Western Ridge Pipelines Vertebrate Fauna Survey

Biologic Environmental Survey

Report to BHP WAIO

July 2022

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EXECUTIVE SUMMARY

BHP Western Australian Iron Ore are investigating the biological values of potential pipeline options for the Western Ridge area (hereafter referred to as the Study Area) to provide local and contextual information to inform future environmental approvals for the area. The Study Area comprises three separate areas ranging from 27 kilometres (km) south-west to 10 km east of Newman), covering a total area of approximately 2,169.40 hectares (ha). To support this assessment, Biologic Environmental Survey Pty Ltd was commissioned to undertake a combined basic and targeted vertebrate fauna assessment of the Study Area. This report documents the findings of this assessment, which consisted of a desktop assessment and a field survey comprising basic and targeted level sampling.

A detailed desktop assessment was conducted prior to the field survey to identify vertebrate fauna species which have previously been recorded or have the potential to occur in the vicinity of the Study Area. The combined basic and targeted field survey was conducted over two trips, the first (trip 1) from 24th to 31st March 2021 and the second (trip 2) from 9th to 19th March 2022. Due to access limitations during trip 1, sampling took place in areas outside of the Prairie Downs Station, while trip 2 was focused solely within the Prairie Downs Station. The primary objective of the survey was to identify the occurrence of terrestrial vertebrate fauna species and their supporting habitats within the Study Area, with a focus on species of conservation significance (herein significant species), which includes those listed as Threatened and/or Migratory under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Biodiversity Conservation Act 2016*, and/or as Priority by the Department of Biodiversity, Conservation and Attractions. Specific methods included targeted searches, spotlighting, camera trips, acoustic bird call recordings, bat echolocation recordings, bilby plots and habitat assessments. Significant species considered to be Matters of National Environmental Significance (and their EPBC Act conservation status) that were targeted during the survey include:

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

Six broad fauna habitat types were recorded and mapped within the Study Area, comprising, in decreasing order of extent, Stony Plain (1,520.57 ha, 70.09% of Study Area), Mulga Woodland (313.33 ha, 14.45%), Drainage Area/ Floodplain (252.50 ha, 11.64%), Major Drainage Line (26.12 ha, 1.20%), Medium Drainage Line (19.99 ha, 0.92%), and Hillcrest/ Hillslope (7.63 ha, 0.35%). The remaining 1.35% (29.26 ha) of the Study Area was mapped as Cleared/ Disturbed. All six fauna habitats mapped are broadly distributed and well represented across the Gascoyne and Pilbara bioregions, and therefore support fauna assemblages which are generally common and widespread. Of the six fauna habitats mapped within the Study Area, none are considered to provide critical habitat for any significant species identified in the desktop assessment.

The desktop assessment identified a total of 365 vertebrate fauna species as potentially occurring in the Study Area, comprising 48 mammals (including 38 native and ten non-native), 200 birds, 110 reptiles and seven amphibians. A total of 100 species, comprising 12 mammals (nine native and three introduced), 75 birds, 11 reptiles and two amphibians were recorded during the field survey. Vertebrate fauna species recorded within the Study Area are typical of the six broad fauna habitat types recorded within the Gascoyne and Pilbara bioregions.

Of the 40 significant species identified in the desktop assessment, two were Confirmed to occur within the Study Area, two species are considered Highly Likely, eight species Possible, and 28 Unlikely to occur within the Study Area. Pilbara olive python was detected at one water feature via eDNA sampling and is considered likely to occur as a resident in rocky habitats within the Study Area. Western pebble-mound mouse (*Pseudomys chapmani* - Priority 4) was recorded three times from secondary evidence (pebble-mounds) and is likely to occur as a resident throughout Stony Plain and Hillcrest/ Hillslope habitats within the Study Area. Given the habitats present within the Study Area and locations of nearby records identified during the desktop assessment, a further two significant species are considered Highly Likely to occur within the Study Area, ghost bat and peregrine falcon (*Falco peregrinus* – Specially Protected).

Ghost bat have previously been recorded approximately 680 m north-west of the Study Area, and on multiple occasions within the Western Ridge area located directly west and 1.7 km to the north of the Study Area. Due to the absence of any potential roosting habitat within the Study Area, occurrence of ghost bat within the Study Area is likely to be restricted to foraging individuals, originating from outside the Study Area, particularly from the Western Ridge area where known and potential roosting caves occur. The caves recorded within the Western Ridge area represent the south-eastern extent of known roost caves for the species, indicating the species occurrence in this area may represent an important population, as defined by the Department of Environment (DoE) significant impact guidelines (DoE, 2013). Due to the proximity of known and likely roosting caves within the Western Ridge area, Mulga Woodland and Drainage Area/ Floodplain habitats are likely to contribute to non-critical foraging and dispersal habitat for this population. The fauna habitats recorded in the Study Area are unlikely to provide any increased importance when compared to the synonymous habitat widespread in the surrounding area.

Peregrine falcon was previously recorded approximately 150 m north of the Study Area. The species has previously been recorded on multiple occasions to the north of the Study Area. Due to the species' broad foraging range and utilisation of habitat types for foraging, it is likely to forage broadly across habitats of the Study Area. No suitable nesting habitat such as Breakaway/ Cliff occur within the Study Area.

The occurrence of a further eight species identified in the desktop assessment within the Study Area was considered Possible, including northern quoll, brush-tailed mulgara (*Dasycercus blythi* – Priority 4), long-tailed dunnart (*Sminthopsis longicaudata* – Priority 4), Pilbara leaf-nosed bat, fork-tailed swift (*Apus pacificus* – Migratory), grey falcon (*Falco hypoleucos* – Vulnerable), spotted ctenotus (*Ctenotus uber* subsp. *johnstonei* – Priority 2; although it is suspected that the Pilbara population may represent an unnamed species) and Pilbara flat-headed blind-snake (*Anilios ganei* – Priority 1). The remaining 28 species were considered Unlikely or Highly Unlikely to occur within the Study Area, based on the absence of suitable permanent or seasonal habitats and/or specific micro-habitats occurring within the Study Area.

1 INTRODUCTION

1.1 Background

BHP Western Australian Iron Ore (BHP WAIO) are investigating the biological values of potential pipeline options for the Western Ridge area (hereafter referred to as the Study Area) to provide local and contextual information to inform future environmental approvals for the area. The Study Area comprises three separate areas, ranging from 27 kilometres (km) south-west to 10 km east of Newman and covers an area of approximately 2,169.40 hectares (ha) (Figure 1.1). The Study Area occurs over two pastoral leases, Ethel Creek Station in the east and Prairie Downs Station in the western most potion of the Study Area (Figure 1.1). Of particular interest is the potential for the Study Area to support significant species, which includes those listed as threatened and/or migratory under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity and Conservation Act 2016* (BC Act) or listed as Priority by the Department of Biodiversity, Conservation and Attractions (DBCA). Significant species considered to be Matters of National Environmental Significance (MNES) under the EPBC Act (and their EPBC Act conservation status) which were the primary focus of targeted sampling during the survey included:

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

To support future approvals, BHP WAIO commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a single season combined basic and targeted vertebrate fauna survey of the Study Area. The vertebrate fauna assessment does not apply to any specific development proposed by BHP WAIO; however, the assessment will be used to inform future environmental approvals within and more broadly in the vicinity of the Study Area. This report documents the findings of this assessment, which consisted of a desktop assessment and field survey comprising basic and targeted sampling.

1.2 Survey Objectives

The overarching objective of this assessment was to undertake a basic survey to identify the occurrence of terrestrial vertebrate fauna species and their supporting habitats within the Study Area, with a focus on significant species (those listed as threatened and/or migratory under the EPBC Act and/or BC Act, or listed as Priority by DBCA), particularly those considered to be MNES. Specifically, the key objectives of the assessment were to:

- conduct a comprehensive desktop assessment (database searches and literature review) to identify vertebrate fauna species potentially occurring within the Study Area;
- define and delineate broad fauna habitats occurring within the Study Area, and describe their significance to vertebrate fauna, particularly significant species;

- conduct a single season field survey to identify vertebrate fauna species occurring within the Study Area, with a focus on significant species; and
- assess the likelihood and distribution of vertebrate significant species occurring within the Study Area.

1.3 Compliance

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

- BHP (2017) Guidance for vertebrate fauna surveys in the Pilbara (SPR-IEN-EMS-012);
- DBCA (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia;
- DEWHA (2010a) Survey guidelines for Australia's threatened bats;
- DEWHA (2010b) Survey guidelines for Australia's threatened birds;
- DoE (2013) Significant impact guidelines 1.1: Matters of National Environmental Significance;
- DoE (2016) EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus)*;
- DPaW (2017) Interim guidelines for the preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles; and
- EPA (2020) Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.

The survey was conducted under a DBCA Regulation 27 "Fauna Taking (Biological Assessment) Licence" issued to Chris Knuckey (licence number BA27000373). Under Section 40 of the BC Act, threatened species sampling was completed under a DBCA "Authorisation to Take or Disturbed Threatened Species" issued to Chris Knuckey (authorisation number TFA 2021-0013).

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770000
780000
790000
7410000
7400000

SHIRE OF EAST PILBARA
Newman
SHIRE OF MEEKATHARRA

G 5200276
E 5202009
AML7000244
G 5200277
AM 7000266
L 5200199
E 5203360
E 5203448
E 5203361
Newman
Marble Bar Rd
Great Northern Hwy

Legend

- Study Area
- BHP Tenement
- Local Road
- State Road
- Local Government Authority

IBRA Subregion

- Augustus
- Fortescue
- Hamersley

N

biologic Environmental Survey

Scale: 1:96,500

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022

Karratha
Dampier
Marble Bar
Nullagine
Tom Price
Paraburdoo
Newman

BHP WAIO

Western Ridge Pipeline Targeted Fauna Survey

Figure 1.1: Study Area and regional location

1.4 Background to Protection of Fauna

Terrestrial fauna may be significant for a range of reasons, including:

- being identified as a threatened or priority species;
- being a species with restricted distribution;
- enduring a degree of historical impact from threatening processes; or
- providing an important function required to maintain the ecological integrity of a significant ecosystem (EPA, 2016).

All native fauna in Western Australia (WA) are protected at a state level under the BC Act and at a national level under the EPBC Act. Any action that has the potential to impact native fauna needs to be approved by relevant state and/or federal departments in accordance with the WA *Environmental Protection Act 1986* (EP Act) and the federal EPBC Act.

While all native fauna is protected under these Acts, some species are afforded extra protection. These include species that are considered Threatened under the EPBC Act and/or BC Act, or; migratory bird species that are protected under international agreements and subsequently listed as Migratory under the EPBC Act and/or BC Act (Table 1.1). Furthermore, any species that may be threatened but for which there is insufficient information available to allocate a threatened status under the EBPC Act and/or BC Act, can also be listed as Priority species by the WA DBCA (Table 1.1).

For the purposes of this assessment, species considered to be of conservation significance (herein significant species), are those that are afforded protection under the EPBC Act, BC Act and/or listed as Priority by DBCA (Table 1.1). A summary of applicable legislation and status codes is provided in Table 1.1.

Table 1.1: Definitions and terms for significant species

Act, Agreement or List	Status Codes[1]
Federal	
EPBC Act In Australia, native fauna are protected under the EPBC Act. This Act makes provisions for an independent committee (the Threatened Species Scientific Committee [TSSC]), which is charged with maintaining a list of threatened species. Threatened species are listed under one of six categories, depending on their specific conservation status. Migratory bird species are those listed under international agreements and protected under the EPBC Act as a MNES. Relevant international agreements include the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).	*Extinct:* • EX – Extinct • EW – Extinct in the Wild *Threatened:* • CR – Critically Endangered • EN – Endangered • VU – Vulnerable • CD – Conservation Dependent *Other:* • MI – Migratory
State	
BC Act In WA, native fauna are protected under the BC Act. Species in special need of protection are listed as being Extinct, Threatened or Specially Protected. Within these groups, species are listed under one of eight categories, depending on their specific conservation status. Migratory bird species are those listed under the Bonn Convention and/or CAMBA, JAMBA and ROKAMBA agreements.	*Extinct:* • EX – Extinct *Threatened:* • CR – Critically Endangered • EN – Endangered • VU – Vulnerable *Specially Protected:* • MI – Migratory • CD – Conservation Dependent • OS – Other specially protected fauna
DBCA Priority List The DBCA maintains a list of Priority species that are considered to be possibly threatened but have not been assigned statutory protection under the BC Act, as not enough information is available for an accurate determination of conservation status. These species are generally in urgent need of survey to determine their distribution and abundance.	*Poorly Known:* • P1 – Priority 1 • P2 – Priority 2 • P3 – Priority 3 *Rare, Near Threatened and other* • P4 – Priority

[1]See Appendix A for definitions of status codes

2 EXISTING ENVIRONMENT

2.1 Biogeography

The Study Area is located within two bioregions as defined by the Interim Biogeographic Regionalisation of Australia (IBRA; Thackway & Cresswell, 1995), Gascoyne and Pilbara (Figure 1.1). The Study Area primarily occurs within the Hamersley subregion of the Pilbara bioregion, covering approximately 63.12% (1,369.39 ha) (Table 2.1; Figure 1.1). The remaining 36.88% (800.01 ha) of the Study Area occurs within the Augustus subregion of the Gascoyne bioregion (Table 2.1; Figure 1.1).

Table 2.1: IBRA bioregion and subregion of the Study Area

Bioregion	Subregion	Extent in Study Area	
		Area (ha)	%
Pilbara 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).	**Hamersley (PIL3)** characterised by mountainous areas of Proterozoic sedimentary ranges (ironstone ranges) and plateaux dissected by gullies and gorges (Kendrick, 2001). Mulga low woodland over bunch grasses on fine-textured soils dominates in valley floors, while skeletal soils of the ranges are dominated by snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* (Kendrick, 2001). Drainage is typically into the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick, 2001).	1,369.39	63.12
Gascoyne Characterised by low, rugged ranges that are divided by broad, flat valleys and interspersed with open mulga woodlands on the plains (Bastin, 2008).	**Augustus (GAS3)** Rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys and contains extensive areas of alluvial valley-fill deposits (Desmond *et al.*, 2001). Mulga Woodland with *Triodia* occurs on shallow stony loam on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga Woodland (Desmond *et al.*, 2001). The Gascoyne River System provides the main drainage for the subregion and the headwaters of the Ashburton and Fortescue Rivers (Desmond *et al.*, 2001).	800.01	36.88
Total		**2,169.40**	**100%**

2.2 Climate

The Gascoyne bioregion has an arid climate with summer rainfall in the east, and winter rainfall in the west (Thackway & Cresswell, 1995; Waddell *et al.*, 2012). Of the two seasons, summer rainfall is generally less reliable, however heavy rainfall events can occur during this period as a result of tropical cyclones (Waddell *et al.*, 2012). The average annual rainfall ranges from 200–290 mm, however rainfall can significantly fluctuate from year to year (Bureau of Meterology [BoM], 2022). 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 are often associated with cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall ranges from 200–400 mm (BoM, 2022; McKenzie *et al.*, 2009).

Long-term climatic data is not available for the Study Area itself; however, long term climatic data is available from the BoM weather station at Newman Airport (station 7176), approximately 2 km south of the Study Area (BoM, 2022). This weather station is expected to provide the most accurate dataset for historic and current climatic conditions experienced within the Study Area.

2.3 Geology

The Hamersley subregion contains Proterozoic sedimentary ranges and gorges of basalt, shale and dolerite. This subregion also contains calcrete deposits (Kendrick, 2001). The Gascoyne subregion consists of Proterozoic sedimentary and granite ranges, and calcrete deposits (Desmond *et al.*, 2001).

The Study Area occurs across four broad (1:96,000) geological units (Table 2.2; Figure 2.1). The dominant geological unit occurring within the Study Area is the Alluvial/fluvial unit, occupying approximately 43.12%, followed by the Exposed unit (27.98%), the Colluvial unit (15.25%) and the Residual or relict unit (13.65%) (Table 2.2; Figure 2.1).

Table 2.2: Geology units within the Study Area

Geological Unit	Description	Extent in Study Area	
		Area (ha)	%
Alluvial/fluvial unit, PIP (A-PIP, Aa-PIP)	Clay, silt, sand, and gravel in channels and on floodplains. Sand- or clay-rich alluvium on alluvial plain.	935.41	43.12
Exposed unit, PIP (X-PIP)	Exposed bedrock.	607.07	27.98
Colluvial unit, PIP (Ct-f-PIP, C-PIP)	Talus deposit from iron-rich rocks and iron-rich weathering products; commonly derived from banded iron-formation and ferruginous duricrust. Colluvium derived from different rock types; includes gravel, sand, silt and clay.	330.89	15.25
Residual or relict unit, PIP (Rr-f-PIP, Rr-k-PIP, Rr-zo-PIP)	Ferruginous duricrust, massive to rubbly; includes iron-cemented reworked products. Calcrete duricrust (residual or relict). Silcrete; opaline silica.	296.04	13.65
Total		**2,169.40**	**100%**

2.4 Soils

The Commonwealth Scientific and Industrial Research Organisation (2009) Atlas of Australian Soils described and mapped the soils of Australia following Bettany *et al.* (1967). The Study Area occurs across three soil units, Oc64, Fa13 and BE6 (Table 2.3; Figure 2.2). The dominant soil unit, covering approximately 50.56% of the Study Area, is Oc64 (Table 2.3; Figure 2.2). This soil unit comprises low stony hills and dissected pediments on granite with occasional basic dykes. The chief soils are hard alkaline red soils (Dr2.33) having shallow stony horizons. Associated are shallow stony (Uc5.11) soils on steep slopes, (Uc1.22) soils along creek lines, and (Um5.11) soils on patches of calcrete (kunkar).

The second soil unit, Oc64, covers approximately 48.15% of the Study Area (Table 2.3) and comprises extensive flat and gently sloping plains that sometimes have a surface cover of gravels and on which red-brown hardpan frequently outcrops. Chief soils are shallow earthy loams (Um5.3) with associated (Gn) soils of units My5O and Mz23.

The remaining soil unit, Fa13, covers only 1.29% of the Study Area and comprises ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations, with some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. Fa13 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 soils on the limited areas of dissected pediments, while Um5.52 and Uf6.71 soils occur on the valley plains.

At the finer scale of land systems mapping, the Study Area consists primarily of red/brown non-cracking clays, self-mulching cracking clays of the Elimunna land system and the stony soils, red shallow loams and calcareous shallow loams of the Rocklea land system (van Vreeswyk *et al.*, 2004). To a lesser extent the Study Area consists of red-brown hardpan shallow loams, red loamy earths and some red sandy earths of the Spearhole land system, stony soils, red-brown hardpan shallow loams and red shallow sands of the Prairie land system, stony soils, red deep loamy duplex soils and red shallow loams of the McKay land system, stony soils, red shallow loams and some red shallow sands of the Newman land system, and deep red/brown non-cracking clays, red loamy earths, river bed soils, and red deep and shallow sands of the River land system (van Vreeswyk *et al.*, 2004).

Table 2.3: Soil units within the Study Area

Soil Unit	Description	Extent in Study Area	
		Area (ha)	%
Oc64	Low stony hills and dissected pediments on granite with occasional basic dykes.	1,096.80	50.56
BE6	Extensive flat and gently sloping plains that sometimes have a surface cover of gravels and on which red-brown hardpan frequently outcrops.	1,044.54	48.15
Fa13	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.	28.07	1.29
Total		**2,169.40**	**100%**

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780000
790000
7410000
7400000
Newman
Marble Bar Rd
Great Northern Hwy

Legend

- Study Area
- State Road

Regolith Geology

- Alluvial/fluvial unit, PIP
- Colluvial unit, PIP
- Eolian unit, PIP
- Exposed unit, PIP
- Residual or relict unit, PIP

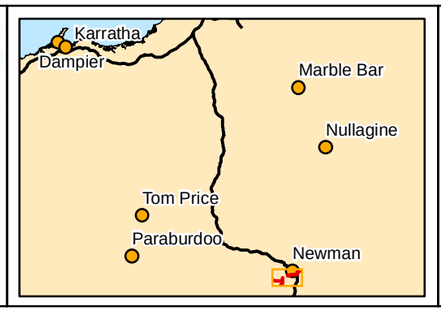
N

biologic Environmental Survey

Scale: 1:96,500

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



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Western Ridge Pipeline
Targeted Fauna Survey

Figure 2.1: Broad geology of the Study Area

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7400000
Newman
Marble Bar Rd
Great Northern Hwy

Legend

Study
State Road

Soil Unit

BE6
Fa13
Fa14
Oc64

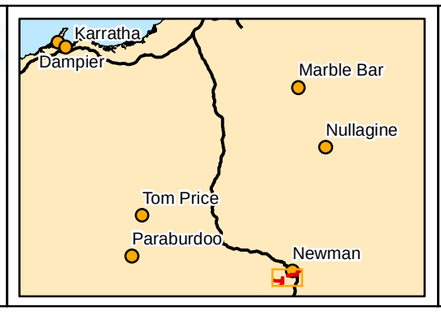
N

biologic Environmental Survey

Scale: 1:96,500

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



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Western Ridge Pipeline
Targeted Fauna Survey

Figure 2.2: Soils of the Study Area

2.5 Land Systems

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

The Study Area intercepts seven land systems (Figure 2.3; Table 2.4). The dominant land system is the Elimunna land system, covering approximately 38.46% of the Study Area (Figure 2.3; Table 2.4). The Elimunna land system is defined as "Stony plains on basalt supporting sparse acacia and cassia shrublands and patchy tussock grasslands" (van Vreeswyk *et al.*, 2004). The second most dominant land system is Rocklea, covering approximately 26.67% of the Study Area, followed by Spearhole, covering approximately 22.30% of the Study Area (Figure 2.3; Table 2.4). The four remaining land systems, Prairie, McKay, Newman and River, occupy 4.89%, 3.89%, 2.23% and 1.57% of the Study Area respectively (Figure 2.3; Table 2.4).

Of the six land systems occurring within the Study Area, the Newman land system contains the most significant habitats for many of the MNES species, as the rocky ridges and mountains associated with this land system can support important refugia and foraging habitats for Pilbara leaf-nosed bat, ghost bat, and northern quoll. The occurrence of this land system within the Study Area however, is only limited to a small 48.28 ha area located on the north-eastern edge of the Study Area (Figure 2.3).

Table 2.4: Land systems of the Study Area

Land System	Land Type	Description	Extent in Study Area	
			Area (ha)	%
Elimunna	Stony plains with Acacia shrublands	Stony plains on basalt supporting sparse acacia and cassia shrublands and patchy tussock grasslands.	834.29	38.46
Rocklea	Hills and ranges with spinifex grasslands	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	578.52	26.67
Spearhole	Wash plains on hardpan with mulga shrublands	Gently undulating gravelly hardpan plains and dissected slopes supporting groved mulga shrublands and hard spinifex.	483.78	22.30
Prairie	Stony plains and low hills with Acacia shrublands	Gently undulating stony plains and granite hills supporting acacia-eremophila-cassia shrublands and minor soft spinifex grasslands.	106.13	4.89
McKay	Hills and ranges with spinifex grasslands	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	84.36	3.89
Newman	Hills and ranges with spinifex grasslands	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	48.28	2.23
River	River plains with grassy woodlands and tussock grasslands	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	34.04	1.57
Total			**2,169.40**	**100%**

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7410000

7400000

McKay System
Elimunna System
Newman System
Marble Bar Rd
Rocklea System
Elimunna System
Newman System
McKay System
Newman
River System
Elimunna System
Egerton System
Elimunna System
Boolgeeda System
Newman System
Washplain System
Rocklea System
Nirran System
Spearhole System
Robe System
Newman System
Sylvania System
Prairie System
Egerton System
Spearhole System
River System
Egerton System
Great Northern Hwy
Prairie System
Divide System
Table System
Egerton System
Prairie System
Divide System
Spearhole System
Newman System
Jamindie System

Legend

- Study Area
- State Road

Land System

- Boolgeeda System
- Divide System
- Egerton System
- Elimunna System
- Jamindie System
- McKay System
- Newman System
- Nirran System
- Prairie System
- River System
- Robe System
- Rocklea System
- Spearhole System
- Sylvania System
- Table System
- Washplain System

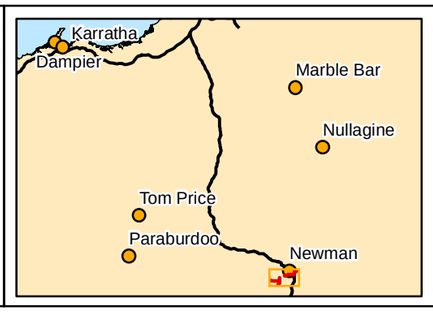
N

biologic Environmental Survey

Scale: 1:96,500

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



BHP WAIO

Western Ridge Pipeline Targeted Fauna Survey

Figure 2.3: Land systems of the Study Area

2.6 Hydrology and Surface Drainage

One major watercourse occurs within the Study Area, the Fortescue River, which flows in a north-easterly direction and intersects the Study Area at its most southern point (Figure 2.4). Several drainage lines and tributaries dissect the Study Area, including Western Creek and numerous other unnamed watercourses, before joining the Fortescue River south and east of the Study Area (Figure 2.4). Most of these watercourses and drainage lines are ephemeral and often only flow during and/or following large rainfall events.

2.7 Pre-European Vegetation

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

Three vegetation associations occur within the Study Area (Table 2.5; Figure 2.5). The dominant vegetation association is vegetation association 29, which comprises low Mulga woodland dominated by *Acacia aneura* and covers approximately 46.85% of the Study Area. It is followed by vegetation association 18, which comprises low Mulga woodland dominated by *Acacia aneura* and covers approximately 37.88% of the Study Area. The remaining vegetation association, covering approximately 15.27% of the Study Area, is vegetation association 82, which is defined as "*Eucalyptus leucophloia* over *Triodia wiseana* hummock grasslands/ low tree steppe".

Table 2.5: Vegetation associations within the Study Area

Vegetation Association	Description	Extent in Study Area	
		Area (ha)	%
18	Mulga (*Acacia aneura*) low woodland	1,016.38	46.85
29	Sparse low Mulga (*Acacia aneura*) woodland, discontinuous in scattered groups	821.78	37.88
82	*Eucalyptus leucophloia* over *Triodia wiseana* hummock grasslands/ low tree steppe	331.24	15.27
Total		**2,169.40**	**100%**

2.8 Land Use and Tenure

The Study Area is located upon two pastoral leases, with the eastern portions occurring on the Ethel Creek Station and the western most portion on Prairie Downs Station (Figure 1.1). Dominant land use within the Study Area is native pasture associated within the two pastoral leases, with no mining or exploration activities having been undertaken within the Study Area to date. Tenure within the Study Area comprises three tenements held by BHP WAIO, one live exploration license (E5203448), one live mineral lease (AML7000244), and one live mining lease (AM7000266) (Figure 1.1).

760000
770000
780000
790000
7410000
7400000

Homestead Creek
Marble Bar Rd
Newman
Fortescue River
Great Northern Hwy
Western Creek
Spearhole Creek
Western Creek
Fortescue River

Legend

Study Area
State Road

Surface Hydrology
Minor
Major

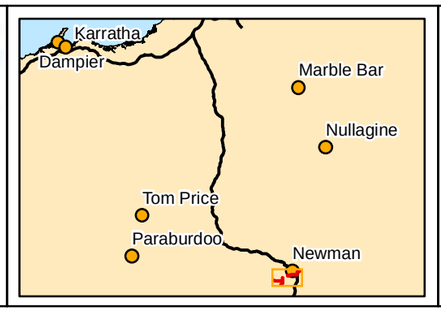
Fortescue River Upper Subcatchment
Ophthalmia Dam
Unnamed

N

biologic Environmental Survey

Scale: 1:96,500
0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



BHP WAIO
Western Ridge Pipeline
Targeted Fauna Survey

Figure 2.4: Hydrology of the Study Area

760000
770000
780000
790000
7410000
7400000
Newman
Marble Bar Rd
Great Northern Hwy

Legend

Study Area
State Road

Pre-European Vegetation

Hammersley 18
Hammersley 82
Kumarina Hills 18
Kumarina Hills 216
Kumarina Hills 29

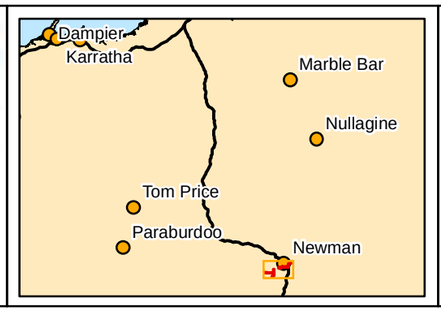
N

biologic Environmental Survey

Scale: 1:96,500

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 28/06/2022



BHP WAIO
Western Ridge Pipeline
Targeted Fauna Survey

Figure 2.5: Vegetation associations of the Study Area

2.9 Threatened and Priority Ecological Communities

One State listed Threatened Ecological Community (TEC) and no Priority Ecological Communities (PECs) occur within the Study Area (Figure 2.6). No Federal listed TECs occur in the Study Area. The State listed TEC occurring within the Study Area is the Ethel Gorge aquifer stygobiont community (EN); however, it has no conservation value related to terrestrial vertebrate fauna. One additional PEC occurs approximately 37 km north Study Area, the vegetation of the sand dunes of the Hamersley Range/Fortescue Valley (P3).

730000 760000 790000 820000 850000 880000

7440000 7410000 7380000

Great Northern Hwy

Marble Bar Rd

Newman

Legend

Study Area

State Road

DBCA TEC/PEC

Ethel Gorge - Endangered

Fortescue Valley Sand Dunes - Priority 3

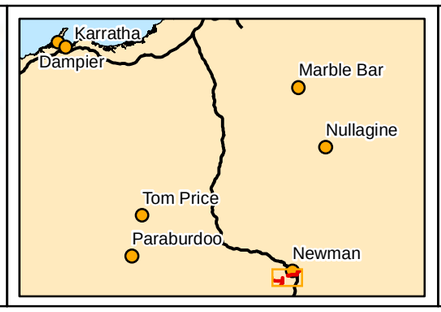
N

biologic Environmental Survey

Scale: 1:480,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



BHP WAIO

Western Ridge Pipeline
Targeted Fauna Survey

Figure 2.6: Threatened and priority ecological community database search results

3 DESKTOP ASSESSMENT

3.1 Methods

A desktop assessment, comprising database searches and a literature review, was undertaken for the Study Area prior to the field survey. The purpose of the desktop assessment was to identify vertebrate fauna potentially occurring in the Study Area, with a focus on significant species.

3.1.1 Database Searches

Five fauna databases were searched (Table 3.1), three to obtain information on all species previously recorded (NatureMap, Birdata and BHP WAIO Fauna Records Database), one to identify significant species previously recorded (DBCA Threatened Fauna Database), and one to identify significant species known or likely to occur within the region (Protected Matters Database).

Table 3.1: Details of database searches conducted

Database	Data Access/ Receival Date	Search Area
DBCA (2021) NatureMap	16/02/2021	Central point of the Study Area (-23.4027 S, 119.6144 E) with a 40 km buffer
DBCA (2020) Threatened and Priority Fauna Database	09/01/2020	
BirdLife Australia (2021) Birdata	16/02//2021	
DAWE (2021) Protected Matters Search Tool	16/02/2021	
BHP WAIO (2021) Fauna Records Database	06/02/2020	

3.1.2 Literature Review

A review of available literature relevant to the Study Area was undertaken to compile a list of vertebrate fauna species with the potential to occur within the Study Area. A total of 29 assessments were reviewed, comprising two targeted surveys, nine detailed surveys and 18 basic surveys (Table 3.2). Of the 29 assessments reviewed, five overlapped with the Study Area, three assessments were adjacent to the Study Area, six were within 1 km, 13 were within 1–10 km, and one assessment was 11 km from the Study Area.

Table 3.2: Literature sources used for the review

Report Title	Survey Type	Approximate Distance from Study Area (km)
Biologic (2009) Newman Power Network Level 2 Flora and Level 1 Fauna Survey	Basic	Overlapping northern tip of eastern portion of Study Area
Eco Logical (2012b) Orebody 37 Level 1 Vertebrate Fauna Assessment	Basic	Overlapping northern tip of eastern portion of Study Area
Onshore (2014) Western Ridge Biological Survey	Basic	Overlapping central portion of Study Area
Onshore (2018) Western Ridge E52/3448 Desktop Flora and Fauna Assessment	Basic	Overlapping northern tip of western portion of Study Area
Biologic (2020a) Coombanbunna Well Level 2 Vertebrate Fauna Survey	Detailed	Overlapping central portion of Study Area

Report Title	Survey Type	Approximate Distance from Study Area (km)
Biologic (2011) Orebody 35 and Western Ridge Vertebrate Fauna Survey	Detailed	Adjacent to north-western border of central portion of Study Area
Biologic (2016b) Western Ridge Southern Tenements Vertebrate Fauna Desktop Assessment.	Basic	Adjacent to the southern border of central portion of Study Area
Biologic (2020d) Western Ridge Targeted Vertebrate Fauna Survey	Targeted	Adjacent to western border of central portion of Study Area
ecologia (2008) RGP5 Fauna Survey Newman to Jimblebar Junction	Basic	200 m N of eastern portion of the Study Area
ENV (2011b) Mt Whaleback East Flora, Vegetation and Fauna Assessment	Basic	300 m N of central portion of Study Area
ENV (2011a) Eastern Ridge (OB23/24/25) Fauna Assessment	Basic	500 m N of eastern portion of Study Area
ENV (2010) Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment	Basic	600 m W of central portion of Study Area
ENV (2006) Mount Whaleback Fauna Assessment Survey Phase III	Detailed	800 m N of central portion of Study Area
Astron (2010) Mt Whaleback TSF Flora, Vegetation and Fauna Assessment	Basic	900 m N of central portion of Study Area
Eco Logical (2012a) Level 1 Flora and Fauna Surveys Along the Great Northern Highway for Jimblebar Mine Module Transport	Basic	1 km W of eastern portion of Study Area
HGM (1999) Orebody 30 and Orebody 35 Soil & Biological Survey	Basic	2 km N of central portion of Study Area
Eco Logical (2011) Newman Power Line Corridor Level 1 Flora and Fauna Survey	Basic	2 km N of central portion of Study Area
Biologic (2014) Orebody 25 Targeted Vertebrate Fauna Survey	Detailed	2.5 km NW eastern portion of the Study Area
ecologia (2005) Western Ridge Exploration Project Biological Survey	Detailed	3 km N of western portion of Study Area
ecologia (2006) Western Ridge Exploration Project Biological Survey	Basic	3 km N of western portion of Study Area
Onshore and Biologic (2009a) Mt Whaleback Mine Site Flora & Vegetation Survey and Fauna Assessment	Basic	3 km N of central portion of Study Area
Biologic (2013) Orebody 24 Targeted Vertebrate Fauna Survey	Targeted	3 km N of eastern portion of Study Area
ecologia (1998) Mt Whaleback Fauna Monitoring Programme: Baseline Sampling 1997-1998	Detailed	4 km N of central portion of Study Area
ecologia (2004) Orebody 24 Expansion Biological Survey	Detailed	5 km N of eastern portion of Study Area
GHD (2008) Myopic Project Area, Newman Flora and Fauna Assessment	Detailed	5.5 km NW of eastern portion of Study Area
ENV (2009b) Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	Basic	6 km N of central portion of Study Area
ENV (2009a) Newman to Jimblebar Transmission Line and Newman Town Substation Terrestrial Fauna Assessment	Basic	6.5 km NW of eastern portion of Study Area
Biota (2001) Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River	Detailed	9 km N of central portion of Study Area
Onshore and Biologic (2009b) Myopic Exploration Leases Biological Survey	Basic	11 km N of central portion of Study Area

3.2 Results

The literature review and database searches identified a total of 365 species of vertebrate fauna, which have previously been recorded and/or have the potential to occur within the Study Area. This comprised 48 mammals (including 38 native and 10 non-native), 200 birds, 110 reptiles and seven amphibians (Table 3.3; Appendix B). Due to the size of the desktop assessment search area, and likelihood of encompassing habitats which may not occur within the Study Area, results of the desktop review are likely to include species which may not occur within the Study Area. Additionally, many species tend to be patchily distributed even where appropriate habitats are present, and many species of birds can occur as regular migrants, occasional visitors or vagrants.

Of the 365 species of vertebrate fauna identified by the desktop assessment, 40 species are of significance, comprising eight mammals, 28 birds and four reptiles (Table 3.4). No significant species have previously been recorded within the Study Area; however, three species, ghost bat, peregrine falcon, and western pebble-mound mouse, have previously been recorded at Western Ridge, within 1 km of the Study Area (BHP WAIO, 2021). Of the 365 species identified, four mammals, eight birds, and two reptiles were included on the International Union for Conservation of Nature (IUCN) Redlist (Appendix B).

Table 3.3: Summary of fauna species recorded within and in the vicinity of the Study Area in the desktop assessment

Source	Reference	Mammals (Native)	Mammals (Introduced)	Birds	Reptiles	Amphibians	Total
Literature Sources							
Biologic (2009) Newman Power Network Level 2 Flora and Level 1 Fauna Survey	A	5	3	51	12	0	**71**
Eco Logical (2012b) Orebody 37 Level 1 Vertebrate Fauna Assessment	B	4	4	64	11	1	**84**
Onshore (2014) Western Ridge Biological Survey	C	0	0	37	8	0	**45**
Onshore (2018) Western Ridge E52/3448 Desktop Flora and Fauna Assessment	D	-	-	-	-	-	**-**
Biologic (2020a) Coombanbunna Well Level 2 Vertebrate Fauna Survey	E	20	5	73	45	2	**145**
Biologic (2011) Orebody 35 and Western Ridge Vertebrate Fauna Survey	F	19	6	82	54	2	**163**
Biologic (2016b) Western Ridge Southern Tenements Vertebrate Fauna Desktop Assessment.	G	-	-	-	-	-	**-**
Biologic (2020d) Western Ridge Targeted Vertebrate Fauna Survey	H	6	2	41	4	2	**55**
ecologia (2008) RGP5 Fauna Survey Newman to Jimblebar Junction	I	0	2	38	9	0	**49**
ENV (2011b) Mt Whaleback East Flora, Vegetation and Fauna Assessment	J	2	1	29	7	0	**39**
ENV (2011a) Eastern Ridge (OB23/24/25) Fauna Assessment	K	10	-	46	13	2	**71**
ENV (2010) Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment	L	4	1	25	5	0	**35**

Source	Reference	Mammals (Native)	Mammals (Introduced)	Birds	Reptiles	Amphibians	Total
ENV (2006) Mount Whaleback Fauna Assessment Survey Phase III	M	8	2	50	28	0	**88**
Astron (2010) Mt Whaleback TSF Flora, Vegetation and Fauna Assessment	N	1	1	1	0	0	**3**
Eco Logical (2012a) Level 1 Flora and Fauna Surveys Along the Great Northern Highway for Jimblebar Mine Module Transport	O	0	1	9	2	0	**12**
HGM (1999) Orebody 30 and Orebody 35 Soil & Biological Survey	P	19	3	113	90	4	**228**
Eco Logical (2011) Newman Power Line Corridor Level 1 Flora and Fauna Survey	Q	0	2	40	8	0	**50**
Biologic (2014) Orebody 25 Targeted Vertebrate Fauna Survey	R	11	2	28	6	0	**47**
ecologia (2005) Western Ridge Exploration Project Biological Survey	S	3	3	24	5	0	**35**
ecologia (2006) Western Ridge Exploration Project Biological Survey	T	8	2	51	15	0	**76**
Onshore and Biologic (2009a) Mt Whaleback Mine Site Flora & Vegetation Survey and Fauna Assessment	U	4	3	51	7	0	**65**
Biologic (2013) Orebody 24 Targeted Vertebrate Fauna Survey	V	18	0	44	18	1	**81**
ecologia (1998) Mt Whaleback Fauna Monitoring Programme: Baseline Sampling 1997-1998	W	9	2	97	45	3	**156**
ecologia (2004) Orebody 24 Expansion Biological Survey	X	1	2	62	21	0	**86**
GHD (2008) Myopic Project Area, Newman Flora and Fauna Assessment	Y	0	3	32	4	0	**39**
ENV (2009b) Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	Z	1	2	59	8	0	**70**
ENV (2009a) Newman to Jimblebar Transmission Line and Newman Town Substation Terrestrial Fauna Assessment	AA	4	2	57	13	1	**77**
Biota (2001) Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River	AB	12	3	104	54	3	**176**
Onshore and Biologic (2009b) Myopic Exploration Leases Biological Survey	AC	0	3	49	7	0	**59**
Database Searches							
DBCA (2021) NatureMap		32	6	173	87	7	**305**
DBCA (2020) Threatened and Priority Fauna Database		7	-	15	3	-	**25**
DAWE (2021)Protected Matters Search Tool		4	8	18	1	-	**31**
BirdLife Australia (2021) Birdata		-	-	178	-	-	**178**
BHP WAIO (2021) Fauna Records Database		34	-	146	45	1	**226**
IUCN (2021) Redlist		4	-	8	2	-	**14**
Total species recorded		**38**	**10**	**200**	**110**	**7**	**365**
Significant species		**8**	**-**	**28**	**4**	**0**	**40**

Table 3.4: Significant species identified and their conservation status

Scientific Name	Common name	Conservation Status			
		EPBC Act	BC Act	DBCA	IUCN
Mammals					
Dasyuridae					
Dasycercus blythi	brush-tailed mulgara			P4	
Dasyurus hallucatus	northern quoll	EN	EN		
Sminthopsis longicaudata	long-tailed dunnart			P4	
Hipposideridae					
Rhinonicteris aurantia (Pilbara form)	Pilbara leaf-nosed bat	VU	VU		
Macropodidae					
Petrogale lateralis subsp. *lateralis*	black-flanked rock-wallaby	EN	EN		NT
Megadermatidae					
Macroderma gigas	ghost bat	VU	VU		VU
Muridae					
Pseudomys chapmani	western pebble-mound mouse			P4	
Thylacomyidae					
Macrotis lagotis	greater bilby	VU	VU		VU
Birds					
Apodidae					
Apus pacificus	fork-tailed swift	MI	MI		
Charadriidae					
Charadrius leschenaultii	greater sand plover	VU/MI	VU/MI		
Charadrius dubius	little ringed plover	MI	MI		
Charadrius veredus	oriental plover	MI	MI		
Ciconiidae					
Ephippiorhynchus asiaticus	black-necked stork				NT
Falconidae					
Falco hypoleucos	grey falcon		VU		VU
Falco peregrinus	peregrine falcon		OS		
Hirundinidae					
Hirundo rustica	barn swallow	MI	MI		
Laridae					
Sterna caspia	caspian tern	MI	MI		
Gelochelidon nilotica	gull-billed tern	MI	MI		
Motacillidae					
Motacilla cinerea	grey wagtail	MI	MI		
Motacilla flava	yellow wagtail	MI	MI		
Psittacidae					
Pezoporus occidentalis	night parrot	EN	CR		EN
Polytelis alexandrae	princess parrot	VU		P4	NT
Rostratulidae					
Rostratula benghalensis subsp. *australis*	Australian painted snipe	EN	EN		EN
Scolopacidae					
Calidris acuminata	sharp-tailed sandpiper	MI	MI		
Calidris ferruginea	curlew sandpiper	CR/MI	CR/MI		NT
Calidris melanotos	pectoral sandpiper	MI	MI		

Scientific Name	Common name	Conservation Status			
		EPBC Act	BC Act	DBCA	IUCN
Calidris ruficollis	red-necked stint	MI	MI		NT
Calidris subminuta	long-toed stint	MI	MI		
Limosa limosa	black-tailed godwit	MI	MI		
Philomachus pugnax	ruff	MI	MI		
Tringa glareola	wood sandpiper	MI	MI		
Tringa hypoleucos	common sandpiper	MI	MI		
Tringa nebularia	common greenshank	MI	MI		
Tringa stagnatilis	marsh sandpiper	MI	MI		
Tringa totanus	common redshank	MI	MI		
Threskiornithidae					
Plegadis falcinellus	glossy ibis	MI	MI		
Reptiles					
Boidae					
Liasis olivaceus subsp. *barroni*	Pilbara olive python	VU	VU		
Scincidae					
Ctenotus uber subsp. *johnstonei*	spotted ctenotus			P2	
Lerista macropisthopus subsp. *remota*				P2	
Typhlopidae					
Anilios ganei	Pilbara flat-headed blind-snake			P1	

Note: NT – Near Threatened

730000 760000 790000

7440000 7410000

Bird

- Curlew sandpiper - CR/MI
- Peregrine falcon - OS
- Caspian tern - MI
- Common greenshank - MI
- Common redshank - MI
- Common sandpiper - MI
- Glossy ibis - MI
- Gull-billed tern - MI
- Long-toed stint - MI
- Marsh sandpiper - MI
- Oriental plover - MI
- Pectoral sandpiper - MI
- Red-necked stint - MI
- Sharp-tailed sandpiper - MI
- Wood sandpiper - MI

Mammal

- Black-flanked rock-wallaby - EN
- Northern quoll - EN
- Ghost bat - VU
- Greater bilby - VU
- Pilbara leaf-nosed bat - VU
- Brush-tailed mulgara - P4
- Long-tailed dunnart - P4
- Western pebble-mound mouse - P4

Reptile

- Pilbara olive python - VU
- Pilbara flat-headed blind-snake - P1

Great Northern Hwy

Marble Bar Rd

Newman

Legend

- Study Area
- State Road

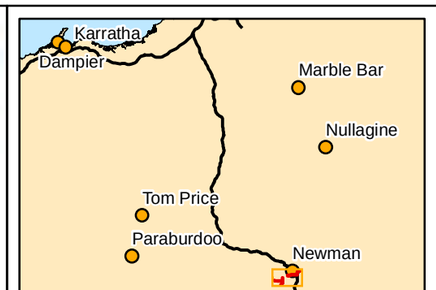
N

biologic Environmental Survey

Scale: 1:250,000

0 4 8 12 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 30/05/2022



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Western Ridge Pipeline Targeted Fauna Survey

Figure 3.1: Vertebrate fauna of significance identified in the desktop assessment

4 FIELD SURVEY METHODS

4.1 Survey Timing and Personnel

The field survey was conducted over two field trips, the first (trip 1) over eight consecutive days from 24th to 31st March 2021 and the second (trip 2) over eight days from 9th to 19th March 2022. Due to access limitations during trip 1, sampling was only undertaken within the portion of the Study Area not occurring within Prairie Downs Station. Sampling during trip 2 was focused solely on the portion of the Study Area occurring within Prairie Downs Station and was completed over eight days, comprising six days of sampling and equipment deployment (9th to 14th March 2022) followed by two days of equipment retrieval (18th to 19th March 2022) approximately four days later. The field surveys were undertaken by Principal Zoologist Ryan Ellis, Senior Zoologist Andrew Hide and Zoologists Amy Hutchison and Georgina Mattner, who collectively have over 25 years of experience undertaking fauna surveys within the Pilbara region, including targeted surveys for the MNES that were the focus of this assessment (Table 4.1).

Table 4.1: Survey personnel and experience

Personnel	Position and Role	Qualification	Experience
Ryan Ellis	Principal Zoologist • project management • field survey (trip 1) • reporting	BESc Wildlife and Conservation Biology Dip (Conservation and Land Management)	11 years' Environmental Impact Assessment (EIA) (consulting) 15 years' field survey 15 years' vertebrate zoology/ ecology
Andrew Hide	Senior Zoologist • field survey (trip 2)	BSc (Hons) Natural Resource Management	16 years' EIA (consulting) 16 years' field survey 16 years' vertebrate zoology/ ecology
Amy Hutchison	Zoologist • field survey (trip 1) • reporting	BSc Zoology and Marine Science	3 years' EIA (consulting) 6 years' field survey 6 years' vertebrate zoology/ ecology
Georgina Mattner	Zoologist • field survey (trip 2)	BSc Animal Ecology	1 years' EIA (consulting) 5 years' field survey 1 years' vertebrate zoology/ ecology

4.2 Climate and Weather

Observed weather conditions prior to and during trip 1 and trip 2 are shown in Figure 4.1, alongside long-term climatic data for Newman Airport (station #007176). In the 12 months prior to both trips, mean minimum and maximum temperatures recorded at Newman Airport were similar to the long-term averages for most months (Figure 4.1). Rainfall in the months preceding both trips was variable, with below long-term averages recorded through most of the dry season prior to both trips. Rainfall was below long-term averages for most of the wet season as well, except for February preceding trip 1 and the April preceding trip 2, which recorded well above the long-term average for the months (169 mm and 56.4 mm respectively) (Figure 4.1). In total, the rainfall received in the 12 months prior to the trip 1 survey (April 2020 to March 2021; 315.6 mm) was only slightly less than the annual long-term average (325.1 mm), while rainfall in the 12 months prior to trip 2 (March 2021 to February 2022; 191.60 mm) was well below the annual long-term average (BoM, 2022). Observed maximum temperatures during both trips (Table 4.2) were slightly above the long-term average on most days (BoM, 2022). No rainfall was recorded during either trip (Table 4.2); however, 0.2 mm was recorded in the intervening days of trip 2.

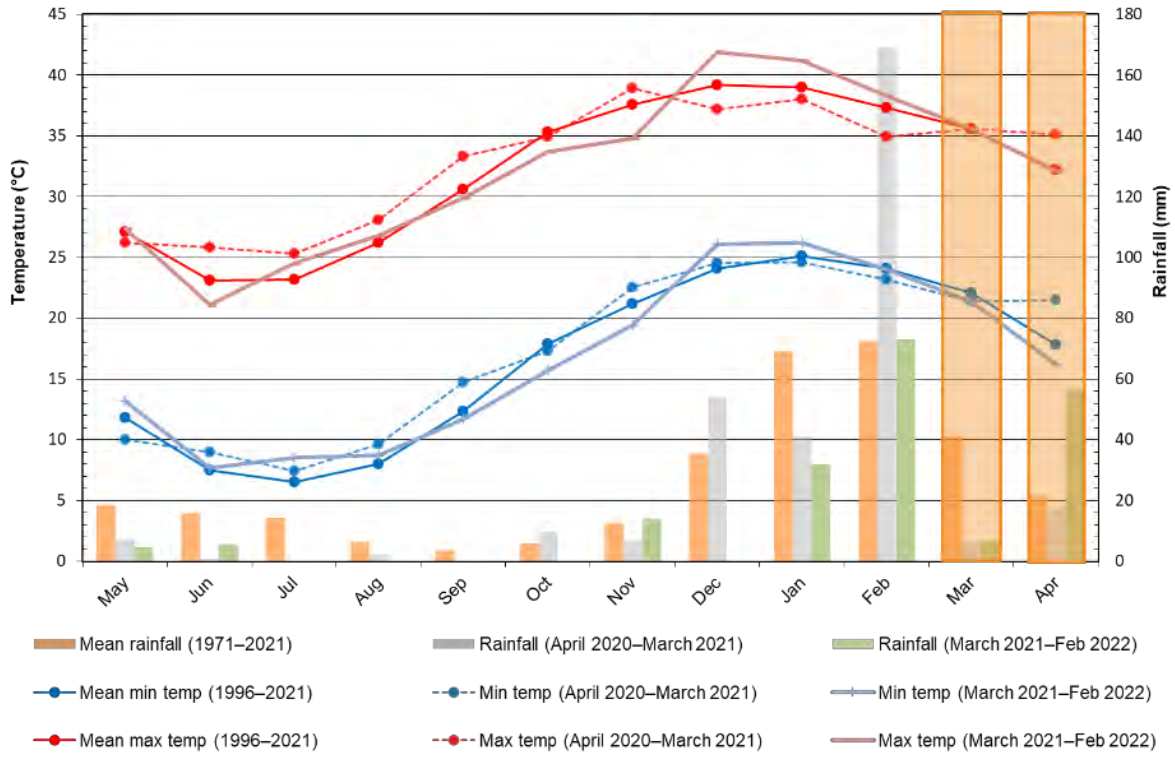


Figure 4.1: Long-term average and contemporary climate data recorded near the Study Area (BoM, 2022) with approximate survey timing shown in shaded box Table 4.2: Climatic conditions recorded for Newman Airport during the field assessment

Date	Min. Temp (°C)	Max. Temp (°C)	Rainfall (mm)
Trip 1			
24/04/2021	19.1	36.7	0
25/04/2021	20.8	37.2	0
26/04/2021	20.8	37.5	0
2704/2021	21.5	37.9	0
28/04/2021	24.2	38.6	0
29/04/2021	24.2	37.7	0
30/04/2021	23.8	37.2	0
31/04/2021	18.4	35.1	0
Average/ total	**21.6**	**37.24**	**0**
Trip 2			
09/03/2022	24.5	37.2	0
10/03/2022	24.9	38.5	0
11/03/2022	24.3	38.3	0
12/03/2022	26.7	35.9	0
13/02/2022	23.6	40.2	0
14/02/2022	29.0	40.0	0
18/02/2022	25.7	39.7	0
19/02/2022	24.7	41.0	0
Average/ total	**25.43**	**38.85**	**0**

4.3 Sampling and Survey Methods

4.3.1 Habitat Assessments and Mapping

Habitat assessments were undertaken in the field to characterise and define habitats and their significance to vertebrate fauna. Habitat assessments were undertaken at 92 locations across the Study Area, including at all sampling sites (Figure 4.2)

Habitat assessments were conducted using methodology and terminology modified from the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information: 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 habitat mapping was completed for the Study Area using the vertebrate fauna habitat assessments completed during the field surveys, as well as high-resolution aerial imagery, vegetation, topographical, geology and soil mapping. Habitats were delineated and mapped across the Study Area at a scale of approximately 1:20,000.

4.3.2 Habitat Features – Water Feature Assessment

Water feature assessments were conducted at three water features within Study Area during the survey. The assessments were aimed to define and characterise the features and identify the likelihood of significant species utilising them, primarily ghost bat, Pilbara leaf-nosed bat and Pilbara olive python. The characteristics recorded during water feature assessments were:

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

4.3.3 Targeted Searches

Targeted searches were undertaken within areas of suitable habitat looking for signs of target species, with a focus on significant species identified in the desktop assessment as potentially occurring within the Study Area. Targeted searches primarily focused on recording species from direct observation, secondary evidence (i.e. tracks, scats, pebble-mounds) or habitat features of significance (i.e. caves and water features) which may provide potential roost sites for bat species. Due to a lack of suitable habitat occurring within the Study Area, a single targeted search was conducted, targeting northern quoll, ghost bat and Pilbara leaf-nosed bat (Table 4.3; Figure 4.2).

4.3.4 Nocturnal Surveys

Spotlighting was undertaken to detect the presence of any nocturnal fauna species within the Study Area. Nocturnal surveys were undertaken between sunset (approximately 1830) and 2130, when activity levels were highest for most nocturnal species. Each survey consisted of searches using head torches and, where possible, road spotting to detect fauna from movement, eye shine and other evidence of species' presence. A total of two person hours of spotlighting was completed across two sites over two evenings (Table 4.3; Figure 4.2). Opportunistic road spotlighting and searches were also undertaken whilst driving between sites and traversing the Study Area.

4.3.5 Ultrasonic Bat Recording

SongMeter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders were deployed at 13 locations within the Study Area during the survey (Table 4.3; Figure 4.2). At each location, recorders were placed in or in the vicinity of areas of prospective foraging and/or roosting habitats and features most likely to be utilised by bats, such as natural waterbodies, stands of trees or drainage lines. Recorders were deployed for three consecutive nights at each location for a total of 39 recording nights. The jumper and audio settings used for all the SM units followed the manufacturer's recommendations contained in the user manual (Wildlife Acoustics, 2011, 2017). Selectable filters and triggers were also set using the manufacturer's recommendations. Bat calls were analysed by Robert Bullen of Bat Call WA.

4.3.6 Targeted Sampling – Northern Quoll Camera Traps

Motion camera transects established within 'critical', habitats such as ranges, escarpments, mesas, gorges, breakaways, major drainage lines or treed creek lines are the "recommended detection technique" for northern quoll as indicated by the DoE (2016). Methods recommended by DoE (2016) include transects comprising ten camera traps placed approximately 100 metres apart. Sampling for northern quoll was undertaken by establishing one motion camera transect within the Study Area where habitat features (outcropping and minor breakaway) were most likely to provide suitable habitat (i.e. denning potential) for the species. Where possible, methods recommended by DoE (2016) where followed; however, due to the limited extent of suitable habitat present within the Study Area, eight cameras were deployed for the single transect sampled during the survey. Cameras remained left *in-situ* for five consecutive nights for a total of 40 sampling nights (Table 4.3; Figure 4.2). Cameras were positioned to allow detailed inspection of an individual's patterning to assist with future population estimates (as verified by Hohnen *et al.*, 2012) where possible, and baited with universal bait (a mixture of oats, peanut butter and sardines) within a non-reward receptacle (perforated and capped PVC pipe).

4.3.7 Targeted Sampling – Greater Bilby Plot Searches

Greater bilby sampling within the Study Area comprised two-hectare (ha) survey plots (bilby plots) within areas of prospective habitat across the Study Area, in accordance with DBCA survey guidelines for the species. Each bilby plot was subjected to targeted searches for a minimum of 30 minutes and comprised searches for secondary evidence for the species (i.e. burrows, diggings, tracks and scats), as described by Southgate *et al.* (2019). A total of six bilby plots were sampled for greater bilby within the Study Area during the survey. Each plot was searched for 0.5 person hours, equating to a total of three person hours of targeted sampling (Table 4.3; Figure 4.2).

4.3.8 Targeted Sampling – Night Parrot Acoustic Recorders

SongMeter (SM; Wildlife Acoustics Inc.) acoustic recorders targeting night parrot were deployed at 15 locations during the field survey where suitable habitat was present (Table 4.3; Figure 4.2). The SM4 acoustic recorders were deployed in potential habitat recommended within the *Interim Guideline for Preliminary Surveys of Night Parrot (Pezoporus occidentalis) in Western Australia* (DPaW, 2017) – "stands of large, old clumps of spinifex (*Triodia*)... especially so if the identified area is part of a paleo-drainage system or contains healthy stands of samphire." SongMeters were deployed for six consecutive nights at each site, for a total of 90 recording nights. Acoustic recordings were analysed for night parrot calls by Nigel Jackett (Appendix E). A list of non-target species recorded at each acoustic recorder site was also compiled and incorporated into the results for each site.

4.3.9 Targeted Sampling – Pilbara Olive Python eDNA Sampling

Environmental DNA (eDNA) is a by-product of the metabolic process, derived from sources such as deceased individuals, faeces, urine, scales mucous secretions and are recoverable from environmental substrates (i.e. water or substrate) (Huerlimann *et al.*, 2020). The extraction of eDNA has emerged as a novel sampling technique in the realm of environmental surveying, monitoring and conservation with potentially greater sensitivity in detecting rare and cryptic species (Bylemans *et al.*, 2019; Harper *et al.*, 2018; Huerlimann *et al.*, 2020). Environmental DNA sampling was undertaken at one water feature within the Study Area during the survey (Table 4.3, Figure 4.2).

Five 1 litre (L) sampling bottles were filled with water from five different locations within the water feature sampled and were then filtered to collect eDNA material present within the sample by passing water samples though a 0.45-micron (µm) filter membrane using a peristaltic Sentino pump. All filtering equipment was sterilised in a 10% bleach solution and rinsed between samples. Once the water had been filtered, the filter membrane was folded, placed into a sample bag and stored at approximately -20^{o}C until it could be delivered to eDNA Frontiers for polymerase chain reaction and metabarcoding analysis (see Appendix F for a detailed description of analysis techniques).

4.3.10 Opportunistic Records

At all times while surveying, all records pertaining to species not previously recorded during the survey, rare species, significant species or other fauna of interest were documented. These records include those from primary (i.e. direct observation of species) or secondary (e.g. burrows, scratching's, diggings, tracks and/or scats) evidence. Efforts were made to target likely microhabitats by turning rocks, logs and anthropogenic debris where present.

Table 4.3: Survey effort by sampling site

Site ID	Latitude	Longitude	Habitat Type	Habitat Assessment	Nocturnal Searches (person hrs)	Ultrasonic Recorder (nights)	Acoustic Recorder (nights)	Camera Traps (nights)	eDNA Sampling (water features)	Targeted Searches
Trip 1										
VWRP-01	-23.4390	119.6058	Stony Plain	•			6			
VWRP-02	-23.3531	119.8126	Stony Plain	•			6			
VWRP-03	-23.4506	119.6072	Stony Plain	•		3				
VWRP-04	-23.3775	119.7921	Major Drainage Line	•	1	3	6			
VWRP-05	-23.4680	119.6066	Stony Plain	•			6			
VWRP-06	-23.3458	119.8336	Major Drainage Line	•	1	3				
VWRP-07	-23.4701	119.6061	Medium Drainage Line	•		3			1	
VWRP-08	-23.3664	119.7950	Medium Drainage Line	•		3				
VWRP-09	-23.4994	119.6079	Mulga Woodland	•		3				
VWRP-10	-23.3995	119.7605	Stony Plain	•		3				
VWRP-11	-23.5131	119.5904	Stony Plain	•			6			
VWRP-13	-23.4129	119.6760	Stony Plain	•			6			
VWRP-14	-23.4139	119.6753	Stony Plain	•						greater bilby
VWRP-16	-23.3994	119.7220	Stony Plain	•			6			greater bilby
VWRP-20	-23.4010	119.7219	Stony Plain	•						greater bilby
VWRP-21	-23.3964	119.7151	Stony Plain	•						
VWRP-22	-23.3997	119.7381	Stony Plain	•			6			
VWRP-23	-23.4009	119.7428	Stony Plain	•						
VWRP-24	-23.4474	119.6055	Hillcrest/ Hillslope	•				40		northern quoll, ghost bat, Pilbara leaf-nosed bat
VWRP-25	-23.4474	119.6055	Stony Plain	•						
VWRP-26	-23.4336	119.6078	Stony Plain	•						
VWRP-27	-23.4365	119.6048	Stony Plain	•						
VWRP-28	-23.4381	119.6074	Stony Plain	•						

Site ID	Latitude	Longitude	Habitat Type	Habitat Assessment	Nocturnal Searches (person hrs)	Ultrasonic Recorder (nights)	Acoustic Recorder (nights)	Camera Traps (nights)	eDNA Sampling (water features)	Targeted Searches
VWRP-29	-23.4425	119.6049	Stony Plain	●						
VWRP-30	-23.4496	119.6050	Drainage Area/ Floodplain	●						
VWRP-31	-23.4576	119.6071	Stony Plain	●						
VWRP-32	-23.4728	119.6054	Mulga Woodland	●						
VWRP-33	-23.4799	119.6058	Mulga Woodland	●						
VWRP-34	-23.5054	119.5982	Mulga Woodland	●						
VWRP-36	-23.4890	119.6053	Stony Plain	●						
VWRP-37	-23.3989	119.7159	Cleared/ Disturbed	●						
VWRP-38	-23.3984	119.7788	Drainage Area/ Floodplain	●						
VWRP-39	-23.3982	119.7870	Mulga Woodland	●		3				
VWRP-41	-23.4065	119.6788	Mulga Woodland	●						
VWRP-44	-23.4058	119.6705	Stony Plain	●						
VWRP-47	-23.4155	119.6670	Drainage Area/ Floodplain	●						
VWRP-50	-23.3978	119.7124	Drainage Area/ Floodplain	●						
VWRP-51	-23.4087	119.6930	Stony Plain	●						
VWRP-52	-23.4151	119.6832	Stony Plain	●						
VWRP-54	-23.4126	119.6793	Stony Plain	●						
VWRP-55	-23.4160	119.6912	Drainage Area/ Floodplain	●						
VWRP-56	-23.4120	119.6944	Mulga Woodland	●						
VWRP-57	-23.4102	119.6936	Mulga Woodland	●						
VWRP-58	-23.4121	119.6895	Stony Plain	●						
VWRP-59	-23.4102	119.6714	Stony Plain	●						
VWRP-60	-23.4099	119.6731	Stony Plain	●						
VWRP-61	-23.4096	119.6736	Stony Plain	●						
VWRP-62	-23.4101	119.6678	Stony Plain	●						
VWRP-63	-23.4132	119.6716	Stony Plain	●						

Site ID	Latitude	Longitude	Habitat Type	Habitat Assessment	Nocturnal Searches (person hrs)	Ultrasonic Recorder (nights)	Acoustic Recorder (nights)	Camera Traps (nights)	eDNA Sampling (water features)	Targeted Searches
VWRP-64	-23.4115	119.6848	Mulga Woodland	●						
VWRP-66	-23.4084	119.6851	Stony Plain	●						
VWRP-67	-23.4066	119.6871	Stony Plain	●						
VWRP-68	-23.3999	119.7510	Stony Plain	●						
VWRP-69	-23.3993	119.7559	Stony Plain	●						
VWRP-70	-23.3980	119.7687	Cleared/ Disturbed	●						
VWRP-71	-23.3951	119.7814	Stony Plain	●						
VWRP-72	-23.3978	119.7904	Drainage Area/ Floodplain	●						
VWRP-73	-23.3934	119.7928	Drainage Area/ Floodplain	●						
VWRP-74	-23.3885	119.7924	Stony Plain	●						
VWRP-75	-23.3818	119.7933	Drainage Area/ Floodplain	●						
VWRP-76	-23.3746	119.7949	Drainage Area/ Floodplain	●						
VWRP-77	-23.3721	119.7921	Drainage Area/ Floodplain	●						
VWRP-78	-23.3550	119.8108	Stony Plain	●						
VWRP-79	-23.3514	119.8198	Stony Plain	●						
VWRP-80	-23.3483	119.8259	Stony Plain	●						
VWRP-86	-23.3559	119.7990	Stony Plain	●						
VWRP-87	-23.4002	119.7295	Stony Plain	●						
VWRP-88	-23.3991	119.7355	Stony Plain	●						
VWRP-89	-23.3523	119.8096	Stony Plain	●						
VWRC-01	-23.5179	119.5879	Major Drainage Line	●		3				
VWRC-02	-23.5184	119.5877	Stony Plain	●			6			
Total (trip 1)				**71**	**2**	**27**	**54**	**40**	**1**	**3x greater bilby** **1x northern quoll, ghost bat, Pilbara leaf-nosed bat**

Site ID	Latitude	Longitude	Habitat Type	Habitat Assessment	Nocturnal Searches (person hrs)	Ultrasonic Recorder (nights)	Acoustic Recorder (nights)	Camera Traps (nights)	eDNA Sampling (water features)	Targeted Searches
Trip 2										
VPDP-01	-23.4716	119.5339	Sand Plain	●			6			
VPDP-02	-23.4714	119.4981	Major Drainage Line	●		3				
VPDP-03	-23.4710	119.6001	Stony Plain	●						
VPDP-04	-23.4697	119.5973	Medium Drainage Line	●		3				
VPDP-05	-23.4706	119.5945	Stony Plain	●			6			
VPDP-06	-23.4699	119.5888	Stony Plain	●						
VPDP-07	-23.4699	119.5820	Stony Plain	●			6			
VPDP-08	-23.4715	119.5017	Stony Plain	●						
VPDP-09	-23.4713	119.5052	Stony Plain	●						
VPDP-10	-23.4711	119.5078	Stony Plain	●			6			
VPDP-11	-23.4726	119.5231	Stony Plain	●			6			
VPDP-12	-23.4723	119.5432	Stony Plain	●			6			
VPDP-13	-23.4723	119.5562	Medium Drainage Line	●		3				
VPDP-14	-23.4733	119.5402	Medium Drainage Line	●		3				
VPDP-15	-23.4730	119.5555	Stony Plain	●						greater bilby
VPDP-16	-23.4743	119.5281	Stony Plain	●						
VPDP-17	-23.4734	119.5303	Stony Plain	●						greater bilby
VPDP-18	-23.4716	119.5290	Stony Plain	●						
VPDP-19	-23.4748	119.5577	Drainage Area/ Floodplain	●						greater bilby
VPDP-20	-23.4744	119.5583	Medium Drainage Line	●						
VPDP-21	-23.4743	119.5592	Stony Plain	●						
Total (trip 2)				**21**	**0**	**12**	**36**	**0**	**0**	**3x greater bilby**
Total				**92**	**2**	**39**	**90**	**40**	**1**	**6x greater bilby** **1x northern quoll, ghost bat, Pilbara leaf-nosed bat**

760000
770000
780000
790000
7410000
7400000
NEWMAN
Marble Bar Rd
Great Northern Hwy

Legend

- Study Area
- Local Road
- State Road

Sampling Sites

- Bilby Plot
- Camera Transect
- eDNA
- Habitat Assessment
- Nocturnal Survey
- SongMeter (acoustic)
- SongMeter (ultrasonic)
- Targeted Search

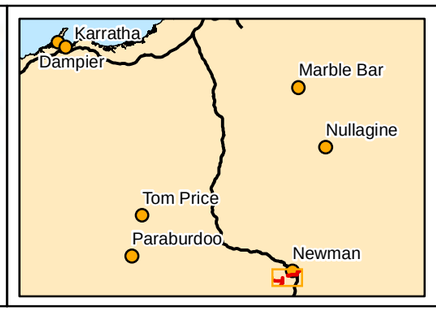
N

biologic Environmental Survey

Scale: 1:96,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 31/05/2022



BHP WAIO

Western Ridge Pipeline
Targeted Fauna Survey

Figure 4.2: Fauna sample sites and traverses

4.4 Likelihood of Vertebrate Fauna Occurrence

Significant species identified by the desktop assessment were assessed for their likelihood of occurring within the Study Area using on a decision matrix which considers the suitability of habitat within the Study Area and the proximity of previous records (Table 4.4). Based on this decision matrix, each species was assigned to one of six categories of likelihood: Confirmed, Highly Likely, Likely, Possible, Unlikely, or Highly Unlikely.

The decision matrix is intended to be an indicative guide only, and the way in which it is interpreted may vary between species, depending on a given species' habitat preferences and ability to disperse, as well as the reliability and availability of contextual information. For example, considering species which have been previously recorded close to the Study Area, a species with a limited dispersal capability will have a reduced likelihood of occurring in the Study Area compared with a species with greater dispersal capability. It is also recognised that a lack of records in the vicinity of the Study Area may indicate limited sampling effort rather than species' absence, and that previous records may include historic or presumed erroneous information which may misrepresent a species' current distribution. Where the determination of a species' likelihood of occurrence within the Study Area deviates from the decision matrix, detailed justification for any variation will be presented.

Table 4.4: Species likelihood of occurrence decision matrix

		Habitat Suitability of Study Area			
		Breeding Habitat Present	**Foraging and Dispersal Habitat Present**	**Marginally Suitable Habitat[2] Present**	**No Suitable Habitat Present**
Species Records[1]	**Recorded in Study Area**	Confirmed	Confirmed	Confirmed	Confirmed
	Recorded within 10 km of Study Area	Highly Likely	Likely	Possible	Possible
	Recorded within 10–50km of Study Area	Likely	Possible	Possible	Unlikely
	Recorded within 50–100 km of Study Area	Possible	Possible	Unlikely	Unlikely
	Recorded >100 km of Study Area	Possible	Unlikely	Unlikely	Highly Unlikely
	Species considered locally/regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

[1] Only records within the previous 50 years are considered.

[2] Marginally suitable habitat is habitat which is possibly used by a species but is unlikely to be depended upon; for example, it may be used only when in proximity to core breeding, foraging or dispersal habitat.

4.5 Assessment of Significance

4.5.1 Fauna Habitats

For the purposes of this assessment, definition on 'critical habitat' followed that of DoE (2013), being areas necessary "for activities such as foraging, breeding, roosting, or dispersal". For each species, suitable habitat was categorised as providing critical foraging, breeding, roosting, or dispersal habitat (as per the definition above), or non-critical foraging, breeding, roosting or dispersal, for habitat types where the species may occur, but it is not necessary for such activities. Due to differing habitat preferences of significant species (including habitat features and/or microhabitats), habitat significance was assessed on a species by species basis. Unsuitable habitat was defined by habitat which is unlikely to support the species and impact upon its presence – note individuals may be recorded in these habitats intermittently, though are not expected to be reliant on them.

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

4.5.2 Significance of Species Occurrence

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

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

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

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

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

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

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

5 FIELD SURVEY RESULTS AND DISCUSSION

5.1 Fauna Habitats of the Study Area

A total of six broad fauna habitat types were recorded and mapped across the Study Area, comprising Stony Plain, Drainage Area/ Floodplain, Mulga Woodland, Hillcrest/ Hillslope, Major Drainage Line and Medium Drainage Line (Table 5.1; Figure 5.1). Stony Plain, Mulga Woodland and Drainage Area/ Floodplain were the dominant broad fauna habitats within the Study Area, covering 70.09% (1,520.57 ha), 14.45% (313.33 ha) and 11.64% (252.5 ha), respectively (Table 5.1; Figure 5.1). Of the remaining broad fauna habitats, Major Drainage Line and Medium Drainage Line habitat cover 1.20% (26.12 ha) and 0.92% (19.99 ha) respectively, while Hillcrest/ Hillslope covers only 0.35% (7.63 ha) (Table 5.1; Figure 5.1). The remaining 1.35% (29.26 ha) of the Study Area was mapped as Cleared/ Disturbed. Descriptions of the distinguishing characteristics and the occurrence within the Study Area for each of these habitat types are presented in Table 5.1, and the data from on-site habitat assessments are presented in Appendix C.

No habitats occurring within the Study Area provide critical habitat for significant species and are unlikely to be relied upon by any species for long-term survival within the Study Area, or more broadly in the vicinity. All six habitats mapped are broadly distributed and well represented across the Pilbara bioregion and surrounding regions, and therefore support fauna assemblages which are generally common and widespread. The condition of habitats within the Study Area ranged from Excellent to Completely Degraded. The greatest disturbances were caused by road/access tracks throughout parts of the Study Area and grazing by cattle (*Bos taurus*) which was largely associated with Drainage Area/ Floodplain habitat.

Stony Plain provides suitable habitat for western pebble-mound mouse, spotted ctenotus and foraging habitat for peregrine falcon. In areas where there are suitable perching trees, it also provides foraging habitat for ghost bat. Foraging habitat for ghost bat and Pilbara leaf-nosed bat is also provided by Mulga Woodland, which is often associated with Drainage Area/ Floodplain. Drainage Area/ Floodplain also provides suitable habitat for brush-tailed mulgara and spotted ctenotus, in addition to foraging habitat for ghost bat, Pilbara leaf-nosed bat and peregrine falcon. Major Drainage Line and Medium Drainage Line habitats provide suitable habitat for Pilbara olive python and additionally foraging and/or dispersal habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat, grey falcon and peregrine falcon. Hillcrest/ Hillslope provides suitable habitat for western pebble-mound mouse, long-tailed dunnart, spotted ctenotus and Pilbara flat-headed blind-snake. It also provides foraging and dispersal habitat for northern quoll, ghost bat and Pilbara leaf-nosed bat, and foraging habitat for peregrine falcon.

Table 5.1: Broad fauna habitats occurring within the Study Area

Habitat	Distinguishing Habitat Characteristics	Extent of Habitat	Significant species	Photo
Stony Plain **1,520.57 ha** **70.09%**	Stony Plain habitat comprises flat to low undulating areas and low hills with vegetation dominated by *Triodia* hummock grasses of various life stages with scattered eucalypts and patches of various small to medium shrub species on gravelly clay loam substrates. In some low-lying areas, isolated patches of sandy substrate occur.	Stony Plain habitat occurs throughout a large portion of the Study 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.	Suitable for: • Ghost bat (non-critical foraging and dispersal) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Peregrine falcon (non-critical foraging) • Western pebble-mound mouse (critical breeding, foraging and dispersal) • Spotted ctenotus (non-critical breeding, foraging and dispersal)	
Mulga Woodland **313.33 ha** **14.45%**	Mulga woodland of varying density, often associated with minor Drainage Area/ Floodplain landforms or minor drainage systems subject to sheet flow following rainfall. Vegetation dominated by open mulga with sparse to no understory of mixed small shrubs and tussock grasses. In the south of the western portion of the Study Area, Mulga Woodland was characterised by bands of vegetation interspersed with bare substrate.	This habitat type covers a significant portion of the Study Area, including the lower half of the western portion and throughout the central portion of the Study Area. It often occurs within broader areas of Stony Plain and/or Drainage Area/ Floodplain habitats. Mulga Woodland is relatively common throughout the Pilbara bioregion, though often sparsely distributed and occurring in small isolated patches.	Suitable for: • Ghost bat (non-critical foraging) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Spotted ctenotus (critical breeding, foraging and dispersal)	

Habitat	Distinguishing Habitat Characteristics	Extent of Habitat	Significant species	Photo
Drainage Area/ Floodplain **252.50 ha** **11.64%**	Lower lying plain often subjected to sheet flow following large rainfall events. Vegetation and substrates of this habitat was variable, often comprising scattered *Eucalyptus* over *Acacia* and/or *Grevillea* shrubs with an understory dominated by *Triodia* hummock grasses and/or mixed tussock grasses on alluvial substrates, often comprising heavy clays and gravel. Tussock grasses were dominant within Drainage Area/ Floodplain habitat as a result of high rainfall in the months preceding the survey.	Drainage Area/ Floodplain habitat occurs across large areas within the Study Area, particularly in the eastern lower lying areas of the Study Area. 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).	Suitable for: • Ghost bat (non-critical foraging and dispersal) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Peregrine falcon (non-critical foraging) • Brush-tailed mulgara (critical breeding, foraging and dispersal) • Spotted ctenotus (critical breeding, foraging and dispersal)	
Major Drainage Line **26.12 ha** **1.20%**	This habitat supported an upper story of relatively tall *Eucalyptus.* Major Drainage Line is prone to flooding and is more likely to retain water when inundated. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing.	Major Drainage Line habitat occurs in three sections within the Study Area, where watercourses intersect the Study 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.	Suitable for: • Northern quoll (non-critical foraging and dispersal) • Ghost bat (non-critical foraging and dispersal) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Grey falcon (non-critical foraging) • Peregrine falcon (non-critical foraging) • Pilbara olive python (critical breeding, foraging and dispersal)	

Habitat	Distinguishing Habitat Characteristics	Extent of Habitat	Significant species	Photo
Medium Drainage Line **19.99 ha** **0.92%**	Vegetation and substrates of this habitat were variable, comprising 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.	Medium Drainage Line habitat occurs in two areas where watercourses dissect the Study 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.	Suitable for: • Northern quoll (non-critical foraging and dispersal) • Ghost bat (non-critical foraging and dispersal) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Grey falcon (non-critical foraging) • Peregrine falcon (non-critical foraging) • Pilbara olive python (non-critical foraging and dispersal)	
Hillcrest/ Hillslope **7.63 ha** **0.35%**	Hillcrest/ Hillslope habitat comprises hills and undulating stony plains of higher elevation, supporting hard spinifex with a mantle of gravel and larger rocks with occasional outcropping or minor breakaway. Vegetation is dominated by hard *Triodia* hummock grassland with scattered *Eucalyptus* trees and *Acacia* and/or *Grevillea* shrubs.	Within the Study Area, Hillcrest/ Hillslope habitat is limited to two small areas of the western side of the Study Area, with both areas containing occasional outcropping and minor breakaway. Although only represented over a small portion of the Study Area, Hillcrest/ Hillslope habitat is a characteristic habitat type of the Pilbara region. Its occurrence throughout the region is widespread and common.	Suitable for: • Northern quoll (non-critical foraging and dispersal) • Pilbara leaf-nosed bat (non-critical foraging and dispersal) • Western pebble-mound mouse (critical breeding, foraging and dispersal) • Long-tailed dunnart (critical breeding, foraging and dispersal) • Pilbara flat-headed blind-snake (critical breeding, foraging and dispersal)	

Habitat	Distinguishing Habitat Characteristics	Extent of Habitat	Significant species	Photo
Cleared/ Disturbed **29.26 ha** **1.35%**	Major roads/highways and historic, large scale clearing.	Within the Study Area, clearing is restricted to major roads dissecting the eastern portion of the Study Area, as well as large areas of vegetation clearance also in the east portion of the Study Area. Although minor access tracks occur through other parts of the Study Area, these are not delineated due to their relatively minimal disruption to the broader habitats in which they occur.	• N/A	

760000
770000
780000
790000
7410000
7400000
NEWMAN
Marble Bar Rd
Great Northern Hwy

Legend

- Study Area
- Local Road
- State Road

Fauna Habitat

- Drainage Area/ Floodplain
- Hillcrest/ Hillslope
- Major Drainage Line
- Medium Drainage Line
- Mulga Woodland
- Stony Plain
- Cleared/ Disturbed
- Water Feature

Pilbara olive python

- eDNA

Western pebble-mound mouse

- Mound (active)
- Mound (inactive)
- Mound (recently inactive)

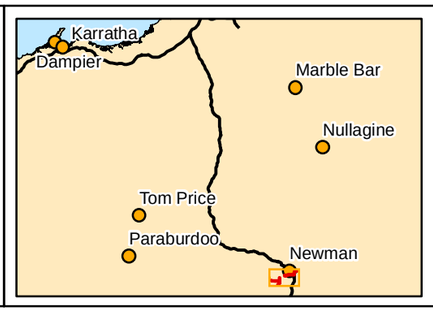
N

biologic Environmental Survey

Scale: 1:96,000

0 2 4 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 31/05/2022



BHP WAIO

Western Ridge Pipeline Targeted Fauna Survey

Figure 5.1: Fauna habitats and species of significance recorded in the Study Area

5.2 Habitat Features

Three water features were recorded within the Study Area during the field survey (Figure 5.1; Appendix D). Of the three water features recorded, one (WWRP-01) is part of a portion of the Fortescue River where water pools for prolonged periods following rainfall events and is likely to be semi-permanent. The extent of this water feature extends well beyond the boundary of the Study Area and forms a continuation of Major Drainage Line habitat. The remaining two water features (WWRP-02 and WWRC-03) are likely to be seasonal, with the presence of water likely due to recent rainfall preceding the field survey. These water features are likely to provide foraging habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat and Pilbara olive python, particularly given their occurrence along likely dispersal corridors formed by Major Drainage Line and Medium Drainage Line habitats.

No caves were recorded within the Study Area; however, numerous caves known to support significant species such as ghost bat and northern quoll have previously been recorded within the Western Ridge area adjacent to the Study Area. Caves within the Western Ridge area in which northern quoll and/or ghost bat evidence has previously been recorded occur approximately 9.6 to 10.5 km from the Study Area (Biologic, 2021). Ghost bat has previously been recorded from direct observation and/or secondary evidence (scats) at seven caves (CWER-01, CWER-02, CWER-03, CWER-06, CWER-10, CWER-14 and CWER-16) and northern quoll from secondary evidence (scats) at two caves (CWER-10 and CWER-16) (Biologic, 2021)

5.3 Fauna Recorded

A total of 100 vertebrate fauna species, comprising 12 mammal species (nine native and three introduced), 75 bird species, 11 reptile species and two amphibian species were recorded from the Study Area. (Appendix B). This comprises approximately 27% of the total number of species identified in the desktop assessment (n = 365) as potentially occurring within the Study Area (see section 3.2). In comparison with the results from previous surveys undertaken in the vicinity of the Study Area, the total species diversity recorded during the current survey was comparable to other basic and targeted surveys (Biologic, 2013; Eco Logical, 2012b) All species recorded during the survey were previously identified in the desktop assessment (Appendix B).

5.4 Significant Species

Two significant species were recorded within the Study Area during trip 1 of the current survey, Pilbara olive python and western pebble-mound mouse (Figure 5.1; Table 5.2). Pilbara olive python was detected at one water feature within Medium Drainage Line (Table 5.2). Three pebble-mounds were recorded in Hillcrest/ Hillslope and Stony Plain habitats, comprising one active, one recently inactive and one inactive (Table 5.2). Based on known species' distributions, previous records and the habitats present within the Study Area, a further two species were deemed Highly Likely to occur, eight were deemed Possible and 28 were considered Unlikely to occur (Table 5.3).

The occurrence of those significant species which are MNES, and a focus of this assessment is discussed in further detail below (Section 5.4.1). The occurrence of other significant species which have either been Confirmed as occurring in the Study Area or are considered Highly Likely to occur, Likely to occur, or to Possibly occur, is also discussed in more detail (Section 5.4.2 to 5.4.4). Consideration for some species as Unlikely to occur within the Study Area is generally based on the absence of suitable permanent or seasonal habitats or micro habitats likely to support the species and/or the Study Area occurring outside the known distribution for the species (Table 5.3).

Table 5.2: Significant species recorded during the current survey

Common Name (Scientific Name)	Site	Location		Habitat	Record Type	No. Records
		Latitude	Longitude			
Pilbara olive python (*Liasis olivaceus* subsp. *barroni*)	VWRP-07	-23.4701	119.6061	Medium Drainage Line	eDNA	1
Western pebble-mound mouse (*Pseudomys chapmani*)	OPP	-23.4332	119.6076	Hillcrest/ Hillslope	Mound (recently inactive)	1
	OPP	-23.4332	119.6076	Hillcrest/ Hillslope	Mound (active)	1
	OPP	-23.4336	119.6055	Stony Plain	Mound (inactive)	1

Table 5.3: Significant species likelihood assessment

Common Name (Scientific Name)	Conservation Status				Preferred Broad Habitats	Nearest Record to the Study Area	Potential Habitat Within the Study Area						Likelihood of Occurrence	Occurrence	Comments
	EPBC Act	BC Act	DBCA	IUCN			Stony Plain	Drainage Area/ Floodplain	Major Drainage Line	Medium Drainage Line	Mulga Woodland	Hillcrest/ Hillslope			
Mammals															
Dasyuridae															
brush-tailed mulgara (*Dasycercus blythi*)			P4		Prefers spinifex *Triodia* spp. grasslands on sand plains and the swales between low dunes (Pavey *et al.*, 2012; Woolley, 2006). Mature spinifex hummocks appear to be important for protection from introduced predators (Körtner *et al.*, 2007).	~10 km north-west (2013) (Biologic, 2013) ~16 km east (2018) (DBCA, 2020)		•					Possible	Resident	May occur as a resident in Drainage Area/ Floodplain habitat.
northern quoll (*Dasyurus hallucatus*)	EN	EN		EN	The species tends to inhabit rocky habitats which 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).	~680 m north-west (2020) (Biologic, 2020d) ~9 km north (2007) (BHP WAIO, 2021; Onshore, 2013)			•	•		•	Possible	Infrequent visitor (foraging/ dispersal only)	Major Drainage Line and Medium Drainage Line habitats may provide dispersal corridors. The extent of these habitats within the Study Area is limited; however, they form part of larger continuations of the habitat beyond the extent of the Study Area, therefore, may potentially act as foraging and/or dispersal corridors where connectivity to other areas of suitable habitat is provided. Hillcrest/ Hillslope habitat occurring within the habitat provides marginal habitat for the species; however, the species is unlikely to utilise due to the habitats limited extent within the Study Area and isolation (i.e. no connectivity to other areas of suitable habitat in the vicinity).
long-tailed dunnart (*Sminthopsis longicaudata*)			P4		Typically occurs on plateaus near breakaways and scree slopes, and on rugged boulder-strewn scree slopes (Burbidge *et al.*, 2008). Once considered rare but now shown to be relatively common and widespread in rocky habitats (Burbidge *et al.*, 2008).	~6 km north-west (1998) (BHP WAIO, 2021)						•	Possible	Resident	May occur as a resident in Hillcrest/ Hillslope habitat.
Hipposideridae															
Pilbara leaf-nosed bat (*Rhinonicteris aurantia* (Pilbara form))	VU	VU			Species roosts within caves and abandoned Mines with high humidity (95%) and temperature (32°C) (Armstrong, 2001). Species forages in caves and along waterbodies with fringing vegetation (TSSC, 2016b).	~1.7 km north (2019) (Biologic, 2020a) ~14 km north (2015) (BHP WAIO, 2021; Biologic, 2016a)	• (HR 2)	• (HR 2)	• (HR 3)	• (HR 2)	• (HR 2)	• (HR 1)	Possible	Infrequent visitor (foraging/ dispersal only)	May occasionally occur as an infrequent visitor to forage and/or during dispersal movements from areas supporting known and potential roosting habitat north of the Study Area in Western Ridge. Extensive sampling was undertaken within the Western Ridge area and some regional areas during 2020 (Biologic, 2021), resulting in no further records of the species within or in close proximity of the Study Area. Foraging may occur in Priority 3 (instances of rocky outcrop occurring with Hillcrest/ Hillslope) and Priority 5 (open grassland and woodland, within Drainage Area/ Floodplain, Stony Plain and Mulga Woodland) habitats (as defined by TSSC (2016b)). Drainage Line habitat may also provide a water source and occasional foraging habitat, particularly where pooling occurs following rainfall. Habitat rating (HR; as defined by Bat Call (2022)) of potential foraging habitat within the Study Area ranges from high (3) to low (1). Occurrence likely to be limited and influenced by the proximity of the Study Area to suitable roost caves.

Common Name (Scientific Name)	Conservation Status				Preferred Broad Habitats	Nearest Record to the Study Area	Potential Habitat Within the Study Area						Likelihood of Occurrence	Occurrence	Comments
	EPBC Act	BC Act	DBCA	IUCN			Stony Plain	Drainage Area/ Floodplain	Major Drainage Line	Medium Drainage Line	Mulga Woodland	Hillcrest/ Hillslope			
Macropodidae															
black-flanked rock-wallaby (*Petrogale lateralis* subsp. *lateralis*)	EN	EN		NT	Rocky habitats, including gorges and gullies or outcrops with sufficient shelter habitat. Often vegetated with *Acacia* thickets and open low eucalypt woodlands with an understory of grasses and low shrubs (Willers *et al.*, 2011).	~12.5 km north-east (1975) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
Megadermatidae															
ghost bat (*Macroderma gigas*)	VU	VU		VU	Ghost bats roost in deep, complex caves beneath bluffs of low, rounded hills, granite rock piles and abandoned Mines (Armstrong & Anstee, 2000). These features often occur within habitats including gorge/gully, hill crest/ hill slope and low hills (Armstrong & Anstee, 2000). Forages broadly across habitats, particularly woodland and open woodland habitats, including eucalypt and Mulga woodlands (Biologic, 2020b; Richards *et al.*, 2008; Tidemann *et al.*, 1985; TSSC, 2016a).	~680 m north-west (2020) (Biologic, 2020d) ~880 m north-west (2011) (Onshore, 2013)	•	•	•	•	•		Highly Likely	Occasional to Frequent visitor (foraging/ dispersal only)	Likely to occur occasionally to regularly to forage and/or during dispersal movements from known and likely roosting habitat north of the Study Area, including known roosting caves located within the Western Ridge area. No roosting habitat present within the Study Area.
Muridae															
western pebble-mound mouse (*Pseudomys chapmani*)			P4		This species occurs on the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (Anstee, 1996; Start *et al.*, 2000).	~500 m north (2009) (BHP WAIO, 2021) (~134 records within 5 km of the Study Area)	•					•	Recorded	Resident	Recorded three times during the current survey on undulating low hills within Stony Plain and Hillcrest/ Hillslope habitat. All records from secondary evidence (pebble mounds), including one active mound and two inactive mounds. Likely to occur as a resident throughout Study Area where suitable stony habitat present.
Thylacomyidae															
greater bilby (*Macrotis lagotis*)	VU	VU		VU	Variety of habitats including spinifex hummock grassland and *Acacia* shrubland, on soft soils (Burrows *et al.*, 2012). In the Pilbara often associated with major drainage line sandy terraces (How *et al.*, 1991).	~700 m south-east (1979) (DBCA, 2020) ~61 km east (2018) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
Aves															
Apodidae															
fork-tailed swift (*Apus pacificus*)	MI	MI			Inhabits dry/open habitats, inclusive of riparian woodlands and tea-tree swamps, low scrub, heathland or saltmarsh, as well as treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes (Johnstone & Storr, 1998). Almost exclusively aerial.	~54 km north-west (2011) (DBCA, 2021)	•	•	•	•	•	•	Possible	Infrequent visitor (foraging/ migration only)	May occasionally occur within the airspace above the Study Area to forage. Unlikely to land or nest within Study Area.
Charadriidae															
greater sand plover (*Charadrius leschenaultii* subsp. *leschenaultii*)	VU/ MI	VU/ MI			A variety of habitats, including coastal habitats, such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches as well as open inland environments such as, semi-arid or arid grasslands, where the grass is short and sparse (Johnstone & Storr, 2004).	~370 km north (2005) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
little ringed plover (*Charadrius dubius*)	MI	MI			Bare or sparsely vegetated sandy and pebbly shores of shallow standing freshwater pools, lakes or slow-flowing rivers. Also found in artificial habitats including gravel pits, sewage works, industrial wastelands and rubbish tips (BirdLife International, 2016).	~430 km north-east (1999) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
oriental plover (*Charadrius veredus*)	MI	MI			A variety of habitats, including coastal habitats, such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches as well as open inland environments such as, semi-arid or arid grasslands, where the grass is short and sparse (Johnstone & Storr, 2004).	~1.5 km south (1981) (DBCA, 2020) ~105 km north (2017) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.

Common Name (Scientific Name)	Conservation Status				Preferred Broad Habitats	Nearest Record to the Study Area	Potential Habitat Within the Study Area						Likelihood of Occurrence	Occurrence	Comments
	EPBC Act	BC Act	DBCA	IUCN			Stony Plain	Drainage Area/ Floodplain	Major Drainage Line	Medium Drainage Line	Mulga Woodland	Hillcrest/ Hillslope			
Ciconiidae															
black-necked stork (*Ephippiorhynchus asiaticus*)				NT	Found along the northern coast and in coastal waters, and occasionally but rarely inland on larger rivers. Also occurs in tidal creeks and mudflats, saltwork ponds, and river pools (Johnstone *et al.*, 2013).	~1.5 km south (2003) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
Falconidae															
grey falcon (*Falco hypoleucos*)	VU	VU			Timbered lowlands, particularly Acacia shrubland and along inland drainage systems. Also frequent spinifex and tussock grassland (Burbidge *et al.*, 2010; Olsen & Olsen, 1986).	~80 km north-west (2008) (DBCA, 2020) ~98 km north (2016) (DBCA, 2021)			•	•			Possible	Infrequent visitor (foraging only)	May occur occasionally to forage. Suitable nesting habitat not present.
peregrine falcon (*Falco peregrinus*)		OS			In arid areas, it is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone & Storr, 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces between 25 m and 50 m high (Olsen *et al.*, 2004; Olsen & Olsen, 1989).	~150 m north (1998) (BHP WAIO, 2021; Onshore, 2013) ~ 3.2 km north (2020) (Biologic, 2020d)	•	•	•	•		•	Highly Likely	Occasional visitor (foraging only)	Likely to occur occasionally to forage. Suitable nesting habitat not present.
Hirundinidae															
barn swallow (*Hirundo rustica*)	MI	MI			The Barn Swallow is a non-breeding summer visitor to the Pilbara. It favours areas near water (Johnstone *et al.*, 2013).	~350 km north (2001) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
Laridae															
caspian tern (*Sterna caspia*)	MI	MI			Mainly sheltered seas, estuaries and tidal creeks; occasionally near-coastal salt lakes (including saltwork ponds) and brackish pools in lower courses of rivers; rarely fresh water (Johnstone & Storr, 1998).	~4.2 km east (2004, 2007, 2008) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
gull-billed tern (*Gelochelidon nilotica*)	MI	MI			Shallow sheltered seas close to land, estuaries, tidal creeks; and inundated samphire flats, flooded salt lakes, claypans and watercourses in the interior (Johnstone & Storr, 1998).	~1.5 km south (1978) (DBCA, 2020) ~4.5 km east (2008) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
Motacillidae															
grey wagtail (*Motacilla cinerea*)	MI	MI			A rare vagrant to Western Australia where it has been recorded within various habitats with open waterbodies (Johnstone & Storr, 2004).	~140 km north-west (2012) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
yellow wagtail (*Motacilla flava*)	MI	MI			An uncommon but regular visitor to the Pilbara region (Johnstone *et al.*, 2013). Occupies a range of damp or wet habitats with low vegetation although favours edges of fresh water, especially sewage ponds (Johnstone & Storr, 2004).	~360 km north-west (1982) (DBCA, 2021) >500 km north-east (2003) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
Psittacidae															
night parrot (*Pezoporus occidentalis*)	EN	CR		EN	The Night Parrot prefers sandy/stony plain habitat with old-growth spinifex for roosting and nesting in conjunction with native grasses and herbs for foraging (DPaW, 2017).	~135 km north-west (2005) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
princess parrot (*Polytelis alexandrae*)	VU		P4	NT	The Princess Parrot inhabits low open eucalypt woodlands and savannah shrublands in arid deserts, usually with *Casuarina* and *Allocasuarina* spp. Primarily nests in Marble Gum hollows (Pavey *et al.*, 2014).	~50 km north (2012) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
Rostratulidae															
Australian painted snipe (*Rostratula benghalensis* subsp. *australis*)	EN	EN		EN	Generally, occupies shallow terrestrial freshwater wetlands (i.e. temporary and permanent lakes, swamps and claypans) with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire (Johnstone & Storr, 1998)	~75 km north (2012) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.

Common Name (Scientific Name)	Conservation Status				Preferred Broad Habitats	Nearest Record to the Study Area	Potential Habitat Within the Study Area						Likelihood of Occurrence	Occurrence	Comments
	EPBC Act	BC Act	DBCA	IUCN			Stony Plain	Drainage Area/ Floodplain	Major Drainage Line	Medium Drainage Line	Mulga Woodland	Hillcrest/ Hillslope			
Scolopacidae															
sharp-tailed sandpiper (*Calidris acuminata*)	MI	MI			Favours flooded samphire flats and grasslands, mangrove creeks mudflats, beaches, river pools, saltwork ponds, sewage ponds and freshwater soaks (Johnstone *et al.*, 2013).	~2.9 km south (1981) (DBCA, 2020) ~4.3 km east (2009) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
curlew sandpiper (*Calidris ferruginea*)	CR/ MI	CR/ MI		NT	Inhabits intertidal mudflats in sheltered coastal areas (i.e. estuaries, bays, inlets and lagoons) (Geering *et al.*, 2007). This rare species generally roosts on bare dry shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands (Geering *et al.*, 2007).	~4.5 km east (2005) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
pectoral sandpiper (*Calidris melanotos*)	MI	MI			Coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (Johnstone & Storr, 2004; Johnstone *et al.*, 2013). It prefers wetlands with open fringing mudflats and low, emergent or fringing vegetation (Geering *et al.*, 2007)	~2.6 km east (2012) (BHP WAIO, 2021)							Unlikely	N/A	Suitable habitat not present.
red-necked stint (*Calidris ruficollis*)	MI	MI		NT	Lives in permanent or ephemeral wetlands of varying salinity, and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In Western Australia they prefer freshwater to marine environments. The species usually forages in shallow water at the edge of wetlands and roost or loaf on tidal mudflats, near low saltmarsh, and around inland swamps (Johnstone & Storr, 1998).	~4.5 km east (2005) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
long-toed stint (*Calidris subminuta*)	MI	MI			They prefer shallow freshwater or brackish wetlands but are also fond of muddy shorelines, growths of short grasses, weeds, sedges, low or floating aquatic vegetation, reeds, rushes and occasionally stunted samphire. The Long-toed Stint also frequents permanent wetlands and forages on wet mud or in shallow water, often among short grass, weeds and other vegetation on islets or around the edges of wetlands. They roost or loaf in sparse vegetation at the edges of wetlands and on damp mud near shallow water. It also roosts in small depressions in the mud (Johnstone & Storr, 1998).	~2.9 km south (1981) (DBCA, 2020) ~4.3 km east (2001) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
black-tailed godwit (*Limosa limosa*)	MI	MI		NT	The species has a primarily coastal habitat environment. There are a few inland records, around shallow, freshwater and saline lakes, swamps, dams and bore-overflows. They also use lagoons in sewage farms and saltworks (Higgins & Davies, 1996)	~350 km north (2005) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
ruff (*Philomachus pugnax*)	MI	MI			Mainly fresh, brackish and saline wetlands with exposed mudflats. Found near lakes, swamps, pools, lagoons, tidal rivers and floodlands. Sometimes observed in sheltered coastal areas, including harbours and estuaries (DoEE, 2019)	~360 km north (2017) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present.
wood sandpiper (*Tringa glareola*)	MI	MI			Species occurs as a non-breeding summer migrant which occurs throughout the region. Occurs mainly in river pools, sewage ponds, flooded claypans, freshwater lagoons and bore overflows (Johnstone *et al.*, 2013).	~1.5 km north (2010) (Biologic, 2011)							Unlikely	N/A	Suitable habitat not present.
common sandpiper (*Tringa hypoleucos*)	MI	MI			Estuaries and deltas of streams, as well as banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans (Geering *et al.*, 2007).	~1.4 km north (2013) (BHP WAIO, 2021; Onshore, 2013)							Unlikely	N/A	Suitable habitat not present.
common greenshank (*Tringa nebularia*)	MI	MI			Species occurs as a non-breeding summer Migrant which occurs throughout the region. Occurs mainly in Tidal mudflats, mangrove creeks, flooded samphire flats, beaches, river pools, and saltworks and sewage ponds (Johnstone *et al.*, 2013).	~1.4 km north (2010) (Onshore, 2013)							Unlikely	N/A	Suitable habitat not present.

Common Name (Scientific Name)	Conservation Status				Preferred Broad Habitats	Nearest Record to the Study Area	Potential Habitat Within the Study Area						Likelihood of Occurrence	Occurrence	Comments
	EPBC Act	BC Act	DBCA	IUCN			Stony Plain	Drainage Area/ Floodplain	Major Drainage Line	Medium Drainage Line	Mulga Woodland	Hillcrest/ Hillslope			
marsh sandpiper (*Tringa stagnatilis*)	MI	MI			Lives in permanent or ephemeral wetlands of varying salinity, and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In Western Australia they prefer freshwater to marine environments. The species usually forages in shallow water at the edge of wetlands and roost or loaf on tidal mudflats, near low saltmarsh, and around inland swamps (Johnstone & Storr, 1998).	~1.4 km north (2010) (Biologic, 2011)							Unlikely	N/A	Suitable habitat not present.
common redshank (*Tringa totanus*)	MI	MI			It is found at sheltered coastal wetlands with bare open flats and banks of mud or sand. They are also found around salt lakes, freshwater lagoons, artificial wetlands and saltworks and sewage farms. The species has been observed feeding in shallow water, on wet bare mud or sand, or on algal deposits and roosting on small elevated areas such as estuarine sandbars and muddy islets surrounded by water (Johnstone & Storr, 1998).	~1.4 km north (2010) (Onshore, 2013)							Unlikely	N/A	Suitable habitat not present.
Threskiornithidae															
glossy ibis (*Plegadis falcinellus*)	MI	MI			Freshwater wetlands, irrigated areas, margins of dams, floodplains, brackish and saline wetlands, tidal mudflats, pastures, lawns and public gardens (Johnstone *et al.*, 2013).	~4.2 km east (2013) (DBCA, 2020)							Unlikely	N/A	Suitable habitat not present.
Reptiles															
Boidae															
Pilbara olive python (*Liasis olivaceus* subsp. *barroni*)	VU	VU			Associated with drainage systems, including areas with localized drainage and watercourses (Pearson, 1993). In the inland Pilbara the species is most often encountered near permanent waterholes in rocky ranges or among riverine vegetation (Pearson, 1993).	~1.4 km north (2010) (Biologic, 2011)			•	•			Recorded	Resident	eDNA recorded within Medium Drainage Line. May also occur in Major Drainage Line. Likely to occur in drainage lines when they provide connectivity between other areas of suitable habitat within and outside the Study Area (i.e. Hillcrest/ Hillslope, Gorge/ Gully habitats)
Scincidae															
spotted ctenotus (*Ctenotus uber* subsp. *johnstonei*)			P2		Within the Pilbara, the taxon is known from *Triodia* on hillslopes, *Acacia xiphophylla* over chenopods, and *Acacia xiphophylla* scattered tall shrubs to high open shrubland (Cogger, 2014).	~18 km east (2018) (DBCA, 2021)	•	•		•			Possible	Resident	May occur in Mulga Woodland, Drainage Area/ Floodplain and Stony Plain habitats. Taxonomic status of the disjunct Pilbara population may represent an undescribed taxon (P. Doughty, Western Australian Museum, *pers. comm.*).
unpatterned robust slider (*Lerista macropisthopus* subsp. *remota*)			P2		Woodlands and semi-arid scrubs with sandy substrate (Cogger, 2014)	~2.5 km north-west (2010) (DBCA, 2021)							Unlikely	N/A	Suitable habitat not present. Desktop records likely erroneous. Previous records most likely attributed to *Lerista neander*.
Typhlopidae															
Pilbara flat-headed blind-snake (*Anilios ganei*)			P1		Little is known of the species' ecology, but it is often associated with moist soils and leaf litter within gorges and gullies (Wilson & Swan, 2014), and potentially within a wide range of other stony habitats. The species has been recorded from numerous habitats but is most likely to be present in rocky terrain and along drainage lines (DBCA, 2021)	~4.1 km north-west (2010) (Biologic, 2011)						•	Possible	Resident	May occur as a resident in Hillcrest/ Hillslope habitat, particularly where most substrates present for prolonged periods.

5.4.1 EPBC Matters of National Environmental Significance

The sections below provide summaries on the Program Matters identified in the approved Program for BHP's Strategic Assessment (greater bilby, northern quoll, Pilbara leaf-nosed bat, ghost bat and Pilbara olive python) as well as night parrot.

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

The northern quoll tends to inhabit rocky habitats which offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; DoE, 2016; 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).

No northern quoll or evidence of the species' occurrence was recorded within the Study Area during the current survey; however, the species is considered to possibly occur based on the presence of suitable habitat within parts of the Study Area and the occurrence of previous records in the vicinity. Although no suitable denning or shelter habitat was recorded within the Study Area, suitable areas of habitat are known to occur in the Western Ridge area and the species has been recorded in this area on multiple occasions from secondary evidence (old scats within caves) (Figure 3.1) (Biologic, 2020d). Within the Western Ridge area however, the species is suspected of only occurring in low abundance (Biologic, 2020d). Northern quoll may occasionally transition through the Study Area via dispersal habitats such as Major Drainage Line and Medium Drainage Line habitats, particularly in areas adjacent to or near areas of suitable habitat outside of the Study Area. The occurrence of both Major Drainage Line and Medium Drainage Line habitats within the Study Area is limited to small areas (46.11 ha total); however, form part of larger extents of these habitats beyond the boundary of the Study Area. Hillcrest/ Hillslope habitat occurring within the Study Area may provide marginal denning or shelter habitat for the species; however, the extent of this habitat's occurrence within the Study Area is limited to a small and relatively isolated area with no connectivity to other areas of suitable habitat and is unlikely to be utilised by the species.

With the exception of northern quoll records from the Western Ridge area, approximately 680 m north of the Study Area, records of the species in the vicinity of the Study Area are sparse, with the nearest record to the Study Area occurring approximately 9 km north, dated from 2007 (BHP WAIO, 2021). Due to the absence of any records of the species occurring within the Study Area and the scarcity of records in the vicinity, the species occurrence within the Study Area may also be limited to infrequent visitations by dispersing individuals. With the exception of Hillcrest/ Hillslope, Major Drainage Line and Medium Drainage Line habitats, the remaining habitats mapped within the Study Area are unlikely to provide significant habitat for the species at a local or regional scale.

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

Extant populations of the greater bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (Southgate, 1990). Throughout its distribution, it occupies three major vegetation types: open tussock grassland on uplands and hills, hummock grassland in plains and alluvial areas and occasionally mulga woodland/shrubland growing on ridges and rises, and (Southgate, 1990). Within the Pilbara region the species is sparsely distributed, and often associated with spinifex sandplain habitat (Dziminski & Carpenter, 2016).

No records or evidence of occurrence of greater bilby was recorded within the Study Area during the current survey. No suitable habitat considered likely to support the species as a resident was recorded within the Study Area. The nearest record of the species is located approximately 700 m south-east of the Study Area (DBCA, 2020); however, based on the date of the record (1979), it is considered to be a historic record and is unlikely to be an accurate representation of the species current occurrence within the Pilbara region. The nearest, contemporary record (dated 2018) is located approximately 61 km east of the Study Area (DBCA, 2021).

Based on the absence of nearby recent records of the species or suitable habitat for the species within the Study Area, in addition to the relative isolation of the Study Area from other areas of suitable habitat in the broader area, the species is considered Unlikely to occur. Although the species is known to utilise broad habitats occurring within the Study Area in other parts of its distribution (i.e. Mulga Woodland and Drainage Area/ Floodplain), 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. sandplain) are present adjacent to or in the vicinity.

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

In the Pilbara region, the species roosts in deep, complex caves beneath bluffs of low rounded hills, often composed of Marra Mamba Iron Formation or banded iron formation, granite rock piles and abandoned mines (Armstrong & Anstee, 2000). They roost either individually or in colonies (Churchill, 2008) and move between a number of caves, both seasonally and as dictated by weather changes (van Dyck & Strahan, 2008). The species will often forage more broadly across habitats, often showing a preference for plain (i.e. Drainage Area/ Floodplain, Stony Plain and Mulga Woodland habitats) habitats where prey species are likely to be most abundant (Bat Call, 2021; Richards *et al.*, 2008; Tidemann *et al.*, 1985). Recent studies of ghost bat home range and foraging behaviour in the Pilbara region have identified Drainage Area/ Floodplain, Gorge/ Gully (particularly in close proximity to roosts), Major Drainage Line and Mulga Woodland as high suitability foraging habitats for the species, followed by Stony Plain as moderate suitability (Bat Call, 2021; Biologic, 2020b; unpublished data). This suitability however, is variable depending on particular habitat characteristics, including the abundance of foraging structures (tree perches) and density of understory vegetation present (Bat Call, 2021; Biologic, 2020b; unpublished data). Foraging can occur up to 12 km from diurnal roosts (Bat Call, 2021).

No ghost bat, or suitable roost caves likely used by the species, were recorded within the Study Area during the current survey. Despite no individuals being detected by ultrasonic recorders, it should be noted that detectability, particularly of foraging individuals can be 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 species has previously been recorded on multiple occasions within the Western Ridge area located directly adjacent to the west and 1.7 km to the north of the Study Area (Figure 3.1). The species has previously been recorded on multiple occasions from direct observation and secondary evidence (including roost caves) within the Western Ridge area, with the nearest record of the species located approximately 680 m north of the Study Area (Biologic, 2020d).

Based on the occurrence of previous records of the species in close proximity to the Study Area and occurrence of potential foraging habitat (Mulga Woodland, Drainage Area/ Floodplain, Major Drainage Line, Medium Drainage Line and possibly Hillcrest/ Hillslope) the species is considered highly likely to occur. Due to the absence of any potential roosting habitat within the Study Area, occurrence of the ghost bat within the Study Area is likely to be individuals originating from outside the Study Area, particularly within the Western Ridge area where known and likely roosting caves occur (Biologic, 2020d). The species occurrence within the Study Area is likely to be higher during use of any of these caves as a maternity roost and especially in areas located closer to known and potential roosting sites, particularly Mulga Woodland and Drainage Area/ Floodplain habitats located in the central part of the Study Area which are closer to known and likely roosting caves within the Western Ridge area. The caves recorded within the Western Ridge area represent the south-eastern extent of known roost caves for the species, indicating the species occurrence in this area may represent an important population, as defined by DoE (2013). This suggests that the potential foraging habitat occurring within Mulga Woodland and Drainage Area/ Floodplain habitats of the Study Area (totalling 565.83 ha) that is associated with (occurs in the vicinity of) these caves represent important foraging habitat for the species.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – Vulnerable (EPBC/BC Act)

This Pilbara leaf-nosed bat's limited ability to conserve heat and water means it requires warm (28–32 ºC) and very humid (85 – 100%) roost sites in caves (Armstrong, 2001; Churchill, 1991) and/or mine shafts as these enable the individuals to persist in arid climates by limiting water loss and energy expenditure (van Dyck & Strahan, 2008). Such caves are relatively uncommon in the Pilbara (Armstrong, 2001), which limits the availability of diurnal roosts for this species. Pilbara leaf-nosed bats roost in undisturbed caves, deep fissures or abandoned mine shafts. The species forages within and in the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016b). Pilbara leaf-nosed bats are predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016); 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 distant approximately 12 months apart (Bullen & Reiffer, 2019), suggesting the species may forage and/or disperse over greater distances than previously thought.

No Pilbara leaf-nosed bats were recorded within the Study Area during the current survey. The nearest known roost of the species is located at Kalgan Creek (R. Bullen, Bat Call WA, *pers. comms.*), approximately 23 km north of the Study Area; however, sampling within the intervening area is sparse and additional sites may occur closer to the Study Area. The scarcity of records in the broader vicinity of the Study Area suggests the species is relatively uncommon in the area and its occurrence may be restricted to foraging and/or dispersal events only, seasonal conditions permitting. The species occurrence within the Study Area is likely to be occasional and restricted to foraging and/or dispersal movements, particularly within Mulga Woodland, Major Drainage Line, Medium Drainage Line, Mulga Woodland and Drainage Area/ Floodplain habitats.

Within the Study Area, based on TSSC (2016b) categories of foraging habitat for the species, Mulga Woodland and Drainage Area/ Floodplain provide potential Priority 5 foraging habitat, Major Drainage Line and Medium Drainage Line provide potential Priority 4 habitat and limited instances where outcropping occurs within Hillcrest/ Hillslope habitat provides potential Priority 3 foraging habitat. The habitat rating (HR; as defined by Bat Call (2022)) of potential foraging habitat within the Study Area ranges from high (3) to low (1); however, occurrence is likely to be limited and influenced by the proximity of the Study Area to suitable roost caves.

No suitable roosting habitat occurs within the Study Area; however, suitable roosting habitat may occur in some caves within the Western Ridge area. The species was not recorded during a targeted survey of the Western Ridge area undertaken in early 2020; however, a number of potential nocturnal roost caves which may be utilised by the species were recorded (Biologic, 2020d). The species has previously been recorded approximately 1.7 km north of the Study Area in 2019 (Biologic, 2020a).

Night Parrot (*Pezoporus occidentalis*) – Endangered (EPBC/BC Act)

The ecology and habitat preferences of the night parrot within the Pilbara region are poorly known. Based on accepted records, the habitat of the species comprises long-unburnt mature *Triodia* grasslands in stony or sandy environments (McGilp, 1931; North, 1898; Whitlock, 1924; Wilson, 1937), and of samphire and chenopod shrublands, including genera such as *Atriplex*, *Bassia* and *Maireana*, on floodplains and claypans, and 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 this species requires old-growth (often more than 50 years unburnt) spinifex (*Triodia*) 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.

Records of the night parrot within the Pilbara region are scarce, with the nearest contemporary record of the species located approximately 135 km northwest from April 2005 (DBCA, 2021). Three individuals of the species were purportedly observed at Minga Well, a station bore and livestock watering point with large pools of water occurring in the vicinity of Fortescue Metals Group's Cloudbreak Mine (Davis & Metcalf, 2008). The site is heavily degraded from cattle and lacks understory within a larger area; however, larger patches of old-growth *Triodia* grasslands occur in the vicinity along the peripherals of the Fortescue Marsh and chenopod shrublands occur throughout the marsh itself. The species has been recorded in the broader vicinity subsequent to the 2005 records as part of annual monitoring (FMG, 2021); however, limited information is available on the additional records.

No evidence of occurrence of night parrot was recorded within the Study Area during the current survey, including from targeted acoustic recorders deployed in areas of habitat considered possibly suitable for the species. Habitat within the Study Area was considered 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 or in the vicinity of the Study Area, which may be utilised for foraging. Despite the habitat preferences and occurrences being largely unknown, the habitats found in the Study Area are not known to support night parrot and therefore this species is considered unlikely to occur.

Pilbara Olive Python (*Liasis olivaceus barroni*) – Vulnerable (EPBC/BC Act)

The Pilbara olive python is moderately common through the ranges of the Pilbara region and the Mt Augustus area in the Gascoyne region. The species is often associated with rocky habitats (i.e. Gorge/Gully and Hillcrest/ Hillslope habitats) and drainage systems (i.e. Major Drainage Lines), including areas with localised drainage and watercourses (Pearson, 1993). In the inland Pilbara, the species is most often encountered near permanent waterholes in rocky ranges or among riverine vegetation (Pearson, 1993). Pilbara olive python are primarily nocturnal and tend to shelter in small caves or under vegetation during the day, although it is occasionally active during the day during warmer summer months (Pearson, 1993).

The Pilbara olive python was detected from one of five replicate samples collected from WWRC-03 (Appendix F). The detection of the species from only a single replicate sample from VWRP-07 may be attributed to several indeterminate factors, including rainfall (and potential dilution of eDNA at water feature), exposited to other conditions (i.e. drying pool) or elements (sunlight and temperature) or the lack of Pilbara olive python occurrence within a reasonable timeframe of detection (i.e. low abundance of detectable DNA in water). It should be noted that it is unknown how long the species' DNA persists at water features once deposited, therefore it is not known if positive recordings are indicative of present (within hours or days of sampling) or a longer duration.

The species has previously been recorded on multiple occasions within the Western Ridge area located directly adjacent to the west and 1.4 km to the north of the Study Area. The species has previously been recorded on multiple occasions from direct observation, secondary evidence (including scats, sloughs) and from eDNA sampling at water features within the Western Ridge area, with the nearest record of the species located approximately 1.4 km north of the Study Area (Biologic, 2011). Records obtained within the Western Ridge area were associated with Gorge/ Gully habitat, often at or in close proximity to water features, which provides critical breeding and foraging habitat for the species (Biologic, 2020d).

Based on the current record within the Study Area and the occurrence of previous records in close proximity to the Study Area and the occurrence of suitable habitat, the species is considered likely to occur as a resident. Suitable habitat within the Study Area is restricted to Major Drainage Line and Medium Drainage line habitats located in the western portion of the Study Area. These habitat types are prone to pooling and ponding in areas, therefore providing foraging and dispersal habitat for the species. The likelihood of these habitats being utilised by the species would increase in areas where it provides connectivity between other areas of critical habitat (i.e. Gorge/ Gully).

5.4.2 Species Confirmed within the Study Area

In addition to Pilbara olive python discussed above (see Section 5.4.1), one other significant species was confirmed as occurring within the Study Area.

Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4 (DBCA)

The western pebble-mound mouse has experienced a significant decline in their range through the Gascoyne and Murchison and is now considered endemic to the Pilbara (Start ***et al.***, 2000). This species almost exclusively occurs on the gentler slopes of rocky ranges and low undulating hills where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (Anstee & Armstrong, 2001).

The western pebble-mound mouse was recorded a total of three times during the current survey (Table 5.2; Figure 5.1). All records were from secondary evidence (pebble mounds) on low undulating stony hills and plains of Stony Plain habitat, comprising one mound deemed active and two considered inactive (with one being recently inactive) (Table 5.2; Figure 5.1). The species has also previously been recorded approximately 500 m north of the Study Area (Onshore & Biologic, 2009a).

The species is likely to occur within the Study Area as a resident, where its occurrence is likely to be common and widespread across Stony Plain and the lower slopes of Hillcrest/ Hillslope habitats (totalling 1,528.20 ha). The species may also forage more broadly into Drainage Area/ Floodplain habitat where adjacent to habitat permitting burrowing and mound construction.

5.4.3 Species Highly Likely to Occur

In addition to ghost bat discussed above (see Section 5.4.1), one other significant species is considered Highly Likely to occur in the Study Area, peregrine falcon.

Peregrine Falcon (*Falco peregrinus*) – Specially Protected (BC Act)

In arid areas of its distribution, the peregrine falcon is often recorded along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone & Storr, 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces between 25–50 m high (Olsen & Olsen, 1989). It also appears to prefer nesting on ledges a reasonable distance (average of 13 m) from the top of the cliff (Olsen & Olsen, 1989), possibly to avoid predators. Nesting also occasionally occurs in tall trees along drainage lines, including use of abandoned nests of other large bird species (Olsen & Olsen, 1989).

No peregrine falcons were recorded within the Study Area during the current survey. The species has previously been recorded on multiple occasions to the north of the Study Area (BHP WAIO, 2021; Biologic, 2020d) and is considered highly likely to occur within the Study Area to forage within all broad fauna habitats occurring. Due to the species broad foraging range and the widespread occurrence of these habitats in the broader vicinity of the Study Area, foraging is likely to occur over a much broader area and not confined to the Study Area. No suitable nesting habitat was recorded within the Study Area.

5.4.4 Species Possibly Occurring

In addition to the northern quoll and Pilbara leaf-nosed bat discussed above (see Section 5.4.1), a further seven significant species are considered to possibly occur in the Study Area.

Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4 (DBCA)

The Brush-tailed Mulgara is often recorded from a range of sandy and stony plain habitats (Pavey *et al.*, 2012) and its likelihood of occurrence within the Study Area is Possible due to the presence of suitable habitat. No evidence of the species was recorded during the current survey; however, the species is considered to possibly occur as a resident in Drainage Area/ Floodplain habitats where suitable vegetation cover and sandy or loamy substrates permitting burrowing are present. The nearest record of the species to the Study Area is located approximately 10 km north-west Biologic (2013).

Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 4 (DBCA)

Despite the relatively widespread distribution of Long-tailed Dunnart, the species is often sparsely distributed and locally uncommon in the Pilbara region, where is often occurs in rugged rocky areas, scree slopes and stony plains and plateaus dominated by open shrubland and *Triodia* grassland vegetation (van Dyck *et al.*, 2013). No evidence of the Long-tailed Dunnart was recorded within the Study Area during the current survey; however, based on the presence of potential habitat for the species and the species previously being recorded approximately 6 km north-west of the Study Area (BHP WAIO, 2021), its likelihood of occurrence is considered Possible. Within the Study Area, the species may occur as a resident within Hillcrest/ Hillslope, potentially moving into adjacent habitats to forage and/or disperse.

Fork-tailed Swift (*Apus pacificus*) – Migratory (EPBC/BC Act)

The fork-tailed swift is a wide ranging but sparsely distributed species that occurs in a wide range of dry and/or open habitats (Johnstone & Storr, 1998). The species does not breed in Australia, migrating from breeding grounds in the northern Hemisphere. During its occurrence in Australia, the species is almost exclusively aerial, feeding and possibly also roosting aerially (DoE, 2018). The fork-tailed swift was not recorded during the current survey, and the nearest recent record (2011) is located approximately 54 km north-west of the Study Area (DBCA, 2021); however, the species is considered to possibly occur. The species may occur as an infrequent visitor and may forage in the airspace above all habitats occurring within the Study Area; however, landing or nesting within the Study Area unlikely.

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

The grey falcon is a widely distributed but infrequently recorded species which appears to have a distribution centred on ephemeral or permanent creek lines (Garnett & Crowley, 2000). The species tends to prefer sparsely-treed, open plains and creek lines for hunting (Olsen & Olsen, 1986), while 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).

The grey falcon was not recorded during the current survey, and the nearest recent record (2016) is located approximately 98 km north of the Study Area (DBCA, 2021); however, the species is considered to possibly occur. The species may occur as an infrequent visitor and may forage in the Major Drainage Line and Medium Drainage Line habitats occurring within the Study Area. No suitable nesting habitat was recorded within the Study Area.

Spotted Ctenotus (*Ctenotus uber* subsp. *johnstonei*) – Priority 2 (DBCA)

Habitat preferences of the spotted ctenotus are poorly known; however, previous records of the subspecies in the Pilbara region are associated with stony hillslope and plain habitats with variable vegetation cover, often dominated by open *Acacia* shrubland and *Triodia* hummock grassland (Cogger, 2014). No evidence of the spotted ctenotus was recorded during the current survey; however, the species is considered to possibly occur as a resident in Stony Plain, Drainage Area/ Floodplain and Mulga Woodland habitats.

The species has previously been recorded approximately 18 km east of the Study Area (DBCA, 2021). It should be noted that there is currently some taxonomic uncertainty regarding the isolated Pilbara population of this subspecies, and the population may represent an undescribed taxon (P. Doughty, Western Australian Museum, *pers. comm*.). However, until the taxa is formally recognised as independent of *Ctenotus uber* subsp. *johnstonei* and its taxonomic and conservation status is resolved, it is treated as such.

Pilbara Flat-headed Blind-snake (*Anilios ganei*) – Priority 1 (DBCA)

Little is known about the Pilbara flat-headed blind-snake; however, it can be assumed that its ecology and behaviour are similar to other blind snake species (Cogger, 2014). Due to its fossorial nature, the species is rarely encountered, and little is known of the species habitat preferences. Records of the species are often associated with moist gorges and gullies (Wilson & Swan, 2014). The Pilbara flat-headed blind-snake was not recorded during the current survey; however, based on the occurrence of habitats that are similar to those in which the species has previously been recorded, and the occurrence of a previous record of the species approximately 4.1 km north-west of the Study Area (Biologic, 2011), it is considered to possibly occur. The species may occur as a resident within Hillcrest/ Hillslope habitat, particularly in areas where leaf litter accumulates, and moisture is retained in leaf litter and substrates.

5.5 Constraints and Limitations

The EPA (2020) outlines several potential limitations to vertebrate fauna surveys. These aspects are assessed and discussed in Table 5.4 below. No major limitations or constraints were identified for the survey.

Table 5.4: 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 in the wider local area and the surrounding region, and most of these previous survey results were available for review. These reports were available at the time of reporting.
Competency/ experience of the survey team	No	The field personnel involved in the survey are experienced in undertaking fauna surveys of similar nature, including with the significant species targeted during the survey. Technical personnel with relevant expertise assisted with analysis of ultrasonic recordings (Robert Bullen), and analysis of acoustic recordings (Nigel Jackett).
Scope (faunal groups sampled and whether any constraints affect this)	No	The scope was a basic level vertebrate fauna survey with targeted sampling components, which was conducted within the EPA (2020) framework.
		Northern quoll –The species was sampled following survey guidelines where applicable, in relation to survey design and effort, site coverage, and detectability (DoE, 2016). However, due to a lack of suitable habitat camera trap transects had to be reduced. Camera trap transects were set during this assessment for 40 sampling nights. Targeted searches were undertaken for secondary evidence (e.g. scats).
		Pilbara leaf-nosed bat – The species has been sampled through targeted surveys (ultrasonic recording; 39 sampling nights). Bat detectors were placed at significant habitat areas including water features where possible. Sampling was undertaken during the wet season, when bats are likely to be dispersing, and there is a greater likelihood of detection.
		Greater bilby – Greater bilby sampling in the Study Area consisted of targeted bilby plots and opportunistic records. Due to the Study Area consisting of minimal greater bilby habitat, only six bilby plots were conducted.
		Ghost bat – The species has been sampled through targeted surveys (ultrasonic recording; 39 sampling nights). Bat detectors were placed at significant habitat areas.
		Night parrot – Sampling has been conducted throughout the Study Area. The acoustic detectors range is only ~300 metres (DPaW, 2017), but due to the limited night parrot habitat present within the area, it is considered adequate coverage. SM4 recorders were deployed for six nights at 15 sampling locations (90 sampling nights). Conditions during the recording period were generally good, with no rain and low winds recorded.
		Pilbara olive python – Targeted diurnal and nocturnal searches were undertaken in potential habitat for active individuals, scats, and water features likely to support the species. Additionally, targeted eDNA sampling for the species was undertaken at one water features within the Study Area.

Potential limitation or constraint	Constraint	Applicability to this survey
Timing, weather, and season	No	Field surveys occurred over appropriate or optimal periods for sampling the target species. No weather or seasonality constraints or limitations were identified during the surveys.
Disturbances (e.g. fire or flood)	No	No disturbance occurred during or immediately prior to the surveys that was likely to impinge on the results of this assessment.
Proportion of fauna identified	No	All fauna observed during the field surveys were identified to species level. Species identification of fauna recorded via camera traps and SongMeter ultrasonic recorders were able to be accurately identified with the assistance of technical personnel with relevant expertise (Robert Bullen and Nigel Jackett).
Adequacy of the survey intensity and proportion of the survey achieved	No	A basic and targeted survey was undertaken across the Study Area to assist with decisions on future environmental approvals. The sampling methods and survey intensity was high and focussed on the significant species.
Remoteness or access issues	No	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used in these areas during this survey were unconstrained by accessibility or remoteness. Due to access constraints in parts of the Study a helicopter was used during trip 1 to facilitate access to allow sufficient sampling to be undertaken throughout the Study 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.

6 CONCLUSION

Six broad fauna habitat types were recorded and mapped within the Study Area, comprising, in decreasing order of extent, Stony Plain (1,520.57 ha, 70.09% of Study Area), Mulga Woodland (313.33 ha, 14.45%) Drainage Area/ Floodplain (252.50 ha, 11.64%), Major Drainage Line (26.12 ha, 1.20%), Medium Drainage Line (19.99 ha, 0.92%), and Hillcrest/ Hillslope (7.63 ha, 0.35%). The remaining 1.35% (29.26 ha) of the Study Area was mapped as Cleared/ Disturbed. All six habitats mapped are broadly distributed and well represented across the Pilbara and Gascoyne bioregions, and therefore support fauna assemblages which are generally common and widespread. No habitats mapped within the Study Area provide critical habitat for any significant species and no species are likely to rely on these for long-term survival within the Study Area or more broadly in the vicinity.

Stony Plain provides suitable habitat for western pebble-mound mouse, spotted ctenotus and foraging habitat for peregrine falcon. Suitable foraging habitat is also provided for ghost bat across the majority of this habitat's occurrence within the Study Area, particularly where suitable perching trees provide vantage points which may facilitate foraging more broadly across the area. In areas where there are suitable perching trees, it also provides foraging habitat for ghost bat. Foraging habitat for ghost bat and Pilbara leaf-nosed bat is also provided by Mulga Woodland, which is often associated with Drainage Area/ Floodplain. Drainage Area/ Floodplain also provides suitable habitat for brush-tailed mulgara and spotted ctenotus, in addition to foraging habitat for ghost bat, Pilbara leaf-nosed bat and peregrine falcon. Major Drainage Line and Medium Drainage Line habitats provide suitable habitat for Pilbara olive python and additionally foraging and/or dispersal habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat, grey falcon and peregrine falcon. Hillcrest/ Hillslope provides suitable habitat for western pebble-mound mouse, long-tailed dunnart, spotted ctenotus and Pilbara flat-headed blind-snake. It also provides foraging and dispersal habitat for northern quoll, ghost bat and Pilbara leaf-nosed bat, and foraging habitat for peregrine falcon.

Three water features were recorded within the Study Area during the field survey. Of these, one which forms part of the Fortescue River is likely to be semi-permanent and the remainder are likely to be seasonal following large rainfall events. These water features are likely to provide foraging habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat and Pilbara olive python, particularly given their occurrence along likely dispersal corridors formed by Major Drainage Line and Medium Drainage Line habitats. No caves were recorded within the Study Area.

A total of 100 vertebrate fauna species, comprising 12 mammal species (nine native and three introduced), 75 bird species, 11 reptile species and two amphibian species were recorded from the Study Area. All these species were recorded in the desktop assessment. Species recorded during the survey were typical of assemblages occurring within the broad fauna habitats occurring within the Study Area and more broadly across the Pilbara and Gascoyne regions.

Of the 40 significant species identified in the desktop assessment, two were recorded within the Study Area during the survey, Pilbara olive python (VU – EPBC/BC) and western pebble-mound mouse (Priority 4 – DBCA). Pilbara olive python was detected at one water feature via eDNA (Figure 5.1). This record indicates that the species may occur within the Study Area as a resident in Major Drainage Line (26.12 ha) or rocky habitats where suitable breakaway or rockpiles occur (7.63 ha) in within the Study Area. Western pebble-mound mouse was recorded three times from secondary evidence (pebble mounds), comprising one active, one recently inactive and one inactive mound. Records of Western pebble-mound mouse during the current survey indicate that the species likely occurs within the Study Area as a resident throughout Stony Plain (1,520.57 ha) and Hillcrest/ Hillslope (7.63 ha) habitats within the Study Area; however, the species is relatively common and widespread more broadly across the Pilbara region. Given the habitats present within the Study Area and locations of nearby records identified during the desktop assessment, a further two significant species are considered Highly Likely to occur within the Study Area; ghost bat and peregrine falcon.

Four habitats within the Study Area provide potential foraging habitat for ghost bat, Mulga Woodland, Drainage Area/ Floodplain, Major Drainage Line, Medium Drainage Line and possibly Hillcrest/ Hillslope. Based on the occurrence of multiple records in close proximity to the Study Area (i.e. within 5 km) it is highly likely the species will occur within the Study Area. As no suitable roosting habitat occurs within the Study Area, the species occurrence is likely to be restricted to foraging events, with individuals likely to originate from areas adjacent to and within the broader vicinity of the Study Area, particularly from the Western Ridge area where known and likely roost caves occur (Biologic, 2020c). Known and potential roost caves within the Western Ridge area represent the south-eastern extent of known roosts for the species in the broader region, which indicates the species occurrence in this area may represent an important population, as defined by DoE (2013). With consideration of this, the occurrence of potential foraging habitat (Mulga Woodland and Drainage Area/ Floodplain) within the Study Area is likely to contribute important foraging habitat for this population. Due to the widespread occurrence of these habitats in the broader vicinity of the Study Area, their occurrence within the Study Area is unlikely to provide any increased importance for the species on a local or regional scale.

Peregrine falcon was considered Highly Likely to occur within the Study Area based on the proximity of the records to the north and occurrence of potential foraging habitat within the Study Area. Due to the absence of nesting habitat and broad foraging range of the species, it's occurrence within the Study Area is likely to vary, depending on the proximity of nesting to the Study Area (BirdLife Australia, 2012). The species is likely to forage broadly across most habitats occurring within the Study Area; however, the Study Area is not considered to be of particular importance to the species due to the relatively widespread occurrence of these habitats in the surrounding area.

The occurrence of a further eight species identified in the desktop assessment within the Study Area was considered Possible, including northern quoll, brush-tailed mulgara, long-tailed dunnart, Pilbara leaf-nosed bat, fork-tailed swift, grey falcon, spotted ctenotus and Pilbara flat-headed blind-snake. The remaining 28 species were considered Unlikely to occur within the Study Area, particularly due to the absence of suitable habitat occurring within the Study Area.

7 REFERENCES

Anstee, S. D. (1996). Use of external mound structures as indicators of the presence of the pebble-mound mouse, *Pseudomys chapmani*, in mound systems. *Wildlife Research, 23*(4), 429–434. doi:http://dx.doi.org/10.1071/WR9960429

Anstee, S. D., & Armstrong, K. N. (2001). The effect of familiarity and mound condition in translocations of the western pebble-mound mouse, *Pseudomys chapmani*, in the Pilbara region of Western Australia. *Wildlife Research, 28*(2), 135-140. doi:https://doi.org/10.1071/WR99081

Armstrong, K. N. (2001). The distribution and roost habitat of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research, 28*, 95–104. doi:https://doi.org/10.1071/WR00011

Armstrong, K. N., & Anstee, S. D. (2000). The ghost bat in the Pilbara: 100 years on. *Australian Mammalogy, 22*, 93–101. doi:https://doi.org/10.1071/AM00093

Astron. (2010). *Mt Whaleback TSF flora, vegetation and fauna assessment*. Astron Environmental Services, Perth, WA.

Bastin, G. (2008). *Rangelands 2008 - Taking the pulse*. Canberra, Australian Capital Territory: National Land & Water Resources Audit.

Bat Call. (2021). *A review of ghost bat ecology, threats and survey requirements*. Bat Call WA, Hillarys, WA.

Bat Call. (2022). *A review of Pilbara leaf-nosed bat ecology, threats and survey requirements*. Bat Call WA, Hillarys, WA.

Beard, J. S. (1975). *The vegetation of the Nullarbor Area: 1:1,000,000 vegetation series, map and explanatory notes to sheet 4*. Nedlands, Western Australia: University of Western Australia Press.

Bettany, E., Churchward, H. M., & McArthur, W. M. (1967). *Atlas of Australian soils*. Melbourne, Victoria: CSIRO Australia and Melbourne University Press.

BHP. (2017). *Guidance for terrestrial vertebrate fauna surveys in the Pilbara*. Unpublished procedure prepared by BHP Billiton Iron Ore. BHP Billiton Iron Ore, Perth, WA.

BHP WAIO. (2021). *BHP WAIO fauna records database (custom search)*.

Biologic. (2009). *Newman power network level 2 flora and level 1 fauna survey*. Biologic Environmental Survey,

Biologic. (2011). *Orebody 35 and Western Ridge vertebrate fauna survey*. Biologic Environmental Survey,

Biologic. (2013). *Orebody 24 targeted vertebrate fauna survey*. Biologic Environmental Survey,

Biologic. (2014). *Orebody 25 targeted vertebrate fauna survey*. Biologic Environmental Survey,

Biologic. (2016a). *Cathedral Gorge level 1 and targeted vertebrate fauna survey*. Biologic Environmental Survey,

Biologic. (2016b). *Western Ridge southern tenements vertebrate fauna desktop assessment*. Biologic Environmental Survey,

Biologic. (2020a). *Coombanbunna Well level 2 vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey, East Perth, WA.

Biologic. (2020b). *Developments in knowledge of ghost bat home range and foraging areas, and its application at Mining Area C - South Flank*. Unpublished report prepared for BHP Western Australian Iron Ore. Biologic Environmental Survey, East Perth, WA.

Biologic. (2020c). *Western Ridge Detailed Flora and Vegetation Assessment*. Unpublished report prepared for BHP Western Australian Iron Ore. Biologic Environmental Survey, Unpublished report prepared for BHP Western Australian Iron Ore.

Biologic. (2020d). *Western Ridge targeted vertebrate fauna survey*. Biologic Environmental Survey, East Perth, WA.

Biologic. (2021). *Western Ridge matters of national environmental significance fauna study*. Biologic Environmental Survey, East Perth, WA.

Biota. (2001). *Baseline biological and soil surveys and mapping for ML244SA west of the Fortescue River*. Biota Environmental Sciences, Leederville, WA.

BirdLife Australia. (2012). *Peregrine Falcon*. BirdLife Australia, Collingwood Australia.

BirdLife Australia. (2021). Birdata (custom search). http://www.birdata.com.au/custom.vm

BirdLife International. (2016). Charadrius dubius. The IUCN Red List of Threatened Species 2016. doi:e.T22693770A86577884. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693770A86577884.en

BoM, Bureau of Meteorology. (2022). Climate Data Online. Retrieved 2022 http://www.bom.gov.au./climate/data/index.shtml

Braithwaite, R. W., & Griffiths, A. D. (1994). Demographic variation and range contraction in the northern quoll, *Dasyurus hallucatus (Marsupialia: Dasyuridae)*. *Wildlife Research, 21*, 203-217.

Bullen, R. D. (2013). *Pilbara leaf-nosed bat (Rhinonicteris aurantia); summary of current data on distribution, energetics, threats*. Paper presented at the Pilbara Leaf-nosed Bat workshop, Kensington, Western Australia.

Bullen, R. D., & Reiffer, S. (2019). A record of movement of a Pilbara leaf-nosed bat between distant diurnal roosts using PIT tags. *Australian Mammalogy, 42*(4), 119-121. doi:https://doi.org/10.1071/AM18054

Burbidge, A. A., McKenzie , N. L., & Fuller, P. J. (2008). Long-tailed Dunnart (Sminthopsis longicaudata). In *Mammals of Australia* (Third ed., pp. 148-150). Sydney, New South Wales: Reed New Holland.

Burbidge, A. H., Johnstone, R. E., & Pearson, D. J. (2010). Birds in a vast arid upland: avian biogeographical patterns in the Pilbara region of Western Australia. *Records of the Western Australian Museum Supplement, 78*, 247-270.

Burrows, N. D., Dunlop, J., & Burrows, S. (2012). Searching for signs of bilby (*Macrotis lagotis*) activity in central Western Australia using observers on horseback. *Journal of the Royal Society of Western Australia, 95*, 167-170.

Bylemans, J., Gleeson, D. M., Duncan, R. P., Hardy, C. M., & Furlan, E. M. (2019). A performance evaluation of targeted eDNA and eDNA metabarcoding analyses for freshwater fishes. *Environmental DNA, 1*(4), 402-414. doi:https://onlinelibrary.wiley.com/doi/abs/10.1002/edn3.41

Churchill, S. K. (1991). Distribution, abundance and roost selection of the orange horseshoe-bat, *Rhinonycteris aurantius*, a tropical cave-dweller. *Wildlife Research, 18*, 343-353.

Churchill, S. K. (2008). *Australian bats* (Second Edition ed.). Crow's Nest, New South Wales: Allen and Unwin.

Cogger, H. G. (2014). *Reptiles and amphibians of Australia* (Seventh ed.). Collingwood, Victoria: CSIRO Publishing.

Cramer, V. A., Armstrong, K. N., Bullen, R. D., Ellis, R., Gibson, L. A., McKenzie, N. L., . . . van Leeuwen, S. (2016). Research priorities for the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form). *Australian Mammalogy, 38*(2), 149-157. doi:https://doi.org/10.1071/AM15012

Cramer, V. A., Dziminski, M. A., Southgate, R., Carpenter, F. M., Ellis, i. R. J., & van Leeuwen, S. (2017). A conceptual framework for habitat use and research priorities for the greater bilby (*Macrotis lagotis*) in the north of Western Australia. *Australian Mammalogy, 39*(2), 137-151. doi:https://doi.org/10.1071/AM16009

CSIRO, Commonwealth Scientific and Industrial Research Organisation. (2009). *Australian soil and land survey field handbook* (Third ed.). Collingwood, Australia: CSIRO Publishing.

Davis, R. A., & Metcalf, B. M. (2008). The night parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. *Emu - Austral Ornithology, 108*(3), 233-236. doi:http://dx.doi.org/10.1071/MU07058

DAWE, Department of Agriculture, Water and the Environment. (2021). Protected Matters Search Tool (custom search). Retrieved 2021 www.environment.gov.au/erin/ert/epbc/index.html

DBCA. (2017). *Guidelines for surveys to detect the presence of bilbies and assess the importance of habitat in Western Australia*. Department of Biodiversity, Conservation and Attractions, Kensington, WA.

DBCA, Department of Biodiversity, Conservation and Attractions. (2020). Threatened and priority fauna database (custom search). from Department of Biodiversity, Conservation and Attractions http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals

DBCA, Department of Biodiversity, Conservation and Attractions. (2021). NatureMap: Mapping Western Australia's biodiversity (custom search). Retrieved 2021 http://naturemap.dec.wa.gov.au./default.aspx

Desmond, A., Kendrick, P., & Chant, A. (2001). Gascoyne 3 (GAS3 - Augustus subregion). In J. May & N. McKenzie (Eds.), *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002* (pp. 240–252). Kensington, Western Australia: Department of Conservation and Land Management.

DEWHA. (2010a). *Survey guidelines for Australia's threatened bats*. Canberra, Australian Capital Territory: Department of Environment, Water, Heritage and the Arts.

DEWHA. (2010b). *Survey guidelines for Australia's threatened birds*. Canberra, Australian Capital Territory: Department of Environment, Water, Heritage and the Arts.

DoE. (2016). *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus*. Canberra, Australian Capital Territory: Department of the Environment.

DoE, Department of the Environment. (2013). *Matters of national environmental significance: significant impact guidelines*. Department of the Environment, Canberra, Australian Capital Territory.

DoE, Department of the Environment. (2018). *Apus pacificus in Species Profile and Threats Database*. Canberra, Australian Capital Territory: Department of the Environment Retrieved from http://www.environment.gov.au/sprat.

DoEE, Department of the Environment and Energy. (2019). Species profile and threats database. from Department of the Environment and Energy http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DPaW, Department of Parks and Wildlife. (2017). *Interim guideline for preliminary surveys of Night Parrot (Pezoporus occidentalis) in Western Australia*. Department of Parks and Wildlife, Kensington, Western Australia.

DSEWPaC. (2011a). *Survey guidelines for Australia's threatened mammals*. Canberra, Australian Capital Territory: Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC. (2011b). *Survey guidelines for Australia's threatened reptiles*. Canberra, Australian Capital Territory: Department of Sustainability, Environment, Water, Population and Communities.

Dziminski, M. A., & Carpenter, F. (2016). *The conservation and management of the bilby (Macrotis lagotis) in the Pilbara: Progress Report 2016*. Department of Parks and Wildlife. Perth, Western Australia.

Eco Logical. (2011). *Newman power line corridor level 1 flora and fauna survey*. Eco Logical Australia, Perth, WA.

Eco Logical. (2012a). *Level 1 flora and fauna surveys along the Great Northern Highway for Jimblebar Mine module transport*. Eco Logical Australia, Perth, WA.

Eco Logical. (2012b). *Orebody 37 level 1 vertebrate fauna assessment*. Eco Logical Australia, Perth, WA.

ecologia. (1998). *Mt Whaleback fauna monitoring programme: Baseline sampling 1997–1998*. ecologia Environmental Consultants, West Perth, WA.

ecologia. (2004). *Orebody 24 expansion biological survey*. ecologia Environmental Consultants, West Perth, WA.

ecologia. (2005). *Western Ridge exploration project biological survey*. ecologia Environmental Consultants, West Perth, WA.

ecologia. (2006). *BHPBIO Western Ridge exploration project biological survey*. ecologia Environmental Consultants, West Perth, WA.

ecologia. (2008). *RGP5 fauna survey Newman to Jimblebar junction*. ecologia Environmental Consultants, West Perth, WA.

ENV. (2006). *Mount Whaleback fauna assessment survey phase III*. ENV Australia, Perth, WA.

ENV. (2009a). *Newman to Jimblebar transmission line and Newman town substation terrestrial fauna assessment*. ENV Australia, Perth, WA.

ENV. (2009b). *Newman to Yandi transmission line terrestrial vertebrate fauna assessment*. ENV Australia, Perth, WA.

ENV. (2010). *Orebody 35 vegetation clearing permit area flora and fauna assessment*. ENV Australia, Perth, WA.

ENV. (2011a). *Eastern Ridge (OB23/24/25) fauna assessment*. ENV Australia, Perth, WA.

ENV. (2011b). *Mt Whaleback East flora, vegetation and fauna assessment*. ENV Australia, Perth, WA.

EPA, Environmental Protection Authority. (2016). *Environmental factor guideline: Terrestrial fauna*. Perth, Western Australia: Environmental Protection Authority.

EPA, Environmental Protection Authority. (2020). *Technical guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment*. Western Australia: Environmental Protection Authority.

ESCAVI, Executive Steering Committee for Australian Vegetation Information. (2003). *Australian vegetation attribute manual: National vegetation information system (version 6.0)*. Canberra, Australian Capital Territory: ESCAVI, Executive Steering Committee for Australian Vegetation Information.

FMG, Fortescue Metals Group. (2021, 25 June 2021). Fortecue research confirms endangered night parrot co-existing with mining. Retrieved from https://www.fmgl.com.au/isobar-development/blog-preview-page/our-stories/2021/06/25/fortescue-research-confirms-endangered-night-parrot-co-existing-with-mining

Garnett, S., & Crowley, G. (2000). *The action plan for Australian birds 2000* (1st ed.). Canberra, Australian Capital Territory: Environment Australia and the Royal Australia Ornithologists Union.

Geering, A., Agnew, L., & Harding, S. (2007). *Shorebirds of Australia*. Collingwood, Victoria: CSIRO Publishing.

GHD. (2008). *Myopic project area, Newman: Flora and fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore Pty Ltd. GHD Pty Ltd, Perth, WA.

Harper, L. R., Lawson Handley, L., Hahn, C., Boonham, N., Rees, H. C., Gough, K. C., . . . Hänfling, B. (2018). Needle in a haystack? A comparison of eDNA metabarcoding and targeted qPCR for detection of the great crested newt (Triturus cristatus). *Ecology and Evolution, 8*(12), 6330-6341. doi:https://onlinelibrary.wiley.com/doi/abs/10.1002/ece3.4013

HGM, Halpern Glick Maunsell. (1999). *Orebody 30 and Orebody 35 soil & biological survey*. Halpern Glick Maunsell, Perth, WA.

Higgins, P. J., & Davies, J. J. F. (Eds.). (1996). *Volume 3: Snipe to Pigeons*. Melbourne, Vic: Oxford University Press.

Hohnen, R., Ashby, J., Tuft, K., & McGregor, H. (2012). Individual identification of northern quolls (*Dasyurus hallucatus*) using remote cameras. *Australian Mammalogy, 35*(2), 131-135. doi:http://dx.doi.org/10.1071/AM12015

How, R. A., Dell, J., & Cooper, N. K. (1991). Ecological survey of Abydos-Woodstock Reserve, Pilbara region, Western Australia: Vertebrate fauna. *Records of the Western Australian Museum Supplement, 37*, 78-125.

Huerlimann, R., Cooper, M. K., Edmunds, R. C., Villacorta-Rath, C., Le Port, A., Robson, H. L. A., . . . Jerry, D. R. (2020). Enhancing tropical conservation and ecology research with aquatic environmental DNA methods: An introduction for non-environmental DNA specialists. *Animal Conservation*. doi:https://zslpublications.onlinelibrary.wiley.com/doi/abs/10.1111/acv.12583

IUCN, International Union for the Conservation of Nature and Natural Resources. (2021). The IUCN Red List of Threatened Species. Retrieved from www.iucnredlist.org

Johnstone, R., & Storr, G. M. (1998). *Handbook of Western Australian Birds Volume I - Non-passerines (Emu to Dollarbird)*. Perth, Western Australia: Western Australian Museum.

Johnstone, R., & Storr, G. M. (2004). *Handbook of Western Australian birds. Volume II: Passerines (Blue-winged Pitta to Goldfinch)*. Perth, Western Australia: Western Australian Museum.

Johnstone, R. E., Burbidge, A. H., & Darnell, J. C. (2013). Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes. *Records of the Western Australian Museum Supplement, 78*, 343-441.

Kendrick, P. (2001). Pilbara 3 (PIL3 - Hamersley subregion). In J. May & N. McKenzie (Eds.), *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002* (pp. 568-580). Kensington, Western Australia: Department of Conservation and Land Management.

Körtner, G., Pavey, C., & Geiser, F. (2007). Spatial ecology of the mulgara in arid Australia: impact of fire history on home range size and burrow use. *Journal of Zoology, 273*(4), 350-357.

Leighton, K. A. (2004). Climate. In A. M. E. van Vreeswyk, A. L. Payne, K. A. Leighton, & P. Hennig (Eds.), *An inventory and condition survey of the Pilbara region, Western Australia* (Vol.

Technical bulletin No. 92). Perth, Western Australia: Western Australian Department of Agriculture.

McGilp, J. N. (1931). *Geopsittacus occidentalis*, night parrot. *South Australian Ornithologist, 11*, 68-70.

McKenzie, N. L., van Leeuwen, S., & Pinder, A. M. (2009). Introduction to the Pilbara biodiversity survey, 2002-2007. *Records of the Western Australian Museum Supplement, 78*, 3-89.

National Committee on Soil and Terrain. (2009). *Australian soil and land survey field handbook* (Third ed.). Collingwood, Victoria: CSIRO Publishing.

North, A. J. (1898). List of birds collected by the Calvert Exploring Expedition in Western Australia. *Transactions of the Royal Society of South Australia, 22*, 125-192.

Oakwood, M. (2000). Reproduction and demography of the northern quoll, *Dasyurus hallucatus*, in the lowland savanna of northern Australia. *Australian Journal of Zoology, 48*, 519–539. doi:https://doi.org/10.1071/ZO00028

Olsen, J., Debus, S., Rose, A. B., & Hayes, G. (2004). Breeding success, cliff characterisation and diet of peregrine falcon at high altitude in the Australian Capital Territory. *Corella, 28*(2), 33-37.

Olsen, P. D., & Olsen, J. (1986). Distribution, status, movement and breeding of the grey falcon *Falco hypoleucos*. *Emu - Austral Ornithology, 86*(1), 47-51.

Olsen, P. D., & Olsen, J. (1989). Breeding of the peregrine falcon *Falco peregrinus*. III. Weather, nest quality and breeding success. *Emu - Austral Ornithology, 89*(1), 6-14. doi:https://doi.org/10.1071/MU9890006

Onshore. (2013). *Flora and vegetation and vertebrate fauna review Mt Whaleback AML 7/244*. Unpublished report preapred for BHP Billiton Iron Ore. Onshore Environmental Consultants, Yallingup, WA.

Onshore. (2014). *Western Ridge biological survey*. Onshore Environmental Consultants, Yallingup, WA.

Onshore. (2018). *Western Ridge E52/3448 Desktop Flora and Fauna Assessment*. Unpublished report prepared for BHP WAIO. Onshore Environmental Consultants, Yallingup, WA.

Onshore, & Biologic. (2009a). *Mt Whaleback mine site flora and vegetation survey and fauna assessment*. Onshore Environmental Consultants & Biologic Environmental Survey, Yallingup, WA.

Onshore, & Biologic. (2009b). *Myopic exploration leases biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. Onshore Environmental Consultants & Biologic Environmental Survey, Yallingup, WA.

Pavey, C. R., Nano, C. E. M., Cole, J. R., McDonald, P. J., Nunn, P., Silcocks, A., & Clarke, R. H. (2014). The breeding and foraging ecology and abundance of the princess parrot (*Polytelis alexandrae*) during a population irruption. *Emu - Austral Ornithology, 114*(2), 106-115. doi:http://dx.doi.org/10.1071/MU13050

Pavey, C. R., Nano, C. E. M., Cooper, S. J. B., Cole, J. R., & McDonald, P. J. (2012). Habitat use, population dynamics and species identification of mulgara, *Dasycercus blythi* and *D. cristicauda*, in a zone of sympatry in central Australia. *Australian Journal of Zoology, 59*(3), 156-169. doi:https://doi.org/10.1071/ZO11052

Payne, A. L., Mitchell, A. A., & Holman, W. F. (1988). *An inventory and condition survey of rangelands in the Ashburton River catchment, Western Australia*. Western Australian Department of Agriculture, South Perth, Western Australia.

Pearson, D. J. (1993). Distribution, status and conservation of pythons in Western Australia. In D. Lunney & D. Ayers (Eds.), *Herpetology in Australia: A diverse discipline* (pp. 383-395). Sydney, New South Wales: Royal Zoological Society of NSW.

Richards, G. C., Hand, S., Armstrong, K. N., & Hall, L. S. (2008). Ghost bat. In S. van Dyck & R. Strahan (Eds.), *Mammals of Australia* (Third ed.). Sydney, New South Wales: Reed New Holland.

Schoenjahn, J., Pavey, C. R., & Walter, G. H. (2019). Ecology of the grey falcon *Falco hypoleucos* – current and required knowledge. *Emu - Austral Ornithology, 120*(1), 1–9. doi:https://doi.org/10.1080/01584197.2019.1654393

Shepherd, D. P., Beeston, G. R., & Hopkins, A. J. M. (2002). *Native vegetation in Western Australia: Extent, type and status*. Perth, Western Australia: Western Australian Department of Agriculture.

Southgate, R. (1990). Habitat and diet of the greater bilby *Macrotis lagotis* (Marsupialia: Peramelidae). In J. H. Seeback, P. R. Brown, R. L. Wallis, & C. M. Kemper (Eds.), *Bandicoots and Bilbies* (pp. 303-309): Surrey Beatty & Sons.

Southgate, R., Dziminski, M. A., Paltridge, R., Schubert, A., & Gaikhorst, G. (2019). Verifying bilby presence and the systematic sampling of wild populations using sign-based protocols – with notes on aerial and ground survey techniques and asserting absence. *Australian Mammalogy, 41*(1). doi:https://doi.org/10.1071/AM17028

Start, A. N., Anstee, S. D., & Endersby, M. (2000). A review of the biology and conservation status of the ngadji, *Pseudomys chapmani* Kitchener, 1980 (Rodentia: Muridae). *CALMScience, 3*(2), 125-147.

Thackway, R., & Cresswell, I. D. (1995). *An Interim Biogeographical Regionalisation for Australia*. Canberra, ACT: Australian Nature Conservation Agency.

Tidemann, C. R., Priddel, D. M., Nelson, J. E., & Pettigrew, J. D. (1985). Foraging behaviour of the Australian ghost bat *Macroderma gigas* (Microchiroptera: Megadermatidae). *Australian Journal of Zoology, 33*(5), 705-713. doi:http://dx.doi.org/10.1071/ZO9850705

TSSC, Threatened Species Scientific Committee. (2016a). *Conservation advice: Macroderma gigas, ghost bat*. Commonwealth of Australia, Canberra, ACT.

TSSC, Threatened Species Scientific Committee. (2016b). *Conservation advice: Rhinonicteris aurantia (Pilbara form), Pilbara leaf-nosed bat*. Commonwealth of Australia, Canberra, ACT.

van Dyck, S., Gynther, I., & Baker, A. (2013). *Field companion to mammals of Australia*. Sydney, New South Wales: New Holland Publishers.

van Dyck, S., & Strahan, R. (2008). *The Mammals of Australia* (Third ed.). Sydney, New South Wales: Australian Museum.

van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., & Hennig, P. (2004). *An inventory and condition survey of the Pilbara region, Western Australia*. South Perth, Western Australia: Western Australian Department of Agriculture.

Waddell, P. A., Thomas, P. W. E., & Findlater, P. A. (2012). *A report on the Gascoyne River catchment following the 2010/11 flood events: Resource Management Technical Report 382*. South Perth WA.

Whitlock, F. L. (1924). Journey to central Australia in search of the night parrot. *Emu - Austral Ornithology, 23*, 248-281.

Wildlife Acoustics, Inc. (2011). *Song meter SM2BAT+ ultrasonic recorder*. Wildlife Acoustics Inc., Massachusetts, United States of America.

Wildlife Acoustics, Inc. (2017). *Song Meter SM4BAT FS bioacoustics recorder user guide*. Wildlife Acoustics Inc., Massachusetts, United States of America.

Willers, N., Mawson, P., Morris, K., & Bencini, R. (2011). Biology and population dynamics of the black-flanked Rock-wallaby (*Petrogale lateralis lateralis*) in the central wheatbelt of Western Australia. *Australian Mammalogy, 33*, 117-127.

Wilson, H. (1937). Notes on the night parrot, with references to recent occurrences. *Emu - Austral Ornithology, 37*(2), 79-87.

Wilson, S., & Swan, G. (2014). *A complete guide to reptiles of Australia*. Sydney, New South Wales: New Holland Publishers.

Woinarski, J. C. Z., Oakwood, M., Winter, J., Burnett, S., Milne, D., Foster, P., . . . Holmes, B. (2008). *Surviving the toads: Patterns of persistence of the northern quoll Dasyurus hallucatus in Queensland*. Report to the Australian Government's Natural Heritage Trust. http://www.nt.gov.au/nreta/wildlife/programs/quoll/pdf/qld_quolls_finalreport.pdf

Woolley, P. A. (2006). Studies on the crest-tailed mulgara *Dasycercus cristicauda* and the brush-tailed mulgara *Dasycercus blythi* (Marsupialia: Dasyuridae). *Australian Mammalogy, 28*, 117-120. doi:https://doi.org/10.1071/AM06018

8 APPENDICES

Appendix A – Conservation Listings

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.

Environment Protection and Biodiversity Conservation Act 1999

Category	Definition
Threatened	
Extinct (EX)	Presumed extinct i.e. there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Presumed extinct in the wild, only surviving in cultivation, captivity or as a naturalised population well outside its past range.
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future (i.e. 50% chance of extinction in the immediate future).
Endangered (EN)	Taxa facing a very high risk of extinction in the wild in the near future i.e. 20% chance of extinction in the near future.
Vulnerable (VU)	Taxa facing a high risk of extinction in the wild in the medium-term future i.e. 10% chance of extinction in the medium-term future.
Conservation Dependent (CD)	Taxa which will become Vulnerable, Endangered or Critically Endangered if specific conservation efforts cease.
Other	
Migratory (MI)	Birds listed under international agreements relating to the protection of migratory birds i.e. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Biodiversity Conservation Act 2016

Category	Definition
Extinct	
Extinct (EX)	Presumed extinct i.e. there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Presumed extinct in the wild i.e. species which have been adequately searched for and there is no reasonable doubt that the last wild individual has died.
Threatened	
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa facing a high risk of extinction in the wild.
Specially Protected	
Migratory (MI)	Birds listed under international agreements relating to the protection of migratory birds i.e. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).
Conservation Dependent (CD)	Species dependent on ongoing conservation intervention to prevent them becoming eligible for listing as threatened.
Other specially protected fauna (OS)	Species otherwise in need of special protection to ensure their conservation.

Department of Biodiversity, Conservation and Attractions Priority codes

Category	Definition
Poorly known	
Priority 1 (P1)	Species that are known from one or a few locations which are potentially at risk. Species whose occurrences are either small, on lands not managed for conservation or otherwise threatened with habitat destruction or degradation. Species that are well known from one or more locations but are under immediate threat from threatening processes. In urgent need of further survey.
Priority 2 (P2)	Species that are known from one or a few locations, some of which are on lands managed for conservation. Species that are well known from one or more locations but are under threat from threatening processes. In urgent need of further survey. In need of further survey.
Priority 3 (P3)	Species that are well known from several locations and are not are under imminent threat. Species known from few but widespread locations with either a large population size or with large areas of suitable habitat remaining, much of which is not under imminent threat. Species that are well known from one or more locations and threatening processes exist that could affect them.
Rare, Near Threatened and other species in need of monitoring	
Priority 4 (P4)	*Rare* – Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection but could be if present circumstances change. *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. *In need of monitoring* - Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy

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

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																													Current Survey
		EPBC Act	BC Act	DBCA	IUCN	NatureMap	Birdata	DBCA T&P Fauna	EPBC Protected Matters	BHP WAIO Fauna Records Database	A (Biologic, 2009)	B (Eco Logical, 2012b)	C (Onshore, 2014)	D (Onshore, 2018)	E (Biologic, 2020a)	F (Biologic, 2011)	G (Biologic, 2016b)	H (Biologic, 2020d)	I (ecologia, 2008)	J (ENV, 2011b)	K (ENV, 2011a)	L (ENV, 2010)	M (ENV, 2006)	N (Astron, 2010)	O (Eco Logical, 2012a)	P (HGM, 1999)	Q (Eco Logical, 2011)	R (Biologic, 2014)	S (ecologia, 2005)	T (ecologia, 2006)	U (Onshore & Biologic, 2009a)	V (Biologic, 2013)	W (ecologia, 1998)	X (ecologia, 2004)	Y (GHD, 2008)	Z (ENV, 2009b)	AA (ENV, 2009a)	AB (Biota, 2001)	AC (Onshore & Biologic, 2009b)	
MAMMALS																																								
BOVIDAE																																								
**Bos taurus*	cow					•				•		•			•	•		•	•							•		•			•					•	•	•
**Capra hircus*	goat																																		•					
CAMELIDAE																																								
**Camelus dromedarius*	camel					•			•						•																									
CANIDAE																																								
**Canis familiaris*	dog/ dingo								•	•	•	•			•	•			•	•		•		•	•	•	•		•	•		•		•	•	•	•		•
**Vulpes vulpes*	fox								•		•												•			•													•	
DASYURIDAE																																								
Dasycercus blythi	brush-tailed mulgara			P4		•		•		•																					•								
Dasykaluta rosamondae	little red kaluta					•				•					•											•							•	•			•		
Dasyurus hallucatus	northern quoll	EN	EN		EN				•	•								•																						
Ningaui timealeyi	Pilbara ningaui					•									•											•							•				•		
Planigale maculata	common planigale																									•							•				•		
Planigale sp.	undescribed Pilbara planigale									•						•																								
Pseudantechinus macdonnellensis	fat-tailed antechinus																									•														
Pseudantechinus woolleyae	woolley's pseudantechinus					•										•										•							•				•		
Sminthopsis crassicaudata	fat-tailed dunnart					•																																		
Sminthopsis longicaudata	long-tailed dunnart			P4		•		•		•																•							•				•		
Sminthopsis macroura	stripe-faced dunnart					•				•					•	•							•			•		•					•				•		
Sminthopsis ooldea	ooldea dunnart					•									•											•							•				•		
Sminthopsis youngsoni	lesser hairy-footed dunnart					•																																		
EMBALLONURIDAE																																								
Saccolaimus flaviventris	yellow-bellied sheathtail-bat					•				•	•	•			•	•					•		•			•		•				•							
Taphozous georgianus	common sheathtail-bat					•				•	•				•	•					•		•			•		•		•		•					•		
Taphozous hilli	hill's sheathtail-bat					•				•					•	•										•							•				•		•
EQUIDAE																																								
**Equus asinus*	donkey								•	•					•	•																								
**Equus caballus*	horse					•			•	•		•				•																								
FELIDAE																																								
**Felis catus*	cat					•			•	•	•	•			•	•		•					•			•		•	•		•			•	•	•	•	•	•	•
RHINONYCTERIDAE																																								
Rhinonicteris aurantia	Pilbara leaf-nosed bat	VU	VU			•		•	•	•					•											•						•							

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																												
		EPBC Act	BC Act	DBCA	IUCN	NatureMap	Birdata	DBCA T&P Fauna	EPBC Protected Matters	BHP WAIO Fauna Records Database	A (Biologic, 2009)	B (Eco Logical, 2012b)	C (Onshore, 2014)	D (Onshore, 2018)	E (Biologic, 2020a)	F (Biologic, 2011)	G (Biologic, 2016b)	H (Biologic, 2020d)	I (ecologia, 2008)	J (ENV, 2011b)	K (ENV, 2011a)	L (ENV, 2010)	M (ENV, 2006)	N (Astron, 2010)	O (Eco Logical, 2012a)	P (HGM, 1999)	Q (Eco Logical, 2011)	R (Biologic, 2014)	S (ecologia, 2005)	T (ecologia, 2006)	U (Onshore & Biologic, 2009a)	V (Biologic, 2013)	W (ecologia, 1998)	X (ecologia, 2004)	Y (GHD, 2008)	Z (ENV, 2009b)	AA (ENV, 2009a)	AB (Biota, 2001)	AC (Onshore & Biologic, 2009b)	Current Survey
LEPORIDAE																																							
**Oryctolagus cuniculus*	rabbit					•			•	•						•												•	•	•									
MACROPODIDAE																																							
Osphranter robustus subsp. *erubescens*	euro					•				•					•	•		•				•						•	•	•	•	•							
Osphranter rufus	red kangaroo					•				•					•	•				•	•	•		•					•	•	•	•							•
Petrogale lateralis subsp. *lateralis*	black-flanked rock-wallaby	EN	EN		NT	•		•																														
Petrogale rothschildi	rothschild's rock-wallaby					•				•						•		•				•						•		•	•							
Petrogale sp.	rock-wallaby					•																																	
MEGADERMATIDAE																																							
Macroderma gigas	ghost bat	VU	VU		VU	•		•	•	•						•		•											•		•							
MOLOSSIDAE																																							
Austronomus australis	white-striped freetail-bat									•											•							•		•									
Chaerephon jobensis subsp. *colonicus*	northern freetail-bat					•				•					•						•							•		•		•							•
Ozimops lumsdenae	northern free-tailed bat									•					•	•					•							•				•							•
MURIDAE																																							
**Mus musculus*	house mouse					•			•	•																													
Notomys alexis	spinifex hopping-mouse					•				•																						•							
Pseudomys chapmani	western pebble-mound mouse			P4		•		•		•					•	•		•		•	•	•										•							•
Pseudomys desertor	desert mouse					•				•					•																								
Pseudomys hermannsburgensis	sandy inland mouse					•				•					•	•																							
Zyzomys argurus	common rock-rat					•				•					•	•		•														•							
TACHYGLOSSIDAE																																							
Tachyglossus aculeatus	echidna					•				•						•							•			•					•	•			•	•		
THYLACOMYIDAE																																							
Macrotis lagotis	bilby	VU	VU		VU	•		•	•																													
VESPERTILIONIDAE																																							
Chalinolobus gouldii	gould's wattled bat					•				•	•	•			•	•					•		•			•		•		•		•							•
Nyctophilus geoffroyi	lesser long-eared bat					•				•					•	•							•			•		•				•							•
Scotorepens balstoni	inland broad-nosed bat					•																				•											•		
Scotorepens greyii	little broad-nosed bat					•				•	•	•			•	•					•		•			•		•			•	•		•		•	•		•
Vespadelus finlaysoni	finlayson's cave bat					•				•	•	•			•	•					•		•			•		•		•		•				•	•		•
AVES																																							
ACANTHIZIDAE																																							
Acanthiza apicalis	inland thornbill					•	•			•					•	•										•			•	•			•	•			•			

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																										Current Survey
		EPBC Act	BC Act	DBCA	IUCN	NatureMap	Birdata	DBCA T&P Fauna	EPBC Protected Matters	BHP WAIO Fauna Records Database	A (Biologic, 2009)	B (Eco Logical, 2012b)	C (Onshore, 2014)	D (Onshore, 2018)	E (Biologic, 2020a)	F (Biologic, 2011)	G (Biologic, 2016b)	H (Biologic, 2020d)	I (ecologia, 2008)	J (ENV, 2011b)	K (ENV, 2011a)	L (ENV, 2010)	M (ENV, 2006)	N (Astron, 2010)	O (Eco Logical, 2012a)	P (HGM, 1999)	Q (Eco Logical, 2011)	R (Biologic, 2014)	S (ecologia, 2005)	T (ecologia, 2006)	U (Onshore & Biologic, 2009a)	V (Biologic, 2013)	W (ecologia, 1998)	X (ecologia, 2004)	Y (GHD, 2008)	Z (ENV, 2009b)	AA (ENV, 2009a)	AB (Biota, 2001)	AC (Onshore & Biologic, 2009b)	
Acanthiza chrysorrhoa	yellow-rumped thornbill					•	•															•				•						•			•		•		
Acanthiza robustirostris	slaty-backed thornbill					•	•								•														•			•				•	•		
Acanthiza uropygialis	chestnut-rumped thornbill					•	•			•	•		•		•	•			•		•					•			•	•		•					•		•
Aphelocephala leucopsis	southern whiteface					•	•																																
Gerygone fusca	western gerygone					•	•			•	•				•	•		•			•					•	•			•	•		•	•	•	•	•	•		
Pyrrholaemus brunneus	redthroat					•	•								•	•																					•		•
Smicrornis brevirostris	weebill					•	•			•	•	•	•		•	•			•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
ACCIPITRIDAE																																							
Accipiter cirrocephalus	collared sparrowhawk					•	•			•																•							•	•			•			
Accipiter fasciatus	brown goshawk					•	•			•	•				•	•							•			•			•		•	•	•		•	•	•		•
Aquila audax	wedge-tailed eagle					•	•			•			•		•	•			•				•			•	•		•	•	•	•	•			•	•	•	•
Circus approximans	swamp harrier					•	•																																
Circus assimilis	spotted harrier					•	•			•			•		•											•							•	•			•	•		
Elanus caeruleus subsp. *axillaris*	black-shouldered kite					•	•			•		•			•				•				•			•							•	•			•	•		
Haliaeetus leucogaster	white-bellied sea-eagle					•	•			•																•														
Haliastur sphenurus	whistling kite					•	•			•		•	•		•	•			•	•	•		•		•	•	•			•	•	•	•	•	•	•	•	•	•
Hamirostra isura	square-tailed kite					•	•			•		•						•																					
Hamirostra melanosternon	black-breasted buzzard					•	•			•			•		•								•			•	•			•					•	•			
Hieraaetus morphnoides	little eagle					•	•			•		•									•					•							•			•	•	•	•
Milvus migrans	black kite					•	•			•		•							•				•		•	•	•												
ACROCEPHALIDAE																																							
Acrocephalus australis	Australian reed-warbler					•	•			•	•					•														•		•				•	•		
AEGOTHELIDAE																																							
Aegotheles cristatus	Australian owlet-nightjar					•	•			•			•		•			•								•			•			•	•	•			•		•
ALAUDIDAE																																							
Mirafra javanica	horsfield's bushlark					•	•			•		•																											•
ALCEDINIDAE																																							
Dacelo leachii subsp. *leachii*	blue-winged kookaburra					•	•			•	•	•									•		•			•						•	•	•		•	•	•	•
Todiramphus pyrrhopygius	red-backed kingfisher					•	•			•	•				•			•	•	•	•		•			•				•	•		•	•			•	•	•	•
Todiramphus sanctus	sacred kingfisher					•	•			•		•			•				•							•	•						•				•	•		•
ANATIDAE																																							
Anas gracilis	grey teal					•	•			•	•	•				•										•					•		•				•		•
Anas rhynchotis	Australasian shoveler					•	•																																
Anas superciliosa	pacific black duck					•	•			•	•	•				•										•					•		•				•		•

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																										Current Survey
		EPBC Act	BC Act	DBCA	IUCN	NatureMap	Birdata	DBCA T&P Fauna	EPBC Protected Matters	BHP WAIO Fauna Records Database	A (Biologic, 2009)	B (Eco Logical, 2012b)	C (Onshore, 2014)	D (Onshore, 2018)	E (Biologic, 2020a)	F (Biologic, 2011)	G (Biologic, 2016b)	H (Biologic, 2020d)	I (ecologia, 2008)	J (ENV, 2011b)	K (ENV, 2011a)	L (ENV, 2010)	M (ENV, 2006)	N (Astron, 2010)	O (Eco Logical, 2012a)	P (HGM, 1999)	Q (Eco Logical, 2011)	R (Biologic, 2014)	S (ecologia, 2005)	T (ecologia, 2006)	U (Onshore & Biologic, 2009a)	V (Biologic, 2013)	W (ecologia, 1998)	X (ecologia, 2004)	Y (GHD, 2008)	Z (ENV, 2009b)	AA (ENV, 2009a)	AB (Biota, 2001)	AC (Onshore & Biologic, 2009b)	
Aythya australis	hardhead					●	●			●	●	●				●														●								
Biziura lobata	musk duck					●	●																														
Chenonetta jubata	Australian wood duck					●	●			●		●																										●
Cygnus atratus	black swan					●	●			●		●				●																●				●		●
Dendrocygna arcuata	wandering whistling duck					●	●			●																											
Dendrocygna eytoni	plumed whistling-duck					●	●			●																											
Malacorhynchus membranaceus	pink-eared duck					●	●			●	●																			●		●				●		●
Stictonetta naevosa	freckled duck					●	●			●																											
Tadorna tadornoides	Australian shell duck					●	●			●		●				●																●				●		
ANHINGIDAE																																					
Anhinga novaehollandiae	Australasian darter					●	●			●		●														●									●		●
ANSERANATIDAE																																					
Anseranas semipalmata	magpie goose					●	●																														
APODIDAE																																					
Apus pacificus	fork-tailed swift	MI	MI						●																	●											
ARDEIDAE																																					
Ardea garzetta	little egret					●	●			●																											
Ardea ibis	cattle egret					●	●		●																												
Ardea intermedia	intermediate egret					●	●			●																											
Ardea modesta	eastern great egret					●	●		●	●		●				●										●						●				●		
Ardea novaehollandiae	white-faced heron					●	●			●		●				●										●						●				●		
Ardea pacifica	white-necked heron					●	●			●		●														●										●		
Nycticorax caledonicus subsp. *australasiae*	nankeen night-heron					●	●			●																											
ARTAMIDAE																																					
Artamus cinereus	black-faced woodswallow					●	●			●	●		●		●	●		●	●		●					●	●		●	●	●	●			●	●	●	●
Artamus cyanopterus	dusky woodswallow					●	●																														
Artamus minor	little woodswallow					●	●			●	●					●				●			●			●		●		●	●	●	●	●	●	●		
Artamus personatus	masked woodswallow					●	●			●		●			●					●		●				●						●						●
Artamus superciliosus	white-browed woodswallow					●	●			●		●																										
Cracticus nigrogularis	pied butcherbird					●	●			●	●	●	●		●	●		●	●		●	●				●	●	●		●	●	●	●	●	●	●	●	●
Cracticus tibicen	Australian magpie					●	●			●					●	●			●		●		●		●	●			●	●		●	●	●	●	●	●	●
Cracticus torquatus	grey butcherbird					●	●			●					●	●		●			●		●			●		●	●				●		●	●		●	
BURHINIDAE																																					
Burhinus grallarius	bush stone-curlew					●	●								●											●												●

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																													Current Survey
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CACATUIDAE																																								
Cacatua roseicapilla	galah					•	•			•	•	•			•	•		•			•	•	•			•	•	•		•	•	•		•	•	•	•	•	•
Cacatua sanguinea	little corella					•	•			•	•	•	•		•				•		•		•			•	•					•	•		•	•	•	•		•
Nymphicus hollandicus	cockatiel					•	•			•	•	•	•		•			•			•					•	•	•			•		•	•		•	•		•	•
CAMPEPHAGIDAE																																								
Coracina maxima	ground cuckoo-shrike					•				•			•			•															•		•					•	
Coracina novaehollandiae subsp. *subpallida*	black-faced cuckoo-shrike					•				•	•	•	•		•	•		•	•	•		•	•			•	•			•	•	•	•	•	•	•	•	•	•
Lalage tricolor	white-winged triller					•	•			•	•				•	•							•			•				•	•		•	•		•	•	•	•	•
CAPRIMULGIDAE																																								
Eurostopodus argus	spotted nightjar					•	•			•					•	•		•				•				•				•			•	•	•	•		•	•	•
CASUARIIDAE																																								
Dromaius novaehollandiae	emu					•	•			•		•			•											•											•			
CHARADRIIDAE																																								
Charadrius leschenaultii subsp. *leschenaultii*	greater sand plover	VU/MI	VU/MI																																					
Charadrius dubius	little ringed plover	MI	MI							•																•														
Elseyornis melanops	black-fronted dotterel					•	•			•						•										•							•				•		
Charadrius ruficapillus	red-capped plover					•	•									•																							
Charadrius veredus	oriental plover	MI	MI					•	•																															
Erythrogonys cinctus	red-kneed dotterel						•			•																													
Vanellus tricolor	banded lapwing					•																																	•
CICONIIDAE																																								
Ephippiorhynchus asiaticus	black-necked stork				NT	•	•																																
CINCLOSOMATIDAE																																								
Cinclosoma castaneothorax	chestnut-breasted quail-thrush					•	•								•											•														
CLIMACTERIDAE																																								
Climacteris melanurus	black-tailed treecreeper						•																																	
COLUMBIDAE																																								
**Columba livia*	domestic pigeon								•																															
Geopelia cuneata	diamond dove					•	•			•	•	•			•			•	•	•			•			•	•	•	•	•	•	•		•	•	•	•	•	•
Geopelia humeralis	bar-shouldered dove					•	•																																	
Geopelia striata subsp. *placida*	peaceful dove					•	•			•	•				•	•			•	•		•									•				•	•	•		•	
Geophaps plumifera subsp. *ferruginea*	spinifex pigeon					•	•			•	•	•	•		•	•			•	•	•	•	•			•	•	•		•	•	•	•	•	•	•		•	•	•
Ocyphaps lophotes	crested pigeon					•	•			•	•	•	•		•	•		•	•		•	•	•			•	•		•	•	•	•	•	•	•		•	•	•	•
Phaps chalcoptera	common bronzewing					•	•			•			•		•	•				•			•			•			•		•		•				•			•

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CORVIDAE																																					
Corvus bennetti	little crow					●	●			●					●											●			●			●	●					
Corvus orru subsp. *cecilae*	torresian crow					●	●			●	●		●		●	●		●			●		●			●	●			●		●	●	●	●	●		●	●
CUCULIDAE																																					
Cacomantis pallidus	pallid cuckoo					●	●			●			●		●			●			●					●	●			●			●	●			●		●
Centropus phasianinus subsp. *highami*	pheasant coucal					●				●		●																						●				
Chrysococcyx basalis	horsfield's bronze-cuckoo					●	●			●					●			●								●				●			●	●				●	●
Chrysococcyx osculans	black-eared cuckoo					●	●		●												●					●							●				●		●
DICAEIDAE																																					
Dicaeum hirundinaceum	mistletoebird					●	●			●						●							●			●		●					●	●			●		
ESTRILDIDAE																																					
Emblema pictum	painted finch					●	●			●	●		●		●	●		●		●	●		●			●	●	●		●	●	●	●	●	●	●	●	●	●
Neochmia ruficauda subsp. *subclarescens*	star finch (western)					●	●			●	●					●															●					●		●	
Taeniopygia guttata	zebra finch					●	●			●		●	●		●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
FALCONIDAE																																					
Falco berigora	brown falcon					●	●			●	●				●	●		●			●		●			●	●			●	●	●	●	●		●	●	●	●
Falco cenchroides	nankeen kestrel					●	●			●	●	●	●		●	●				●	●	●	●			●	●			●	●	●	●	●	●	●	●	●	●
Falco hypoleucos	grey falcon	VU	VU		VU				●																	●													
Falco longipennis	Australian hobby					●	●			●	●										●					●	●			●		●	●	●			●	●	
Falco peregrinus	peregrine falcon		OS			●	●	●		●					●	●		●								●						●	●		●			●	
GLAREOLIDAE																																					
Stiltia isabella	Australian pratincole					●	●			●																												
HIRUNDINIDAE																																					
Cheramoeca leucosterna	white-backed swallow					●	●			●																●								●			●		
Hirundo neoxena	welcome swallow					●	●																			●													
Hirundo rustica	barn swallow	MI	MI						●																														
Petrochelidon ariel	fairy martin					●	●			●		●				●			●				●			●								●				●		
Petrochelidon nigricans	tree martin					●	●			●		●				●										●	●		●				●			●	●	●		
LARIDAE																																					
Larus novaehollandiae	silver gull					●	●																															
Sterna caspia	caspian tern	MI	MI			●	●	●																														
Sterna hybrida	whiskered tern						●			●																													
Gelochelidon nilotica	gull-billed tern	MI	MI			●		●																														
LOCUSTELLIDAE																																					
Eremiornis carteri	spinifexbird					●	●			●		●	●		●			●		●		●	●			●		●				●	●	●			●	●	●
Cincloramphus cruralis	brown songlark						●			●		●									●					●							●				●		

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Cincloramphus gramineus	little grassbird					•	•			•																											
Cincloramphus mathewsi	rufous songlark						•			•	•				•			•					•			•	•	•		•	•					•		•
MALURIDAE																																					
Amytornis striatus subsp. *whitei*	striated grasswren					•	•			•					•	•		•		•			•			•			•		•	•	•		•		•	•	•
Malurus lamberti subsp. *assimilis*	variegated fairy-wren					•	•			•	•	•	•		•	•		•	•	•	•	•	•			•		•	•	•	•	•	•	•	•	•	•	•
Malurus leucopterus subsp. *leuconotus*	white-winged fairy-wren					•	•			•	•	•			•	•		•	•	•	•	•	•			•				•		•	•		•	•	•	•	•
Malurus splendens	splendid fairy-wren					•	•			•						•																		•		•			
Stipiturus ruficeps	rufous-crowned emu-wren					•	•								•											•						•					•		
MEGAPODIIDAE																																					
Acanthagenys rufogularis	spiny-cheeked honeyeater					•	•			•	•		•		•	•		•	•	•			•			•		•	•	•	•		•	•	•	•	•	•
Certhionyx variegatus	pied honeyeater					•	•								•											•												
Epthianura aurifrons	orange chat					•																																
Epthianura tricolor	crimson chat					•	•			•		•			•	•										•				•		•	•			•		•		•
Gavicalis virescens subsp. *forresti*	singing honeyeater					•	•			•	•	•	•		•	•		•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
Conopophila whitei	grey honeyeater					•	•								•											•				•						•		
Lichmera indistincta	brown honeyeater					•	•			•	•	•			•	•			•		•	•				•	•			•	•		•	•		•	•	•	•
Manorina flavigula	yellow-throated miner					•	•			•	•	•	•		•	•		•			•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Melithreptus gularis subsp. *laetior*	black-chinned honeyeater					•				•		•														•							•				•		
Ptilotula keartlandi	grey-headed honeyeater					•	•			•					•	•			•		•		•			•		•				•	•	•		•	•	•	•
Ptilotula ornata	yellow-plumed honeyeater																									•												
Ptilotula pencillata	white-plumed honeyeater						•			•	•	•			•	•			•	•	•		•				•	•		•	•		•	•		•	•	•	•
Ptilotula plumula	grey-fronted honeyeater									•																•											•		
Purnella albifrons	white-fronted honeyeater					•	•			•						•										•							•		•		•		•
Sugomel niger	black honeyeater						•				•										•	•				•				•					•	•	•	•	
MEROPIDAE																																					
Merops ornatus	rainbow bee-eater					•	•		•	•	•	•	•		•	•		•	•		•		•	•		•	•	•	•		•	•	•	•	•	•	•	•
MONARCHIDAE																																					
Grallina cyanoleuca	magpie-lark					•	•			•	•	•	•		•	•			•	•	•		•			•	•	•			•	•	•	•	•	•	•	•
MOTACILLIDAE																																					
Anthus australis subsp. *australis*	Australasian pipit					•	•			•						•							•			•	•			•	•		•	•			•	•	•
Motacilla cinerea	grey wagtail	MI	MI						•																														
Motacilla flava	yellow wagtail	MI	MI						•																														

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NEOSITTIDAE																																							
Daphoenositta chrysoptera	varied sittella															•										•													•
OREOICIDAE																																							
Oreoica gutturalis	crested bellbird					•	•			•	•		•		•	•		•	•	•	•	•				•			•	•	•		•	•		•	•	•	•
OTIDIDAE																																							
Ardeotis australis	Australian bustard					•	•			•		•	•			•					•				•	•		•					•			•	•	•	
PACHYCEPHALIDAE																																							
Colluricincla harmonica subsp. *rufiventris*	grey shrike-thrush					•	•			•		•	•		•	•		•	•	•	•		•			•	•	•		•		•	•	•	•	•		•	•	•
Pachycephala rufiventris subsp. *rufiventris*	rufous whistler					•	•				•	•	•		•	•		•	•	•	•	•	•			•	•			•	•		•	•	•		•	•	•	•
PARDALOTIDAE																																							
Pardalotus rubricatus	red-browed pardalote					•	•			•	•		•		•	•		•	•							•					•		•	•				•		
Pardalotus striatus subsp. *murchisoni*	striated pardalote					•	•			•					•	•										•							•	•		•	•	•	•	
PELECANIDAE																																							
Pelecanus conspicillatus	Australian pelican					•	•			•		•														•														
PETROICIDAE																																							
Melanodryas cucullata	hooded robin					•	•			•	•		•		•	•		•			•					•			•	•	•		•	•		•		•	•	•
Petroica goodenovii	red-capped robin					•	•			•	•				•	•			•	•			•			•				•	•	•	•	•		•	•	•		•
PHAETHONTIDAE																																							
Phalacrocorax carbo	black cormorant					•	•			•		•																											
Phalacrocorax melanoleucos	little pied cormorant					•	•			•		•																					•					•	
Phalacrocorax sulcirostris	little black cormorant					•	•			•		•														•													
Phalacrocorax varius subsp. *hypoleucos*	pied cormorant					•	•			•		•														•										•			
PHASIANIDAE																																							
Coturnix pectoralis	stubble quail					•																																	
Synoicus ypsilophora	brown quail					•	•																													•	•			•
PODARGIDAE																																							
Podargus strigoides	tawny frogmouth					•	•			•						•						•				•						•				•			
PODICIPEDIDAE																																							
Podiceps cristatus	great crested grebe					•	•			•		•																											
Poliocephalus poliocephalus	hoary-headed grebe					•	•			•																•													
Tachybaptus novaehollandiae	Australasian grebe					•	•			•						•																	•				•		
POMATOSTOMIDAE																																							
Pomatostomus superciliosus	white-browed babbler					•	•			•			•			•										•						•	•				•		
Pomatostomus temporalis subsp. *rubeculus*	grey-crowned babbler					•	•			•	•	•			•	•			•	•	•	•	•			•	•	•		•	•	•	•	•	•	•	•	•	•

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PSITTACIDAE																																								
Melopsittacus undulatus	budgerigar					•	•			•	•	•			•			•			•		•			•	•	•		•	•		•	•	•	•	•	•	•	•
Neopsephotus bourkii	Bourke's parrot					•	•																			•														•
Neophema elegans	elegant parrot															•																								
Pezoporus occidentalis	night parrot	EN	CR		EN				•																															
Psephotus varius	mulga parrot					•										•		•								•				•		•	•					•		
Platycercus zonarius subsp. *zonarius*	Port Lincoln parrot					•	•			•	•	•	•		•	•		•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Polytelis alexandrae	princess parrot	VU		P4	NT				•																														
PSOPHODIDAE																																								
Psophodes occidentalis	chiming wedgebill					•	•																																	
PTILINORHYNCHIDAE																																								
Ptilonorhynchus maculatus subsp. *guttatus*	western bowerbird					•	•			•	•	•				•		•		•	•		•			•	•			•	•	•	•	•			•	•		•
RALLIDAE																																								
Fulica atra	Eurasian coot					•	•			•	•	•				•															•		•					•		
Gallirallus philippensis	buff-banded rail					•	•																																	
Porphyrio porphyrio	purple swamphen					•	•			•																														
Porzana pusilla	Baillon's crake					•	•																																	
Porzana tabuensis	spotless crake					•	•			•																														
Tribonyx ventralis	black-tailed nativehen					•	•			•		•																										•		
RECURVIROSTRIDAE																																								
Himantopus himantopus	black-winged stilt					•				•						•																						•		
Recurvirostra novaehollandiae	red-necked avocet					•	•																															•		
Cladorhynchus leucocephalus	banded Stilt					•	•																																	
RHIPIDURIDAE																																								
Rhipidura albiscapa	grey fantail					•	•								•	•										•				•						•		•	
Rhipidura leucophrys subsp. *leucophrys*	willie wagtail					•	•			•	•	•			•	•		•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
ROSTRATULIDAE																																								
Rostratula benghalensis subsp. *australis*	Australian painted snipe	EN	EN		EN				•																														
SCOLOPACIDAE																																								
Calidris acuminata	sharp-tailed sandpiper	MI	MI			•	•	•	•	•																														
Calidris ferruginea	curlew sandpiper	CR/MI	CR/MI		NT	•	•	•	•	•																														
Calidris melanotos	pectoral sandpiper	MI	MI			•		•	•	•																														
Calidris ruficollis	red-necked stint	MI	MI		NT	•	•	•																																
Calidris subminuta	long-toed stint	MI	MI			•	•	•		•																														

Scientific Name	Common Name	Conservation Status				Databases Searches					Previous Surveys																										Current Survey
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Limosa limosa	black-tailed godwit	MI	MI		NT					•																											
Philomachus pugnax	ruff	MI	MI							•																											
Tringa glareola	wood sandpiper	MI	MI			•	•	•		•						•																•				•		
Tringa hypoleucos	common sandpiper	MI	MI			•	•	•	•	•																											
Tringa nebularia	common greenshank	MI	MI			•	•	•		•						•																•				•		
Tringa stagnatilis	marsh sandpiper	MI	MI			•	•	•		•																											
Tringa totanus	common redshank	MI	MI			•		•		•																											
STRIGIDAE																																					
Ninox boobook	boobook owl						•			•						•		•	•							•		•	•			•	•	•		•		•
Ninox connivens	barking owl					•				•																												•
THRESKIORNITHIDAE																																					
Platalea flavipes	yellow-billed spoonbill					•	•			•																•											
Platalea regia	royal spoonbill					•	•			•																										•	
Plegadis falcinellus	glossy ibis	MI	MI			•	•	•		•																											
Threskiornis molucca	Australian white ibis						•			•																											
Threskiornis spinicollis	straw-necked ibis					•	•			•																•											
TURNICIDAE																																					
Turnix velox	little button-quail					•	•			•		•	•		•				•		•		•		•	•			•	•					•		•
TYTONIDAE																																					
Tyto alba	barn owl					•	•									•		•					•			•						•	•			•		
REPTILES																																					
AGAMIDAE																																					
Ctenophorus caudicinctus	ring-tailed dragon					•				•	•	•	•		•	•			•	•	•	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•
Ctenophorus isolepis subsp. *isolepis*	military dragon or crested dragon					•				•	•	•	•		•	•			•		•		•				•			•	•	•				•	•	•
Ctenophorus nuchalis	central netted dragon					•				•	•	•														•												
Ctenophorus reticulatus	western netted dragon					•									•											•						•				•		
Diporiphora amphiboluroides	mulga dragon					•																				•											
Diporiphora valens	southern Pilbara tree dragon																									•											
Gowidon longirostris	long-nosed dragon					•				•	•	•			•	•			•	•	•	•	•			•				•	•	•	•		•	•	•	•
Tympanocryptis diabolicus/pseudosephos	Hamersley/Goldfields pebble dragon				DD	•									•											•											
Diporiphora winneckei	blue-lined dragon																									•											
Pogona minor subsp. *minor*	dwarf bearded dragon					•				•					•	•							•			•		•				•		•	•		•	•	

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CARPHODACTYLIDAE																																						
Nephrurus cinctus	banded knob-tailed gecko					•				•					•											•						•					•		
CHELUIDAE																																						
Chelodina steindachneri	flat-shelled turtle					•																				•						•					•		•
DIPLODACTYLIDAE																																						
Crenadactylus pilbarensis	clawless gecko																									•						•					•		
Diplodactylus conspicillatus	fat-tailed gecko					•				•					•	•							•			•						•	•				•		
Diplodactylus pulcher	fine-faced gecko					•																																
Diplodactylus savagei	southern Pilbara beak-faced gecko					•				•					•	•							•			•		•					•	•				•		
Lucasium stenodactylus	gecko					•				•					•	•							•			•							•	•				•		
Lucasium wombeyi	gecko					•				•					•											•								•				•		
Oedura fimbria	western marbled velvet gecko					•				•	•					•							•			•					•		•			•	•	•	•	
Rhynchoedura ornata	western beaked gecko					•				•					•	•																	•	•				•		
Strophurus elderi	jewelled gecko					•									•											•														
Strophurus wellingtonae	gecko					•										•							•			•							•					•		
ELAPIDAE																																						
Acanthophis pyrrhus	desert death adder																			•						•														
Acanthophis wellsi	Pilbara death adder					•				•					•					•						•							•					•		
Brachyurophis approximans	north-western shovel-nosed snake					•										•																						•		
Demansia psammophis subsp. *cupreiceps*	yellow-faced whipsnake					•																	•			•	•												
Demansia rufescens	rufous whipsnake					•										•										•				•			•				•		
Furina ornata	moon snake					•									•	•										•														
Suta monachus	snake					•										•										•							•					•		
Pseudechis australis	mulga snake					•				•	•				•	•							•			•				•	•	•	•			•	•		
Pseudonaja mengdeni	western brown snake					•				•					•											•								•						
Pseudonaja modesta	ringed brown snake					•									•	•										•														•
Suta fasciata	rosen's snake					•													•							•							•					•		
Suta punctata	little spotted snake					•																				•														
Simoselaps approximans	northern desert banded snake																									•							•							
Vermicella snelli	Pilbara bandy bandy					•																																		
GEKKONIDAE																																						
Gehyra pilbara	Pilbara dtella					•																				•														
Gehyra punctata	spotted rock dtella					•				•			•		•	•			•				•			•		•		•			•			•	•	•		
Gehyra variegata	tree dtella					•				•	•	•	•		•	•			•	•	•	•				•		•		•			•			•	•	•		•
Heteronotia binoei	Bynoe's gecko					•					•				•	•			•				•			•	•			•			•			•		•		•

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Heteronotia planiceps	gecko					•																															
Heteronotia spelea	desert cave gecko					•				•						•										•			•								•	
PYGOPODIDAE																																						
Delma borea	legless lizard																																				•	
Delma butleri	legless lizard					•										•							•			•												
Delma elegans	legless lizard					•										•										•												
Delma nasuta	long-nosed delma					•				•																•								•	•			•	
Delma pax	legless lizard					•				•		•			•	•							•			•	•					•		•			•	
Delma tincta	legless lizard																									•												
Lialis burtonis	Burton's legless lizard					•				•					•	•							•			•			•								•	
Pygopus nigriceps	legless lizard					•										•										•							•				•	
Delma haroldi	neck-barred delma					•																											•				•	
PYTHONIDAE																																						
Antaresia perthensis	pygmy python					•				•					•	•				•						•							•	•			•	
Antaresia childreni	Children’s python					•					•				•	•										•									•			
Aspidites melanocephalus	black-headed python					•				•						•		•							•	•												
Liasis olivaceus subsp. *barroni*	Pilbara olive python	VU	VU			•		•	•	•						•		•			•					•		•				•						•
SCINCIDAE																																						
Carlia munda	shaded-litter rainbow skink					•				•		•			•	•			•		•		•			•				•		•	•	•			•	•
Carlia triacantha	desert rainbow skink					•				•		•				•					•					•									•	•		
Cryptoblepharus buchananii	Buchanan's snake-eyed skink					•									•														•									
Cryptoblepharus plagiocephalus	skink																						•			•							•				•	
Cryptoblepharus ustulatus	russet snake-eyed skink					•				•					•	•																•						
Ctenotus ariadnae	Ariadna's ctenotus					•																																
Ctenotus duricola	skink					•				•			•		•	•										•								•	•			
Ctenotus grandis subsp. *titan*	grand ctenotus					•									•																				•			
Ctenotus hanloni	skink																									•												
Ctenotus helenae	skink																						•			•								•	•		•	
Ctenotus inornatus	skink					•				•			•		•	•				•	•	•							•			•						•
Ctenotus leonhardii	skink					•					•					•							•			•												
Ctenotus pantherinus subsp. *ocellifer*	leopard ctenotus					•				•		•			•	•					•		•			•	•		•	•			•	•	•		•	•	
Ctenotus piankai	coarse sand ctenotus																									•												
Ctenotus rubicundus	ruddy ctenotus					•				•																•							•	•			•	
Ctenotus rutilans	skink					•				•																•						•						
Ctenotus saxatilis	rock ctenotus																						•			•	•							•	•		•	•	•

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Ctenotus schomburgkii	skink					•										•										•												
Ctenotus serventyi	north-western sandy-loam ctenotus									•											•					•						•						
Ctenotus uber subsp. *uber*	spotted ctenotus					•									•											•												
Ctenotus uber subsp. *johnstonei*	spotted ctenotus			P2		•		•																														
Cyclodomorphus melanops subsp. *melanops*	slender blue-tongue					•									•											•				•			•				•	
Egernia cygnitos	pygmy spiny-tailed skink (western)					•																																
Egernia depressa	pygmy spiny-tailed skink					•				•					•	•					•					•								•		•	•	
Egernia formosa	Goldfields crevice-skink					•				•						•										•						•		•				
Eremiascincus richardsonii	broad-banded sand swimmer					•																				•							•				•	
Lerista bipes	two-toed skink					•																																
Lerista flammicauda	Pilbara flame-tailed slider																									•												
Lerista macropisthopus remota	skink			P2		•						•														•										•		
Lerista muelleri	skink					•										•										•				•						•		
Lerista neander	skink					•				•			•		•	•										•				•			•				•	
Lerista zietzi	Pilbara blue-tailed slider					•										•										•										•		
Menetia greyii	common dwarf skink					•				•		•			•	•										•												
Menetia surda subsp. *surda*	skink					•									•											•												
Morethia ruficauda subsp. *exquisita*	fire-tailed skink					•				•					•	•					•		•			•	•					•	•		•		•		•
Notoscincus ornatus	ornate soil-crevice skink																									•												
Proablepharus reginae	skink																				•					•												
Cryptoblepharus carnabyi																							•			•												
Lerista chalybura	skink																																•					
Tiliqua multifasciata	central blue-tongue lizard					•				•					•	•							•			•												
TYPHLOPIDAE																																						
Anilios diversus																										•												
Anilios ganei	Pilbara flat-headed blind-snake			P1		•		•		•						•																						
Anilios grypus	blind snake														•	•							•			•							•				•	
Anilios hamatus	blind snake															•										•												
Anilios waitii	blind snake																									•												
VARANIDAE																																						
Varanus acanthurus	spiny-tailed monitor					•				•	•				•	•		•					•			•				•	•	•	•	•				•	•	•
Varanus brevicauda	short-tailed pygmy monitor					•				•			•			•										•											•		

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Varanus bushi	bush's monitor					•																														
Varanus caudolineatus	stripe-tailed pygmy monitor					•									•	•										•			•			•				•	
Varanus eremius	pygmy desert monitor																									•											
Varanus giganteus	perentie					•				•						•				•			•			•						•	•			•	
Varanus gouldii	Gould's monitor or bungarra					•					•											•								•							•	
Varanus panoptes	yellow spotted monitor					•									•	•		•								•	•					•				•	
Varanus pilbarensis	Pilbara rock monitor					•				•																•						•	•			•	
Varanus tristis subsp. *tristis*	racehorse goanna					•				•					•	•			•							•						•	•	•		•	
AMPHIBIANS																																					
LIMNODYNASTIDAE																																					
Neobatrachus kunapalari	kunapalari frog					•																														
Platyplectrum spenceri	centralian burrowing frog					•																				•							•			•	
MYOBATRACHIDAE																																					
Pseudophryne douglasi	gorge toadlet					•																															
Uperoleia russelli	Russell's toadlet					•																				•											
Uperoleia saxatilis	Pilbara toadlet					•																															
PELODRYADIDAE																																					
Cyclorana maini	sheep frog					•									•	•		•			•					•							•			•	•
Litoria rubella	little red tree frog					•				•		•			•	•		•			•					•						•	•		•	•	•

Appendix C – Vertebrate Fauna Habitat Assessment

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Water present	Disturbances	Last Fire
VWRP-01	-23.4390, 119.6058	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Small Rocks (11-20cm)	Many Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	None	None Discernible	Moderate (3 to 5 yr)
VWRP-02	-23.3531, 119.8126	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Gravel (1-4cm)	Scarce	Scattered Acacias, Spinifex Hummock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-03	-23.4506, 119.6072	24/03/2021	Stony Plain	Minor Drainage Line	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Many Small Patches	Mulga Woodland, Spinifex Hummock Grassland	Nil	Low	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-04	-23.3775, 119.7921	24/03/2021	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Loam	Many Large Patches	Negligible	Negligible	Scarce	Eucalypt Woodland	Nil	Nil	Prone to Flooding	Road/ Access Track	Old (6+ yr)
VWRP-05	-23.4680, 119.6066	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Tussock Grassland	Nil	Low	None	None Discernible	Moderate (3 to 5 yr)
VWRP-06	-23.3458, 119.8336	24/03/2021	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Loam	Evenly Spread	Negligible	Negligible	Evenly Spread	Eucalypt Woodland	Nil	Low	Prone to Flooding	Road/ Access Track	Old (6+ yr)
VWRP-07	-23.4701, 119.6061	24/03/2021	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Negligible	Many Small Patches	Mulga Woodland, Tussock Grassland	Nil	Moderate	Prone to Pooling	Cattle Grazing	Old (6+ yr)
VWRP-08	-23.3664, 119.7950	24/03/2021	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Few Small Patches	Scattered Eucalypts, Scattered Acacias, Tussock Grassland	Nil	Nil	Prone to Flooding	Road/ Access Track	Old (6+ yr)
VWRP-09	-23.4994, 119.6079	24/03/2021	Mulga Woodland	Minor Drainage Line	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Negligible	Many Small Patches	Mulga Woodland, Tussock Grassland	Nil	Moderate	None	None Discernible	Old (6+ yr)
VWRP-10	-23.3995, 119.7605	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Scattered Mulga over small to medium shrubs, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-11	-23.5131, 119.5904	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Pebbles (5-10cm)	Evenly Spread	Mulga Woodland, Spinifex Hummock Grassland	Nil	Low	None	None Discernible	Moderate (3 to 5 yr)
VWRP-13	-23.4129, 119.676	25/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Limited Outcropping; BIF	Pebbles (5-10cm)	Few Large Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	None Discernible	Moderate (3 to 5 yr)
VWRP-14	-23.4139, 119.6753	25/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Negligible	Few Small Patches	Open Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-16	-23.3994, 119.7220	25/03/2021	Stony Plain	Sand Plain	Flat	Flat	Sandy Clay Loam	Evenly Spread	Negligible	Negligible	Evenly Spread	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	High	None	None Discernible	Old (6+ yr)
VWRP-20	-23.4010, 119.7219	25/03/2021	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	High	None	Road/ Access Track	Old (6+ yr)
VWRP-21	-23.3964, 119.7151	25/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Pebbles (5-10cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Road/ Access Track	Recent (0 to 2 yr)
VWRP-22	-23.3997, 119.7381	25/03/2021	Stony Plain	Stony Plain	Flat	Low	Clay Loam	Evenly Spread	Limited Outcropping; BIF	Small Rocks (11-20cm)	Scarce	Grevillea Shrubland, Spinifex Hummock Grassland, Tussock Grassland	Nil	Low	None	None Discernible	Moderate (3 to 5 yr)
VWRP-23	-23.4009, 119.7428	25/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	Scarce	Sparsely Scattered Mulga over patchy Tussock Grassland	Nil	Nil	None	Cattle Grazing	Recent (0 to 2 yr)
VWRP-24	-23.4474, 119.6055	26/03/2021	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	West	Moderate	Clay Loam	Scarce	Major Outcropping; BIF	Boulders (>61cm)	Few Small Patches	Acacia Shrubland, Mulga Shrubland, Tussock Grassland	Moderate	Nil	None	None Discernible	Old (6+ yr)
VWRP-25	-23.4474, 119.6055	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Limited Outcropping; Granite	Large Rocks (21-60cm)	Few Small Patches	Sparsely Scattered Eucalypts over Open Acacia and Grevillea Shrubland, Spinifex Hummock Grassland	Low	Nil	None	None Discernible	Recent (0 to 2 yr)
VWRP-26	-23.4336, 119.6078	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Few Small Patches	Sparsely Scattered Eucalypts over Open Acacia and Grevillea Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Recent (0 to 2 yr)

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Water present	Disturbances	Last Fire
VWRP-27	-23.4365, 119.6048	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Few Small Patches	Sparsely Scattered Eucalypts over Open Acacia/Mulga and Grevillea Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Recent (0 to 2 yr)
VWRP-28	-23.4381, 119.6074	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Few Small Patches	Open Acacia/Mulga and Grevillea Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-29	-23.4425, 119.6049	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Previously Mulga Woodland. Post fire shrub regrowth - Acacia Shrubland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-30	-23.4496, 119.6050	26/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Small Rocks (11-20cm)	Many Small Patches	Scattered Mulga patches, Tussock Grassland	Nil	Low	None	Cattle Grazing	Moderate (3 to 5 yr)
VWRP-31	-23.4576, 119.6071	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Scattered Mulga and Acacia, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-32	-23.4728, 119.6054	26/03/2021	Mulga Woodland	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Spinifex Hummock Grassland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-33	-23.4799, 119.6058	26/03/2021	Mulga Woodland	Hardpan Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland over Scattered Eremophila	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VWRP-34	-23.5054, 119.5982	26/03/2021	Mulga Woodland	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Few Small Patches	Mulga Woodland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-36	-23.4890, 119.6053	26/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Post fire-Scattered Grevilleas. Previously Open Mulga/Acacia/Grevillea Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Road/ Access Track	Recent (0 to 2 yr)
VWRP-37	-23.3989, 119.7159	26/03/2021	Cleared/ Disturbed	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	None Discernible	Large area void of vegetation from previous clearing and disturbance.	Nil	Nil	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-38	-23.3984, 119.7788	26/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Negligible	Many Small Patches	Sparsely Scattered Eucalypts, Open Mulga Woodland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-39	-23.3982, 119.7870	27/03/2021	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Tussock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VWRP-41	-23.4065, 119.6788	27/03/2021	Mulga Woodland	Stony Plain	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Road/ Access Track	Old (6+ yr)
VWRP-44	-23.4058, 119.6705	27/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Limited Outcropping; Granite	Small Rocks (11-20cm)	Scarce	Spinifex Hummock Grassland	Low	Nil	None	None Discernible	Old (6+ yr)
VWRP-47	-23.4155, 119.667	27/03/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Low	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Scarce	Sparsely Scattered Eucalypts with post-fire regrowth over open immature Spinifex Hummock Grassland, Tussock Grassland, Scattered burnt Mulga and Grevillea.	Nil	Nil	None	None Discernible	Recent (0 to 2 yr)
VWRP-50	-23.3978, 119.7124	27/03/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Scattered Mulga and Acacia, Spinifex Hummock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-51	-23.4087, 119.6930	27/03/2021	Stony Plain	Stony Plain	North	Moderate	Clay Loam	Few Small Patches	Moderate Outcropping; Granite	Large Rocks (21-60cm)	Scarce	Scattered Acacia, Spinifex Hummock Grassland	Low	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-52	-23.4151, 119.6832	27/03/2021	Stony Plain	Stony Plain	Flat	Low	Clay Loam	Few Small Patches	Limited Outcropping; Granite	Gravel (1-4cm)	Few Small Patches	Open Acacia Shrubland over mature Spinifex Hummock Grassland	Nil	Low	None	None Discernible	Old (6+ yr)
VWRP-54	-23.4126, 119.6793	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Large Patches	Limited Outcropping; Granite	Small Rocks (11-20cm)	Few Small Patches	Scattered Acacia, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-55	-23.4160, 119.6912	28/03/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles	Few Small Patches	Open Acacia Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Water present	Disturbances	Last Fire
										(5-10cm)							
VWRP-56	-23.4120, 119.6944	28/03/2021	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Tussock Grassland	Nil	Moderate	None	None Discernible	Old (6+ yr)
VWRP-57	-23.4102, 119.6936	28/03/2021	Mulga Woodland	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Few Small Patches	Open Acacia Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-58	-23.4121, 119.6895	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-59	-23.4102, 119.6714	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-60	-23.4099, 119.6731	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Many Small Patches	Scattered Mallee, Acacia Shrubland, mature Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-61	-23.4096, 119.6736	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Minor Outcropping; BIF	Pebbles (5-10cm)	Few Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-62	-23.4101, 119.6678	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-63	-23.4132, 119.6716	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Pebbles (5-10cm)	Few Small Patches	Scattered Eucalypts, Scattered Acacias, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-64	-23.4115, 119.6848	28/03/2021	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Tussock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VWRP-66	-23.4084, 119.6851	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Scattered Eucalypts, Acacias and Grevilleas, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Old (6+ yr)
VWRP-67	-23.4066, 119.6871	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Scarce	Acacia Shrubland, Scattered Mulga, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-68	-23.3999, 119.7510	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Scarce	Acacia Shrubland, Scattered Mulga, Tussock Grassland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-69	-23.3993, 119.7559	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Scarce	Scattered Mulga, Open Acacia Shrubland, Sparsely Scattered patches of Tussock Grasses	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-70	-23.3980, 119.7687	28/03/2021	Cleared/ Disturbed	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Scattered Acacias, Tussock Grassland	Nil	Low	None	Historic large scale clearing	Old (6+ yr)
VWRP-71	-23.3951, 119.7814	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Scattered Acacias, Tussock Grassland	Nil	Low	None	Historic large scale clearing	Old (6+ yr)
VWRP-72	-23.3978, 119.7904	28/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Gravel (1-4cm)	Many Small Patches	Scattered Acacias and Mulga, Tussock Grassland	Nil	Moderate	None	Road/ Access Track	Old (6+ yr)
VWRP-73	-23.3934, 119.7928	28/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	Gravel (1-4cm)	Scarce	Scattered Acacias and Mulga, Tussock Grassland	Nil	Moderate	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-74	-23.3885, 119.7924	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Negligible	Few Small Patches	Scattered Acacias and Mulga, Spinifex Hummock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-75	-23.3818, 119.7933	28/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Scattered Acacias, Tussock Grassland	Nil	Moderate	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-76	-23.3746, 119.7949	28/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Scarce	Negligible	Negligible	Few Small Patches	Open Eucalypt Woodland, Scattered Acacias, Tussock Grassland	Nil	Moderate	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-77	-23.3721, 119.7921	28/03/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Gravel (1-4cm)	Scarce	Acacia Shrubland, Scattered Mulga, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)

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VWRP-78	-23.3550, 119.8108	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Scarce	Scattered Acacias, Spinifex Hummock Grassland	Nil	Nil	None	Road/ Access Track	Old (6+ yr)
VWRP-79	-23.3514, 119.8198	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	Gravel (1-4cm)	Scarce	Scattered Acacia, Spinifex Hummock Grassland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Recent (0 to 2 yr)
VWRP-80	-23.3483, 119.8259	28/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Few Small Patches	Scattered Acacia, Spinifex Hummock Grassland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-86	-23.3559, 119.7990	29/03/2021	Stony Plain	Undulating Low Hills	South/ East	Low	Clay Loam	Scarce	Limited Outcropping; BIF	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Scattered Grevillea, Spinifex Hummock Grassland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-87	-23.4002, 119.7295	29/03/2021	Stony Plain	Undulating Low Hills	Flat	Low	Clay Loam	Many Small Patches	Limited Outcropping; Granite	Small Rocks (11-20cm)	Scarce	Scattered Acacia and Grevillea, Spinifex Hummock Grassland, Tussock Grassland	Nil	Nil	None	None Discernible	Moderate (3 to 5 yr)
VWRP-88	-23.3991, 119.7355	28/03/2021	Stony Plain	Stony Plain	Flat	Low	Clay Loam	Scarce	Negligible	Pebbles (5-10cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland, Tussock Grassland	Nil	Nil	None	Road/ Access Track	Moderate (3 to 5 yr)
VWRP-89	-23.3523, 119.8096	27/03/2021	Stony Plain	Stony Plain	North	Moderate	Clay Loam	Few Small Patches	Moderate Outcropping; Granite	Large Rocks (21-60cm)	Scarce	Scattered Acacia, Spinifex Hummock Grassland	Low	Nil	None	Road/ Access Track	Old (6+ yr)
VWRC-01	-23.5179, 119.5879	24/03/2021	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Clay Loam	Evenly Spread	Negligible	Small Rocks (11-20cm)	Scarce	Mulga Woodland, Scattered Eucalypts, Tussock Grassland	Nil	Moderate	Prone to Pooling	Cattle Grazing	Old (6+ yr)
VWRC-02	-23.5184, 119.5877	24/03/2021	Stony Plain	Stony Plain	Flat	Flat	Clay Loam	Many Small Patches	Negligible	Small Rocks (11-20cm)	Many Large Patches	Mulga Woodland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VPDP-01	-23.4716, 119.5339	10/03/2022	Sand Plain	Sand Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Many Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-02	-23.4714, 119.4981	10/03/2022	Major Drainage Line	Major Drainage Line	Flat	Flat	Sand	Many Small Patches	Limited Outcropping; Granite	Small Rocks (11-20cm)	Few Small Patches	Acacia Shrubland, Eucalypt Woodland, Tussock Grassland	Nil	Moderate	None	Weed Invasion	Old (6+ yr)
VPDP-03	-23.4710, 119.6001	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-04	-23.4697, 119.5973	13/03/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Small Rocks (11-20cm)	Many Small Patches	Acacia Shrubland, Tussock Grassland	Nil	Moderate	None	Weed Invasion	Old (6+ yr)
VPDP-05	-23.4706, 119.5945	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-06	-23.4699, 119.5888	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-07	-23.4699, 119.5820	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-08	-23.4715, 119.5017	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-09	-23.4713, 119.5052	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-10	-23.4711, 119.5078	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-11	-23.4726, 119.5231	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Scarce	Minor Outcropping; BIF	Large Rocks (21-60cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VPDP-12	-23.4723, 119.5432	13/03/2022	Stony Plain	Stony Plain	South	Low	Sandy Clay Loam	Scarce	Minor Outcropping; Quartz	Small Rocks (11-20cm)	Many Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VPDP-13	-23.4723, 119.5562	13/03/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Pebbles (5-10cm)	Many Small Patches	Acacia Shrubland, Eucalypt Woodland, Tussock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-14	-23.4733, 119.5402	13/03/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Pebbles (5-10cm)	Many Small Patches	Acacia Shrubland, Eucalypt Woodland, Tussock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-15	-23.4730, 119.5555	13/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-16	-23.4743, 119.5281	14/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Few Small Patches	Limited Outcropping; Quartz	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Water present	Disturbances	Last Fire
VPDP-17	-23.4734, 119.5303	14/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Many Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VPDP-18	-23.4716, 119.5290	14/03/2022	Stony Plain	Stony Plain	Flat	Flat	Sandy Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Scarce	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	None	Cattle Grazing	Old (6+ yr)
VPDP-19	-23.4748, 119.5577	14/03/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Sandy Clay Loam	Few Large Patches	Negligible	Pebbles (5-10cm)	Many Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-20	-23.4744, 119.5583	14/03/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Pebbles (5-10cm)	Few Small Patches	Acacia Shrubland, Tussock Grassland	Nil	Moderate	None	Cattle Grazing	Old (6+ yr)
VPDP-21	-23.4743, 119.5592	14/03/2022	Stony Plain	Calcrete Plain	Flat	Low	Clay Loam	Many Small Patches	Negligible	Gravel (1-4cm)	Many Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	High	None	Cattle Grazing	Old (6+ yr)

Appendix D – Water Features Recorded During the Field Survey

Water feature ID	Coords.	Date Assessed	Length (m)	Width (m)	Water present above surface	Depth (m)	Water present in intermediate zone	Emergent macrophyte present	Aquatic vegetation	Fauna present	Notes	Photo
WWRP-01	-23.3782, 119.7914	26/03/2021	400	150	Yes	0.5	Yes	No	No	No	Multiple pools of various size over area. Pools only present following large rainfall events, not permanent.	
WWRP-02	-23.3466, 119.8342	27/03/2021	500	230	Yes	1	Yes	No	No	No	Measurements only to extent of Study Area, extends well beyond along continuation of Major Drainage Line habitat. Unsure of extent of permanency in this section. Extent of water likely to be attributed to recent rainfall.	
WWRC-03	-23.4701, 119.6059	26/03/2021	18	11	Yes	0.4	Yes	No	No	*Taeniopygia guttata*		

Appendix E – Night Parrot Targeted Survey Results

Nigel Jackett
P.O. Box 3221
Broome W.A. 6725
Phone: 0472 529 904
Email: nigel.jackett@gmail.com
ABN 28 786 512 608

6 May 2021

Courtney Proctor
Zoologist
Biologic Environmental Survey

Ref: 20137 Western Ridge (Pipeline) Night Parrot sound analysis

Dear Courtney,

Please find below the acoustic results of the targeted survey for Night Parrots at Western Ridge (Pipeline).

Survey and analysis background

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in late March 2021. Three Song Meter 4 and six Song Meter Mini (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across 9 sites and recorded a combined total of 46 nights of data (Table 1). The analysed dataset comprised 528 sound files (198 w4v format; 330 wav format) totalling 123.0 GB. Each unit recorded continuously from sunset until sunrise (approx. 11 hours).

The analysis was undertaken using the software Kaleidoscope Pro v5.2.1, targeting the frequency range of 1000 – 4000 Hz for which all known calls of the Night Parrot are distributed within (Jackett et al. 2017; Murphy et al. 2017; Leseberg et al. 2019). Searching for calls over a large frequency range such as this is likely to produce a high number of false-positive results due to many other bird species calling at similar frequencies but is a necessary procedure in order to capture the potential repertoire of Night Parrot.

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

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

Table 1. Bioacoustic recordings analysed from the March 2021 survey

Site name	Recording start date (PM)	Recording end date (AM)	Total recording nights
VWRP-01	24/03/21	27/03/21	3
VWRP-02	24/03/21	30/03/21	6
VWRP-04	24/03/21	30/03/21	6
VWRP-05	24/03/21	28/03/21	4
VWRP-11	24/03/21	28/03/21	4
VWRP-12	25/03/21	31/03/21	6
VWRP-13	25/03/21	31/03/21	6
VWRP-16	25/03/21	31/03/21	6
VWRP-22	25/03/21	30/03/21	5
		Total	46

Results

All 55,486 Kaleidoscope detections were manually assessed for Night Parrot vocalisations, and as expected, a high percentage (100% of all calls in this analysis) were false-positives.

No calls attributable to Night Parrots were detected during the analysis.

A total of 48 non-target species were detected during the analysis and are shown for each site and night in Appendix 1.

Analysis remarks

The sound recordings were of good quality with minimal noise interference, except at three sites close to road infrastructure (VWRP-02, 04, 12), where relatively regular vehicle or heavy machinery noise was detected to ~1500 Hz (i.e. at the lowest end of the Night Parrot vocal frequency range, and therefore potentially masking such calls).

Non-target species were readily detected across all sites, suggesting Night Parrot vocalisations would have similarly been detected had they occurred within a reasonable distance of a recording unit.

If you have any questions or comments relating to the analysis, don't hesitate to be in touch.

Sincerely,

Nigel Jackett

Selected references

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

Leseberg, N.P, Murphy, S.A., Jackett, N.A., Greatwich, B.R., Brown, J., Hamilton, N., Joseph, L. & Watson, J. (2019). Descriptions of known vocalisations of the Night Parrot *Pezoporus occidentalis*. *Australian Field Ornithology*, **36**, 79-88.

Murphy, S.A., Austin, J.A., Murphy, R.K., Silcock, J., Joseph, L., Garnett, S.T., Leseberg, N.P., Watson, J.E.M. & Burbidge, A.H. (2017). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *Emu* **117**, 107-113.

Appendix 1 – Species detected during the analysis

Species	VWRP-01			VWRP-02						VWRP-04						VWRP-05				VWRP-11				VWRP-12						VWRP-13						VWRP-16						VWRP-22				
	24	25	26	24	25	26	27	28	29	24	25	26	27	28	29	24	25	26	27	24	25	26	27	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29
Brown Quail													•	•	•																				•			•								
Australian Wood Duck										•																																				
Pacific Black Duck															•																														
Grey Teal										•	•	•		•																														
Pink-eared Duck													•	•	•																														
Crested Pigeon														•																														
Horsfield's Bronze-Cuckoo				•																		•																			•		•
Black-eared Cuckoo																														•														
Pallid Cuckoo	•	•					•										•										•			•						•								
Spotted Nightjar																					•																							
Australian Owlet-nightjar	•	•	•	•					•							•		•	•	•	•	•	•	•		•	•				•					•	•	•		•	•				
Australasian Darter											•																																	
Bush Stone-curlew																•	•										•																	
Banded Lapwing																					•																							
Barking Owl										•					•																													
Southern Boobook																			•		•	•	•																					
Sacred Kingfisher															•																													
Red-backed Kingfisher			•																								•			•	•				•								
Rainbow Bee-eater																																												•
Brown Falcon		•														•	•	•	•	•																				•		•		
Nankeen Kestrel																																											•	•

Species	VWRP-01			VWRP-02						VWRP-04						VWRP-05				VWRP-11				VWRP-12						VWRP-13						VWRP-16						VWRP-22				
	24	25	26	24	25	26	27	28	29	24	25	26	27	28	29	24	25	26	27	24	25	26	27	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29
Falco sp.																																		•														
Galah		•												•																																		
Little Corella																																													•				
Cockatiel										•	•	•	•	•	•																													•			•	•
Australian Ringneck										•		•		•	•					•		•	•																									
Budgerigar	•	•	•				•		•	•	•	•							•							•								•								•	•	•	•	•
White-winged Fairywren				•	•	•		•	•																					•			•										•			
Striated Grasswren	•																																														
Yellow-throated Miner										•	•	•	•	•	•																																	
Spiny-cheeked Honeyeater	•	•	•	•	•	•	•	•	•						•	•	•	•	•	•	•	•	•	•		•		•		•				•	•	•							•	•	•	•	•
Singing Honeyeater	•	•	•													•																													•	•	•	•	•
White-plumed Honeyeater										•	•	•	•		•																																	
Black-chinned Honeyeater										•			•		•																																	
Redthroat																						•																										
Grey-crowned Babbler			•																	•																											
Black-faced Woodswallow																													•																	•
Masked Woodswallow	•																																													
Australian Magpie																						•	•																									
Pied Butcherbird																							•																									
Grey Shrike-thrush																	•																															

Species	VWRP-01			VWRP-02						VWRP-04						VWRP-05				VWRP-11				VWRP-12						VWRP-13						VWRP-16						VWRP-22				
	24	25	26	24	25	26	27	28	29	24	25	26	27	28	29	24	25	26	27	24	25	26	27	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29	30	25	26	27	28	29
Rufous Whistler																•		•	•																											
Crested Bellbird			•													•	•																										•		•	
Magpie-lark										•																																				
Torresian Crow								•								•			•	•		•																					•		•	•
Rufous Songlark															•																														
Spinifexbird			•																						•	•	•	•	•								•	•	•	•	•					
Zebra Finch																•	•																									•		•		•
Painted Finch																									•																				
Total	7	7	8	4	2	2	3	3	4	10	6	6	6	8	12	9	7	4	7	6	5	8	6	2	1	5	4	3	2	4	3	0	3	2	2	3	2	3	2	2	4	6	4	8	6	11

* Number below site name (i.e. 24 – 30) refers to the day of month in March 2021

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at Western Ridge Creeks

Report to:

Biologic Environmental Survey

Prepared by:

Nigel Jackett

Adaptive NRM

10 May 2022

1. Summary

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

2. Survey effort

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

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

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

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in March 2022. Four Song Meter 4 (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across four sites and recorded a combined total of 24 nights of data (Table 1). The analysed dataset comprised 264 sound files (w4v format) totalling 22.6 GB. Each unit recorded continuously from sunset until sunrise (approx. 12 hours).

Table 1. Bioacoustic recordings analysed from the Western Ridge Creeks survey

Site	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
VPDC-02	10/03/22	16/03/22	6	6
VPDC-03	11/03/22	17/03/22	6	6
VPDC-07	11/03/22	17/03/22	6	6
VPDC-22	11/03/22	17/03/22	6	6
		Total	24	24

3. Data analysis

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

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

Kaleidoscope Pro search parameters were optimised using a random selection of 250 Night Parrot call examples manually detected from both Great Sandy Desert and East Murchison datasets, of which 205 (82.0%) were automatically detected. Calls not detected were typically extremely faint. The probability of non-detection of a true-positive call was 18.0%; two true-positive calls was 3.2%; three true-positive calls was 0.6%; etc. Of the data tested, the median number of consecutive (spaced at <5 minutes apart) calls in a sequence when Night Parrots

were recorded was 5 (1–34, n=29). The probability of at least one call being detected within a sequence of median length, assuming there was variation in the location of the source of the call, was >99.9%.

4. Survey results

A total of 4,065 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

A total of 20 non-target species were detected during the analysis and are shown for each site and night in Appendix 1.

5. Conclusion

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

6. References

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

Kearney, M. R., Porter, W. P., & Murphy, S. A. (2016). An estimate of the water budget for the endangered night parrot of Australia under recent and future climates. *Climate Change Responses, 3*, 14-31.

Leseberg, N. P., Murphy, S. A., Jackett, N. A., Greatwich, B. R., Brown, J., Hamilton, N., Joseph, L., & Watson, J. E. M. (2019). Descriptions of known vocalisations of the Night Parrot *Pezoporus occidentalis*. *Australian Field Ornithology*, 79-88.

Leseberg, N. P., Venables, W. N., Murphy, S. A., Jackett, N. A., & Watson, J. E. M. (2021). Accounting for both automated recording unit detection space and signal recognition performance in acoustic surveys: A protocol applied to the cryptic and critically endangered Night Parrot (*Pezoporus occidentalis*). *Austral Ecology*.

Murphy, S. A., Austin, J. J., Murphy, R. K., Silcock, J., Joseph, L., Garnett, S. T., Leseberg, N. P., Watson, J. E. M., & Burbidge, A. H. (2017a). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *Emu - Austral Ornithology, 117*(2), 107–113.

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

Appendix 1 – Species detected during the analysis

Species	VPDC-02						VPDC-03						VPDC-07						VPDC-22					
	10	11	12	13	14	15	11	12	13	14	15	16	11	12	13	14	15	16	11	12	13	14	15	16
Horsfield's Bronze Cuckoo			•											•								•		
Pallid Cuckoo																				•			•	
Australian Owlet-nightjar			•		•	•		•	•	•	•	•		•		•	•	•	•	•	•	•	•	•
Bush Stone-curlew			•	•		•		•											•	•	•	•	•	•
Little Buttonquail			•																•	•				
Whistling Kite													•											
Barking Owl										•	•			•										
Southern Boobook		•	•			•					•			•					•	•	•		•	•
Eastern Barn Owl								•	•															
Red-backed Kingfisher														•			•							
Brown Falcon									•															
Galah	•	•				•					•					•			•			•		
Little Corella		•																						
Australian Ringneck			•											•			•							•
Budgerigar								•					•	•						•				
White-plumed Honeyeater	•	•	•	•		•	•	•	•	•	•	•										•	•	•
Black-faced Cuckooshrike								•																
Pied Butcherbird								•						•										
Willie Wagtail																	•							
Torresian Crow		•						•		•	•	•												
Total	2	5	8	2	1	5	1	9	4	4	6	3	2	9	0	2	6	1	5	6	3	5	5	5

Value below site name indicates date of the month in March 2022

Appendix F – eDNA Sampling Results

eDNA frontiers
Curtin University
Office: 303.194, Kent Street, Bentley, Perth, WA 6102
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T: +61 8 9266 4119 | E: ednafrontiers@curtin.edu.au
W: https://scieng.curtin.edu.au/edna-frontiers/

REPORT OF eDNA ANALYSIS

Scope of Work:	EF-123		
Project Title:	eDNA biodiversity audit targeting reptile presence/absence in pools of water in the Pilbara using eDNA metabarcoding. March 2021.		
Client:	Biologic Environmental Survey Pty Ltd (ABN: 55 133 116 131) 24-26 Wickham St, East Perth 6004 Postal: PO Box 179, Floreat 6014		
Contact Details:	Ryan Ellis Senior Zoologist E: ryan@biologicenv.com.au | P: +61 8 6365 5066		
Test Facility	eDNA frontiers Curtin University (ABN: 99 143 842 569) 303.194 Kent Street Bentley WA 6102 Phone: +61 8 9266 4119 Email: ednafrontiers@curtin.edu.au		
Report Author:	Dr Kat Dawkins eDNA frontiers | Curtin University Email: kat.dawkins@curtin.edu.au Phone: +61 8 9266 5263		
Curtin Office Contact:	Director, Research Services and Systems Research Office at Curtin Building 100 Kent Street, Bentley WA 6102 E: director.research@curtin.edu.au		
Report Reference:	EF-123_Biologic_Final Report		
Laboratory Start Date:	24/05/2021	**Laboratory End Date:**	01/06/2021
Report Issue Date:	15/06/2021		

APPROVALS

	Name	Signature	Date (DD/MM/YYYY)
Author	Dr Kathryn Dawkins		
Author	Dr Tina Berry		15/06/2021
Reviewer	Melissa Borges Rodriguez		15/06/2021

DISCLAIMER

The eDNA frontiers laboratory offers DNA services across a number of biological applications. While eDNA frontiers stands by the validity of its methodology and the science that underpins it, stakeholders use the information contained within the report at their own risk. DNA results should be regarded as only one line of evidence in decision making processes and it may be necessary or advisable-to repeat results, re-sample at sites, corroborate data using other DNA markers or use other non-molecular methods. eDNA frontiers accordingly accepts no liability or responsibility in respect of any use of or reliance upon this report. Copying this report without prior written consent of eDNA frontiers is not permitted.

NOTE: If this eDNA report has specific parts reproduced and cited within a wider report on field work, results displayed should be attributed to eDNA frontiers (Curtin University) and the report included in an appendix in its entirety for referencing purposes.

1.0 OBJECTIVE

The objective of this study was to assess the presence of *Liasis olivaceus barroni* (Pilbara Olive python) from water samples collected in the 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 *L. olivaceus barroni* at eight sites across the Pilbara region. The client provided a total of 40 samples consisting of water filtrate suspended on filter membranes. No in-field control samples were supplied.

2.0 SAMPLE DETAILS

Table 1. Sample receipt details

Date received:	23/04/2021
Transport:	Frozen
Number of samples:	40
Storage:	All samples were stored at -20ºC prior to analysis.

Table 2. Supplied sample details

eDNA frontiers ID	Client Sample ID	Sample Type	Collection Date
E-123-001	WWRC-15 Sample 1	Water - filtered to 0.45μm	25/03/2021
E-123-002	WWRC-15 Sample 2	Water - filtered to 0.45μm	25/03/2021
E-123-003	WWRC-15 Sample 3	Water - filtered to 0.45μm	25/03/2021
E-123-004	WWRC-15 Sample 4	Water - filtered to 0.45μm	25/03/2021
E-123-005	WWRC-15 Sample 5	Water - filtered to 0.45μm	25/03/2021
E-123-006	WWRC-16 Sample 1	Water - filtered to 0.45μm	25/03/2021
E-123-007	WWRC-16 Sample 2	Water - filtered to 0.45μm	25/03/2021
E-123-008	WWRC-16 Sample 3	Water - filtered to 0.45μm	25/03/2021
E-123-009	WWRC-16 Sample 4	Water - filtered to 0.45μm	25/03/2021
E-123-010	WWRC-16 Sample 5	Water - filtered to 0.45μm	25/03/2021
E-123-011	WWRC-26 Sample 1	Water - filtered to 0.45μm	26/03/2021
E-123-012	WWRC-26 Sample 2	Water - filtered to 0.45μm	26/03/2021
E-123-013	WWRC-26 Sample 3	Water - filtered to 0.45μm	26/03/2021
E-123-014	WWRC-26 Sample 4	Water - filtered to 0.45μm	26/03/2021
E-123-015	WWRC-26 Sample 5	Water - filtered to 0.45μm	26/03/2021
E-123-016	WWRC-29 Sample 1	Water - filtered to 0.45μm	27/03/2021
E-123-017	WWRC-29 Sample 2	Water - filtered to 0.45μm	27/03/2021
E-123-018	WWRC-29 Sample 3	Water - filtered to 0.45μm	27/03/2021
E-123-019	WWRC-29 Sample 4	Water - filtered to 0.45μm	27/03/2021
E-123-020	WWRC-29 Sample 5	Water - filtered to 0.45μm	27/03/2021
E-123-021	WWRC-31 Sample 1	Water - filtered to 0.45μm	27/03/2021
E-123-022	WWRC-31 Sample 2	Water - filtered to 0.45μm	27/03/2021
E-123-023	WWRC-31 Sample 3	Water - filtered to 0.45μm	27/03/2021

eDNA frontiers ID	Client Sample ID	Sample Type	Collection Date
E-123-024	WWRC-31 Sample 4	Water - filtered to 0.45μm	27/03/2021
E-123-025	WWRC-31 Sample 5	Water - filtered to 0.45μm	27/03/2021
E-123-026	WWRC-39 Sample 1	Water - filtered to 0.45μm	28/03/2021
E-123-027	WWRC-39 Sample 2	Water - filtered to 0.45μm	28/03/2021
E-123-028	WWRC-39 Sample 3	Water - filtered to 0.45μm	28/03/2021
E-123-029	WWRC-39 Sample 4	Water - filtered to 0.45μm	28/03/2021
E-123-030	WWRC-39 Sample 5	Water - filtered to 0.45μm	28/03/2021
E-123-031	WWRC-47 Sample 1	Water - filtered to 0.45μm	28/03/2021
E-123-032	WWRC-47 Sample 2	Water - filtered to 0.45μm	28/03/2021
E-123-033	WWRC-47 Sample 3	Water - filtered to 0.45μm	28/03/2021
E-123-034	WWRC-47 Sample 4	Water - filtered to 0.45μm	28/03/2021
E-123-035	WWRC-47 Sample 5	Water - filtered to 0.45μm	28/03/2021
E-123-036	WWRP-07 Sample 1	Water - filtered to 0.45μm	26/03/2021
E-123-037	WWRP-07 Sample 2	Water - filtered to 0.45μm	26/03/2021
E-123-038	WWRP-07 Sample 3	Water - filtered to 0.45μm	26/03/2021
E-123-039	WWRP-07 Sample 4	Water - filtered to 0.45μm	26/03/2021
E-123-040	WWRP-07 Sample 5	Water - filtered to 0.45μm	26/03/2021

3.0 METHODS

3.1 Sampling Locations

Water samples were collected at eight locations by Biologic staff between 25th and 28th March 2021. Five replicates were collected at each sampling point, giving a total of 40 samples.

3.2 Sample Collection

Water samples (1L) were collected and filtered using 0.45μm mixed cellulose ester (MCE) with a peristaltic Sentino pump to capture eDNA present in the water. Of the water collected, differing volumes were passed through the filter membrane, ranging from 150-1000mL. All filtering was carried out by Biologic Environmental staff; no control samples of water used to clean common filtration equipment was supplied. Filter membranes were transported frozen to eDNA frontiers laboratories where they were stored at -20°C until scheduled for DNA extraction.

3.3 Laboratory Methods

3.3.1 eDNA Extraction and Analysis

DNA was extracted from half of each filter paper 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 an in-house 16S assay that detects reptiles. A library was generated and sequenced using the Illumina MiSeq. Laboratory extraction and PCR controls were included to test for contamination.

3.3.2 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 family level. Taxonomic assignments were based on an in-house Python script which further filters the Blast results (evalue ≤1e-5, %identity ≥95 and qCov =100), combines them with the ZOTU table results and produces a table containing the taxonomic information available from Blast taxonomy database (accessed June 2021). Additionally, Geneious Prime (version 2021.0.3) 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.

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

Liasis olivaceus barroni was only detected at site WWRP-07 (Table 4); however, it was only detected in one replicate with low level sequence reads (*n*=2). The *L. olivaceus barroni* detected in the sample matched with 100% similarity to the reference sequence generated in a previous study.

In addition to *L. olivaceus barroni*, a species of turtle, frog, and several birds, fish, and mammal species were detected. Taxa that had ≥95% similarity in the sequence region have been reported (Tables 3&4). As no water control samples were supplied, it cannot be determined if any cross-contamination between sites occurred. Laboratory extraction controls were all negative.

Table 3. Taxa detected at Pilbara sites WWRC-15, -16, -26, and -29 in 2021. Presence of the species at each site is indicated by the * symbol. Blue text indicates taxa that have not been recorded in the region previously. The target species *L. olivaceus barroni* is highlighted.

				WWRC-15					WWRC-16					WWRC-26					WWRC-29				
Class	**Order**	**Family**	**Species**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Actinopteri	Atheriniformes	Melanotaeniidae	*Melanotaenia duboulayi*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Centrarchiformes	Terapontidae	*Leiopotherapon unicolor*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Amphibia	Anura	Hylidae	*Cyclorana maini*					*															
Aves	Accipitriformes	Accipitridae	*Haliastur indus*																	*	*	*	*
	Columbiformes	Columbidae	*Geopelia cuneata*																	*		*	
	Coraciiformes	Alcedinidae	*Todiramphus sanctus vagans*											*	*					*		*	
	Galliformes	Phasianidae	*Gallus gallus*																				
	Passeriformes	Artamidae	*Gymnorhina tibicen*																		*		
		Estrildidae	*Taeniopygia guttata*	*																			
	Psittaciformes	Cacatuidae	*Eolophus roseicapilla*													*							
		Psittaculidae	*Melopsittacus undulatus*	*		*			*					*								*	
Mammalia	Artiodactyla	Bovidae	*Bos* sp.							*													
			Bos taurus							*													
	Chiroptera	Emballonuridae	*Saccolaimus flaviventris*	*				*															
Reptilia	Testudines	Chelidae	*Chelodina steindachneri*	*		*																	
	Squamata	Pythonidae	*Liasis olivaceus barroni*																				

Table 4. Taxa detected at Pilbara sites WWRC-31, -39, -47, and WWRP-07 in 2021. Presence of the species at each site is indicated by the * symbol. Blue text indicates taxa that have not been recorded in the region previously. The target species *L. olivaceus barroni* is highlighted.

				WWRC-31					WWRC-39					WWRC-47					WWRP-07				
Class	**Order**	**Family**	**Species**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Actinopteri	Atheriniformes	Melanotaeniidae	*Melanotaenia duboulayi*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
	Centrarchiformes	Terapontidae	*Leiopotherapon unicolor*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Amphibia	Anura	Hylidae	*Cyclorana maini*			*		*															
Aves	Accipitriformes	Accipitridae	*Haliastur indus*																				
	Columbiformes	Columbidae	*Geopelia cuneata*																			*	
	Coraciiformes	Alcedinidae	*Todiramphus sanctus vagans*																				
	Galliformes	Phasianidae	*Gallus gallus*							*													
	Passeriformes	Artamidae	*Gymnorhina tibicen*																				
		Estrildidae	*Taeniopygia guttata*																			*	
	Psittaciformes	Cacatuidae	*Eolophus roseicapilla*																				
		Psittaculidae	*Melopsittacus undulatus*	*				*	*	*		*										*	
Mammalia	Artiodactyla	Bovidae	*Bos* sp.																*	*	*	*	*
			Bos taurus																*	*	*	*	*
	Chiroptera	Emballonuridae	*Saccolaimus flaviventris*																				
Reptilia	Testudines	Chelidae	*Chelodina steindachneri*																				
	Squamata	Pythonidae	*Liasis olivaceus barroni*																				*

5.0 SUMMARY

This report documents the detection of *Liasis olivaceus barroni* from environmental water samples collected in the Pilbara; however, it was only detected in a single replicate at a single site, with only a low number of sequence reads generated. The species matched with 100% similarity to the reference sequence generated in a previous study. In addition to the target taxon, several other taxonomic groups were identified, including two species not previously recorded in the area.

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.

REFERENCES

Atlas of Living Australia. https://www.ala.org.au/ (Accessed June 2021)

Edgar RC (2018) Updating the 97% identity threshold for 16S ribosomal RNA OTUs. *Bioinformatics* 34(14), 2371-2376.

Koziol A, Stat M, Simpson T, Jarmon S, DiBattista JD, Harvey ES, Marnane M, McDonald J, Bunce M (2018) Environmental DNA metabarcoding studies are critically affected by substrate selection. *Molecular Ecology Resources*: https://doi.org/10.1111/1755-0998.12971

Mousavi-Derazmahalleh M, Stott A, Lines R, Peverley G, Nester G, Simpson T, Zawierta M, De La Pierre M, Bunce M, Christophersen CT (2021). eDNAFlow, an automated, reproducible and scalable workflow for analysis of environmental DNA (eDNA) sequences exploiting Nextflow and Singularity. Molecular Ecology Resources.

Rawlings LH, Rabosky DL, Donnellan SC, Hutchinson MN (2008) Python phylogenetics: inference from morphology and mitochondrial DNA. *Biol. J. Linn. Soc. Lond.* 93 (3), 603-619.

Stat M, Huggett MJ, Bernasconi R, DiBattista JD, Berry TE, Newman SJ, Harvey ES, Bunce M (2017) Ecosystem biomonitoring with eDNA: metabarcoding across the tree of life in a tropical marine environment. *Scientific Reports,* 7, 12240.

Stat M, John J, DiBattista JD, Newman SJ, Bunce M, Harvey ES (2018) Combined use of eDNA metabarcoding and video surveillance for the assessment of fish biodiversity. *Conservation Biology* 0, 1-10

APPENDIX 1

Glossary

Term	Definition
% value in data	Represents the percentage similarity of a DNA sequence recovered from a sample compared to reference sequences in a database (e.g. compared to DNA databases such as GenBank or references generated in-house)
(x) value in data	Represents the frequency the % value was recorded in the dataset
16S rRNA	The 16S rRNA refers to a conserved gene region of mitochondrial DNA, which codes for a subunit of the ribosome. 16S rRNA is found in all eukaryotes making it a good candidate for DNA barcoding
18S rRNA	The 18S rRNA refers to a conserved gene region of nuclear DNA, which codes for a subunit of the ribosome. 18S rRNA is found in all eukaryotes making it a good candidate for DNA barcoding
18S AIS reference database	Reference 18S rRNA sequences of invasive marine species that are available in DNA databases
AIS	Alien Invasive Species
Assay	In the context of eDNA metabarcoding an assay refers to a PCR 'test' that selectively targets a subset of biota from an environmental DNA sample. The use of multiple assay when combined will always detect a wider diversity of taxa than a single assay. eDNA assays should be selected to address the question relevant to the study.
Barcode	Refers to a region of DNA sequenced for many species that is able to (through variation in the DNA sequence) is able to differentiate species. DNA barcodes are the most common targets of eDNA studies that seek to explore taxon assemblages.
COI	The gene region that is being used as the standard barcode for almost all animal groups is a 648 base-pair region of the mitochondrial cytochrome c oxidase 1 gene ("CO1"). COI is proving highly effective in identifying birds, butterflies, fish, flies and many other animal groups. COI is not an effective barcode region in plants because it evolves too slowly, but two gene regions in the chloroplast, matK and rbcL, have been approved as the barcode regions for plants
CO1 AIS reference database	Reference COI sequences of invasive marine species that are available in DNA databases
DNA	Deoxyribonucleic Acid (DNA) is the hereditary material that contains the genetic information of an organism
DNA metabarcoding	Is a genetic technique that simultaneously amplifies and sequences barcode regions (e.g. COI, 18S, 16S) of many different species in parallel

Term	Definition
eDNA	Environmental DNA (eDNA) refers to genetic material that is recovered from an environmental substrate (e.g. water, sediment, air)
Eukaryotes	An organism where cells contain a nucleus surrounded by a membrane and has the DNA bound together by proteins (histones) into chromosomes. The cells of eukaryotes also contain an endoplasmic reticulum and numerous specialised organelles not present in prokaryotes, especially mitochondria, golgi bodies, and lysosomes
Fisheries	Department of Primary Industries and Regional Development, Fisheries Division, Aquatic Biosecurity Section
GenBank	Publicly available repository of genetic information. Contains the barcode information of genes that have previously been sequenced
Genome	A genome is all the genetic material of an organism. It consists of DNA (or RNA in RNA viruses). The genome includes both the genes (the coding regions) and the noncoding DNA. In eukaryotes it refers to the genomes of the nucleus, mitochondria and chloroplasts. In prokaryotes, there is a single genome (as they do not contain mitochondria or chloroplasts)
Illumina MiSeq	Next generation sequencing platform developed by the company Illumina
IMP	Introduced marine pests
Low abundance	Low abundance reads have been defined as those that constitute <0.1% of total reads for a particular sample
Metabarcoding assay	A PCR reaction using a specific set of primers that simultaneously amplifies the same gene target from multiple species. Also see definition of 'assay'.
Mitochondrial DNA (mtDNA)	The mitochondrion (plural mitochondria) is a double membrane-bound organelle found in all eukaryotic organisms. mtDNA markers (e.g. 16S or COI) are common DNA barcodes.
Mitogenomes	Refers to the mitochondrial genome
NGS	Next generation sequencing or second generation sequencing refers to massively parallel sequencing technology, as opposed to first generation sequencing or sanger sequencing where only a single template is sequenced at one time
Nucleotide	A compound consisting of a nucleotide linked to a phosphate group. Nucleotides form the basic structural unit of nucleic acids such as DNA
PCR	Polymerase chain reaction (PCR) is the technique that is used to amplify (akin to photocopying DNA) specific regions of the genome from specific groups of taxa
Primer	A short DNA strand (≈20bp in size) used in PCR to target particular groups of organisms and genes. Two of them are required for PCR (a forward and a reverse)

Term	Definition
Primer binding site	A primer-binding site is the target region of a genome where the primer attaches to start replication. The primer binding site is on one of the two complementary strands of a double-stranded nucleotide polymer, in the strand which is to be copied, or is within a single-stranded nucleotide polymer sequence
Prokaryote	Any of the typically unicellular microorganisms that lack a distinct nucleus and membrane-bound organelles and that are classified as a kingdom (Prokaryotae syn. Monera) or into two domains (Bacteria and Archaea)
RNA	Ribonucleic acid (RNA) is a polymeric molecule implicated in various biological roles in coding, decoding, regulation, and expression of genes
rRNA	ribosomal ribonucleic acid is the RNA component of the ribosome, and is essential for protein synthesis in all living organisms
Sequence	DNA sequencing is the process of determining the precise order of nucleotides within a DNA molecule. It includes any method or technology that is used to determine the order of the four bases—adenine, guanine, cytosine, and thymine—in a strand of DNA
Shotgun sequencing	Refers to randomly sequencing short pieces of DNA (≈150bp in size) after shearing or cutting DNA (e.g. fragmenting a genome)
OTU	Operational Taxonomic Unit is a molecular biology term that describes unique DNA barcode clusters and how they are different from one another. It is usually defined by a % cut-off based on DNA sequence similarity. The value of OTUs is that biodiversity can be compared without the need to assign each sequence into a taxonomic framework and is most appropriate when there are large deficiencies in the underpinning taxonomic framework. OTU are very similar in function to ZOTUs (see below).
ZOTU	Zero-radius Operational Taxonomic Unit is a molecular biology terms that describes unique DNA barcode clusters and how they are different from one another. It is usually defined by a % cut-off based on DNA sequence similarity. The value of ZOTUs is that biodiversity can be compared without the need to assign each sequence into a taxonomic framework and is most appropriate when there are large deficiencies in the underpinning taxonomic framework. ZOTU are very similar in function to OTUs (see above) but describe more exact sequence variants