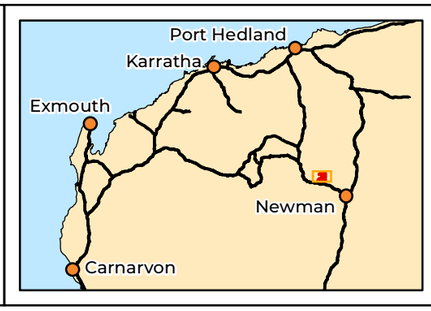
Record
eDNA
Individual (alive)
Scat
Ultrasonic Recorder

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



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Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 6.6: Ghost bat sampling, records and habitat in the Survey Area

6.3.4 Survey Results

6.3.4.1 Targeted searches

Ghost bat was recorded on 18 occasions in the Survey Area during the current surveys, including one observation of an individual roosting in CJIN-33 recorded during trip 2 (Plate 6.1). Scat was recorded from thirteen caves, two of which had fresh (<1 month) or recent (1-6 months) scat and eleven with old (6 months – 3 years) or very old (3–10 years). Cave CJIN-26 was estimated to have up to 1,000 scats including some fresh (<1 month), and CJIN-13 and CJIN-33 were estimated to have 5,000 each including some fresh (CJIN-33) and recent (1–6 months, CJIN-13) (Plate 6.2; Table 6.6). One detection was also recorded from eDNA sampling at Weeli Wolli Creek (WJIN-01) (Figure 6.6).

Plate 6.1: Ghost bat observed in cave CJIN-33 during May 2023 (trip 2)

Plate 6.2: Large pile of ghost bat scat observed in cave CJIN-33.

Of the 34 caves recorded in the Survey Area, three were classified as Category 2 roosts (CJIN-13, CJIN-14, and CJIN-33), eight as Category 3, and 14 as Category 4 (Table 6.6; Figure 5.2). This includes caves from existing databases or previous reports that could be located during the current surveys; several low-value caves from the database searches could not be located or were in habitat unsuitable to support caves (Table 5.2). Caves CJIN-33, CJIN-13, and CJIN-14 were categorised as Category 2 caves due to suitable features to support diurnal roosting and breeding (deep, dark, and with an elevated roosting chamber that provides a stable microclimate; Bat Call, 2021a). These caves also show use by ghost bats (e.g. fresh scats present in CJIN-33), and it was noted that potentially pregnant individuals were present in CJIN-14 in 2011 (Biologic, 2011c). Category 3 caves were determined through less suitable cave characteristics for roosting (e.g. less well-developed features) than the Category 2 caves that still may show usage by ghost bat. These categories may change as monitoring continues and more data on usage becomes available. Caves CJIN-09, CJIN-13, CJIN-14 and CJIN-33 have previously recorded ghost bat scats (Biologic (2011c); Biota (2013b)).

The remaining nine caves showed no evidence of use and are considered unsuitable for ghost bats. One Category 3 cave (CJIN-32) occurs as part of an apartment block with a Category 2 cave (CJIN-33) and is considered critical habitat for the species.

Table 6.6: Ghost bat scat recorded within the Survey Area

Site	Cave ID	Category	Habitat	Date	~ No. Scats	Scat Age
VJIN-32	CJIN-26	Category 3	Hillcrest/ Hillslope	30/03/2023	1,000	Fresh (<1 mth)
VJIN-83	CJIN-15*	Category 3	Gorge/ Gully	14/05/2023	10	Old (6 mths to 3 yrs)
VJIN-93	CJIN-13*	Category 2	Gorge/ Gully	16/05/2023	4,000	Recent (1–6 mths)
VJIN-79	CJIN-30	Category 3	Gorge/ Gully	15/05/2023	1	Old (6 mths to 3 yrs)
VJIN-79	CJIN-38	Category 3	Gorge/ Gully	15/05/2023	25	Old (6 mths to 3 yrs)
VJIN-84	CJIN-32	Category 3	Gorge/ Gully	17/05/2023	300	Recent (1–6 mths)
VJIN-84	CJIN-33*	Category 2	Gorge/ Gully	17/05/2023	5,000	Fresh (<1 mth)
VJIN-42	CJIN-37	Category 3	Hillcrest/ Hillslope	18/05/2023	50	Old (6 mths to 3 yrs)
VJIN-75	CJIN-39	Category 4	Gorge/ Gully	18/05/2023	60	Very Old (3–10 yrs)
VJIN-93	CJIN-14*	Category 2	Gorge/ Gully	19/05/2023	100	Old (6 mths to 3 yrs)
VJIN-98	CJIN-44	Category 4	Gorge/ Gully	28/09/2023	3	Very Old (3–10 yrs)
VJIN-98	CJIN-43	Category 4	Gorge/ Gully	28/09/2023	4	Old (6 mths to 3 yrs)
VJIN-101	CJIN-42	Category 4	Gorge/ Gully	29/09/2023	1	Very Old (3–10 yrs)

(*cave previously recorded by Biologic (2011c) and Biota (2013b))

6.3.4.2 Ultrasonic Recording

Three ghost bats calls were recorded at two sites in South Parmelia during trip 2, two calls at VJIN-32 (cave CJIN-26), and one at VJIN-54 (Drainage Area/ Floodplain habitat) (Figure 6.6).

6.3.5 Discussion

Ghost bat was recorded on 18 occasions in the Survey Area during the current survey, including one observation of an individual roosting in cave CJIN-33, one eDNA detection at Weeli Wolli Creek (WJIN-01), three calls via ultrasonic in the southern section of the Survey Area (two calls at VJIN-32 (cave CJIN-26; Gorge/ Gully habitat), and one at VJIN-54 (Drainage Area/ Floodplain)), and scats from 13 locations, ranging from fresh to very old in age. It should be noted that ghost bat detectability via ultrasonic recorders, particularly of foraging individuals is difficult due to their foraging behaviour (i.e. infrequent and highly variable calling during foraging) and capabilities of ultrasonic recording devices (i.e. limited detection zones).

The most suitable areas of habitat to support the species are in the Northeast Corner, the large range in South Parmelia, and the south and south-eastern portions of Jinidi, where multiple Category 2 and 3 caves were recorded in Gorge/ Gully or Hillcrest/ Hillslope habitats. Three caves (CJIN-13, CJIN-14, CJIN-33; all in Gorge/ Gully habitat) were classified as Category 2 roost (maternity/ diurnal roost caves with regular occupancy) for ghost bats and provide critical breeding habitat for the species. One Category 3 cave (CJIN-32; Gorge/ Gully habitat) occurs as part of an apartment block with a Category 2 cave (CJIN-33) and is considered critical habitat for the species. Eight caves (seven Gorge/ Gully; one Hillcrest/ Hillslope) in the Survey Area were identified as Category 3 (diurnal roost caves with occasional occupancy) and 13 caves (nine Gorge/ Gully; four Hillcrest/ Hillslope) were identified as Category 4 (nocturnal roost caves with opportunistic usage).

Critical foraging and dispersal habitat within the Survey Area is provided by Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Stony Plain (5.62%, 1,214.52 ha), Gorge/ Gully (2.28%, 491.71 ha), Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Mulga Woodland (2.61%, 564.76%), Minor Drainage Line (2.15%, 463.72 ha), and Major Drainage Line (1.94%, 419.49 ha), when proximal (<12 km) to roosting caves. Some small sections of Northeast Corner are just outside the 12 km radius of a roosting cave. Records of ghost bat were made in Drainage Area/ Floodplain and Major Drainage Line (via ultrasonic and eDNA records) and indicates foraging and/or dispersal potential where other habitat characteristics are present. 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 not uncommon to not record ghost bats in areas where their presence is observed. As three Category 2 roosts occur in the southern extent of the Survey Area, most of the occurrence of the aforementioned habitats within the Survey Area provides critical foraging habitat for the species (i.e. occurs within 12km of the Category 2 caves). The suitability of these habitats is variable throughout the Survey Area depending on habitat characteristics, including the abundance of foraging structures (tree perches) and vegetation structure and density present. Due to the presence of known roosting caves and confirmed records within the Survey Area and surrounds, occurrence of suitable breeding and roosting habitat, and recent records of the species, it is likely to occur as a resident and utilise the above habitats within the Survey Area regularly for foraging.

The occurrence ghost bats within the Survey Area is likely to form part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), in particular with the known populations at South Flank/Mining Area C, West Angelas, and potentially further east at Jimblebar and Western Ridge. Due to the presence of three Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts and critical foraging habitat, the individuals present in the Survey Area forms part of the broader meta-population of ghost bats in the Pilbara. The individuals present likely contribute to the

high genetic diversity present in the region, potentially linking larger populations at South Flank/Mining Area C and Western Ridge and Jimblebar through dispersing individuals. As such, the population within the Survey Area aligns with the DoE (2013b) definition of 'important'.

6.4 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – Vulnerable EBPC Act & BC Act

6.4.1 Species Profile

The Pilbara leaf-nosed bat is recognised as a geographically isolated population of the orange leaf-nosed bat, which is distributed across northern Australia and separated from the Pilbara population by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara leaf-nosed bat is regarded as a single interbreeding population comprising multiple colonies (TSSC, 2016c; Umbrello *et al.*, 2022). Currently, there are 48 permanent diurnal Category 1 and 2 roost sites (17 of known location and 31 yet to be found) assumed 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). Its limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they require warm (28–32°C) 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 are 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 microclimates (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). 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).

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). It is predicted to travel up to 20 km from roost caves during nightly foraging in the dry season (Cramer *et al.*, 2016a) and up to 50 km during the wet season (Bullen, 2013).

6.4.2 Previous Records

Previous survey effort for significant bat species within the Survey Area includes ultrasonic recorders deployed at twenty locations within Jinidi and South Parmelia between 2006 and 2011 (Table 6.4) and targeted searches; no ultrasonic survey effort has been previously undertaken in Northeast corner. Pilbara leaf-nosed bat has previously been recorded in the Survey Area from a single call in the vicinity of survey site CJIN-06 by ENV (2010b) in the south-eastern Jinidi area, with an additional database record from the same vicinity in the same month (DBCA, 2023b) (Figure 6.7). The call timing was indicative of a foraging or dispersing individual. The next closest records comprised three calls (indicative of foraging

individuals) in Gorge/ Gully and Breakaway habitats at the Rio Tinto Hope Downs 2 mine, approximately 5 km west of the Survey Area (Astron, 2019, 2020).

The database search identified 12 records of Pilbara leaf-nosed bat occurring within 40 km of the Survey Area (BHP WAIO, 2023b; DBCA, 2023b) (Figure 6.7). Four of these records are from the Gudai-Darri locality approximately 30 km north-west of the Survey Area. The Gudai-Darri area contains an old adit that has formed a cave system. This cave system is one of the few known roosts in the north-eastern Hamersley Range, and formerly supported a population of over 400 Pilbara leaf-nosed bats (EPA, 2014); however, recent surveys have indicated numbers less than this (Bat Call, 2021b). There are no other significant roosts present in the local region according to Bat Call (2021b). The remaining records are: four from Mining Area C (west of the Survey Area) from 2006 - 2018, one record from Western Ridge area to the south-east in 2021, and one record from the Ophthalmia Range in 2013 (DBCA, 2023b).

6.4.3 Survey Methods

6.4.3.1 Targeted Searches

Targeted searches for significant bat species were undertaken at 70 locations across the Survey Area in habitats with rocky outcropping (i.e. Gorge/ Gully). The searches were conducted on foot to determine the presence of caves likely to be used by ghost bats and/or Pilbara leaf-nosed bats (Appendix F; Figure 6.8). Where suitable caves or overhangs were located, detailed cave assessments were undertaken to search for evidence of occurrence and determine the cave classification as detailed in Bat Call (2021a). Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 165.5 person hours of search effort was undertaken during the surveys (Figure 6.8; Appendix F).

6.4.3.2 Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter ultrasonic bat recorder at 36 sites across the three surveys (Table 6.5; Figure 6.8). Recorders were placed near water features, caves, and foraging/ dispersal corridors. Recorders were deployed for three consecutive nights at each site, resulting in a total of 108 Recording nights (Table 6.5; Figure 6.8). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of ghost bat and Pilbara leaf-nosed bat calls.

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

Newman

LEGEND

Survey Area
Desktop Assessment Area

BHP (2023)
Individual (alive)
Unknown

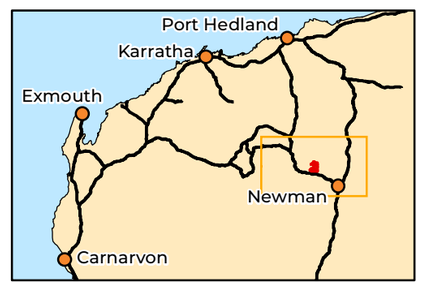
DBCA (2023)
Secondary Evidence
Unknown

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.7: Previous Pilbara leaf-nosed bat records in the Survey Area and region

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Supporting
Nil

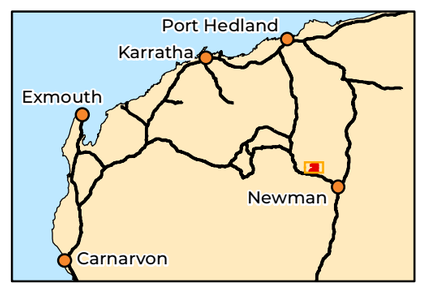
Sampling Method
Ultrasonic Recorder
Targeted Search

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.8: Pilbara leaf-nosed bat sampling and habitat in the Survey Area

6.4.4 Survey Results

6.4.4.1 Targeted searches

Of the 34 caves occurring within the Survey Area, none were assessed as likely or potentially suitable as Category 1, 2 or 3 (permanent or semi-permanent diurnal) roosts for Pilbara leaf-nosed bats (table 5.2). Eight caves (six Gorge/ Gully; two Hillcrest/ Hillslope) were classified as Category 4 (nocturnal refuge) and the remaining 26 as Category 5 (no usage by Pilbara leaf-nosed bats)

6.4.4.2 Ultrasonic Recorders

No calls from Pilbara leaf-nosed bats were recorded by ultrasonic recorders during the current survey.

6.4.5 Discussion

The nearest known permanent diurnal roost for this species is the Rio Tinto Gudai-darri mine, approximately 30 km north-west of the Survey 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).

Currently, no habitat within the Survey Area is considered critical for the Pilbara leaf-nosed bat, as it is not within 20 km of any known diurnal roosts (Bat Call, 2021b); however, the occurrence of a potential critical roost (due to a previous ultrasonic foraging record within the Survey Area) may later determine critical foraging habitat. Although Gorge/ Gully and Breakaway/ Cliff habitats are not classified as critical habitat for the Pilbara leaf-nosed bat, they have the potential to contain critical habitat in the form of Category 1–3 caves. As such these habitats represent a Habitat Rating 4 (very high) as defined by Bat Call (2021b). Presently, the Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.81%, 174.27 ha), and Major Drainage Line (1.94%, 419.49 ha) habitats provide supporting foraging and dispersal habitat for the species and tend to contain important habitat features such as nocturnal refuges and water features. Other supporting foraging and dispersal habitat for Pilbara leaf-nosed bat within the Survey Area is provided by Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Stony Plain (5.62%, 1,214.52 ha), Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Mulga Woodland (2.61%, 564.76%), and are classified as Habitat Rating 2 (low) (Bat Call, 2021b). The Survey Area contains water features likely to provide supporting foraging habitat.

The results of this survey support previous studies (summarised by Biologic (2020b)) which have showed that the Pilbara leaf-nosed bat is relatively scarce within the broader Newman region, due to the limited availability of roosting habitat. The scarcity of records within the Survey Area and its immediate surrounds, and the lack of suitable roosting caves, indicates its occurrence is likely restricted to foraging or dispersal events only.

The Pilbara population is regarded as a single interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022), and therefore, the entire population of Pilbara leaf-nosed bat present is classified as an 'important population'. The Survey Area is considered unlikely to represent a significant area for Pilbara leaf-nosed bats based on the absence of Category 1, 2 and 3 roosts, as defined by (Bat Call, 2021b).

6.5 Night Parrot (*Pezoporus occidentalis*) – Endangered EPBC Act & Critically Endangered BC Act

6.5.1 Species Profile

The night parrot is an elusive, nocturnal ground dwelling parrot that inhabits arid and semi-arid areas that contain a specific structure of dense, low vegetation (DPaW, 2017). Based on accepted records, the species' habitat consists of long-unburnt mature *Triodia* grasslands in stony or sandy environments (McGilp, 1931; North, 1898; Whitlock, 1924; Wilson, 1937), 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 (DPaW, 2017; Murphy *et al.*, 2017). 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 (Night Parrot Recovery Team, 2017). *Triodia* is likely to provide a good seasonal food resource, particularly in times of mass flowering and seeding. *Sclerolaena* and other succulent chenopods also provide a source of food and moisture throughout the year, and are also likely to provide significant habitat (DPaW, 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).

The distribution of the night parrot is very poorly understood. The small number of confirmed/ 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 (Garnett & Crowley, 2000). The largest of these subpopulations is estimated, with low reliability, to consist of 20 breeding birds (Garnett & Crowley, 2000).

6.5.2 Previous Records

No previous surveys within the Survey Area deployed acoustic recorders as targeted search effort for night parrot. The nearest record of the night parrot to the Survey Area is approximately 77 km to the north-east, which was recorded from Cloudbreak mine in 2021 (FMG, 2021) (Table 6.7). This is the most recent documented record of the species in Western Australia and is the first to provide evidence of the night parrot persisting in suitable habitat areas adjacent to active mining operations (three individuals sighted in 2005 (Davis & Metcalf, 2008)) (Table 6.7). The 2005 record is from a permanent soak that was heavily degraded by cattle and lacking an understory; however, larger patches of old-growth *Triodia* grasslands were noted to occur in the vicinity near the Fortescue Marsh and chenopod shrublands occur within the marsh itself. Despite this observation, subsequent targeted survey for the species at the location and in the vicinity have failed to record the species again. Kanyirninpa Jukurrpa rangers recorded night parrot calls at two locations on Martu country in 2020 (Michelmore & Birch, 2020). 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 6.7: Previous records of night parrot within Western Australia

Location	Date of Observation	Source	Distance from Survey Area	Recorded Habitat Type/ Comments
Minga Well, south of Cloudbreak mine site	12/04/2005	Davis and Metcalf (2008)	~77 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)	~77 km north-east	Not noted but located near Fortescue Marsh Adjacent to mining operations
Moojarri Well	~2005 (exact date not noted)	Biota (2005)	~55 km north north-east	Not noted Unconfirmed Biota record between Fortescue Marsh and FMG phase B Rail Corridor
Vacant crown land	15/07/1970	DBCA (2022)	Undisclosed location	Spinifex grassland (Spinifex and scattered gums) Crest/summit. Four individuals observed

Location	Date of Observation	Source	Distance from Survey Area	Recorded Habitat Type/ Comments
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, sedges, chenopods. Thick *Eremophila*, Mulga and grasses One individual each night
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
Telfer area, Great Sandy Desert	Oct–Nov 2020 April–May 2021 (exact date not given)	Biologic (2021)	~295km northeast	Spinifex hummock grassland on sandy loam substrate, with scattered *Acacia* shrubs and eucalypts. Acoustic recordings (two confirmed and one unconfirmed)

6.5.3 Survey Methods

6.5.3.1 Acoustic Recorders

Song Meter acoustic recorders were deployed at 17 sites within the Survey Area (Table 6.8; Figure 6.9). No critical habitat aligning with habitat preferences of the species was recorded within the Survey Area, therefore acoustic recorders were deployed in best available habitats; however, overall, these habitats were considered marginal and unlikely to provide critical nesting/ roosting or foraging habitat for the species. Units were placed within habitat considered most suitable for roosting and nesting as recommended by DPaW (2017). Song Meters were deployed for six consecutive nights each (except VJIN-82, five nights only), as per DPaW (2017) recommendations, for a total of 101 recording nights (Table 6.8). Acoustic recordings were analysed for night parrot calls by specialists Nigel Jackett and Nicholas Leseberg (Adaptive NRM).

Table 6.8: Acoustic sampling for night parrot

Site	Habitat	Deployment	Retrieval	Sampling Nights
Trip 1				
VJIN-03	Hillcrest/ Hillslope	22/03/2023	28/03/2023	6
VJIN-04	Hillcrest/ Hillslope	22/03/2023	28/03/2023	6
VJIN-05	Drainage Area/ Floodplain	22/03/2023	28/03/2023	6
VJIN-06	Stony Plain	22/03/2023	28/03/2023	6
VJIN-07	Hillcrest/ Hillslope	22/03/2023	28/03/2023	6
VJIN-08	Mulga Woodland	22/03/2023	28/03/2023	6
VJIN-11	Stony Plain	22/03/2023	28/03/2023	6
VJIN-16	Stony Plain	23/03/2023	29/03/2023	6
			Subtotal	**48**
Trip 2				
VJIN-51	Stony Plain	12/05/2023	18/05/2023	6
VJIN-53	Drainage Area/ Floodplain	12/05/2023	18/05/2023	6
VJIN-56	Drainage Area/ Floodplain	13/05/2023	19/05/2023	6
VJIN-57	Drainage Area/ Floodplain	13/05/2023	19/05/2023	6
VJIN-58	Mulga Woodland	13/05/2023	19/05/2023	6
VJIN-70	Hillcrest/ Hillslope	13/05/2023	19/05/2023	6
VJIN-72	Drainage Area/ Floodplain	13/05/2023	19/05/2023	6
VJIN-73	Hillcrest/ Hillslope	13/05/2023	19/05/2023	6
VJIN-82	Mulga Woodland	14/05/2023	19/05/2023	5
			Subtotal	**53**
Total acoustic recorders deployed				**17**
Total trap nights				**101**

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Nil

Sampling Type
Acoustic Recorder
Targeted Search

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024

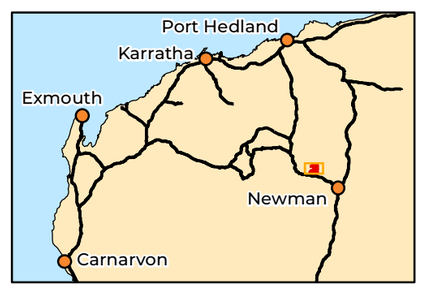


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Figure 6.9: Night parrot sampling locations and habitat in the Survey Area

6.5.4 Survey Results

No evidence of night parrot was recorded at any of the acoustic recorder sampling sites. Twenty-six (26) non-target species were identified (Appendix C).

6.5.5 Discussion

The distribution of the night parrot is very poorly understood in Western Australia; however, the Survey Area occurs within the species' potential distribution, as currently mapped by DoEE (2019b). No evidence of occurrence of night parrot was recorded within the Survey Area during the current survey, including from targeted acoustic recorders deployed in areas of marginally suitable habitat. Habitat within the Survey Area was considered suboptimal for the species, particularly due to most areas of *Triodia* grasslands lacking large, long-unburnt hummocks and the absence of any chenopod shrubland habitat within the Survey Area. Although little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, the extent of which these habitats may still provide habitat for the species is unknown. It is possible that any night parrots occurring near the Cloudbreak mine could potentially use the Survey Area as it is located only 77 km north and within the known cumulative foraging distance (Night Parrot Recovery Team, 2017). However, based on the absence of any habitat considered to be of significance to the species, it is considered unlikely to occur within the Survey Area either as a resident or infrequent visitor during foraging and or dispersal.

6.6 Southern Whiteface (*Aphelocephala leucopsis*) – Vulnerable EPBC Act

6.6.1 Species Profile

The southern whiteface is distributed across the majority of mainland Australia, inhabiting a variety of open woodlands and shrublands containing an understorey of grasses or shrubs, or both (Higgins & Peter, 2002). The distribution within the Pilbara is largely outside the "known" mapped distribution, with the Survey Area mapped as the "species or species habitat may occur" (DCCEEW, 2023a). Typically these woodlands are dominated by acacias or eucalyptus on ranges, foothills and lowlands and plains (Higgins & Peter, 2002). The species is considered to be sedentary; however, records suggest that individuals move to wetter areas outside their normal range during drought conditions (Higgins & Peter, 2002). Southern whiteface primarily forage on the ground, preferring areas with sparse tree cover and an herbaceous understory litter cover, primarily feeding on insects, spiders, and seeds (DCCEEW, 2023a; Higgins & Peter, 2002). The species commonly forages in small groups of two to eight individuals, however, may flock in larger foraging parties during the winter months with as many as 70 individuals previously recorded (Higgins & Peter, 2002).

Breeding takes place between July to October, however exact timing in arid regions through the species range can be impacted by rainfall; individuals may breed outside of the known range following sufficient rainfall events, or not at all during periods of drought (Higgins & Peter, 2002). Nesting often occurs in a hollow or crevice, and less frequently in low bushes, where nests are made of a combination of grass, bark and roots forming a large, dome-like shape (Higgins & Peter, 2002). Southern whiteface are typically observed to nest in pairs, however little is known about the species' social organisation (DCCEEW, 2023a). Cooperative breeding has been recorded, with multiple instances of up to four adults participating in chick rearing (Higgins & Peter, 2002).

6.6.2 Previous Records

There is one previous record of the species from the Survey Area from 2007 (ALA, 2023b); this is the only record of the species within 40 km of the Survey Area (Figure 6.10). The record is a buffered to a precision of 10 km. The scarcity of southern whiteface records in the broader vicinity of the Survey Area may be attributed to the Survey Area's occurrence in the north-western peripheral of the species distribution, whereby the species may naturally occur at a lower abundance which has resulted in fewer records of the species. Additionally, the species' EPBC Act status has only recently been updated to Vulnerable, which could also be a contributing factor (i.e. less/no specific consideration during previous surveys in the vicinity of the Survey Area).

6.6.3 Survey Methods

6.6.3.1 Avifauna Census

Song Meter acoustic recorders were deployed at 17 sites within the Survey Area in suitable habitat, including Drainage Area/ Floodplain and Mulga Woodland (Table 6.8; Figure 6.11). Camera trap transects deployed in suitable habitat (Major Drainage Line, VJIN-19 and VJIN-21) were analysed for presence of the species. Avifauna sampling was undertaken whilst undertaking targeted searches in suitable habitat throughout the Survey Area; sampling was undertaken during periods of likely activity, with a focus on recording either direct observation, calls and/or secondary evidence (e.g. nests, feathers and/or tracks).

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

Newman

LEGEND

Survey Area

Desktop Assessment Area

ALA (2023)

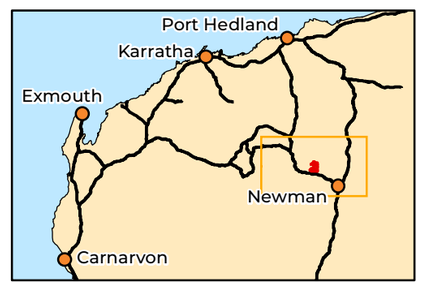
Southern Whiteface - VU

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.10: Previous southern whiteface records in the Survey Area and region

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Critical
Nil

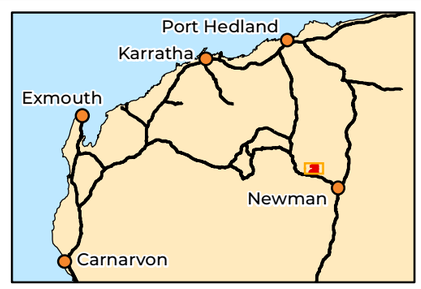
Sampling Type
Camera Trap
Acoustic Recorder
Targeted Search

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.11: Southern whiteface and princess parrot sampling locations and habitat in the Survey Area

6.6.4 Survey Results

No southern whiteface or evidence of the species' occurrence was recorded during the current survey.

6.6.5 Discussion

The Survey Area is outside the modelled distribution for which the species or species habitat is known or likely to occur; however, the Survey Area is located within the modelled distribution for which the species or species habitat may occur (DCCEEW, 2023a). Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Minor Drainage Line (2.15%, 463.72 ha), Mulga Woodland (2.61%, 564.76 ha), and Stony Plain (5.62%, 1,214.52 ha) habitats within the Survey Area are likely to provide suitable nesting, foraging and dispersal for southern whiteface. Suitability of these habitats within the Survey Area is variable, depending on particular habitat characteristics, including the presence of an understorey of grasses or shrubs, or both, with low tree densities and an herbaceous understorey litter cover (DCCEEW, 2023a). The species may also forage and disperse more broadly across other habitats where suitable vegetation cover is present.

No southern whiteface records were made during the current survey and there is a scarcity of records in the broader vicinity. However, the species conservation status has only recently been updated to Vulnerable under the EPBC Act, and as such may not have been previously subjected to the same targeted search effort in the region as other significant fauna during historic surveys (which predominantly targeted significant species or were basic surveys), and other records may be present. The Survey Area occurs on the northern periphery of the species distribution (DCCEEW, 2023a), and as such any records present may represent part of or contribute to an important population of the species, with the habitats within the Survey Area potentially relied upon for individuals for persistence at a local and/or regional scale. However, there is a level of uncertainty due to the species distribution only extending into the southern edges of the Pilbara, with its core range in the Gascoyne and Murchison (DCCEEW, 2023a).

6.7 Princess Parrot (*Polytelis alexandreae*) – Vulnerable EPBC Act and Priority 4 (DBCA)

6.7.1 Species Profile

The princess parrot inhabits low open eucalypt woodlands and savannah shrublands in arid deserts, usually where *Casuarina* and *Allocasuarina* species are present (Baxter & Henderson, 2000; Pavey *et al.*, 2014). The species also occurs and breeds in vegetated riverine and littoral areas, with breeding primarily occurring in marble gum hollows (DEWHA, 2008; Pavey *et al.*, 2014). Princess parrots have been observed feeding on grass, *Acacia* seed pods

flowers (mulga, *Grevillea* sp., *Leptosema* sp., *Hakea* sp., *Eremophila* sp.), leaf stems, lerps, and other plant material (Pavey *et al.*, 2014).

6.7.2 Previous Records

There are no records of princess parrot in the immediate vicinity of the Survey Area; the nearest record is approximately 60 km south-east from 2002 (DBCA, 2023b). The Survey Area is outside the modelled distribution for which the species or species habitat is known, likely, or may occur (DoEE, 2019); the core range of the princess parrot occurs in the arid interior in the Great Sandy Desert, Gibson Desert, or Great Victorian Desert (Pavey *et al.*, 2014).

6.7.3 Survey Methods

Song Meter acoustic recorders were deployed at 17 sites within the Survey Area in marginally suitable habitat, including Stony Plain, Mulga Woodland, Minor Drainage Line, and Drainage Area/ Floodplain (Table 6.8; Figure 6.11). No critical habitat aligning with habitat preferences of the species was recorded within the Survey Area, therefore acoustic recorders were deployed in best available habitats. Avifauna sampling was undertaken whilst undertaking targeted searches throughout the Survey Area; sampling was undertaken during periods of likely activity, with a focus on recording either direct observation, calls and/or secondary evidence (e.g. nests, feathers and/or tracks).

6.7.4 Survey Results

No records or evidence of princess parrot were recorded within the Survey Area during the current survey.

6.7.5 Discussion

The Survey Area is outside the modelled distribution for which the species or species habitat is known, likely, or may occur (DoEE, 2019), with the core range for the species occurring in the arid interior in the Great Sandy Desert, Gibson Desert, or Great Victorian Desert (Pavey *et al.*, 2014). No princess parrot or evidence of the species' occurrence was recorded during the current survey, and there is a scarcity of records within the region. Princess parrot is a boom-bust species (Pavey *et al.*, 2014), and as such previous records of the species in the Pilbara may be attributed to population expansion during the time. Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Major Drainage Line (1.94%, 419.49 ha), Mulga Woodland (2.61%, 564.76 ha), and Stony Plain (5.62%, 1,214.52 ha) habitats within the Survey Area may provide suitable nesting, foraging and dispersal for princess parrot. However overall, the habitats present are unlikely to provide critical nesting/ roosting or foraging habitat for the species in consideration of the lack of previous records and location outside the known distribution, and princess parrot is considered unlikely to occur.

6.8 Grey Falcon (*Falco hypoleucos*) – Vulnerable EPBC Act & BC Act

6.8.1 Species Profile

The grey falcon is 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 studies 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 (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). It 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 (Schoenjahn *et al.*, 2019). Breeding habitat comprises riparian vegetation as well as other productive 'oases' within arid environments, 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, 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, especially budgerigars (*Melopsittacus undulatus*), pigeons, doves and zebra finches (*Taeniopygia guttata*) but can, under unusual circumstances, include small non-avian species (Schoenjahn, 2013). Whether they scavenge carrion 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 as 882,558 km^2. Recent research has shown that it 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, it tends to keep physical activity levels lows (Schoenjahn *et al.*, 2022).

6.8.2 Previous Records

Three records of grey falcon occur within 40 km of the Survey Area, all comprising a single individual observed 25–30 km west of the Survey Area in the Packsaddle range at South Flank (DBCA, 2023b; WAIO, 2022). The individual was observed foraging in Stony Plain and Drainage Area/ Floodplain habitat, and also recorded roosting in a eucalypt (ENV, 2008a). There are no previous records of grey falcon within the Survey Area.

6.8.3 Survey Methods

6.8.3.1 Targeted Searches

Five targeted searches were undertaken within the Survey Area, focusing on suitable habitat within Major Drainage Line habitat (VJIN-09, VJIN-108) or suitable habitats immediately adjacent to Minor Drainage Line that were traversed (VJIN-75, VJIN-110, VJIN-112), totalling 11 person hours (Figure 6.12, Appendix F; Figure 6.13). Sampling was undertaken during periods of likely activity, with a focus on recording either direct observation, calls and/or secondary evidence (e.g. nests, feathers and/or tracks). Given that there was limited preferred habitat for the species, most of the targeted searches were undertaken alongside targeted searches for other species, including ghost bat Pilbara leaf-nosed bat and Pilbara olive python.

6.8.4 Survey Results

6.8.4.1 Targeted Searches

No grey falcon were observed during the current surveys.

640000 680000 720000 760000 800000 840000

7520000 7480000 7440000 7400000

Newman

LEGEND

Survey Area
Desktop Assessment Area

BHP (2023)
Individual (alive)

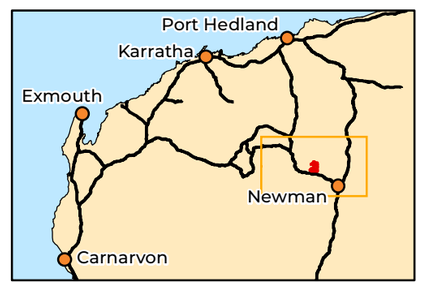
DBCA (2023)
Individual (alive)

Biologic

Scale 1:600,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.12: Previous grey falcon records in the Survey Area and region

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

LEGEND

Survey Area
Rail
Local Road

Habitat
Critical
Supporting
Nil

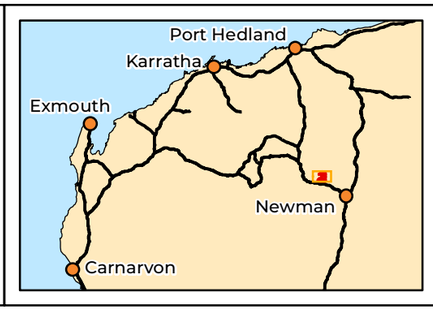
Sampling Method
Traverse

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 6.13: Grey falcon sampling and habitat in the Survey Area

6.8.5 Discussion

The Survey Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur (DoE, 2022), The grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020) and the Pilbara is thought to be a stronghold (Sutton, 2010). Thus, any grey falcon present in the Pilbara is therefore considered to be part of an 'important population'.

The Major Drainage Line habitat (1.94%, 419.49 ha) is considered critical habitat for grey falcon. The Drainage Area/ Floodplain (20.21%, 4367.47 ha) and Minor Drainage Line (2.15%, 463.72 ha) habitats may provide supporting habitat for foraging and dispersal functions, and to a lesser extent, other habitats more broadly; however, the species' occurrence is likely to be dependent on the proximity of nesting. Nesting may occur in Major or Minor Drainage Line habitats where suitable tall trees are present or suitable tall infrastructure (i.e. powerline or transmission towers) occurs. Critical habitat within the Survey Area is likely limited to the Major and Minor Drainage Line habitats in Weeli Wolli Creek, Northeast Corner, and South Parmelia sections. Weeli Wolli creek contains large *Eucalyptus camaldulensis* and *E. victrix* trees that may provide suitable nesting sites. There is also a powerline corridor running through South Parmelia that may be used by the species for nesting. If breeding was recorded within the Survey Area, these areas would be considered important on a local and regional scale. Grey falcons are known to be "reluctant nomads", only moving on from their home range when conditions become a risk to their survival (Schoenjahn, 2018); as such, if any individuals are recorded, they are likely to rely on the habitats within the Survey Area or local vicinity for long-term persistence.

6.9 Pilbara Olive Python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable EPBC Act & BC Act

6.9.1 Species Profile

The Pilbara olive python is Western Australia's largest snake, averaging 2.5 metres (m) in length, with records up to 4.5 m (Bush & Maryan, 2011; Cogger, 2014). It has a dull olive-brown upper surface and is pale cream below (Burbidge, 2004; Cogger, 2014). It 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).

It 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, it is primarily nocturnal, although adult pythons can sometimes be

found basking in the morning sun (DSEWPaC, 2011b). The breeding season takes place in the cooler months, which extends from June to August, and males will travel up to 3 km in search of a mate (DSEWPaC, 2011b). It is a well-adapted opportunistic ambush predator and common prey items include rock-wallabies, small euros, fruit bats, waterbirds, doves/pigeons (Ellis, 2013; Ellis & Johnstone, 2016; Pearson, 2007; Pearson, 2003; TSSC, 2008).

It commonly inhabits 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, it is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). It is likely to be attracted to these areas due to the productivity and abundance of suitably-sized prey (Pearson, 2003).

6.9.2 Previous Records

Previous survey effort within the Survey Area includes 273 hours of diurnal searches and 71 hours of nocturnal searches (Table 6.9). There are 46 records of the species within 40 km of the Survey Area (BHP WAIO, 2023b; DBCA, 2023b)(Figure 6.14). Of these, four occur within the Survey Area, including three scat records within Jinidi and one live individual in South Parmelia (Biologic, 2011c; Onshore & Biologic, 2009) (Figure 6.14).

Outside the Survey Area, a roadkill individual was recorded 2.1 km south along the Hope Downs access road (Biologic, 2011c) (Figure 6.14; Figure 6.14). Twelve records are located along Weeli Wolli creek to the north and north-west of the Survey Area, ranging from 1.7 to 31 km away (BHP WAIO, 2023b; DBCA, 2023b). In 2013, two live individuals were observed within two gorges within Mudlark Well and a live individual was also recorded within Major Drainage Line habitat at Area C West, 42 km west of the Survey Area (Biologic, 2013a, 2013d) (Figure 6.14). Pilbara olive python was also recorded via an eDNA sample within Gorge/ Gully habitat 7.4 km north of the Survey Area (Biologic, 2023) (Figure 6.14).

Table 6.9: Survey effort for Pilbara olive python within the Survey Area

Survey	Survey effort	Notes
Biologic (2011b)	64.8 hours diurnal searches	Jinidi
Biologic (2011c)	75.2 hours diurnal searches	Jinidi
Onshore and Biologic (2009)	Opportunistic reptile surveys	South Parmelia
Outback Ecology (2010)	11 hours diurnal searches	Jinidi
Biota (2013b)	1175 minutes targeted searches	South Parmelia
Ecologia (2006b)	62.6 hours diurnal searches 33.2 hours nocturnal searches	Jinidi

Survey	Survey effort	Notes
ENV (2010a)	40 hours diurnal searches 38 hours nocturnal searches	Jinidi

6.9.3 Survey Methods

6.9.3.1 Targeted Searches

Diurnal searches were conducted along 42 transects, with efforts focused in habitats with particular habitat features such as caves and overhangs (i.e. Gorge/ Gully and Breakaway/ Cliff) and where pooling water remains for prolonged periods following rainfall events (i.e. Major Drainage Line) (Figure 6.15; Appendix F). No nocturnal searches were conducted during the surveys due to safety limitations (Table 4.3). Searches focused on observing active individuals, in particular in or around water features, and from secondary evidence such as scats, sloughs or skeletal remains. A total of 116 person hours of targeted searches were undertaken within the Survey Area (Appendix F).

6.9.3.2 eDNA sampling

Environmental DNA (eDNA) is a by-product of the metabolic process, derived from sources such as faeces, urine, scales, and mucous secretions, and are recoverable from environmental substrates (i.e. water or substrate) (Huerlimann *et al.*, 2020). The extraction of eDNA has become increasingly important in biological surveys and monitoring, particularly for rare and cryptic species. A recent study has demonstrated the efficacy of eDNA sampling for Pilbara olive python (Mousavi-Derazmahalleh *et al.*, 2023) which is often difficult to detect using other survey techniques.

Sampling for eDNA was undertaken at ten water features within the Survey Area (Table 6.10; Figure 6.15); samples were collected from Gorge/ Gully (n = 7), Major Drainage Line (Weeli Wolli creek, Ben's Oasis, n = 3) habitats.

Five 1 litre (L) replicate samples were collected from each water feature, for a total of 50 water samples. Samples were collected and stored in a refrigerator, prior to being filtered through a 0.45-micron (µm) mixed cellulose ester (MCE) filter membrane using a peristaltic Sentino pump. All filtering equipment was sterilised in a 10% bleach solution and rinsed between samples. Once filtering was completed, filter membranes were individually stored in 100% ethanol at room temperature for transport and then stored at -20°C at Curtin University's eDNA Frontiers laboratory prior to analysis. Methods for the eDNA analysis are provided in Appendix G.

Table 6.10: eDNA sample locations

Site ID	Water Feature ID	Date	Habitat
VBEN-01	WBEN-01	19/03/2023	Major Drainage Line
VJIN-12	WJIN-02	22/03/2023	Gorge/ Gully
VJIN-15	WJIN-03	22/03/2023	Gorge/ Gully
VJIN-21	WJIN-01	24/03/2023	Major Drainage Line
VJIN-12	WJIN-04	27/03/2023	Gorge/ Gully
VJIN-21	WJIN-16	13/05/2023	Major Drainage Line
VJIN-81	WJIN-14	13/05/2023	Gorge/ Gully
VJIN-75	WJIN-13	14/05/2023	Gorge/ Gully
VJIN-85	WJIN-15	14/05/2023	Gorge/ Gully
VJIN-60	WJIN-06	15/05/2023	Gorge/ Gully

640000
680000
720000
760000
800000
840000
7520000
7480000
7440000
7400000
Newman
LEGEND
Survey Area
Desktop Assessment Area
BHP (2023)
Individual (alive)
Individual (dead)
Nest
Scat
Unknown
DBCA (2023)
Individual (alive)
Individual (dead)
Unknown
Biologic
Scale 1:600,000
0 10 20 Km
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 29/04/2024
Port Hedland
Karratha
Exmouth
Newman
Carnarvon
BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey
Figure 6.14: Previous Pilbara olive python records in the Survey Area and region

712000 724000 736000 748000

7464000

7452000

West Angelas Rd

WJIN-19 WJIN-01 WJIN-09 WJIN-06 WJIN-07
WJIN-16 WJIN-18
WJIN-17
WJIN-08

1001_11_0016 1001_11_0015
1001_11_0018
1001_11_0019 1001_11_0022
Jinidi 4
1001_11_0025

WJIN-03
1001_11_0008
Jinidi
Jinidi 7
Jinidi 2
Jinidi 3
WJIN-02 Jinidi 6
1001_11_0012
WJIN-04
1001_11_0014
1001_11_0011

WBEN-01

JINSP2
WJIN-12
WJIN-13
WJIN-10 WJIN-15
WJIN-05
WJIN-11

LEGEND

- Survey Area
- Rail
- Local Road

Habitat
- Critical
- Supporting
- Nil

Sampling Method
- eDNA
- Traverse

Water Feature This Survey
- Permanent
- Ephemeral
- Temporary

Other Survey
- Ephemeral

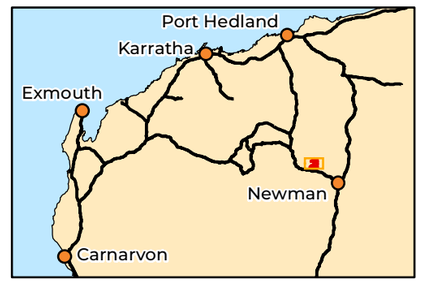
Record
- Individual (alive)
- eDNA
- Scat - Old (6mths to 3yrs)
- Scat - Very Old (3 to 10yrs)

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO

Jinidi Targeted MNES Vertebrate Fauna Survey

Figure 6.15: Pilbara olive python sampling, records and habitat in the Survey Area

6.9.4 Survey Results

6.9.4.1 Targeted Searches

Evidence of Pilbara olive python was recorded from eight locations across the Survey Area, from live individuals, scats, and eDNA detection. Two active individuals were observed; in cave CJIN-037 and opportunistically in central Jinidi by a Biologic flora and vegetation survey undertaken in November 2023 (Biologic, 2024) (Plate 6.3; Figure 6.15; Appendix H). Five records of scats were made, categorised as old to very old. One detection of the species from eDNA sampling was made at Weeli Wolli Creek (WJIN-01) (Figure 6.15, Appendix H).

Plate 6.3: Pilbara olive python recorded in cave CJIN-037 during trip 2.

6.9.5 Discussion

Thirty-eight water features were historically recorded or recorded in the Survey Area during the current surveys (Figure 5.2). Five are classified as permanent (permanent pools and discharge along Weeli Wolli Creek, and Ben's Oasis), twenty-six as likely ephemeral, and seven as likely temporary ephemeral, noting that the classification and location of some of the historical features is not confirmed. For Pilbara olive pythons, these water features often act as critical foraging locations and for that reason it is often associated with such features, particularly in rocky habitats. These water features also occur to a lesser degree in Major Drainage Line and Minor Drainage Line habitat where suitable vegetation cover is present (Pearson, 1993). The permanent water features (Weeli Wolli Creek and Ben's Oasis) are therefore considered critical habitat; with the ephemeral and temporary ephemeral pools in Gorge/ Gully habitat considered supporting habitat. Given the number of current and

previous records along Weeli Wolli creek, extending north out of the Survey Area (Figure 6.14), the species is reliant on this feature within the Survey Area for long-term persistence.

Overall, the Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.8%, 174.27 ha) Major Drainage Line (1.94%, 419.49 ha) habitats provide critical habitat for the Pilbara olive python (Figure 6.15). Areas of Major Drainage Line (1.94%, 419.49 ha), and Minor Drainage Line (2.15%, 463.72 ha) areas that don't contain permanent or near-permanent water features are classified as supporting habitat, particularly in areas where they connectivity between areas of critical habitat (i.e. Gorge/ Gully). In addition, Hillcrest/Hillslope and Drainage Area/ Floodplain is considered supporting habitat where in the home range (88 - 440 ha, BHP WAIO, 2023d)) of critical habitat and where important microhabitats (e.g. under or on top of rocks, under spinifex, or temporary pools) are present (BHP WAIO, 2023d).

The Pilbara olive python has been recorded multiple times within the Survey Area across its extent, and the Survey Area contains both critical and supporting habitat. Based on this, the population would be considered part of or contributing to an 'important population' as defined by DoE (2013a).

6.10 Great desert skink (*Liopholis kintorei*) – Vulnerable EPBC Act & BC Act

6.10.1 Species Profile

The great desert skink is endemic to the Australian arid zone in the western deserts region (TSSC, 2016a). Within Western Australia, the species appears to have undergone a range contraction in WA, with surveys failing to detect the species in former strongholds in the Gibson Desert north of Warburton and in the Great Victoria Desert (Pearson *et al.*, 2001).

Sandplain vegetated by spinifex and scattered shrubs appears to be the habitat type most widely used by the species, and some adjacent dunefield swales (Pavey, 2006). In the Tanami Desert and parts of the Great Sandy Desert they also inhabit paleodrainage lines characterised by giant termite mounds and titree (*Melaleuca* spp.) shrubs. The recently discovered population in northern South Australia is located in an area of spinifex and woollybutt grass (*Eragrostis* sp.) with scattered mulga. Extensive areas of dunefields, rocky ranges and mulga woodlands occur through the western deserts and are considered unsuitable habitat (Pavey, 2006).

6.10.2 Previous Records

The Survey Area is outside the modelled distribution for which the species or species habitat is known or likely to occur (DoEE, 2019). There are no records of great desert skink in the region of the Survey Area; the nearest available record is approximately 280 km south-west at Birriliburu, where more 20 active burrows found across 3 sites along a 20km wide area

were recorded in 2021 (Indigenous Desert Alliance, 2022). The species is also present at Parnngurr, approximately 250 km north-east (Indigenous Desert Alliance, 2022).

6.10.3 Survey Methods

Opportunistic sampling was undertaken during targeted searches throughout the Survey Area in suitable habitat. No high value habitat aligning with habitat preferences of the species was recorded within the Survey Area; overall, the habitats present were considered marginal and unlikely to provide critical habitat for the species due to the lack of sandplain present.

6.10.4 Survey Results

No records or evidence of great desert skink were recorded within the Survey Area during the current survey.

6.10.5 Discussion

The Survey Area is outside the modelled distribution for which the species or species habitat is known or likely, to occur (DoEE, 2019), with the core range for the species occurring in the arid interior (Indigenous Desert Alliance, 2022). No great desert skink or evidence of the species' occurrence was recorded during the current survey, and there is a scarcity of records within the region. The habitats present in the Survey Area are not considered suitable to support the species due to the absence of sand plain. In consideration of this, the lack of previous records, and location outside the known distribution, great desert skink is considered highly unlikely to occur.

6.11 Other Fauna of Significance

Two other significant species were recorded in the Survey Area, the western pebble-mound mouse (*Pseudomys chapmani* – Priority 4 DBCA), and brush-tailed mulgara (*Dasycercus blythi* – Priority 4 DBCA). Thirty-seven pebble-mounds were recorded, including 29 classified as active mounds, four as recently inactive mounds, and five as inactive mounds (Plate 6.4, Appendix H; Figure 6.16). The western pebble-mound mouse has previously been recorded on more than 1,500 occasions within 40 km of the Survey Area (BHP WAIO, 2023b; DBCA, 2023b), 213 of which are from the Survey Area (none of which aligning with current records), primarily within Hillcrest/ Hillslope and Stony Plain habitats. The species is likely to occur as a resident throughout the Survey Area, in Hillcrest/ Hillslope and Stony Plain habitats. The species occurrence within the Survey Area is unlikely to represent an important population and the species is not likely to be reliant upon the Survey Area, or habitat within, for the long-term persistence of the species at a local or regional scale.

Three brush-tailed mulgara burrows (one active and two inactive) were recorded during trip 2 (VJIN-96) in a sandy area of Drainage Area/ Floodplain habitat within the Jinidi part of the Survey Area (Plate 6.5; Figure 6.16; Appendix H). These are the first records of this species from the Survey Area. The nearest records are from approximately 13 km to the north-east (BHP WAIO, 2023b; DBCA, 2023b). The species may occur as a resident in small sections of the Survey Area, in Drainage Area/ Floodplain (20.21%, 4367.47 ha) and Stony Plain (5.62%, 1,214.52 ha) habitats. The species occurrence within the Survey Area is unlikely to represent an important population and the species is not likely to be reliant upon the Survey Area, or habitat within, for the long-term persistence of the species at a local or regional scale.

While a number of other significant species were identified in the desktop assessment as recorded within the vicinity of the Survey Area (peregrine falcon, eastern osprey, fork-tailed swift, Pilbara barking gecko, and Gane's blind snake), the Survey Area and habitats within are unlikely to be relied upon by any species for their long-term persistence at a local and/or regional scale.

Plate 6.4: Western pebble-mound mouse mound recorded from VJIN-39

Plate 6.5: Brush-tailed mulgara burrows recorded from VJIN-96.

712000
724000
736000
748000
7464000
7452000
West Angelas Rd

Habitat Type
- Breakaway/ Cliff
- Calcrete Plain
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hillcrest/ Hillslope
- Major Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Rehabilitated Area
- Stony Plain

LEGEND
- Surey Area
- Rail
- Local Road

Sampling Method
- Camera Trap
- Traverse

Brush-tailed mulgara (*Dasycercus blythi*) - P4
- Burrow (active)
- Burrow (inactive)

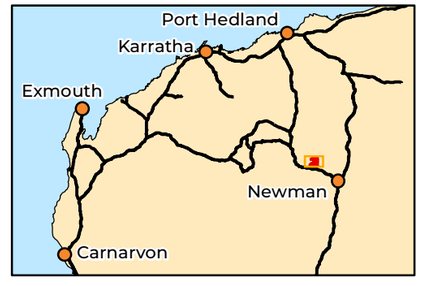
Western pebble-mound mouse (*Pseudomys chapmani*) - P4
- Mound (active)
- Mound (recently inactive)
- Mound (inactive)

Biologic

Scale 1:105,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 10/05/2024



BHP WAIO
Jinidi Targeted MNES
Vertebrate Fauna Survey

Figure 6.16: Other significant species sampling, records and habitat in the Survey Area

7 Conclusion

7.1 Northern quoll

Northern quoll was recorded from scats at 12 locations within Northeast Corner of the Survey Area in Gorge/ Gully and Hillcrest/ Hillslope habitats. These are the first records of the species in the Survey Area. The Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.8%, 174.27 ha), and Major Drainage Line (1.94%, 419.49 ha) habitats meet the definition of critical habitat (i.e. denning/ shelter habitat) for northern quoll. These habitats also provide critical foraging and dispersal habitat for the species. Potential supporting habitat for the northern quoll occurs in the Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Drainage Area/ Floodplain (20.21%, 4367.47 ha), and Minor Drainage Line (2.15%, 463.72 ha) habitats, where proximal (within 35 hectares (ha)) to the Gorge/ Gully and Breakaway/ Cliff habitats. The extent of critical habitat within the Survey Area is limited; however, they form part of larger continuations of the habitat beyond the extent of the Survey Area and may therefore potentially act as foraging and dispersal corridors where connectivity to other areas of critical habitat is provided.

Overall, in consideration of the overall scarcity and concentration of records, the species is unlikely to be reliant on the habitats within the Survey Area for long-term persistence at a local and/or regional scale; however, the habitat is considered critical for individual persistence within the Survey Area. Based on the results of the current survey, the occurrence of northern quoll within Survey Area is unlikely to contribute to or form part of an important population. The presence of scats in the Northeast Corner section of the Survey Area during the current surveys suggests a potentially recent, low abundance population or possible transient individuals in this northern section of the Survey Area. Further monitoring would be required to confirm this.

7.2 Greater bilby

No records or evidence of the greater bilby was recorded within the Survey Area during the current survey; the nearest previous records are approximately 20–35 km northeast in the Fortescue Valley. Based on the limited number of nearby recent records, and lack of suitable Sand Plain habitat or evidence of species occurrence, the greater bilby is considered unlikely to occur in the Survey Area. Although the species is known to utilise broad habitats occurring within the Survey Area in other parts of its distribution (i.e. Major Drainage Line (1.94%, 419.49 ha), Mulga Woodland (2.61%, 564.76 ha) and Drainage Area/ Floodplain (20.21%, 4,367.47 ha)), these habitats are rarely utilised by the species within the Pilbara region. The likelihood of these habitats being utilised by the species may also increase when larger areas of suitable habitat (e.g. Sand Plain) are present adjacent to or in the vicinity.

7.3 Ghost bat

Ghost bat was recorded on 18 occasions in the Survey Area during the current survey, including one observation of an individual roosting, one detection from eDNA sampling at Weeli Wolli Creek, three calls via ultrasonic in the southern section of the Survey Area, and scat evidence on 13 occasions. Three caves were classified as Category 2 roost (maternity/ diurnal roost caves with regular occupancy) for ghost bats and provide critical breeding habitat for the species. One Category 3 cave occurs as part of an apartment block with a Category 2 cave and is considered critical habitat for the species. Eight caves (seven Gorge/ Gully; one Hillcrest/ Hillslope) in the Survey Area were identified as Category 3 (diurnal roost caves with occasional occupancy) and 14 caves (nine Gorge/ Gully; four Hillcrest/ Hillslope) were identified as Category 4 (nocturnal roost caves with opportunistic usage).

The most suitable areas of habitat to support the species are in the Northeast Corner, the large range in South Parmelia, and the south and south-eastern portions of Jinidi. Critical foraging and dispersal habitat within the Survey Area is provided by Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Stony Plain (5.62%, 1,214.52 ha), Gorge/ Gully (2.28%, 491.71 ha), Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Mulga Woodland (2.61%, 564.76%), Minor Drainage Line (2.15%, 463.72 ha), and Major Drainage Line (1.94%, 419.49 ha), when proximal (<12 km) to roosting caves. The suitability of these habitats is dependent on specific characteristics of the habitat, including the abundance of foraging structures (tree perches) and the structure and density of understorey vegetation. Due to the presence of known roosting caves and confirmed records within the Survey Area and surrounds, the presence of suitable breeding and roosting habitat, and recent records of the species, it is likely to occur as a resident and utilise the above habitats within the Survey Area regularly for foraging.

Due to the presence of three Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts and critical foraging habitat, the individuals present in the Survey Area form part of a key population for breeding and contribute to the broader meta-population of ghost bats in the Pilbara. The individuals present contribute to the high genetic diversity present in the region, potentially linking larger populations at South Flank/Mining Area C and Western Ridge and Jimblebar through dispersing individuals. As such, the individuals present within the Survey Area contribute to a population aligning with the DoE (2013b) definition of 'important'.

7.4 Pilbara leaf-nosed bat

Pilbara leaf-nosed bat has been previously recorded from ultrasonic recording in the Survey Area; however, no records or evidence of the species were recorded within the Survey Area during the current survey. The nearest known permanent diurnal roost for this species is the

Rio Tinto Gudai-Darri project, approximately 30 km north-west of the Survey Area (Bat Call, 2021b).

No habitat within the Survey Area is considered critical for the Pilbara leaf-nosed bat, as it is not within 20 km of any known diurnal roosts. The Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.81%, 174.27 ha), and Major Drainage Line (1.94%, 419.49 ha) habitats provide supporting foraging and dispersal habitat for the species and tend to contain important habitat features such as nocturnal refuges and water features. Although Gorge/ Gully and Breakaway/ Cliff habitats are not classified as critical habitat for the Pilbara leaf-nosed bat, they have the potential to contain critical habitat in the form of Category 1–3 caves. As such these habitats represent a Habitat Rating 4 (very high). Other supporting foraging and dispersal habitat for Pilbara leaf-nosed bat within the Survey Area is provided by Hillcrest/ Hillslope (57.46%, 12,415.13 ha), Stony Plain (5.62%, 1,214.52 ha), Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Mulga Woodland (2.61%, 564.76%), and are classified as Habitat Rating 2 (low). The Survey Area also contains water features likely to provide supporting foraging habitat.

The results of this survey support previous studies which have showed that the Pilbara leaf-nosed bat is relatively scarce within the broader Newman region (summarised in Biologic (2020b), due to the limited availability of roosting habitat. The scarcity of records within the Survey Area and its immediate surrounds, and the lack of suitable roosting caves, indicates its occurrence is likely restricted to foraging or dispersal events only, unless suitable caves are located. The Survey Area is considered unlikely to represent a significant area for Pilbara leaf-nosed bats based on the absence of Category 1, 2 and 3 roosts.

7.5 Night parrot

No evidence of occurrence of night parrot was recorded within the Survey Area during the current survey. Habitat within the Survey Area was considered suboptimal for the species, particularly due to most areas of *Triodia* grasslands lacking large, long-unburnt hummocks and the absence of any chenopod shrubland habitat within the Survey Area. Although little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, the extent of which these habitats may still provide habitat for the species is unknown. It is possible that any night parrots occurring near the Cloudbreak mine could potentially use the Survey Area as it is located only 77 km north and within the known cumulative foraging distance. However, based on the absence of any habitat considered to be of significance to the species, it is considered unlikely to occur within the Survey Area either as a resident or infrequent visitor during foraging and or dispersal.

7.6 Southern whiteface

No southern whiteface or evidence of the species' occurrence was recorded during the current survey. The Survey Area is outside the modelled distribution for which the species or species habitat is known or likely to occur; however, the Survey Area is located within the modelled distribution for which the species or species habitat may occur. Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Minor Drainage Line (2.15%, 463.72 ha), Mulga Woodland (2.61%, 564.76 ha), and Stony Plain (5.62%, 1,214.52 ha) habitats within the Survey Area are likely to provide suitable nesting, foraging and dispersal for southern whiteface. Suitability of these habitats within the Survey Area is variable, depending on particular habitat characteristics, including the presence of an understorey of grasses or shrubs, or both, with low tree densities and an herbaceous understorey litter cover. The species may also forage and disperse more broadly across other habitats where suitable vegetation cover is present.

No southern whiteface records were made during the current survey and there is a scarcity of records in the broader vicinity. However, the species conservation status has only recently been updated to Vulnerable under the EPBC Act, and as such may not have been previously subjected to the same targeted search effort in the region as other significant fauna during historic surveys (which predominantly targeted significant species or were basic surveys), and other records may be present. The Survey Area occurs on the northern periphery of the species distribution (DCCEEW, 2023a), and as such any records present may represent part of or contribute to an important population of the species, with the habitats within the Survey Area potentially relied upon for individuals for persistence at a local and/or regional scale. However, there is a level of uncertainty due to the species distribution only extending into the southern edges of the Pilbara, with its core range in the Gascoyne and Murchison (DCCEEW, 2023a).

7.7 Princess parrot

The Survey Area is outside the modelled distribution for which the species or species habitat is known, likely, or may occur. No princess parrot or evidence of the species' occurrence was recorded during the current survey, and there is a scarcity of records within the region. Princess parrot is a boom-bust species (Pavey *et al.*, 2014), and as such previous records of the species in the Pilbara may be attributed to population expansion during the time. Drainage Area/ Floodplain (20.21%, 4,367.47 ha), Major Drainage Line (1.94%, 419.49 ha), Mulga Woodland (2.61%, 564.76 ha), and Stony Plain (5.62%, 1,214.52 ha) habitats within the Survey Area may provide suitable nesting, foraging and dispersal for princess parrot. However overall, the habitats present are unlikely to provide critical nesting/ roosting or foraging habitat for the species in consideration of the lack of previous records and location outside the known distribution, and Princess parrot is considered unlikely to occur.

7.8 Grey falcon

The Survey Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur. The grey falcon is regarded as representing a single interbreeding population and the Pilbara is thought to be a stronghold. Thus, any grey falcon present in the Pilbara is therefore considered to be part of an 'important population'.

No grey falcons were recorded in the current surveys. The Major Drainage Line habitat (1.94%, 419.49 ha) is considered critical habitat for grey falcon, and the Drainage Area/ Floodplain (20.21%, 4367.47 ha) and Minor Drainage Line (2.15%, 463.72 ha) habitats may provide supporting habitat for foraging and dispersal functions; however, the species' occurrence is likely to be dependent on the proximity of nesting. Nesting may occur in Major or Minor Drainage Line habitats where suitable tall trees are present or suitable tall infrastructure (i.e. powerline or transmission towers) occurs. Critical habitat within the Survey Area is likely limited to the Major and Minor Drainage Line habitats in Weeli Wolli Creek, Northeast Corner, and South Parmelia sections. If breeding was recorded within the Survey Area, these areas would be considered important on a local and regional scale. If any individuals are present, they are likely to rely on the habitats within the Survey Area or local vicinity for long-term persistence.

7.9 Pilbara olive python

Evidence of Pilbara olive python was recorded from eight locations across the Survey Area, including two live individuals, five records of scats, and one detection from eDNA sampling at Weeli Wolli Creek. There are four previous records within the Survey Area, including three scat records within Jinidi and one live individual in South Parmelia.

The permanent water features present (including Weeli Wolli Creek and Ben's Oasis) are considered critical habitat; with the likely ephemeral and temporary ephemeral pools in Gorge/ Gully habitat considered supporting habitat. Given the number of current and previous records along Weeli Wolli creek, extending north out of the Survey Area, the species is reliant on this feature within the Survey Area for long-term persistence. Overall, the Gorge/ Gully (2.28%, 491.71 ha), Breakaway/ Cliff (0.8%, 174.27 ha) Major Drainage Line (1.94%, 419.49 ha) habitats provide critical habitat for the Pilbara olive python. Areas of Major Drainage Line (1.94%, 419.49 ha), and Minor Drainage Line (2.15%, 463.72 ha) areas that don't contain permanent or near-permanent water features are classified as supporting habitat, particularly in areas where they connectivity between areas of critical habitat (i.e. Gorge/ Gully). In addition, Hillcrest/Hillslope and Drainage Area/ Floodplain is considered supporting habitat where in the home range (88 - 440 ha, BHP WAIO, 2023d) of critical habitat and where important microhabitats (e.g. under or on top of rocks, under spinifex, or temporary pools) are present.

The Pilbara olive python has been recorded multiple times within the Survey Area across its extent, and the Survey Area contains both critical and supporting habitat. Based on this, the individuals present would form part of a population considered an 'important population' as defined by DoE (2013a).

7.10 Great desert skink

No great desert skink or evidence of the species' occurrence was recorded during the current survey, and there is a scarcity of records within the region. The Survey Area is outside the modelled distribution for which the species or species habitat is known or likely to occur, with the core range for the species occurring in the arid interior (Indigenous Desert Alliance, 2022). The habitats present in the Survey Area are not considered suitable to support the species due to the absence of sand plain. In consideration of this, the lack of previous records, and location outside the known distribution, great desert skink is considered highly unlikely to occur.

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Appendix A: Conservation Codes

Environment Protection and Biodiversity Conservation Act 1999

Category	Definition
Threatened Fauna Species	
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	Taxa known to survive only in captivity.
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (VU)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Migratory (MIG)	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA) China-Australia Migratory Bird Agreement (CAMBA) Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

Biodiversity Conservation Act 2016

Category	Definition
Threatened Fauna Species	
Critically Endangered (Cr)	Rare or likely to become extinct, as *critically endangered* fauna.
Endangered (En)	Rare or likely to become extinct, as *endangered* fauna.
Vulnerable (Vu)	Rare or likely to become extinct, as *vulnerable* fauna.
Extinct (Ex)	Being fauna that is presumed to be extinct.
Migratory (Mi)	Birds that are subject to international agreements relating to the protection of migratory birds.
Conservation Dependent (CD)	Special conservation need being species dependent on ongoing conservation intervention. (Conservation Dependant)
Other Specially Protected Species (OS)	In need of special protection, otherwise than for the reasons pertaining to Schedule 1 through to Schedule 6 Fauna. (Other specially protected species

Department of Biodiversity, Conservation and Attractions Priority Definitions

Category	Definition
Priority Fauna Species	
Priority 1 (P1)	**Poorly-known Species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2 (P2)	**Poorly-known Species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3 (P3)	**Poorly-known Species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4 (P4)	**Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

International Union for Conservation of Nature

Category	Definition
Extinct (Ex)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (Ex)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (Cr)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (En)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (Vu)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases, great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Appendix B: Significant Vertebrate Fauna Recorded in the Desktop Assessment

Species		Conservation Status				Database review					Literature review																									
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	NatureMap (40 km)	EPBC Protected Matters (40km)	DBCA Priority and Threatened Database (40km)	ALA (40km)	Birdlife (40km)	Ecologia (1997). Hope Downs Biological Survey	Ecologia (1998). Weeli Wolli Creek Biological Assessment Survey	Ecologia (1998). Mining Area C Biological Survey	Specialised Zoological (2008). Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3	ENV (2007). Area C Deposit R Fauna Assessment	Biologic (2010). East Packsaddle Level 1 Vertebrate Fauna Study	ENV (2009). Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	Biologic (2011). Area C and Surrounds Vertebrate Fauna Survey	Biologic (2013). South Flank Targeted Northern Quoll Survey	Biota (2005). Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy,	Ninox (2009). A Fauna Survey of the Proposed Hope Downs 4 Mining Area, near Newman, Western Australia	Astron (2019). Hope Downs 2 Proposal Fauna Survey	Biota (2013). Jinidi to Mindy Level 1 Fauna Survey	Biota (2015). Baby Hope Downs Deposit Targeted Fauna Survey	Biologic (2013). Marillana and Surrounds Targeted Mulgara Survey	Biologic (2013). Central Pilbara Ghost Bat Population and Roost Assessment	Biologic (2011). Jinidi Targeted Northern Quoll Survey	Outback Ecology (2010). Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey	ENV (2010). Jinayri Access Road Vertebrate Fauna Survey	Onshore and Biologic (2009). South Parmelia Exploration Leases Biological Survey	Ecologia (2006). Jirridi Biological Survey Summary Report	ENV (2010). Jinayri Mining Lease Vertebrate Fauna Survey	Biologic (2017). Hamersley Subregion Ghost Bat Population and Roost Assessment 2015 - 2016	Biota (2010). Yandicoogina Junction South West and Oxbow Fauna Survey	Current survey
DASYURIDAE																																				
Antechinomys longicaudatus	Long-tailed dunnart			P4																X																
Dasycercus blythi	Brush-tailed mulgara			P4		X		X												X					X										x
Dasyurus hallucatus	Northern quoll	EN	EN		EN	X	Known	X												X		X														x
MEGADERMATIDAE																																				
Macroderma gigas	Ghost bat	VU	VU		VU	X	Known	X	X							X		X	X			X				X		X			X	X	X		x
MURIDAE																																				
Leggadina lakedownensis	Northern short-tailed mouse			P4																X																
Pseudomys chapmani	Western pebble-mound mouse			P4		X		X	X		X	X	X		X	X		X	X	X	X	X		X				X	X	X	X	X		X	x
RHINONYCTERIDAE																																				
Rhinonicteris aurantia	Pilbara leaf-nosed bat	VU	VU			X	Known	X							X							X										X			
THYLACOMYIDAE																																				
Macrotis lagotis	Greater bilby	VU	VU		VU	X	Likely	X																												
ACANTHIZIDAE																																				
Aphelocephala leucopsis	Southern whiteface	VU				X			X	X										X																
ACCIPITRIDAE																																				
Elanus scriptus	Letter-winged kite			P4	NT	X		X														X														
Pandion haliaetus	Eastern osprey	MI	MI			X		X																							X					
APODIDAE																																				
Apus pacificus	Fork-tailed swift	MI	MI			X	X	X	X	X									X		X															
CHARADRIIDAE																																				
Charadrius veredus	Oriental plover	MI	MI				May															X														
FALCONIDAE																																				

Species		Conservation Status				Database review					Literature review																												
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	NatureMap (40 km)	EPBC Protected Matters (40km)	DBCA Priority and Threatened Database (40km)	ALA (40km)	Birdlife (40km)	Ecologia (1997). Hope Downs Biological Survey	Ecologia (1998). Weeli Wolli Creek Biological Assessment Survey	Ecologia (1998). Mining Area C Biological Survey	Specialised Zoological (2008). Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3	ENV (2007). Area C Deposit R Fauna Assessment	Biologic (2010). East Packsaddle Level 1 Vertebrate Fauna Study	ENV (2009). Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	Biologic (2011). Area C and Surrounds Vertebrate Fauna Survey	Biologic (2013). South Flank Targeted Northern Quoll Survey	Biota (2005). Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy,	Ninox (2009). A Fauna Survey of the Proposed Hope Downs 4 Mining Area, near Newman, Western Australia	Astron (2019). Hope Downs 2 Proposal Fauna Survey	Biota (2013). Jinidi to Mindy Level 1 Fauna Survey	Biota (2015). Baby Hope Downs Deposit Targeted Fauna Survey	Biologic (2013). Marillana and Surrounds Targeted Mulgara Survey	Biologic (2013). Central Pilbara Ghost Bat Population and Roost Assessment	Biologic (2011). Jinidi Targeted Northern Quoll Survey	Outback Ecology (2010). Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey	ENV (2010). Jinayri Access Road Vertebrate Fauna Survey	Onshore and Biologic (2009). South Parmelia Exploration Leases Biological Survey	Ecologia (2006). Jirridi Biological Survey Summary Report	ENV (2010). Jinayri Mining Lease Vertebrate Fauna Survey	Biologic (2017). Hamersley Subregion Ghost Bat Population and Roost Assessment 2015 - 2016	Biota (2010). Yandicoogina Junction South West and Oxbow Fauna Survey	Current survey
Falco hypoleucos	Grey falcon	VU	VU		VU	X	Known	X	X																													x
Falco peregrinus	Peregrine falcon		OS			X		X	X	X		X	X						X		X	X																
HIRUNDINIDAE																																						
Hirundo rustica	Barn swallow	MI	MI				May																															
LARIDAE																																						
Sterna anaethetus	Bridled tern		MI						X																													
Sterna nereis subsp. nereis	Australian fairy tern	VU	VU		VU																																X	
MOTACILLIDAE																																						
Motacilla flava	Yellow wagtail	MI	MI				X																															
PSITTACIDAE																																						
Pezoporus occidentalis	Night parrot	EN	CR		CR		Likely																															
ROSTRATULIDAE																																						
Rostratula australis	Australian painted snipe	EN	EN		EN		May																															
SCOLOPACIDAE																																						
Actitis hypoleucos	Common sandpiper	MI	MI			X	May	X																														
Calidris acuminata	Sharp-tailed sandpiper	MI	MI		VU		May																															
Calidris ferruginea	Curlew sandpiper	MI / CR	CR		NT		May																															
Calidris melanotos	Pectoral sandpiper	MI	MI				May																															
Tringa nebularia	Common greenshank	MI	MI			X		X																														
CARPHODACTYLIDAE																																						
Underwoodisaurus seorsus	Pilbara barking gecko			P2		X		X	X							X		X																				
PYTHONIDAE																																						
Liasis olivaceus subsp. barroni	Pilbara olive python	VU	VU			X	X	X	X										X																			X

Species		Conservation Status				Database review					Literature review																								
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	NatureMap (40 km)	EPBC Protected Matters (40km)	DBCA Priority and Threatened Database (40km)	ALA (40km)	Birdlife (40km)	Ecologia (1997). Hope Downs Biological Survey	Ecologia (1998). Weeli Wolli Creek Biological Assessment Survey	Ecologia (1998). Mining Area C Biological Survey	Specialised Zoological (2008). Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3	ENV (2007). Area C Deposit R Fauna Assessment	Biologic (2010). East Packsaddle Level 1 Vertebrate Fauna Study	ENV (2009). Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	Biologic (2011). Area C and Surrounds Vertebrate Fauna Survey	Biologic (2013). South Flank Targeted Northern Quoll Survey	Biota (2005). Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy,	Ninox (2009). A Fauna Survey of the Proposed Hope Downs 4 Mining Area, near Newman, Western Australia	Astron (2019). Hope Downs 2 Proposal Fauna Survey	Biota (2013). Jinidi to Mindy Level 1 Fauna Survey	Biota (2015). Baby Hope Downs Deposit Targeted Fauna Survey	Biologic (2013). Marillana and Surrounds Targeted Mulgara Survey	Biologic (2013). Central Pilbara Ghost Bat Population and Roost Assessment	Biologic (2011). Jinidi Targeted Northern Quoll Survey	Outback Ecology (2010). Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey	ENV (2010). Jinayri Access Road Vertebrate Fauna Survey	Onshore and Biologic (2009). South Parmelia Exploration Leases Biological Survey	Ecologia (2006). Jirridi Biological Survey Summary Report	ENV (2010). Jinayri Mining Lease Vertebrate Fauna Survey	Biologic (2017). Hamersley Subregion Ghost Bat Population and Roost Assessment 2015 - 2016	Biota (2010). Yandicoogina Junction South West and Oxbow Fauna Survey	Current survey
TYPHLOPIDAE																																		
Anilios ganei	Gane's blind-snake			P1		X		X	X			X			X			X										X						

Appendix C: Vertebrate Fauna Habitat Assessments

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VBEN-01 (Ben's Oasis)	-23.0535	119.1519	27/03/2023	Major Drainage Line	Wetland	Flat	Flat	Sand	None Discernible	Negligible	-	Negligible	None Discernible	-	Nil	Nil	0	Permanent	1	None Discernible	Recent (0-2 yr)	
VJIN-01	-22.9162	119.2109	22/03/2023	Major Drainage Line	Major Drainage Line	North/ East	Low	Clay Loam Sandy	Many Small Patches	Negligible	-	Gravel (1-4cm)	Many Large Patches	*Shrubland, Eucalypt Woodland, Tussock Grassland*	Nil	Moderate	0	Permanent	0.8	Discharge point nearby	Old (6+ yr)	
VJIN-02	- 22.9195	119.1998	22/03/2023	Major Drainage Line	Drainage Area/ Floodplain	North/ East	Low	Clay Loam Sandy	Scarce	Negligible	-	Pebbles (5-10cm)	Many Small Patches	Eucalypt Woodland, Melaleuca	Nil	Moderate	0	None	0.6	Vehicle Tracks, Cattle Grazing	Old (6+ yr)	
VJIN-03	-22.9171	119.2119	22/03/2023	Hillcrest/ Hillslope	Hillslope	North/ West	Moderate	Sandy Clay Loam	Few Small Patches	Limited Outcropping	BIF	Pebbles (5-10cm)	Many Small Patches	*Scattered Eucalypts, Spinifex Hummock Grassland*	Low	Low	3	None	0.8	None Discernible	Old (6+ yr)	
VJIN-04	-22.9419	119.2328	22/03/2023	Stony Plain	Undulating Low Hills	West	Low	Silty Clay Loam	Scarce	Negligible	-	Gravel (1-4cm)	Scarce	*Shrubland, Spinifex Hummock Grassland*	Nil	Low	0	None	0.4	Fire	Moderate (3 to 5 yr)	
VJIN-05	-22.9227	119.2043	22/03/2023	Minor Drainage Line	Drainage Area/ Floodplain	South/ East	Low	Loamy Sand	Many Small Patches	Limited Outcropping	BIF	Pebbles (5-10cm)	Few Large Patches	*Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland*	Nil	Low	0	Prone to Pooling	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-06	-22.9485	119.2326	22/03/2023	Stony Plain	Drainage Area/ Floodplain	West	Low	Silty Clay Loam	Many Small Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	*Shrubland, Spinifex Hummock Grassland, Scattered Corymbia*	Nil	Low	0	None	0.6	Cattle Grazing	Old (6+ yr)	
VJIN-07	-22.9306	119.2166	22/03/2023	Stony Plain	Stony Plain	South/ West	Flat	Sandy Clay Loam	Many Small Patches	Negligible	-	Pebbles (5-10cm)	Many Small Patches	*Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland*	Nil	Low	0	Scarce	0.8	Cattle Grazing	Moderate (3 to 5 yr)	
VJIN-08	-22.9715	119.2543	22/03/2023	Stony Plain	Undulating Low Hills	North/ West	Low	Silty Clay Loam	Few Small Patches	Negligible	-	Gravel (1-4cm)	Scarce	Scattered Shrubs, Spinifex Hummock Grassland, Scattered Eucalypts	Nil	Low	0	None	0.6	Road/ Access Track	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-09	-22.9314	119.2036	22/03/2023	Major Drainage Line	Major Drainage Line	East	Low	Loamy Sand	Many Large Patches	Major Outcropping	BIF	Pebbles (5-10cm)	Few Large Patches	Shrubland, Scattered Eucalypts, Tussock Grassland	Low	High	1	Prone to Flooding	0.8	Cattle Grazing	Old (6+ yr)	
VJIN-10	-22.9774	119.2415	22/03/2023	Breakaway/ Cliff	Breakaway	West	Steep	Sandy Clay Loam	Few Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Scarce	Scattered Eucalypts, Scattered Shrubs, Spinifex Hummock Grassland	High	Nil	0	None	0.8		Moderate (3 to 5 yr)	
VJIN-11	-22.9630	119.2362	22/03/2023	Stony Plain	Stony Plain	Flat	Flat	Clayey Sand	Many Small Patches	Negligible	-	Gravel (1-4cm)	Many Small Patches	Scattered Shrubs, Spinifex Hummock Grassland	Nil	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-12	-23.0270	119.2328	22/03/2023	Gorge/ Gully	Gorge	South/ West	Low	Silty Clay Loam	Few Small Patches	Major Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs, Scattered Figs	Very High	Nil	0	Prone to Pooling	1	None Discernible	Old (6+ yr)	
VJIN-13	-22.9875	119.2294	22/03/2023	Drainage Area/ Floodplain	Drainage Area/ Floodplain	North	Flat	Clayey Sand	Many Large Patches	Negligible	-	Gravel (1-4cm)	Many Small Patches	Shrubland, Eucalypt Woodland, Spinifex Hummock Grassland	Nil	Low	3	Prone to Pooling	0.8	Road/ Access Track	Old (6+ yr)	
VJIN-14	-23.0700	119.1804	23/03/2023	Breakaway/ Cliff	Breakaway	South/ West	Steep	Sandy Clay Loam	Few Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	Moderate	Nil	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-15	-23.0139	119.2374	22/03/2023	Gorge/ Gully	Gully	North/ West	Cliff	Clayey Sand	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Shrubland, Scattered Eucalypts	Moderate	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-16	-23.0388	119.1789	23/03/2023	Stony Plain	Stony Plain	North	Low	Sandy Clay Loam	Many Small Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Shrubs, Mulga Woodland	Nil	High	0	None	0.8	Cattle Grazing	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-17	-22.9873	119.2818	23/03/2023	Gorge/ Gully	Gorge	North	Steep	Clayey Sand	Scarce	Major Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-18	-23.0402	119.1734	23/03/2023	Major Drainage Line	Major Drainage Line	North	Low	Sandy Clay Loam	Few Small Patches	Negligible	-	Small Rocks (11-20cm)	Evenly Spread	Eucalypt Woodland, Shrubland, Tussock Grassland	Nil	Moderate	7	None	0.6	Cattle Grazing	Old (6+ yr)	
VJIN-19	-22.9094	119.2152	23/03/2023	Major Drainage Line	Hillslope	South/ West	Moderate	Clayey Sand	Many Large Patches	Major Outcropping	Granite	Boulders (>61cm)	Many Large Patches	Typha and Melaleuca	Moderate	Moderate	2	Permanent	0.8	Cattle Grazing	Moderate (3 to 5 yr)	
VJIN-20	-23.0237	119.2733	28/03/2023	Gorge/ Gully	Gully	South	Moderate	Sandy Clay Loam	Scarce	Moderate Outcropping	BIF	Small Rocks (11-20cm)	Many Small Patches	Shrubland, Spinifex Hummock Grassland, Tussock Grassland, Scattered Corymbia	High	Nil	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-21	-22.9164	119.2017	24/03/2023	Major Drainage Line	Major Drainage Line	South/ East	Low	Sandy Loam	Many Large Patches	Limited Outcropping	Detrital	Gravel (1-4cm)	Many Large Patches	Scattered Shrubs, Eucalypt Woodland	Low	High	3	Permanent	0.8	Cattle Grazing	Old (6+ yr)	
VJIN-22	-22.9284	119.2077	25/03/2023	Undulating Low Hills	Undulating Low Hills	North	Moderate	Silty Clay Loam	Scarce	Limited Outcropping	Sandstone	Gravel (1-4cm)	None Discernible	Scattered Shrubs, Spinifex Hummock Grassland, Scattered Corymbia	Low	Low	0	None	0.8	Road/ Access Track	Old (6+ yr)	
VJIN-23	-23.0387	119.2884	24/03/2023	Breakaway/ Cliff	Hillcrest/ Upper Hillslope	South	Very Steep	Clay Loam	Few Small Patches	Extensive Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	None	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-24	-23.0100	119.2148	25/03/2023	Breakaway/ Cliff	Cliff	North/ West	Cliff	Silty Loam	Scarce	Extensive Outcropping	BIF	Small Rocks (11-20cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Nil	3	None	0.8	Patchy moderate fire	Old (6+ yr)	
VJIN-25	-23.0329	119.2867	25/03/2023	Medium Drainage Line	Gully	South/ West	Moderate	Clay Loam	Many Small Patches	Moderate Outcropping	BIF	Pebbles (5-10cm)	Many Small Patches	Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland,	Low	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
														Tussock Grassland								
VJIN-26	-22.9968	119.2610	25/03/2023	Medium Drainage Line	Medium Drainage Line	North/ West	Low	Silty Clay Loam	Scarce	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Nil	1	None	0.8	None Discernible	Old (6+ yr)	
VJIN-27	-23.0718	119.1953	25/03/2023	Gorge/ Gully	Gully	South	Steep	Clay Loam	Few Small Patches	Major Outcropping	Conglomerate	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	1	Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-28	-22.9942	119.2806	26/03/2023	Medium Drainage Line	Medium Drainage Line	South/ East	Low	Silty Clay Loam	Few Small Patches	Minor Outcropping	BIF	Large Rocks (21-60cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs, Scattered Figs	Low	Low	0	Prone to Flooding	0.8	Road/ Access Track	Old (6+ yr)	
VJIN-29	-23.0728	119.2535	26/03/2023	Gorge/ Gully	Gully	North/ East	Moderate	Clayey Sand	Few Small Patches	Moderate Outcropping	Conglomerate	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	2	None	0.8	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-30	-23.0324	119.2304	26/03/2023	Breakaway/ Cliff	Breakaway	South/ East	Moderate	Silty Clay Loam	Scarce	Major Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Nil	0	None	0.8	Road/ Access Track	Old (6+ yr)	
VJIN-31	-23.0646	119.2356	26/03/2023	Breakaway/ Cliff	Breakaway	South/ West	Steep	Clay Loam	Few Small Patches	Major Outcropping	Conglomerate	Boulders (>61cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Prone to Pooling	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-32	-23.0663	119.2560	30/03/2023	Gorge/ Gully	Ironstone Outcrops	North	Moderate	Clayey Sand	None Discernible	Moderate Outcropping	BIF	Pebbles (5-10cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	None	0.8	Mining Exploration	Moderate (3 to 5 yr)	
VJIN-33	-23.0699	119.2727	26/03/2023	Minor Drainage Line	Major Drainage Line	North/ West	Low	Clayey Sand	Few Large Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Moderate	0	Prone to Pooling	0.6	Road/ Access Track	Moderate (3 to 5 yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-34	-23.0658	119.2534	30/03/2023	Gorge/ Gully	Ironstone Outcrops	North	Moderate	Clayey Sand	None Discernible	Moderate Outcropping	BIF	Pebbles (5-10cm)	Scarce	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	None	0.8	Mining Exploration	Moderate (3 to 5 yr)	
VJIN-35	-23.0361	119.2925	27/03/2023	Gorge/ Gully	Gorge	West	Very Steep	Clay Loam	Many Small Patches	Extensive Outcropping	Conglomerate	Boulders (>61cm)	Many Large Patches	Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-36	-23.0757	119.2475	30/03/2023	Undulating Low Hills	Sandy/ Stony Plain	East	Moderate	Clayey Sand	Scarce	Minor Outcropping	BIF	Gravel (1-4cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Low	Low	0	Prone to Pooling	0.6	Mining Exploration	Moderate (3 to 5 yr)	
VJIN-37	-23.0256	119.2294	27/03/2023	Undulating Low Hills	Hillcrest/ Upper Hillslope	East	Moderate	Clayey Sand	Many Small Patches	Minor Outcropping	Conglomerate	Small Rocks (11-20cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	0	Prone to Pooling	0.6	None Discernible	Moderate (3 to 5 yr)	
VJIN-38	-23.0688	119.2443	30/03/2023	Undulating Low Hills	Ironstone Outcrops	East	Moderate	Clayey Sand	None Discernible	Minor Outcropping	BIF	Pebbles (5-10cm)	Scarce	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland, Scattered Mulga	Moderate	Low	0	None	0.6	Mining Exploration	Moderate (3 to 5 yr)	
VJIN-39	-23.0601	119.2460	28/03/2023	Gorge/ Gully	Hillcrest/ Upper Hillslope	North/ West	Steep	Clay Loam	Few Small Patches	Moderate Outcropping	Conglomerate	Boulders (>61cm)	Many Small Patches	Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	Scarce	0.8	None Discernible	Recent (0 to 2 yr)	
VJIN-40	-23.0698	119.2583	30/03/2023	Stony Plain	Undulating Low Hills	East	Low	Clay Loam Sandy	None Discernible	Limited Outcropping	BIF	Pebbles (5-10cm)	Scarce	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	Low	Low	0	None	0.6	Mining Exploration	Moderate (3 to 5 yr)	
VJIN-41	-23.0624	119.2560	30/03/2023	Gorge/ Gully	Undulating Low Hills	North	Moderate	Clayey Sand	Few Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Tussock Grassland	High	Low	1	Prone to Pooling	0.8	None Discernible	Moderate (3 to 5 yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-97	-23.0597	119.2263	31/03/2023	Gorge/ Gully	Gorge	South	Moderate	Silty Clay Loam	None Discernible	Extensive Outcropping	BIF	Pebbles (5-10cm)	Scarce	Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Very High	Nil	1	Prone to Pooling	0.8	Frequent Fire	Moderate (3 to 5 yr)	
VJIN-43	-23.0574	119.2561	30/03/2023	Hillcrest/ Hillslope	Undulating Low Hills	North/ West	Low	Clay Loam	Many Large Patches	Minor Outcropping	Conglomerate	Pebbles (5-10cm)	Many Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Low	Moderate	0	Scarce	0.6	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-44	-23.0706	119.2738	31/03/2023	Stony Plain	Undulating Low Hills	South/ West	Moderate	Clay Loam Sandy	Few Large Patches	Negligible	-	Gravel (1-4cm)	Many Large Patches	Scattered Shrubs, Eucalypt Woodland, Spinifex Hummock Grassland	Nil	Moderate	0	Scarce	0.6	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-45	-23.0644	119.2392	30/03/2023	Gorge/ Gully	Gully	East	Steep	Clay Loam	Few Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	1	Scarce	0.8	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-46	-23.0771	119.2757	31/03/2023	Stony Plain	Stony Plain	South/ West	Moderate	Clay Loam Sandy	Few Large Patches	Negligible	-	Gravel (1-4cm)	Many Large Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Moderate	0	Scarce	0.6	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-47	-23.0383	119.2149	30/03/2023	Medium Drainage Line	Medium Drainage Line	Flat	Low	Clay Loam Sandy	None Discernible	Negligible	-	Small Rocks (11-20cm)	Scarce	Scattered Eucalypts, Scattered Shrubs, Scattered mulga	Nil	Low	0	Scarce	0.8	Road/ Access Track	Old (6+ yr)	
VJIN-48	-23.0759	119.2635	31/03/2023	Medium Drainage Line	Undulating Low Hills	South/ East	Low	Clay Loam	Many Small Patches	Negligible	-	Pebbles (5-10cm)	Many Large Patches	Shrubland, Eucalypt Woodland, Spinifex Hummock Grassland, Tussock Grassland	Nil	Low	0	Prone to Pooling	0.6	Road/ Access Track	Moderate (3 to 5 yr)	
VJIN-49	-23.0618	119.2305	30/03/2023	Gorge/ Gully	Gorge	South	Steep	Clay Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts	High	Low	0	Scarce	0.8	None Discernible	Moderate (3 to 5 yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-42	-23.0659	119.2195	18/05/2023	Gorge/ Gully	Gorge	South	Very Steep	Clay Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Very High	Nil	0	None	1	None Discernible	Old (6+ yr)	
VJIN-50	-23.0678	119.2290	12/05/2023	Minor Drainage Line	Minor Drainage Line	South	Moderate	Clay Loam	Few Small Patches	Limited Outcropping	Conglomerate	Pebbles (5-10cm)	Few Small Patches	Spinifex Hummock Grassland	Moderate	Nil	0	None	0.6	Mining Exploration	Recent (0 to 2 yr)	
VJIN-51	-23.0772	119.2096	12/05/2023	Minor Drainage Line	Drainage Area/ Floodplain	North	Low	Silty Clay Loam	Many Large Patches	Negligible	-	Gravel (1-4cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs, Tussock Grassland	Nil	Moderate		Prone to Flooding	0.8	None Discernible	Old (6+ yr)	
VJIN-52	-23.0540	119.2270	12/05/2023	Medium Drainage Line	Medium Drainage Line	East	Moderate	Clay Loam	Scarce	Moderate Outcropping	BIF	Small Rocks (11-20cm)	Few Small Patches	Scattered Eucalypts, Tussock Grassland	Low	Low	0	None	0.8	Frequent Fire	Recent (0 to 2 yr)	
VJIN-53	-23.0687	119.2879	12/05/2023	Hardpan Plain	Hardpan Plain	Flat	Flat	Sandy Loam	Evenly Spread	Negligible	-	Gravel (1-4cm)	Many Small Patches	Tussock Grassland, Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	Nil	Moderate		Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-54	-23.0745	119.2996	12/05/2023	Medium Drainage Line	Medium Drainage Line	South/ East	Flat	Clay Loam	Many Small Patches	Negligible	-	Gravel (1-4cm)	Many Small Patches	Scattered Shrubs, Shrubland	Nil	Low	0	None	0.6	Cattle Grazing	Moderate (3 to 5 yr)	
VJIN-55	-22.9760	119.3009	13/05/2023	Medium Drainage Line	Medium Drainage Line	North	Very Steep	Silty Loam	Scarce	Extensive Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Low	0	Prone to Flooding	0.8	None Discernible	Old (6+ yr)	
VJIN-56	-22.9692	119.2963	13/05/2023	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clayey Sand	Few Large Patches	Limited Outcropping	BIF	Negligible	Few Small Patches	Tussock Grassland	Nil	High	0	None	0.6	Weed Invasion	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-57	-22.9555	119.2850	13/05/2023	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Silty Loam	Few Large Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Tussock Grassland, Scattered Shrubs	Nil	Moderate	0	Prone to Flooding	0.6	Weed Invasion	Old (6+ yr)	
VJIN-58	-22.9610	119.2712	13/05/2023	Mulga Woodland	Sandy/ Stony Plain	Flat	Flat	Clayey Sand	Few Large Patches	Limited Outcropping	BIF	Pebbles (5-10cm)	Few Small Patches	Mulga Woodland	Nil	Moderate	0	None	0.6	None Discernible	Old (6+ yr)	
VJIN-59	-22.9518	119.2588	13/05/2023	Minor Drainage Line	Minor Drainage Line	Flat	Low	Silty Clay Loam	Evenly Spread	Negligible	-	Pebbles (5-10cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland, Scattered Shrubs	Nil	Moderate	0	Prone to Flooding	0.8	None Discernible	Old (6+ yr)	
VJIN-60	-22.9155	119.2702	13/05/2023	Gorge/ Gully	Gully	West	Very Steep	Sandy Loam	Many Large Patches	Major Outcropping	BIF	Small Rocks (11-20cm)	Many Large Patches	Shrubland, Scattered Eucalypts	Moderate	Moderate	0	Scarce	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-61	-22.9234	119.2529	13/05/2023	Gorge/ Gully	Gorge	North	Very Steep	Sandy Loam	Few Small Patches	Major Outcropping	Conglomerate	Small Rocks (11-20cm)	Many Large Patches	Shrubland, Scattered Eucalypts	High	Low	0	Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-62	-22.9134	119.2966	13/05/2023	Undulating Low Hills	Undulating Low Hills	North	Moderate	Sandy Loam	Scarce	Minor Outcropping	Conglomerate	Pebbles (5-10cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Low	Low	0	None	0.6	Frequent Fire	Moderate (3 to 5 yr)	
VJIN-63	-22.9316	119.2978	13/05/2023	Gorge/ Gully	Gorge	West	Steep	Sandy Loam	Few Small Patches	Major Outcropping	Conglomerate	Large Rocks (21-60cm)	Many Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	Scarce	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-64	-22.9295	119.2591	14/05/2023	Gorge/ Gully	Gorge	North/ West	Very Steep	Sandy Loam	Scarce	Major Outcropping	Conglomerate	Large Rocks (21-60cm)	Many Large Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Scarce	0.8	Frequent Fire	Moderate (3 to 5 yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-65	-22.9366	119.2724	14/05/2023	Breakaway/ Cliff	Hillcrest/ Upper Hillslope	South	Cliff	Sandy Loam	Scarce	Major Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Tussock Grassland	High	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-66	-22.9160	119.2291	14/05/2023	Gorge/ Gully	Gorge	North/ West	Very Steep	Sandy Loam	Many Large Patches	Major Outcropping	BIF	Large Rocks (21-60cm)	Many Large Patches	Scattered Shrubs, Scattered Eucalypts	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-67	-22.8802	119.2460	15/05/2023	Gorge/ Gully	Gorge	South/ East	Very Steep	Loamy Sand	Few Small Patches	Major Outcropping	BIF	Large Rocks (21-60cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Low	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-68	-22.9387	119.2655	16/05/2023	Gorge/ Gully	Hillcrest/ Upper Hillslope	South	Steep	Sandy Loam	Scarce	Major Outcropping	Conglomerate	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	None	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-69	-22.9348	119.2901	16/05/2023	Drainage Area/ Floodplain	Drainage Area/ Floodplain	South	Low	Loamy Sand	Few Small Patches	Limited Outcropping	Conglomerate	Pebbles (5-10cm)	Many Large Patches	Shrubland, Eucalypt Woodland, Spinifex Hummock Grassland	Low	Low	0	Prone to Pooling	0.6	Cattle Grazing	Old (6+ yr)	
VJIN-70	-22.9108	119.2620	13/05/2023	Medium Drainage Line	Gully	East	Low	Clay Loam	Few Small Patches	Negligible	-	Pebbles (5-10cm)	Few Small Patches	Spinifex Hummock Grassland	Low	Low	0	None	0.6	None Discernible	Moderate (3 to 5 yr)	
VJIN-71	-22.9229	119.2585	13/05/2023	Gorge/ Gully	Gully	South	Steep	Clay Loam	Few Large Patches	Moderate Outcropping	BIF	Small Rocks (11-20cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	Moderate	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-72	-22.9156	119.2960	13/05/2023	Gorge/ Gully	Gully	Flat	Low	Clay Loam	Scarce	Minor Outcropping	BIF	Small Rocks (11-20cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Low	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-73	-22.9326	119.2935	13/05/2023	Minor Drainage Line	Gully	South	Moderate	Clay Loam	Scarce	Limited Outcropping	BIF	Small Rocks (11-20cm)	Scarce	Spinifex Hummock Grassland, Scattered Eucalypts	Low	Nil	0	None	0.6	Frequent Fire	Moderate (3 to 5 yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-74	-22.9292	119.2551	14/05/2023	Gorge/ Gully	Gorge	North	Very Steep	Clay Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Scarce	Spinifex Hummock Grassland, Scattered Eucalypts, Tussock Grassland	High	Nil	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-75	-23.0577	119.2218	14/05/2023	Gorge/ Gully	Gorge	North	Very Steep	Clay Loam	None Discernible	Major Outcropping	BIF	Boulders (>61cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland, Scattered Shrubs	High	Nil	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-76	-22.8808	119.2550	15/05/2023	Gorge/ Gully	Gorge	Flat	Very Steep	Clay Loam	Few Small Patches	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Tussock Grassland, Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-77	-22.9316	119.2447	17/05/2023	Gorge/ Gully	Gorge	South	Very Steep	Clay Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Nil	0	Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-78	-22.9170	119.2616	15/05/2023	Gorge/ Gully	Gorge	Flat	Steep	Clay Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Shrubs, Scattered Eucalypts, Tussock Grassland	High	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-79	-22.9282	119.2400	15/05/2023	Gorge/ Gully	Gully	South	Moderate	Sand	Few Small Patches	Extensive Outcropping	BIF	Large Rocks (21-60cm)	Evenly Spread	Scattered Eucalypts, Spinifex Hummock Grassland	Very High	Low	0	None	1	None Discernible	Old (6+ yr)	
VJIN-80	-23.0672	119.1899	17/05/2023	Gorge/ Gully	Gully	South	Very Steep	Clay Loam	None Discernible	Extensive Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Scattered Eucalypts	High	Nil	1	Prone to Pooling	1	None Discernible	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-81	-22.9885	119.2723	13/05/2023	Gorge/ Gully	Gully	Flat	Steep	Clayey Sand	Few Large Patches	Major Outcropping	BIF	Small Rocks (11-20cm)	Many Small Patches	Scattered Eucalypts	High	Low	0	Prone to Pooling	0.6	None Discernible	Old (6+ yr)	
VJIN-82	-22.9604	119.2438	14/05/2023	Mulga Woodland	Hillslope	Flat	Flat	Clayey Sand	Many Small Patches	Limited Outcropping	BIF	Pebbles (5-10cm)	Many Small Patches	Spinifex Hummock Grassland	Nil	Moderate	0	None	0.6	None Discernible	Old (6+ yr)	
VJIN-83	-23.0173	119.2925	14/05/2023	Gorge/Gully	Gully	East	Moderate	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Spinifex Hummock Grassland, Tussock Grassland, Scattered Eucalypts, Shrubland	High	Low		Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-84	-23.0615	119.1971	17/05/2023	Gorge/ Gully	Gully	South	Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-85	-23.0627	119.2016	14/05/2023	Gorge/ Gully	Gully	West	Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs, Tussock Grassland	Very High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-86	-23.0496	119.2062	15/05/2023	Hillcrest/ Hillslope	Ironstone Outcrops	North/ West	Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts, Scattered Shrubs	High	Low	0	None	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-87	-23.0669	119.2097	15/05/2023	Gorge/ Gully	Gully	South	Moderate	Silty Loam	Scarce	Major Outcropping	BIF	Large Rocks (21-60cm)	Many Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-88	-23.0537	119.1836	15/05/2023	Gorge/ Gully	Gully	North/ West	Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Many Small Patches	Scattered Shrubs, Spinifex Hummock Grassland, Scattered Eucalypts	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-89	-22.9787	119.2903	16/05/2023	Gorge/ Gully	Gully	North	Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Low	0	Scarce	0.8	None Discernible	Old (6+ yr)	
VJIN-90	-22.9296	119.2408	17/05/2023	Gorge/ Gully	Breakaway	South	Very Steep	Loamy Sand	Scarce	Extensive Outcropping	BIF	Large Rocks (21-60cm)	Many Large Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	High	Nil	0	Scarce	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-91	-22.9381	119.2698	17/05/2023	Breakaway/ Cliff	Breakaway	South/ East	Very Steep	Loamy Sand	Scarce	Extensive Outcropping	Conglomerate	Large Rocks (21-60cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	0	Scarce	0.8	None Discernible	Moderate (3 to 5 yr)	
VJIN-92	-22.9878	119.2999	17/05/2023	Gorge/ Gully	Gully	North	Moderate	Loamy Sand	Few Small Patches	Moderate Outcropping	Conglomerate	Pebbles (5-10cm)	Many Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-93	-23.0172	119.2872	16/05/2023	Gorge/ Gully	Gully	North	Very Steep	Silty Loam	Scarce	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Low	0	Prone to Pooling	0.8	None Discernible	Old (6+ yr)	
VJIN-94	-23.0722	119.2212	18/05/2023	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-95	-22.9342	119.2648	16/05/2023	Gorge/ Gully	Gorge	South/ West	Very Steep	Clay Loam	None Discernible	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Nil	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-96	-22.9478	119.2327	19/05/2023	Sandy Plain	Sandy/ Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	-	Gravel (1-4cm)	Few Small Patches	Scattered Shrubs, Scattered Eucalypts, Spinifex Hummock Grassland,	Nil	High	0	Prone to Flooding	0.8	None Discernible	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
														Tussock Grassland								
VJIN-98	-22.9430	119.2575	28/09/2023	Gorge/ Gully	Gully	South/ West	Moderate	Clay Loam	Many Large Patches	Moderate Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Very High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-99	-22.9449	119.2627	28/09/2023	Gorge/ Gully	Gully	South/ West	Moderate	Clay Loam	Many Large Patches	Moderate Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Very High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-100	-22.9116	119.2347	28/09/2023	Gorge/ Gully	Gorge	North	Moderate	Clay Loam	Many Large Patches	Moderate Outcropping	BIF	Boulders (>61cm)	Many Large Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-101	-22.0659	119.2267	29/09/2023	Gorge/ Gully	Gorge	South/ East	Very Steep	Clay Loam	Many Large Patches	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-102	-22.0536	119.2036	29/09/2023	Gorge/ Gully	Gorge	North/ West	Very Steep	Clay Loam	Many Large Patches	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-103	-22.0251	119.2962	30/09/2023	Gorge/ Gully	Gully	South/ East	Moderate	Clay Loam	Many Large Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Moderate	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-104	-22.0444	119.2919	30/09/2023	Gorge/ Gully	Gully	South/ West	Steep	Clay Loam	Many Large Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-105	-22.9375	119.30146	30/09/2023	Gorge/ Gully	Gully	South/ East	Steep	Clay Loam	Many Small Patches	Major Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Soil		Outcropping		Ground Cover			Rocky Cracks / Crevices	Burrowing Suitability	Hollow count	Water presence	Habitat condition	Disturbances	Time since last fire (years)	Photo
	Latitude	Longitude						Type	Availability	Extent	Rock type	Rock Size	Veg. Litter	Dominant Veg. Type								
VJIN-106	-23.0589	119.1937	30/09/2023	Gorge/ Gully	Gully	North/ West	Moderate	Clay Loam	Many Small Patches	Moderate Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-107	-22.9925	119.2968	1/10/2023	Gorge/ Gully	Gully	West	Steep	Clay Loam	Many Small Patches	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Moderate	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-108	-23.0046	119.3050	1/10/2023	Gorge/ Gully	Gully	South/ West	Steep	Clay Loam	Many Small Patches	Major Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-109	-23.0075	119.3035	1/10/2023	Gorge/ Gully	Gorge	North/ East	Moderate	Clay Loam	Many Large Patches	Limited Outcropping	BIF	Small Rocks (11-20cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-110	-22.9913	119.2934	3/10/2023	Gorge/ Gully	Gully	West	Low	Clay Loam	Many Small Patches	Moderate Outcropping	BIF	Boulders (>61cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Moderate	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-111	-22.9948	119.2233	3/10/2023	Gorge/ Gully	Gorge	North/ East	Steep	Clay Loam	Many Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	, Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	High	Moderate	0	None	0.8	None Discernible	Old (6+ yr)	
VJIN-112	-22.9999	119.2445	3/10/2023	Gorge/ Gully	Gully	North/ West	Moderate	Clay Loam	Many Small Patches	Moderate Outcropping	BIF	Large Rocks (21-60cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Moderate	Moderate	0	None	0.8	Road/ Access Track	Old (6+ yr)	

Appendix D: Caves recorded in the Survey Area

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-06	Cave 6 (10011_11_00284)	-23.0278	119.2318	Gorge/ Gully	Category 5	Category 5		Previous Pilbara leaf-nosed bat call from foraging individual (Biologic, 2011c)
CJIN-09	Cave 9 (10180_11_00289)	-23.0323	119.2304	Hillcrest/ Hillslope	Category 4	Category 4		Ghost bat scats present (Biologic, 2011c)
CJIN-10	Cave 10 (10180_11_002540	-23.0361	119.2929	Gorge/ Gully	Category 4	Category 5		None

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-11	Cave 11 (10180_11_00255)	-23.0358	119.2932	Gorge/ Gully	Category 4	Category 5		None
CJIN-13	Cave 13 (10180_11_00260)	-23.0169	119.2872	Gorge/ Gully	Category 2	Category 4		Was not entered previously, but was presumed as a suitable cave (Biologic, 2011c)

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-14	Cave 14 (10180_11_00262)	-23.0171	119.2873	Gorge/ Gully	Category 2	Category 4		Large pile of ghost bat scats present (Biologic, 2011c)
CJIN-15	Cave 15 (10180_11_002560)	-23.0184	119.2916	Gorge/ Gully	Category 3	Category 5		None
CJIN-18	-	-22.9282	119.2405	Hillcrest/ Hillslope	Category 4	Category 4		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-19	-	-23.0722	119.1958	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-20	-	-22.9975	119.2841	Gorge/ Gully	Category 4	Category 4		Recorded during current survey
CJIN-21	-	-23.0618	119.2308	Hillcrest/ Hillslope	Category 4	Category 5		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-22	-	-23.0238	119.2732	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-23	-	-23.0236	119.2745	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-24	-	-23.0291	119.2317	Hillcrest/ Hillslope	Category 5	Category 5		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-25	-	-23.0671	119.2554	Hillcrest/ Hillslope	Category 5	Category 5		Recorded during current survey
CJIN-26	-	-23.0664	119.2551	Hillcrest/ Hillslope	Category 3	Category 5		Recorded during current survey
CJIN-27	-	-22.9322	119.2444	Gorge/ Gully	Category 5	Category 5		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-28	-	-23.0601	119.2261	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-29	-	-23.0159	119.2862	Gorge/ Gully	Category 3	Category 4		Recorded during current survey
CJIN-30	-	-22.9282	119.2401	Gorge/ Gully	Category 3	Category 5		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-31	-	-22.9877	119.3000	Gorge/ Gully	Category 4	Category 5		Recorded during current survey
CJIN-32	-	-23.0626	119.1909	Gorge/ Gully	Category 3	Category 5		Recorded during current survey
CJIN-33	10180_11_00302/00303	-23.0628	119.1912	Gorge/ Gully	Category 2	Category 5		Large pile of ghost bat scats present (Biota, 2013b)

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-34	-	-22.9170	119.2616	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-35	-	-22.9273	119.2596	Gorge/ Gully	Category 4	Category 4		Recorded during current survey
CJIN-36	-	-23.0677	119.1891	Gorge/ Gully	Category 3	Category 4		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-37	-	-23.0659	119.2195	Gorge/ Gully	Category 3	Category 5		Recorded during current survey
CJIN-38	-	-22.9282	119.2405	Gorge/ Gully	Category 3	Category 5		Recorded during current survey
CJIN-39	-	-23.0606	119.2218	Gorge/ Gully	Category 4	Category 5		Recorded during current survey

Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-40	-	-23.0228	119.2732	Gorge/ Gully	Category 5	Category 5		Recorded during current survey
CJIN-41	-	-22.9317	119.2978	Gorge/ Gully	Category 4	Category 5		Recorded during current survey
CJIN-42	-	-23.0645	119.2254	Hillcrest/ Hillslope	Category 4	Category 5		Recorded during current survey

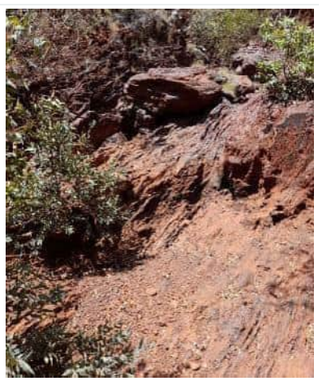
Cave ID	Previous Cave ID	Location		Habitat	Ghost bat significance	Pilbara leaf-nosed bat significance	Photo	Previous usage
		Latitude	Longitude					
CJIN-43	-	-22.9416	119.2586	Gorge/ Gully	Category 4	Category 5		Recorded during current survey
CJIN-44	-	-22.9417	119.2574	Gorge/ Gully	Category 4	Category 5		Recorded during current survey

Appendix E: Water features recorded in the Survey Area

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WBEN-01	Permanent	-23.0529	119.1514	Major Drainage Line		
WJIN-01 (Weeli Wolli Creek)	Permanent	-22.9163	119.2109	Major Drainage Line		Feature represents Weeli Wolli creek downstream of discharge point.
WJIN-02 • Jinidi 1 (Biologic, in prep.)) • 1001_11_00010 (Biologic, 2011c)	Likely ephemeral	-23.0271	119.2329	Gorge/ Gully		 Water present in March 2023. Water present in June 2023 Small amount of water present in October 2023 (photo shown) Water present in April 2024

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-03	Likely temporary ephemeral	-23.0138	119.2375	Gorge/ Gully		
WJIN-04 Jinidi 1a (Biologic, in prep.)	Likely ephemeral	-23.0294	119.2324	Gorge/ Gully		 Water present March 2023 Small amount of water June 2023 (photo shown)
WJIN-05	Likely temporary ephemeral	-23.0636	119.2557	Minor Drainage Line		

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-06	Likely temporary ephemeral	-22.9159	119.2686	Gorge/ Gully		
WJIN-07	Likely ephemeral	-22.9169	119.2712	Gorge/ Gully		
WJIN-08	Likely temporary ephemeral	-22.9316	119.2448	Gorge/ Gully		

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-09	Likely ephemeral	-22.9153	119.2287	Gorge/ Gully		No water present in April 2024
WJIN-10	Likely temporary ephemeral	-23.0615	119.1971	Gorge/ Gully		
WJIN-11 JINSP1 (Biologic, in prep.) 10180_11_00864	Likely ephemeral	-23.0676	119.1892	Gorge/ Gully		 First recorded in consolidated mapping project Water present May 2023 No water present October 2023 (photo shown) Water present April 2024

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-12	Likely temporary ephemeral	-23.0615	119.1971	Gorge/ Gully		
WJIN-13	Likely ephemeral	-23.059	119.2223	Gorge/ Gully		
WJIN-14 Jinidi5 (Biologic, in prep.)	Likely ephemeral	-22.9885	119.2724	Gorge/ Gully		 Wet in May 2023 (current survey) Dry in October 2023 (Biologic, in prep.). Wet in April 2024 (Biologic, in prep.)

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-15	Likely temporary ephemeral	-23.0627	119.2016	Gorge/ Gully		
WJIN-16	Likely ephemeral	-22.9200	119.1972	Major Drainage Line		Upstream pool of gabion discharge
WJIN-17 WWUD-01 (Biologic, in prep.)	Likely permanent	-22.9232	119.1955	Major Drainage Line		Upstream pool of gabion discharge

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
WJIN-18 WWUD-04 (Biologic, in prep.)	Likely permanent	-22.9171	119.2012	Major Drainage Line		Upstream pool of gabion discharge
WJIN-19 WWUD-05 (Biologic, in prep.)	Likely permanent	-22.9161	119.2064	Major Drainage Line		Upstream pool of gabion discharge
Additional water features						
Jinidi 2	Likely ephemeral	-23.0248	119.2492	Gorge/ Gully		Water present October 2023 and April 2024

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
Jinidi 3 (Biologic, in prep.) **1001_11_00009** Biologic (2011c)	Likely ephemeral	-23.0203	119.2762	Gorge/ Gully		First recorded during Biologic (2011c) No water in October 2023 Water present in April 2024
Jinidi 4 1001_11_00023 and 1001_11_00024 Biologic (2011c)	Likely ephemeral	-22.9994	119.2874	Gorge/ Gully		First recorded during Biologic (2011c) No water in October 2023 Water present in April 2024
Jinidi 6 (Biologic, in prep.)	Likely ephemeral	-23.0248	119.2479	Gorge/ Gully		Water present October 2023 and April 2024

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
Jinidi 7 (Biologic, in prep.)	Likely ephemeral	-23.0246	119.2483	Gorge/ Gully		Water present October 2023 and April 2024
JINSP2 (Biologic, in prep.)	Likely ephemeral	-23.0585	119.1816	Gorge/ Gully		Water present October 2023 and April 2024
1001_11_0008	Likely ephemeral	119.2723	-23.0175	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0011	Likely ephemeral	119.2284	-23.035	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in South Parmelia
1001_11_0012	Likely ephemeral	119.2574	-23.0246	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0013	Likely ephemeral	119.2567	-23.0254	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0014	Likely ephemeral	119.2559	-23.0267	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0015	Likely ephemeral	119.2825	-22.9863	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0016	Likely ephemeral	119.2749	-22.9856	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0018	Likely ephemeral	119.2704	-22.9881	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0019	Likely ephemeral	119.2704	-22.9886	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi

Water Feature ID	Type	Location		Habitat	Photo (current survey)	Notes
		Latitude	Longitude			
1001_11_0020	Likely ephemeral	119.272	-22.9889	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0021	Likely ephemeral	119.2721	-22.9888	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0022	Likely ephemeral	119.2784	-22.989	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi
1001_11_0025	Likely ephemeral	119.289	-23.0022	Gorge/ Gully		Likely ephemeral or temporary ephemeral pool in Jinidi

Appendix F: Targeted searches undertaken

Trip	Site	Date	Person hours	Targeted species	Habitat
1	VJIN-09	25/03/23	1.7	Grey Falcon, Western Pebble-mound Mouse, Pilbara Olive Python, Northern Quoll, Southern Whiteface, Princess Parrot	Major Drainage Line
1	VJIN-12	22/03/23	2.8	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-12	24/03/23	6.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-12	25/03/23	1.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-12	28/03/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-14	23/03/23	5.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat	Hillcrest/ Hillslope
1	VJIN-17	24/03/23	5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-18	26/03/23	3	Northern Quoll, Pilbara Olive Python, Grey Falcon, Southern Whiteface, Princess Parrot	Major Drainage Line
1	VJIN-19	24/03/23	4	Northern Quoll, Pilbara Olive Python, Grey Falcon, Southern Whiteface, Princess Parrot	Major Drainage Line
1	VJIN-19	29/03/23	3	Northern Quoll, Pilbara Olive Python, Grey Falcon, Southern Whiteface, Princess Parrot	Major Drainage Line
1	VJIN-20	28/03/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
1	VJIN-21	24/03/23	4	Pilbara Olive Python, Southern Whiteface, Princess Parrot	Major Drainage Line
1	VJIN-23	24/03/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-23	29/03/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-26	25/03/23	1	Northern Quoll, Pilbara Olive Python	Gorge/ Gully
1	VJIN-26	28/03/23	1	Northern Quoll, Pilbara Olive Python	Gorge/ Gully
1	VJIN-27	25/03/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
1	VJIN-28	26/03/23	7	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Drainage Area/ Floodplain
1	VJIN-29	26/03/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-29	30/03/23	1.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-30	26/03/23	2.8	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse	Hillcrest/ Hillslope
1	VJIN-30	27/03/23	5.6	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse	Hillcrest/ Hillslope
1	VJIN-31	26/03/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-32	30/03/23	5.3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope

Trip	Site	Date	Person hours	Targeted species	Habitat
1	VJIN-34	30/03/23	1.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-34	30/03/23	0.75	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-37	27/03/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse	Hillcrest/ Hillslope
1	VJIN-38	30/03/23	1.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse	Hillcrest/ Hillslope
1	VJIN-41	30/03/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-45	30/03/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-49	30/03/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
1	VJIN-97	31/03/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-21	13/05/23	2	Pilbara Olive Python, Southern Whiteface, Princess Parrot	Major Drainage Line
2	VJIN-42	18/05/23	5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-50	15/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse, Southern Whiteface, Princess Parrot	Hillcrest/ Hillslope
2	VJIN-60	13/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-60	15/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-60	16/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-61	13/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-62	13/05/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse, Night Parrot	Hillcrest/ Hillslope
2	VJIN-63	13/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-64	14/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-65	14/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-66	17/05/23	1.5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-68	16/05/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-71	13/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-72	13/05/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse, Night Parrot	Drainage Area/ Floodplain
2	VJIN-73	13/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse, Night Parrot, Mulgara, Greater Bilby, Southern Whiteface, Princess Parrot	Hillcrest/ Hillslope

Trip	Site	Date	Person hours	Targeted species	Habitat
2	VJIN-75	14/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Grey Falcon	Hillcrest/ Hillslope
2	VJIN-75	18/05/23	0.75	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Grey Falcon	Hillcrest/ Hillslope
2	VJIN-77	17/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-78	15/05/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
2	VJIN-79	15/05/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-80	17/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-83	14/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-84	17/05/23	8	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-85	14/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-86	15/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Western Pebble-mound Mouse	Hillcrest/ Hillslope
2	VJIN-87	15/05/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
2	VJIN-88	15/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-89	16/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
2	VJIN-90	17/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-91	17/05/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-92	17/05/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-93	16/05/23	5	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
2	VJIN-94	18/05/23	1	Western Pebble-mound Mouse, Princess Parrot, Western Pebble-mound Mouse	Mulga Woodland
2	VJIN-96	19/05/23	2	Greater Bilby, Brush-tailed Mulgara, Western Pebble-mound Mouse	Drainage Area/ Floodplain
3	VJIN-42	02/10/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-98	28/09/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Hillcrest/ Hillslope
3	VJIN-99	28/09/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-100	28/09/23	2	Ghost Bat, Northern Quoll, Pilbara Olive Python	Gorge/ Gully
3	VJIN-101	29/09/23	3	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-101	02/10/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-102	29/09/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-103	30/09/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully

Trip	Site	Date	Person hours	Targeted species	Habitat
3	VJIN-104	30/09/23	4	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-105	30/09/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-106	30/09/23	2	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-107	01/10/23	6	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-107	02/10/23	1	Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python	Gorge/ Gully
3	VJIN-108	01/10/23	2	Grey Falcon, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Ghost Bat	Major Drainage Line
3	VJIN-110	03/10/23	2	Grey Falcon, Northern Quoll, Western Pebble-mound Mouse	Hillcrest/ Hillslope
3	VJIN-111	03/10/23	1	Northern Quoll, Grey Falcon, Pilbara Olive Python, Ghost Bat, Western Pebble-mound Mouse	Hillcrest/ Hillslope
3	VJIN-112	03/10/23	0.5	Northern Quoll, Grey Falcon, Pilbara Olive Python, Ghost Bat, Western Pebble-mound Mouse	Hillcrest/ Hillslope

Appendix G: eDNA Analysis Report

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SERVICE REPORT

eDNA ANALYSIS

ASSAYS

Universal

Fish

Sharks & Rays

Corals

Crustaceans

Bacteria

Plants & Algae

Mammals

Insects

Vertebrates

Molluscs

Reptiles

Birds

Fungi

SAMPLES

Water

Plankton tows

Sediment

Deposition arrays

Biofoul

Bore water

Scats

Tissue

Plants

Fossils

Pollen

Stomach contents

DNA	Deoxyribonucleic acid
eDNA	Environmental DNA
NCBI	National Centre for Biotechnology Information
OTU	Operational taxonomic unit
ZOTU	Zero-radius operational taxonomic unit
AIS	Alien Invasive Species
LULU	A post-clustering algorithm for curation of DNA amplicon data
PCR	Polymerase chain reaction
mtGenome	The full mitochondrial genome
fasta	A formatting type for sequence data
18S	The nuclear gene region, 18S
COI	The mitochondrial gene region, cytochrome c oxidase I
16S	The mitochondrial subunit ribosomal RNA gene region, 16S
12S	The mitochondrial gene region, 12S

Project Details

Scope of Work: EF285

Project Title: Biodiversity audit for the Pilbara Olive python and the Pilbara leaf-nosed bat at sites in the Central Pilbara, WA using eDNA metabarcoding.

Client Details

Client: Biologic Environmental Survey Pty Ltd (ABN: 55 133 116 131)
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Report Details

Report reference: EF285_Biologic_Final Report

Report issue date: 25/10/2023

Laboratory start date: 20/04/2023 Laboratory end date: 26/06/2023

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Approvals	Dr Kathryn Dawkins (Author)	Dr Tina Berry (Reviewer)

1.0 OBJECTIVE

The objective of this study was to assess the presence of *Liasis olivaceus barroni* (Pilbara Olive python) and *Rhinonicteris aurantius* (Pilbara leaf-nosed bat) from water samples collected from sites in Central Pilbara using eDNA metabarcoding.

1.1 Study Scope

Using environmental DNA (eDNA) testing, eDNA frontiers was tasked with analysing water samples for the presence of *Liasis olivaceus barroni* (Pilbara Olive python) and *Rhinonicteris aurantius* (Pilbara leaf-nosed bat). The client provided a total of 53 samples (including three in-field control samples) across two sampling periods, consisting of water filtrate suspended on filter membranes and preserved in ATL buffer (Tables 1 and 2).

2.0 SAMPLE DETAILS

Table 1. Sample receipt details.

Date received:	18/04/2023 & 26/05/2023
Transport temp:	Ambient – ATL buffer (810µL)
Number of samples:	53
Storage:	All samples were stored at -20°C prior to analysis.

Table 2. Supplied sample details.

eDNA Frontiers ID	Client Sample ID	Sample Type	Volume filtered (mL)	Collection Date
E-285-001	VBEN-01-01	Water - filtered to 0.45uM	1000	27/03/2023
E-285-002	VBEN-01-02	Water - filtered to 0.45uM	1000	27/03/2023
E-285-003	VBEN-01-03	Water - filtered to 0.45uM	1000	27/03/2023
E-285-004	VBEN-01-04	Water - filtered to 0.45uM	1000	27/03/2023
E-285-005	VBEN-01-05	Water - filtered to 0.45uM	1000	27/03/2023
E-285-006	VJIN-21-01	Water - filtered to 0.45uM	1000	24/03/2023
E-285-007	VJIN-21-02	Water - filtered to 0.45uM	1000	24/03/2023
E-285-008	VJIN-21-03	Water - filtered to 0.45uM	1000	24/03/2023
E-285-009	VJIN-21-04	Water - filtered to 0.45uM	1000	24/03/2023
E-285-010	VJIN-21-05	Water - filtered to 0.45uM	1000	24/03/2023
E-285-011	VJIN-15-01	Water - filtered to 0.45uM	200	22/03/2023
E-285-012	VJIN-15-02	Water - filtered to 0.45uM	200	22/03/2023
E-285-013	VJIN-15-03	Water - filtered to 0.45uM	200	22/03/2023
E-285-014	VJIN-15-04	Water - filtered to 0.45uM	200	22/03/2023
E-285-015	VJIN-15-05	Water - filtered to 0.45uM	200	22/03/2023
E-285-016	VJIN-12 (WJIN-02)-01	Water - filtered to 0.45uM	550	22/03/2023
E-285-017	VJIN-12 (WJIN-02)-02	Water - filtered to 0.45uM	550	22/03/2023
E-285-018	VJIN-12 (WJIN-02)-03	Water - filtered to 0.45uM	550	22/03/2023
E-285-019	VJIN-12 (WJIN-02)-04	Water - filtered to 0.45uM	550	22/03/2023
E-285-020	VJIN-12 (WJIN-02)-05	Water - filtered to 0.45uM	550	22/03/2023
E-285-021	VJIN-12 (WJIN-04)-01	Water - filtered to 0.45uM	310	27/03/2023
E-285-022	VJIN-12 (WJIN-04)-02	Water - filtered to 0.45uM	300	27/03/2023
E-285-023	VJIN-12 (WJIN-04)-03	Water - filtered to 0.45uM	270	27/03/2023
E-285-024	VJIN-12 (WJIN-04)-04	Water - filtered to 0.45uM	200	27/03/2023
E-285-025	VJIN-12 (WJIN-04)-05	Water - filtered to 0.45uM	260	27/03/2023
E-285-026	22059_Trip 1_Control	Control	1000	27/03/2023
E-285-027	VJIN-81 (WJIN-14)-01	Water - filtered to 0.45uM	300	13/05/2023
E-285-028	VJIN-81 (WJIN-14)-02	Water - filtered to 0.45uM	250	13/05/2023

eDNA Frontiers ID	Client Sample ID	Sample Type	Volume filtered (mL)	Collection Date
E-285-029	VJIN-81 (WJIN-14)-03	Water - filtered to 0.45uM	500	13/05/2023
E-285-030	VJIN-81 (WJIN-14)-04	Water - filtered to 0.45uM	400	13/05/2023
E-285-031	VJIN-81 (WJIN-14)-05	Water - filtered to 0.45uM	350	13/05/2023
E-285-032	VJIN-21 (WJIN-01)-01	Water - filtered to 0.45uM	700	13/05/2023
E-285-033	VJIN-21 (WJIN-01)-02	Water - filtered to 0.45uM	650	13/05/2023
E-285-034	VJIN-21 (WJIN-01)-03	Water - filtered to 0.45uM	650	13/05/2023
E-285-035	VJIN-21 (WJIN-01)-04	Water - filtered to 0.45uM	400	13/05/2023
E-285-036	VJIN-21 (WJIN-01)-05	Water - filtered to 0.45uM	450	13/05/2023
E-285-037	VJIN-60 (WJIN-06)-01	Water - filtered to 0.45uM	300	15/05/2023
E-285-038	VJIN-60 (WJIN-06)-02	Water - filtered to 0.45uM	300	15/05/2023
E-285-039	VJIN-60 (WJIN-06)-03	Water - filtered to 0.45uM	200	15/05/2023
E-285-040	VJIN-60 (WJIN-06)-04	Water - filtered to 0.45uM	200	15/05/2023
E-285-041	VJIN-60 (WJIN-06)-05	Water - filtered to 0.45uM	200	15/05/2023
E-285-042	VJIN-85 (WJIN-15)-01	Water - filtered to 0.45uM	300	14/05/2023
E-285-043	VJIN-85 (WJIN-15)-02	Water - filtered to 0.45uM	200	14/05/2023
E-285-044	VJIN-85 (WJIN-15)-03	Water - filtered to 0.45uM	200	14/05/2023
E-285-045	VJIN-85 (WJIN-15)-04	Water - filtered to 0.45uM	400	14/05/2023
E-285-046	VJIN-85 (WJIN-15)-05	Water - filtered to 0.45uM	200	14/05/2023
E-285-047	VJIN-75 (WJIN-13)-01	Water - filtered to 0.45uM	500	14/05/2023
E-285-048	VJIN-75 (WJIN-13)-02	Water - filtered to 0.45uM	500	14/05/2023
E-285-049	VJIN-75 (WJIN-13)-03	Water - filtered to 0.45uM	400	14/05/2023
E-285-050	VJIN-75 (WJIN-13)-04	Water - filtered to 0.45uM	350	14/05/2023
E-285-051	VJIN-75 (WJIN-13)-05	Water - filtered to 0.45uM	400	14/05/2023
E-285-052	22059_Trip 2_Control1	Control	1000	14/05/2023
E-285-054	22059_Trip 2_Control2	Control	1000	13/05/2023

3.0 METHODS

3.1 Sample Collection

Water samples were collected at five locations by Biologic staff between the 22nd and 27th March 2023, and five locations between the 13th and 15th of May 2023. Five replicates were collected at each sampling point, with water samples filtered using 0.45µM mixed cellulose ester (MCE) with a peristaltic Sentino pump to capture eDNA present in the water. All filtering was carried out by Biologic Environmental staff; across the two sampling periods three control samples of water used to clean common filtration equipment were supplied. All samples were transported at ambient temperature while preserved in ATL buffer to eDNA Frontiers' laboratories where they were stored at -20°C until scheduled for DNA extraction.

3.2 eDNA Extraction and Analysis

DNA digestion was performed on each filter paper, with half of the digest taken through for DNA extraction using a Qiagen DNeasy blood and tissue kit, following the eDNA Frontiers lab's SOPs and detailed in Koziol *et al.,* (2018), Stat *et al.,* (2017), and Stat *et al.,* (2018). Each sample was assigned an individual combination of index tags and amplified by PCR using a 16S assay targeting reptiles; this assay has been shown in a previous study to also successfully amplify the target bat species (see project EF220). A library was generated and sequenced using the Illumina MiSeq. Laboratory extraction and PCR controls were included to test for contamination.

3.3 Bioinformatics and Taxonomic Assignments

Bioinformatic tools were used to analyse raw sequence data (Mousavi-Derazmahalleh *et al*., 2021) generated from the metabarcoding. The sequencing results were demultiplexed and trimmed using Obitools and quality filtered with Usearch v11 for sequencing errors (maxee=1) with a minimum length of 70 used. Sequences were then dereplicated and unique sequences were transformed into zero radius operational taxonomic units (ZOTUs) to provide sensitive taxonomic resolution (Usearch v11) (Edgar, 2018). ZOTUs, in contrast to OTUs, are a more exact sequence variant, clustering at 99% to improve taxonomic resolution. Generated ZOTUs were queried against the nucleotide database NCBI (GenBank) and assigned to the species level where possible. Taxonomic assignments were based on an in-house Python script which further filters the Blast results (evalue ≤1e-5, %identity ≥95, qCov =100, LULU minMatch =97%), combines them with the ZOTU table results and produces a table containing the taxonomic information available from Blast taxonomy database (accessed June 2023). Additionally, Geneious Prime (version 2023.1.1) was used to align any ZOTU identified as potential *L. olivaceus barroni* against the refence sequence generated by eDNA frontiers in a previous study for the client, as well as all previously recovered ZOTUs for this species.

It is important to note that while sequences recovered are converted to the lowest possible taxon based on similarities and differences to a DNA database (NCBI's GenBank), this database, and the taxonomic framework that underpins it, may contain errors. Accordingly, the DNA taxon identifications should be interpreted as the best available assignment based on currently available information and that errors are possible.

4.0 RESULTS

4.1 Taxonomic Diversity

One of the species of interest, *Liasis olivaceus barroni*, was detected in one replicate from site VJIN-21 (WJIN-01) (>700 sequencing reads). The *L. olivaceus barroni* ZOTU detected in this sample matches the reference sequence generated in a previous study (100%), as well as sequences retrieved from project EF057 (Zotu2, 99.07% similarity; Zotu3, 100% similarity), EF123 (Zotu3, 100% similarity), EF138 (Zotu5, 100% similarity), and EF272 (Zotu16, 100% similarity).

Although the target *Rhinonicteris aurantia* was not detected in any sample, two other species of bat (*Macroderma gigas* and *Chaerephon jobensis*) were detected in the same replicate as *L. olivaceus barroni*.

In addition to the target species, several species of fish, frog, bird, and mammal were detected in the samples, as well as other species of reptile (Table 3). Taxa that had ≥95% similarity in the sequence region have been reported, with species-level classification provided for those ≥97% similarity. Although contamination was evident in field control samples, none of these detections were attributable to the target organisms. Laboratory extraction controls were negative, and the positive control amplified successfully.

Table 3. Diversity detected from water samples using a 16S assay targeting reptiles. Presence of the species at each site is indicated by the symbol *. Taxonomy was assigned as per NCBI and classifications were standardised according to the Global Biodiversity Information Facility (accessed June 2023). Blank cells indicate where taxa could not be resolved to a lower taxonomic level; species-level taxonomy is only shown for matches ≥97%. Blue text indicates taxa whose distribution is not recorded to extend to the area according to GBIF. Blue highlighting indicates the species of interest. * indicates where an alternate taxonomy was retrieved and this has been altered to reflect the local species that has no reference sequence.

Phylum	Class	Order	Family	Genus	Species	VBEN-01	VJIN-21	VJIN-15	VJIN-12 (WJIN-02)	VJIN-12 (WJIN-04)	Trip 1_Control	VJIN-81 (WJIN-14)	VJIN-21 (WJIN-01)	VJIN-60 (WJIN-06)	VJIN-85 (WJIN-15)	VJIN-75 (WJIN-13)	Trip 2_Control1	Trip 2_Control2
Arthropoda	Ostracoda	Podocopida	Cyprididae	*Cypridopsis*	*Cypridopsis vidua*		*											
Bryozoa	Phylactolaemata	Plumatellida	Plumatellidae	*Plumatella*												*		
					Plumatella vorstmani				*									
Chordata	Actinopterygii	Atheriniformes	Melanotaeniidae	*Melanotaenia*	*Melanotaenia duboulayi*	*	*					*	*					
		Perciformes	Terapontidae	*Leiopotherapon*	*Leiopotherapon unicolor*	*	*											
	Amphibia	Anura	Myobatrachidae	*Uperoleia*									*	*				
			Pelodryadidae	*Litoria*				*	*	*		*		*	*	*		
				Ranoidea	*Ranoidea maini*			*		*	*	*						
	Aves	Accipitriformes	Accipitridae	*Accipiter*		*				*								
		Charadriiformes	Turnicidae	*Turnix*	*Turnix velox*				*									
		Coraciiformes	Alcedinidae	*Dacelo*	*Dacelo novaeguineae*	*												
			Meropidae	*Merops*			*											
		Galliformes	Phasianidae	*Gallus*	*Gallus gallus*								*					
		Passeriformes	Pachycephalidae	*Colluricincla*	*Colluricincla harmonica*										*			
			Estrildidae	*Taeniopygia*	*Taeniopygia guttata*					*								
			Meliphagidae	*Manorina*				*										
				Ptilotula	*Ptilotula penicillata*	*		*		*						*		
			Monarchidae	*Grallina*	*Grallina cyanoleuca*	*												
			Ptilonorhynchidae	*Chlamydera*	*Chlamydera guttata**	*										*		
		Psittaciformes	Psittacidae	*Platycercus*		*												
		Strigiformes	Strigidae	*Ninox*	*Ninox novaeseelandiae*	*												
	Mammalia	Artiodactyla	Bovidae	*Bos*	*Bos taurus*	*	*	*										
			Suidae	*Sus*	*Sus scrofa*								*	*				
		Carnivora	Canidae	*Canis*	*Canis lupus familiaris*	*				*		*	*	*				
			Felidae	*Felis*	*Felis catus*								*					*
		Chiroptera	Megadermatidae	*Macroderma*	*Macroderma gigas*								*					
			Molossidae	*Chaerephon*	*Chaerephon jobensis**								*					
		Dasyuromorphia	Dasyuridae	*Dasyurus*	*Dasyurus hallucatus*													*
		Diprotodontia	Macropodidae	*Macropus*	*Macropus robustus*	*		*					*					
	-	Squamata	Pythonidae	*Liasis*	*Liasis olivaceus barroni*								*					
	-		Scincidae	*Lerista*	*Lerista chalybura*				*									
	-	Testudines	Chelidae	*Chelodina*	*Chelodina steindachneri*	*												
Platyhelminthes	Catenulida	-	Stenostomidae	*Stenostomum*	*Stenostomum cf. simplex AW-2018*				*									

5.0 SUMMARY

This analysis successfully detected the target species *Liasis olivaceus barroni* from one environmental water sample collected from sites in the Newman area. The *L. olivaceus barroni* ZOTU detected matched with 100% similarity to the reference sequence generated in a previous study. While the target *Rhinonicteris aurantia* was not detected, two other species of bat (*Macroderma gigas* and *Chaerephon jobensis*) were found. Several other taxonomic groups were also identified, including fish, frogs, birds, and mammals.

ARCHIVING OF STUDY DATA

The DNA extracts derived from this study will be stored within eDNA Frontiers' premises for a period of 12 months. If samples are required to be stored longer a sample archiving service can be provided.

All electronic data relating to the study is stored in an offsite secure server. This includes; all laboratory raw data; personnel records; and the study report. Hard copy documents are archived by study number into a locked area of the test facility located in eDNA Frontiers, Curtin University administration area.

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Appendix H: Significant Fauna Records

Scientific Name	Common name	Conservation Status				Site ID	Observation	Habitat type	Comment
		EPBC Act	BC Act	DBCA	IUCN				
Dasycercus blythi	Brush-tailed Mulgara			P4		VJIN-96	Burrow (inactive)	Drainage Area/ Floodplain	
Dasycercus blythi	Brush-tailed Mulgara			P4		VJIN-96	Burrow (inactive)	Drainage Area/ Floodplain	
Dasycercus blythi	Brush-tailed Mulgara			P4		VJIN-96	Burrow (active)	Drainage Area/ Floodplain	
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-100	Scat	Gorge/ Gully	Recent (1–6 mths)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-60	Scat	Gorge/ Gully	Very Old (3 to 10 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-66	Scat	Gorge/ Gully	Old (6 mths to 3 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-66	Scat	Gorge/ Gully	Recent (1–6 mths)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-77	Scat	Gorge/ Gully	Old (6 mths to 3 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-77	Scat	Gorge/ Gully	Old (6 mths to 3 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-78	Scat	Gorge/ Gully	Recent (1–6 mths)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-78	Scat	Gorge/ Gully	Recent (1–6 mths)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-79	Scat	Hillcrest/ Hillslope	Old (6 mths to 3 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-90	Scat	Hillcrest/ Hillslope	Recent (1–6 mths)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-91	Scat	Hillcrest/ Hillslope	Old (6 mths to 3 yrs)
Dasyurus hallucatus	Northern quoll	EN	EN			VJIN-98	Scat	Hillcrest/ Hillslope	Old (6 mths to 3 yrs)
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-102	Scat	Hillcrest/ Hillslope	Very Old (3 to 10yrs)
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-104	Scat	Hillcrest/ Hillslope	Very Old (3 to 10yrs)
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-20	Individual (alive)	Major Drainage Line	Observed during flora and vegetation survey
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-21	Other	Gorge/ Gully	eDNA water sample

Scientific Name	Common name	Conservation Status				Site ID	Observation	Habitat type	Comment
		EPBC Act	BC Act	DBCA	IUCN				
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-42	Individual (alive)	Gorge/ Gully	
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-93	Scat	Gorge/ Gully	Old (6mths to 3yrs)
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-98	Scat	Gorge/ Gully	Very Old (3 to 10yrs)
Liasis olivaceus barroni	Pilbara olive python	VU	VU			VJIN-98	Scat	Drainage Area/ Floodplain	Very Old (3 to 10yrs)
Macroderma gigas	Ghost bat	VU	VU			VJIN-84	Individual (alive)	Gorge/ Gully	
Macroderma gigas	Ghost bat	VU	VU			VJIN-21	Other	Major Drainage Line	eDNA water sample
Macroderma gigas	Ghost bat	VU	VU			VJIN-32	Other	Cleared/ Disturbed	Call
Macroderma gigas	Ghost bat	VU	VU			VJIN-32	Other	Hillcrest/ Hillslope	Call
Macroderma gigas	Ghost bat	VU	VU			VJIN-54	Other	Drainage Area/ Floodplain	Call
Macroderma gigas	Ghost bat	VU	VU			VJIN-101	Scat	Hillcrest/ Hillslope	CJIN-42
Macroderma gigas	Ghost bat	VU	VU			VJIN-32	Scat	Hillcrest/ Hillslope	CJIN-26
Macroderma gigas	Ghost bat	VU	VU			VJIN-42	Scat	Gorge/ Gully	CJIN-37
Macroderma gigas	Ghost bat	VU	VU			VJIN-75	Scat	Hillcrest/ Hillslope	CJIN-39
Macroderma gigas	Ghost bat	VU	VU			VJIN-79	Scat	Gorge/ Gully	CJIN-30
Macroderma gigas	Ghost bat	VU	VU			VJIN-79	Scat	Gorge/ Gully	CJIN-38
Macroderma gigas	Ghost bat	VU	VU			VJIN-83	Scat	Gorge/ Gully	CJIN-15
Macroderma gigas	Ghost bat	VU	VU			VJIN-84	Scat	Gorge/ Gully	CJIN-32
Macroderma gigas	Ghost bat	VU	VU			VJIN-84	Scat	Hillcrest/ Hillslope	CJIN-33
Macroderma gigas	Ghost bat	VU	VU			VJIN-93	Scat	Gorge/ Gully	CJIN-13

Scientific Name	Common name	Conservation Status				Site ID	Observation	Habitat type	Comment
		EPBC Act	BC Act	DBCA	IUCN				
Macroderma gigas	Ghost bat	VU	VU			VJIN-93	Scat	Gorge/ Gully	CJIN-14
Macroderma gigas	Ghost bat	VU	VU			VJIN-98	Scat	Hillcrest/ Hillslope	CJIN-44
Macroderma gigas	Ghost bat	VU	VU			VJIN-98	Scat	Hillcrest/ Hillslope	CJIN-43
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-04	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-08	Mound (inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-101	Mound (inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-105	Mound (recently inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-109	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-16	Mound (active)	Calcrete Plain	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-19	Mound (inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-19	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-30	Mound (recently inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-39	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-40	Mound (recently inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-40	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-40	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-40	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-40	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-50	Mound (active)	Hillcrest/ Hillslope	

Scientific Name	Common name	Conservation Status				Site ID	Observation	Habitat type	Comment
		EPBC Act	BC Act	DBCA	IUCN				
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-50	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-50	Mound (active)	Stony Plain	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-50	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-50	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-52	Mound (active)	Drainage Area/ Floodplain	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-62	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-62	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-62	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-63	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-66	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-69	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-69	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-69	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-69	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-70	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-70	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-74	Mound (inactive)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-94	Mound (active)	Hillcrest/ Hillslope	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-94	Mound (active)	Stony Plain	
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-94	Mound (recently inactive)	Hillcrest/ Hillslope	

Scientific Name	Common name	Conservation Status				Site ID	Observation	Habitat type	Comment
		EPBC Act	BC Act	DBCA	IUCN				
Pseudomys chapmani	Western Pebble-mound Mouse			P4		VJIN-95	Mound (active)	Hillcrest/ Hillslope	