

Mulga Downs Iron Ore Mine Consolidated Terrestrial Fauna Report

Prepared for:

Hancock Prospecting Pty Ltd (HPPL)

25 April 2023





Document Information

DOCUMENT	Mulga Downs
ATTEXO REF	STR-001
DATE	25-04-2023
PREPARED BY	Matthew Whitehouse and Richard Floyd
REVIEWED BY	Jason Richard

Quality Information

VERSION	DATE	DETAILS	AUTHORISATION		
			Name/Position	Signature	
1	28-09-2022	Initial draft for review	Matthew Whitehouse Senior Ecologist	MW	
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Attexo Group Pty Ltd 2023

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Executive Summary

Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Iron Ore Mine and the associated borefield and infrastructure areas (collectively referred to as the 'MDIOM' and 'the Proposal'). The Proposal is located approximately 210 km south of Port Hedland and approximately 180 km north-west of Newman in the Pilbara region of Western Australia. This Proposal is being assessed under Part IV of the *Environmental Protection Act 1986* (EP Act). The Proposal is also being assessed separately as a Controlled Action under the terms of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The MDIOM Survey Area comprises the Mulga West Borefield tenement, the Mulga East tenement, the Malay Well tenement, the Mulga East Southern Corridor, the Mulga North tenement and the Central Transport Corridor.

Several terrestrial vertebrate and short-range endemic (SRE) invertebrate fauna assessments have been undertaken across the Survey Area for the purpose of environmental impact assessment as per the Western Australia Environmental Protection Authority requirements. This report is the consolidation of the terrestrial faunal data collected from several terrestrial fauna assessments from 2019 until 2022 (*ecologia* 2020, 2021a, & Biologic 2022), including a 2018 reconnaissance survey (*ecologia* 2021a).

Consolidated desktop and literature reviews were completed for each of the terrestrial fauna assessments. In total, 384 species of vertebrate fauna have previously been recorded or have the potential to occur within the MDIOM Survey Area. This comprised 49 mammal species, 188 birds, 134 reptiles and 13 amphibians. Of these, 39 species are considered to be species of conservation significance.

There are 888 desktop records of SRE invertebrates from the Survey Area representing 144 taxa. Comparing these records and those found through the literature review, a total of 15 Confirmed and 91 Potential SRE invertebrate taxa are known to occur within a 40 km search area which includes the Survey Area. Of the taxa which may potentially occur, 12 SRE taxa have previously been recorded within the Survey Area.

Habitat types

Eight broad fauna habitat types were identified within the Survey Area: Claypan, Chenopod/Cracking Clay Floodplain, Drainage Line/Floodplain, Mulga Woodland, Mixed Eucalypt/Mulga Floodplain, Rocky Hills, Stony Spinifex Plains and Hillslopes, and Calcrete Stony Plain. The habitats were mapped using aerial imagery and vegetation survey data and from extensive ground truthing. The majority of the fauna habitats mapped during the 2019 – 2022 assessments are not restricted to the Survey Area and are considered widespread at both a local and regional scale. Fauna habitat assessments undertaken across the Survey Area identified habitat condition which varied form 'Good' to 'Excellent' with some areas allocated a lower rating of 'Good' having been grazed by cattle.

The Claypan habitat includes the Freshwater Claypans of the Fortescue Valley Priority 1 Priority Ecological Community (Claypan PEC) which are located within the Survey Area. Two of the claypans – the Gnalka Gnoona and Koodjeepindarranna claypans areas have been excluded from the MDIOM Development Envelope to avoid direct impacts and protect these habitats. This habitat type has limited extent in the Survey Area, however there are claypans dispersed along the Fortescue Valley area forming a mosaic of wetlands which is characteristic of the arid interior of Western Australia.

The Claypan PECs only fills after significant rainfall and provide foraging habitat for a number of waterbirds, including migratory species. The significance of these claypans when inundated is recognised, the area classified in the Directory of Important Wetlands (WA066). Three migratory wading species, the Common Greenshank, the Red-necked Stint and the Wood Sandpiper were recorded foraging in surface water in the Gnalka Gnoona Claypan PEC during the 2019 survey.

Chenopod/Cracking Clay Floodplain habitat type also has limited extent in the Survey Area and compared to the other habitats was considered restricted. It was only mapped within the Mulga East tenement during these surveys. This habitat type condition was rated as 'Good' as long-term grazing from cattle had caused degradation. This



habitat type is considered potentially suitable Night Parrot foraging habitat, however the condition mapped in the Survey Area was degraded which reduces the likelihood of occurrence of this species. Three recording devices deployed for an appropriate timeframe did not detect any Night Parrot calls (*ecologia* 2021a). The habitat has low leaf litter and is generally sparse, generally it is not considered to have high value for fauna.

The Drainage Line/Floodplain habitat found within the Survey Area is generally considered common at a local and regional scale. Extensive Drainage Line/Floodplain habitat extends across the Mulga West Borefield and the Central Transport corridor. Within the Mulga East tenement the drainage lines are less broad and closer to the Chichester subregion. It often occurs as the intervening area between other habitat types such as the Rocky Hills and Stony Spinifex Plains and Hillslopes in Mulga East. The Drainage Line/Floodplain habitat aligns with the Mulga Woodland habitat and the Mixed Eucalypt/Mulga Floodplain habitat within the Fortescue Valley IBRA subregion. This habitat type functions as fauna corridors throughout the Survey Area and is relatively common throughout the Pilbara bioregion. This habitat type is considered important foraging habitat for Northern Quolls and the Pilbara Leaf-nosed Bat as Priority 5 foraging in the floodplain and potentially Priority 2 toward the gullies and hillslopes.

Mulga Woodland is extensive across the Survey Area but has been disturbed through exploration activities and grazing. It is the most extensive vegetation type in Western Australia and well represented regionally. The Mulga Woodland habitat is considered to be of low value to conservation significant species except for the Gane's Blind Snake which was recorded at several locations within Mulga East area. This habitat type is not favourable to burrowing species. Mulga Woodlands have been noted as supporting Bilbies. However, extensive UAV searches did not find secondary evidence of the Bilby in the Mulga Woodland across the Survey Area.

The Mixed Eucalypt/Mulga Floodplain occurs along the Fortescue Valley surrounding the claypan PEC and is considered widespread along the valley. This habitat contains large woody trees which can provide suitable habitat to Northern Quolls and hollows for nesting birds.

The Rocky Hills habitat was assessed to be of high conservation value to species of conservation significance. Breakaways, gorges and gullies within the Rocky Hills habitat type provide high quality refugia such as caves, denning and foraging habitat considered to be critical habitat for the survival of Northern Quolls, Pilbara Leaf-nosed Bats and Ghost Bats (Priority 2 to 3 foraging). This is important habit for the Pilbara Olive Python. Rocky Hills are common and widespread in the Pilbara.

The coarse stony red clay soils of the Stony Spinifex Plains and Hillslopes habitat was found to provide habitat for the Western Pebble-mound Mouse to construct mounds in the Survey Area. Several other conservation significant species are also known to forage within this type of habitat, which is widespread throughout the Pilbara, including the Northern Quoll, Pilbara Leaf-nosed Bat, and the Ghost Bat. This habitat type occurs with the Rocky Hills and Drainage Lines and is widespread in the Pilbara. The substrates and vegetation present support termitaria which are a known refuge for vertebrate fauna, though generally there is minimal refugia to conservation species. This habitat supports Priority 5 foraging for the Pilbara Leaf-nosed and Ghost bats.

Calcrete Stony Plain habitat is restricted to the Mulga East and Malay Well areas of the MDIOM Survey Area. It occurs within the valley area and aligns with the claypans along the river floodplain. Shallow burrowing is permitted in this habitat type for the smaller species; however it is unsuitable for deeper burrowing species such as the Bilby. The spinifex provides foraging and nesting for many bird species. This habitat type is widespread throughout the Pilbara region.

Conservation significant vertebrate fauna

Eleven conservation significant fauna species listed as Threatened and/or Migratory under the EPBC Act and/or BC Act, or as Priority by the Department of Biodiversity, Conservation and Attractions (DBCA), were recorded in the Survey Area:

• Northern Quoll (Dasyurus hallucatus) (Endangered EPBC Act and BC Act);



- Pilbara Leaf-nosed Bat (Rhinonicteris aurantia Pilbara form) (Vulnerable EPBC Act and BC Act);
- Ghost Bat (Macroderma gigas) (Vulnerable EPBC Act and BC Act);
- Grey Falcon (Falco hypoleucos) (Vulnerable EPBC Act, BC Act);
- Pilbara Olive Python (Liasis olivaceus) (Vulnerable EPBC Act, BC Act);
- Gane's Blind Snake (Anilios ganei) (Priority 1 DBCA);
- Western Pebble-mound Mouse (Pseudomys chapmani) (Priority 4 DBCA).
- Peregrine Falcon (Falco peregrinus) (Species Otherwise in need of special protection under S18 of BC Act);
- Common Greenshank (*Tringa nebularia*) (Migratory EPBC Act and BC Act);
- Red-necked Stint (Calidris ruficollis) (Migratory EPBC Act, BC Act); and
- Wood Sandpiper (Tringa glareola) (Migratory EPBC Act, BC Act)

Two Northern Quolls (a male and a female) were captured in cage traps and three individuals were captured on motion sensor camera traps at six locations within the Rocky Hills habitat of the Mulga East component area. It is anticipated that a low-density population occurs within the broader Rocky Hills habitat in the northern and north-eastern portions of the Survey Area.

Pilbara Leaf-nosed Bat echolocation calls were recorded at 103 locations within the Survey Area. Regular detections (in all seasons) in a particular valley of the Mulga East area indicates the creek line is a preferred commuting and foraging area and is considered critical foraging habitat within the Survey Area.

A total of 82 cave habitat assessments were completed and a total of 61 caves were assessed within the MDIOM area using Acoustic Recording Units. The remaining 21 caves were not surveyed as they lacked the characteristics to be used for diurnal roosting. Within the Survey Area, 44 caves were identified as potential roosts of nocturnal refuges for the Pilbara Leaf-nosed Bat, while 73 caves were found to provide potential nocturnal refuges for this species. All caves were identified as Category 4 caves which are used opportunistically and are not considered important to the long-term preservation of the species within the area.

A single Ghost Bat call was recorded only once during the initial surveys in 2019 indicating the presence of this species within the Survey Area. Repeated survey effort failed to identify or record this species within the Survey Area. Of the 82 caves assessed, six had potential roosts or nocturnal refuges for the Ghost Bat, with scat and feeding debris recorded at three caves. It is considered unlikely that a permanent Ghost Bat roost exists in the Survey Area. Critical habitat for this species within the Survey Area overlaps with the Northern Quoll and Pilbara Olive Python in the form of breakaway, gorge and gully habitat within the Rocky Hills.

One Pilbara Olive Python was opportunistically recorded at the Mulga East camp. Despite considerable survey effort, no additional Pilbara Olive Pythons were recorded, and it is considered unlikely to be present in high numbers within the Survey Area. Critical habitat for this species is Rocky Hills and the species was recorded close to this habitat type.

Four individual Gane's Blind Snakes were recorded across the Mulga East tenement. This species was recorded within the Mulga Woodlands and Stony Spinifex Plains and Hillslopes habitat types. Although there were no records of this species within 40 km of the Survey Area, according to DBCA database search, this species was recorded during the field surveys (*ecologia*, 2021a).

The Grey Falcon (*Falco hypoleucos*) was recorded in October 2018 during a reconnaissance survey by *ecologia* in 2018 within the north western section of the Mulga East tenement. This species has previously been recorded on multiple occasions within the vicinity of the Survey Area with eight records of this species within 40 km of the Survey Area.



Grey Falcons have the potential to overfly all habitat types within the Survey Area. The frequency of occurrence of the species within the Survey Area is likely to be dependent on the proximity of available nesting habitat. The Mixed Eucalypt/Mulga Floodplain and Drainage Line habitats are expected to provide potential nesting locations for this species. No nests were observed during the surveys.

The Western Pebble-mound Mouse has been recorded on numerous occasions within the vicinity of the Survey Area including from seven records within Mulga East Southern Corridor. Across the Mulga West Borefield and the Mulga East Southern Corridor up to 24 secondary observations of this species in the form of their mounds (active and inactive) have been recorded. The mounds were found in Stony Plains and Slopes habitats, Drainage Area/Floodplain and Rocky Hills. The species is most likely to occur within the Survey Area as a resident and its occurrence is likely to be common and widespread across Stony Plains and Slopes and the lower slopes of Rocky Hills habitats. The species may also forage more broadly into Drainage Area/Floodplain habitat adjacent to habitat permitting burrowing and mound construction.

A Peregrine Falcon was also recorded opportunistically approximately 5 km east of the Mulga West Borefield area during a survey that ran concurrently with Biologic (2022). The Peregrine Falcon is a highly mobile species which may intermittently utilise breakaways within Rocky Hills and large trees in the Mixed Eucalypt/Mulga Floodplain provide potential nesting habitat for this species.

A total of eight Red-necked Stints were recorded within the Gnalka Gnoona Claypan PEC on two separate occasions during surveys across the Mulga East area. It is considered likely that this species will be an infrequent visitor to the Claypan habitats in the Survey Area when inundated after rainfall. The Wood Sandpiper was also recorded in the Gnalka Gnoona Claypan PEC and there as a single historical record of the Glossy Ibis from this claypan in 2004. Both species are likely to to be infrequent visitors, present primarily when the Claypans are inundated.

In addition to the eleven conservation significant fauna recorded within the Survey Area, the Brush-tailed Mulgara (*Dasycercus blythi*) (P4), In addition to the eleven conservation significant fauna recorded within the Survey Area, the Brush-tailed Mulgara (*Dasycercus blythi*) (P4), the Short-tailed Mouse (*Leggadina lakedownensis*) (P4) and the Spotted Ctenotus (*Ctenotus uber*) (P2) were considered likely to occur, however were not recorded. Extensive surveys using UAV to search for secondary evidence of Bilbies. However, there was no evidence of burrows, scats or diggings and stated that the Survey Area was generally unsuitable for Bilbies.

Additionally, the elusive Night Parrot has been targeted in surveys. Recording devices have been placed in habitat that is considered suitable on Mulga Downs. There have been no recordings of Night Parrot calls during any surveys undertaken within the Survey Area. This species is considered unlikely to occur within the Survey Area due to the historic and on-going grazing activities occurring in the habitat areas which would otherwise be most suitable to support it. It has been recorded from the Fortescue Marsh 60 km to east of the Survey Area.

Short-range endemic invertebrate fauna

Rocky Hills and Mulga Woodlands provide important microhabitat for many SRE invertebrates including mygalomorph spiders, selenopid spiders, polydesmid millipedes, and terrestrial isopods. From the desktop assessment, 15 Confirmed SRE invertebrate taxa have been identified for the region and ten Potential SRE species have been recorded from within the Survey Area.

Field surveys of the Study Area collected 140 invertebrate specimens, representing 28 morphological and molecular species. Of the 28 species recorded ten were considered to represent Potential SRE species and 17 were considered to be Widespread species. One Confirmed SRE species was collected during field surveys - *Buddelundia* `56` (including *Buddelundia* `sp. SJ_56_DNA`). Four of the ten Potential SRE taxa were olpiid pseudoscorpions. Habitat for all four taxa was widespread through the Survey Area and hence, it is unlikely that these taxa will be restricted in range. The remaining Potential SRE taxa were represented by armadillid isopods, also collected in widespread habitats.



Abbreviations

Acoustic Recording Units
Biosecurity Agriculture Management Act 2007
Biodiversity Conservation Act 2016
Bureau of Meteorology
China-Australia Migratory Bird Agreement
Commonwealth of Australia
Critically Endangered
Department of Biodiversity, Conservation and Attractions
Department of Climate Change, Energy, the Environment and Water
Department of Environment, Water, Heritage and Arts
Directory of Important Wetlands in Australia
Deoxyribonucleic acid
Department of the Environment
Department of the Environment and Energy
Department of Mines, Industry Regulation and Safety
Department of Primary Industries and Regional Development
Department of Sustainability, Water, Population, and Communities
Department of Parks and Wildlife
Environmental Impact Assessment
Endangered
Environmental Protection Act 1986
Environmental Protection Authority
Environment Protection and Biodiversity Conservation Act 1999
Extinct in Wild
Extinct
Hancock Prospecting Pty Ltd
Interim Biogeographic Regionalisation of Australia



MNES	Matter of National Environmental Significance
MDIOM	Mulga Downs Iron Ore Mine
MI	Migratory
MA	Migratory Marine
NVIS	National Vegetation Information System
P1	Priority 1
P2	Priority 2
Р3	Priority 3
P4	Priority 4
PEC	Priority Ecological Community
PLnB	Pilbara Leaf-nosed Bat
PVC	Polyvinyl Chloride
PRI	Pilbara Regional Inventory
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SRE	Short-range Endemic
TEC	Threatened Ecological Community
TSSC	Threatened Species Scientific Committee
UAV	Unmanned Aerial Vehicle
VU	Vulnerable
WA	Western Australia
WAM	Western Australian Museum

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1.0 Introduction

1.1 Background

Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Iron Ore Mine and the associated borefield and infrastructure areas (collectively referred to as the 'MDIOM' and 'the Proposal'). The Proposal is located approximately 210 km south of Port Hedland and approximately 180 km north-west of Newman in the Pilbara region of Western Australia (WA). The tenements that comprise the proposed MDIOM are defined in **Table 1-1** and the areas of the MDIOM which are collectively referred to as the 'Survey Area' are shown on **Figure 1-1**. Previous flora and fauna survey reports for each component area are also listed as key reference documents in **Table 1-1**.

Survey Area	Tenement	Pastoral Stations	Area (ha)	Reference Document
Mulga East Tenements	R47/0012 L48/380 (portion of) E47/2044-1 (portion of)	Mulga Downs	22,185.98	<i>ecologia</i> , 2021a and Maia, 2022
Malay Well Tenement	E47/2117	Mulga Downs	9,834.72	ecologia 2021a
Mulga West Borefield	E47/1315	Mulga Downs Mt Florance Hooley	22,223.21	Biologic, 2022
Mulga East Southern Corridor	L45/316	Mulga Downs	731.69	Biologic, 2022
Mulga North	E 47/2044-I	Mulga Downs	1,652.02	Maia, 2022
Central Transport Corridor	E45/3593, E45/4231, E45/4417, E47/2044, L45/380, L45/383, L45/384 and R47/12	Mulga Downs	1,774.8	Biologic, 2022
Total			58,402.42	

Table 1-1 Description of the Mulga Downs Iron Ore Mine components

The Proposal intersects three pastoral stations (**Figure 1-1**) - Mt Florance, Hooley Station and Mulga Downs Station. Prominent landscape features in the Survey Area include the Fortescue Marshes which are located to the east of Goodiadarrie Hills and the Fortescue River, which bisects the Malay Well and Mulga West Borefield tenements. The Wittenoom Asbestos Management Area (WAMA) intersects the Survey Area and the Karijini National Park is located approximately 15 km to the south of the Survey Area (**Figure 1-1**).

The Goodiadarrie Swamp including the associated Freshwater claypans of the Fortescue Valley Priority 1 (P1) Priority Ecological Community (PEC) occur within the Survey Area.



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Sites - Department of Planning, Lands and Heritage; Mining Tenements - Department of Mines Industry Regulation and Safety) 2022 Esri, CGIAR, Esri, HERE, Garmin, FAO, NOAA, USGS, Esri, USGS

10

Scale: 1:500,000@A3

National Parks; Directory of Important Wetlands - Departme of Biodiversity, Conservation and Attractions; Contaminated

0

Data Source(s):

5

15

20 Km



1.2 Purpose of this Report

Since 2018, several terrestrial vertebrate and invertebrate fauna assessments have been conducted across the Survey Area to support the environmental impact assessment for this Proposal. These reports are intended for use as supporting documents for the Environmental Impact Assessment (EIA) of the MDIOM which is being assessed under Part IV of the *Environmental Protection Act 1986* (EP Act). The Proposal is also being assessed separately as a Controlled Action under the terms of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), for which these documents also provide technical data.

The objective of this report is to consolidate the terrestrial fauna survey data from the previous assessments undertaken for the MDIOM. The fauna assessments which have been included are:

- ecologia Environment (2019). Mulga East Baseline Terrestrial Fauna Assessment ;
- ecologia Environment (2020). Mulga East SRE Invertebrate Fauna Survey;
- ecologia Environment (2021a). Mulga East Baseline Terrestrial Vertebrate Fauna Assessment;
- ecologia Environment (2021b). HPPL Mulga East Targeted Pilbara Leaf-nosed Bat Letter Addendum Survey;

Biologic (2022). Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (which also considers the Central Transport Corridor).

In addition to the fauna survey reports listed above, vegetation mapping provided by Maia (2022) has been used, along with aerial imagery to map fauna habitats which could not be accessed during field surveys. All efforts have been made to survey the MDIOM Development Envelope. Additional surveys were completed in early 2023 to address areas which had been added to the Development Envelope. The information from these surveys is presented in a memorandum supplementary to this consolidated report.

1.3 Policy and Guidance

Terrestrial vertebrate and Short-Range Endemic (SRE) invertebrate assessments for the Proposal have been undertaken in a manner consistent with the following documents developed by the Environmental Protection Authority (EPA), the Department of Biodiversity, Conservation and Attractions (DBCA), and the Commonwealth (the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and its former departments):

- 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;
- EPA (2016a) Environmental Factor Guideline: Terrestrial fauna; and



- EPA (2016b) Technical Guidance: Sampling of short-range endemic invertebrate fauna; and
- EPA (2020) Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.

1.4 Background to the protection of fauna in Western Australia

All native fauna in WA are protected at a State level under the *Biodiversity Conservation Act 2016* (BC Act) and species of conservation concern at a national level are protected under the Commonwealth *Environment Protection Biodiversity and Conservation Act 1999* (EPBC Act). Any action that has the potential to impact native fauna requires approval by relevant State and/or Commonwealth department in accordance with the EP Act and the EPBC Act, respectively. 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, 2016a).

While all native fauna are protected, 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. Furthermore, any species that may be threatened but for which there is insufficient information available to allocate a threatened status under the EPBC Act and/or BC Act, can also be listed as Priority species by the WA DBCA. A summary of definitions and terms used to define significant species has been provided below in **Table 1-2**.

Table 1-2 Definitions and terms for significant species

ACT, AGREEMENT OR LIST	STATUS CODES
Federal	
EPBC Act In Australia, native fauna is 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 Matter of National Environmental Significance (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 MA - Marine



ACT, AGREEMENT OR LIST	STATUS CODES
State	
BC Act In WA, native fauna is 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 • CD – Conservation Dependent Other • MI - Migratory
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 4

For the purposes of this assessment, species considered to be of conservation significance (herein referred to as 'significant species'), are those that are afforded protection under the EPBC Act, BC Act and/or listed as Priority species by DBCA.

1.5 Short-range Endemic Fauna (SRE)

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national, or local scale (Allen *et al.*, 2002). Endemism at a local scale is referred to as short-range endemism (Harvey, 2002). Short-range endemism of a species is influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions and historical conditions which not only influence the distribution of a species, but also the tendency for differentiation and speciation (Ponder & Colgan, 2002).

Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) invertebrate species at less than 10,000 km² (or 100 km x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA, 2016b). Short-range endemic invertebrate species often share similar biological, behavioral and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey, 2002). For example, burrowing taxa such as mygalomorph spiders and Urodacus scorpions may only leave their burrows (or a narrow home territory near the burrow) as juveniles during dispersal from the maternal burrow, or when males search for a mate (Rix *et al.*, 2017). Taxa such as terrestrial isopods, millipedes and snails are dispersal-limited because of their slow movement and cryptic habitat (Car *et al.*, 2019), while other taxa may be limited by highly specific habitat requirements, such as selenopid spiders within fractured rocky outcrops (Crews, 2013).

Several invertebrate taxonomic groups are currently understood to have a high proportion of species with restricted ranges and as such are given additional consideration in fauna assessments. The EPA considers the existence of SRE invertebrate fauna to be a significant biodiversity issue and that SRE fauna "may be at a greater risk of changes in conservation status as a result of habitat loss or other threatening processes" (EPA, 2016b). In the Pilbara and nearby regions of Western Australia, invertebrate groups with many known SRE species that are targeted during SRE invertebrate fauna surveys include mygalomorph spiders (Castalanelli *et al.*, 2014), selenopid spiders (Crews, 2013), scorpions (Volschenk *et al.*, 2010), pseudoscorpions (Harvey *et al.*, 2016), millipedes (Car *et al.*, 2019), land snails (Johnson *et al.*, 2004), and terrestrial isopods (Wilson & Keable, 2002). As taxonomic knowledge of Pilbara invertebrates increases many more groups may be found to include SRE fauna.



Most SRE invertebrate species and communities are not currently listed under state or federal legislation, due largely to incomplete taxonomic and ecological knowledge. As such, the assessment of conservation significance for SRE invertebrates is guided primarily by advice provided by the Western Australian Museum (WAM) and other taxonomic experts, and under technical guidance from the EPA (2016b).

1.5.1 SRE Categorization

The SRE categorization used in this report follows the WAM's revised classification system for SRE invertebrates, based upon the 10,000 km² range criterion proposed by Harvey (2002), and uses three categories (Confirmed SRE, Potential SRE, and Widespread) to describe the degree of certainty with which a species can be considered to be SRE or not (**Table 1-3**).

Table 1-3	SRE categorization used by	WAM, adapted	from Harvey	(2002)
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Distribution	Taxonomic Certainty	Taxonomic Uncertainty	
Species range <10,000 km ²	 Confirmed SRE A known distribution of <10,000 km² The taxonomy is well known The group is well represented in collections and/or has been comprehensively sampled 	 Potential SRE Patchy sampling has resulted in incomplete knowledge of geographic distribution 	
Species range >10,000 km ²	 Widespread A known distribution of >10,000 km² The taxonomy is well known The group is well represented in collections and/or has been comprehensively sampled 	 Incomplete taxonomic knowledge The group is not well represented in collections Any other significant knowledge gaps occur. 	

'Confirmed' SRE species are those for which sufficient evidence exists, from both taxonomic certainty and extent of sampling, to confirm that the species is restricted to a range of less than 10,000 km², whereas 'Widespread' species are confirmed to have a range greater than 10,000 km². For taxa belonging to groups known to include SRE species, unless sufficient evidence exists to denote 'Confirmed' SRE or 'Widespread' status, the default categorization is 'Potential' SRE. This is usually due to lack of taxonomic knowledge and extensity of sampling.

For the purposes of this consolidated report, only 'Confirmed' and 'Potential' SRE taxa are discussed.



2.0 Existing Environment

2.1 Biogeography

The Survey Area occurs entirely within the Pilbara bioregion as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell, 1995). Within the Pilbara region, the Survey Area intersects two subregions; Chichester and Fortescue Plains (**Figure 2-2**); which are described further in **Table 2-1**. Most of the Survey Area is located within the Fortescue Plains subregion.

Table 2-1 IBRA bioregion and subregions of the Survey Area

Bioregion	Subregion	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) PIL3 is the Southern section of the Pilbara Craton. Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and <i>Eucalyptus leucophloia</i> over <i>Triodia brizoides</i> on skeletal soils of the ranges. The climate is Semi-desert tropical, average 300mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Drainage into either the Fortescue (to the north), the Ashburton to the south, or the Robe to the west.	21.54
	Chichester (PIL1) Comprises the northern section of the Pilbara Craton (Kendrick & McKenzie, 2001). Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The basalt plains host a shrub steppe characterised by <i>Acacia inaequilatera</i> over <i>Triodia</i> spp. hummock grasslands, while <i>Eucalyptus leucophloia</i> tree steppes occur on ranges. The Chichester subregion drains to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock).	654.00
	Fortescue Plains (PIL2) Characterised by alluvial plains and river frontage (Kendrick, 2001). The Fortescue Plains contains extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains, and river gum woodlands fringing major drainage lines (Kendrick, 2001). The significant and dominant feature of this subregion is the Fortescue Marsh. This drainage feature, 100 km long, is effectively the terminus of the upper Fortescue River (EPA, 2013). The lower Fortescue River arises from streams draining the Chichester and Hamersley Ranges below the Marsh and west of the Goodiadarrie Hills.	57,726.88
Total		58,402.42



2.2 Climate

The Survey Area occurs in the Pilbara region of WA and experiences an arid-tropical climate with two distinct seasons: a hot summer from October to April and a mild winter from May to September. Temperatures are generally high, with summer temperatures frequently exceeding 40°C. Light frosts occasionally occur inland during the winter months of July and August.

Rainfall is generally localized, variable and unpredictable, and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year. Most of the Pilbara has a bimodal rainfall distribution; from December to March rains result from tropical storms producing isolated, sporadic thunderstorms. Tropical cyclones moving south also bring heavy rains. From May to June, extensive cold fronts move eastwards across the state and occasionally reach the Pilbara. These fronts usually produce only light rain. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses generally flow intermittently due to the short wet season (Beard, 1975a).

Climate data is collected by the Bureau of Meteorology (BOM) and long-term rainfall data is available from the Mulga Downs weather station (Station Number 5015) (Bureau of Meteorology, 2020); however, this station did not provide temperature data and ceased recording rainfall data in June 2018. Mean maximum and minimum temperature data was taken from the nearest weather station at Wittenoom (Station number 5026) and 2018-2021 until 2019 when this weather station ceased collecting data. Rainfall data was then taken from the nearest weather station at Karijini North (Station Number 5098) (Bureau of Meteorology, 2020). These stations are located approximately 10 km south-west and 12 km south from the Survey Area, respectively. A summary of mean rainfall, mean maximum and minimum temperatures has been provided in **Figure 2-1**.



Figure 2-1 Climate data for the region surrounding the Survey Area



2.3 Geology

The Survey Area occurs across five broad (1:500,000) geographic units (DMIRS, 2021), which have been summarized in **Table 2-2** and shown on **Figure 2-3**.

Table 2-2	Geology Units within the Surve	y Area (DMIRS, 2021)
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Geological Unit	Description (DMIRS, 2021)	Area (ha)
Sheetwash unit, PIP (W-PIP)	Clay, silt and sand in distal sheetwash fan and slope deposits; local ferruginous pisoliths and gravel.	26,272.63
Exposed unit, PIP (X-PIP)	Exposed bedrock.	9,469.50
Residual or relict unit, PIP (Rr-fh-PIP, Rr- kc-PIP, Rt-PIP)	Hematitic duricrust, massive to rubbly; includes iron-cemented reworked products. Calcrete, nodular to massive; includes calcite and reworked carbonate products. Transported duricrust; cemented sand, gravel, cobbles, and boulders in alluvial/ colluvial deposits	7,430.38
Alluvial/fluvial unit, PIP (A-PIP, Ac-PIP)	Clay, silt, sand, and gravel in fluvial channels, in channels and on floodplains.	12,816.04
Colluvial unit, PIP (C-PIP)	Colluvium derived from different rock types; includes gravel, sand, silt and clay.	2,413.87
Total		58,402.42



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Mulga Downs Mine Broad geology of the Survey Area Figure 2-3

- 🔲 Malay Well
- Mulga West Borefield
 - Mulga East
 - J Mulga East Southern Corridor
 - Central Transport Corridor
- ____ Mulga North
 - Highway/Road
 - Watercourse



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2.4 Land Systems

The Department of Primary Industries and Regional Development (DPIRD) (formally the Department of Agriculture) Western Australia (Van Vreeswyk *et al.*, 2004) undertook a regional inventory of the Pilbara rangelands to document the land systems present and their condition. The Pilbara Regional Inventory (PRI) which covers 181,723 km² is bounded by the Indian Ocean and Roebourne Plains to the north and west, extending to Broome in the north-east and the Ashburton River catchment in the south. A total of 10 land systems occur within the Survey Area, the extent of which are shown on **Figure 2-4**. A description of these land systems has been provided in **Table 2-3**.



Table 2-3 Land Systems within the Survey Area (Van Vreeswyk, et al. 2004)

Land System	Geomorphology	Land Management	Area (ha)
Coolibah Land System	Depositional surfaces; active flood plains and alluvial plains with shallow, meandering and anastomosing central channels of the Fortescue River.	Vegetation includes perennial grasses and forbs which are preferred by grazing animals and are prone to depletion under uncontrolled grazing. Flood plains (unit 1) generally have low susceptibility to erosion. Alluvial plains (unit 2) are highly susceptible to erosion.	11,888.12
Jamindie Land System	Depositional surfaces; non-saline plains with hardpan at shallow depth and groved vegetation, stony upper plains and low rises on hardpan or rock, very widely spaced tributary drainage tracts and channels; minor stony gilgai plains, sandy banks and low ridges and hills. Relief up to 30 m.	Most vegetation is only moderately preferred by grazing animals but can become degraded by overgrazing. Drainage tracts (unit 6) are moderately susceptible to erosion, some hardpan plains (unit 3) are slightly susceptible and other parts are inherently resistant.	7,591.04
Newman land System	Erosional surfaces; plateaux and mountains - extensive high plateaux, mountains and strike ridges with vertical escarpments and steep scree slopes and more gently inclined lower slopes; moderately spaced dendritic and rectangular tributary drainage patterns of narrow valleys and gorges with narrow drainage floors and channels. Relief up to 450 m.	Much of the system is inaccessible or poorly accessible and is unsuitable for pastoral purposes. The system contains iron ore deposits which are currently being mined and deposits which are likely to be mined in the future. Spinifex is the dominant vegetation and the system is burnt fairly frequently.	6,178.91
Calcrete Land System	Depositional surfaces; valley fill deposits - stony plains as a mosaic of calcrete tables and low rises elevated up to 10 m above the surrounding surfaces of narrow inter-table drainage areas and restricted sandy plains; drainage patterns absent to sparse tributary tracts and occasional through going trunk channels.	Some shrubs and grasses associated with the spinifex grasslands of this system are attractive to grazing animals and may be depleted if grazing levels are excessive. Low erosion risk.	2,487.98
Hooley Land System	Depositional surfaces; level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony, and non-gilgaied surfaces with abundant stony mantles; mostly sluggish internal drainage but occasional drainage tracts with major through going channels.	Tussock grasslands and snakewood shrub communities are favoured by grazing animals and are prone to degradation (especially the snakewood communities) if overgrazed. Those parts of the system not protected by a stony surface mantle are moderately susceptible to soil erosion.	3,172.17



Land System	Geomorphology	Land Management	Area (ha)
Boolgeeda Land System	Predominantly depositional surfaces; very gently inclined stony slopes and plains below hill systems becoming almost level further downslope; closely spaced, dendritic and sub-parallel drainage lines. Relief up to about 20 m.	Hard spinifex grasslands are not preferred by livestock but soft spinifex is moderately preferred for a few years following fire. Vegetation is generally not prone to degradation and the system is not susceptible to erosion. The system is subject to fairly frequent burning.	8,976.42
Jurrawarrina Land System	Depositional surfaces; plains receiving overland sheet flow and with prominent drainage foci (groves) arranged as right angles to direction of flow, broad drainage tracts receiving more concentrated flow, with or without defined channels and with prominent gilgaied drainage foci; minor plains with clay soils and gilgai microrelief, also occasional through going creek channels.	Much of the vegetation on this system is highly preferred by grazing animals and is prone to degradation if overgrazed. Some hardpan washplains, drainage tracts and groves (units 2, 3 and 4) are moderately susceptible to erosion.	10,622.97
McKay Land System	Erosional surfaces; hill tracts, ridges, plateaux remnants and breakaways with steep upper slopes and more gently inclined lower footslopes, restricted stony plains and interfluves; moderately spaced tributary drainage patterns incised in narrow valleys in upper parts becoming broader and more widely spaced downstream. Relief up to 100 m.	This system supports predominantly hard spinifex vegetation and is not preferred by livestock. Some areas are poorly accessible, and the system is not prone to degradation or soil erosion.	5,596.67
Brockman Land System	Depositional surfaces; level, non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains, sluggish internal drainage zones on plains and occasional through going trunk channels.	Tussock grasslands on this system are highly preferred by livestock and other animals and are susceptible to overgrazing and degradation. Overgrazing can be prevented by appropriate land management including control of total grazing pressure. Soil erosion, despite the inherent resistance of the system, can occur if vegetative cover is severely depleted.	1,477.19



Land System	Geomorphology	Land Management	Area (ha)
Urandy Land System	Depositional surfaces; level stony plains and plains and fans of sandy alluvium with widely spaced through going or sub-parallel distributary creeklines and channels; subject to sheet flow and overbank flooding. Relief less than 10 m.	The system supports soft spinifex vegetation which, except for old mature stands, is moderately preferred by grazing animals. The system is prone to fairly regular burning. Most of the system is not susceptible to erosion or vegetation degradation.	410.95
Total			58,402.42



2.5 Soils

Tille (2006) described the soil landscapes of Western Australia's arid rangelands and interior at a broad scale. The Atlas of Australian Soils (Northcote *et al.*, 1960-1968) describes soil units on a finer scale and five soils units have been identified within the Survey Area. None of these soil units are considered to be restricted. These soil units have been described in greater detail in **Table 2-4** and shown on **Figure 2-5**.

Soil Unit	Description	Area (ha)
Gf1	Steep ranges on basic lavas along with dolomites, tuff, banded iron formations, and dolerite dykes, with some narrow valley plains and high-level gently undulating areas of limited extent. The soils are generally shallow and stony and there are large areas without soil cover: chief soils are brown loams (Um6.23) along with significant areas of earthy loams (Um5.51). (Dr2.33) soils occur on lower slopes, with (Uf6.71) and (Ug5.37) on valley floors.	582.39
Ja1	Extensive valley plains largely associated with the Fortescue River: chief soils are earthy clays (Uf6.71) along with some (Ug5.38), (Um5.5), and (Dr2.33) soils. Small areas of calcrete (kunkar) with (Um5.11) soils occur also.	32,167.73
Oc71	Outwash plains with much coarse surface gravel: chief soils are hard alkaline red soils (Dr2.33) but (Uf6.71), (Ug5.38), and (Gn2.12) soils also occur. There are areas of (Gc) soils in proximity to unit Lb12.	5,386.57
Oc70	Dissected pediments and low stony hills associated with cherts, jaspilites, and iron ore formations; much coarse surface gravel: chief soils are hard alkaline red soils (Dr2 33) along with some (Dr2.32) and (Um5.52) soils.	14,287.84
Lb12	Valley flats along major drainage lines, associated with limestone and calcareous gravels (kunkar): chief soils are highly calcareous earths (Gc1.12), with minor areas of shallow calcareous loams (Um1.1). Associated are areas of hard red soils (Dr2.33) and some cracking clays (Ug5.37).	5,977.87
Total		58,402.42

 Table 2-4
 Soil units within the Survey Area (Northcote et al., 1960-1968)



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2.6 Pre-European Vegetation

The major structural vegetation types of WA were broadly (1:1,000,000) mapped by Beard (1975b), before being reinterpreted by Shepherd *et al.* (2002) who updated the vegetation association mapping to reflect the National Vegetation Information System (NVIS) standards (ESCAVI, 2003) and account for extensive clearing since Beard's original mapping.

Seven pre-European vegetation communities have been mapped as occurring within the Survey Area. Descriptions of these communities and their revised descriptions under Shephard *et. al.* (2002) are provided below in **Table 2-5** and they are shown in **Figure 2-6**.

Table 2-5	Vegetation	associations	within	the	Survey	Area
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Beard Vegetation Community	Vegetation Association	Shephard Description	Area (ha)
Low woodland, open low woodland or sparse woodland. Flora: Mulga (<i>Acacia aneura</i>) shrubs of <i>Eremophila</i> spp. and <i>Senna</i> spp. and annuals such as <i>Ptilotus nobilis</i> (tall mulla mulla).	29	Sparse Low woodland; mulga, discontinuous in scattered groups	34,284.48
Low tree-steppe. Flora: Hummock grassland with scattered bloodwoods & snappy gum <i>Triodia</i> spp., <i>Corymbia dichromophloia</i> and <i>Eucalyptus leucophloia</i>	562	Mosaic: Low woodland; mulga valleys/Hummock grasslands, open low tree-steppe; snappy gum over <i>Triodia</i> <i>wiseana</i>	14,469.41
Riverine sedgeland/grassland with trees. Flora: Rivergum, coolibah over mixed sedges Eucalyptus camaldulensis, E. microtheca and E. victrix	151	Sedgeland; sedges with open low trees; coolabah over various sedges	1,632.60
Grasslands, short bunch-grass savanna. Flora: Annual grasses <i>Enneapogon</i> spp. <i>Aristida</i> spp. etc on dry plains and saltwater grasses <i>Sporobolus virginicus</i> on the coast	175	Short bunch grassland – savanna/grass plain	6,852.85
Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee <i>Triodia</i> spp. <i>Acacia</i> spp., <i>Grevillea</i> spp. and <i>Eucalyptus</i> spp	111	Hummock grassland, shrub steppe; <i>Eucalyptus gamophylla</i> over hard spinifex	696.14
Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee <i>Triodia</i> spp. <i>Acacia</i> spp., <i>Grevillea</i> spp. <i>Eucalyptus</i> spp	173	Hummock grasslands, shrub steppe; snappy gum over soft spinifex and <i>Triodia</i> <i>brizioides</i>	448.27
Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee <i>Triodia</i> spp. <i>Acacia</i> spp., <i>Grevillea</i> spp. <i>Eucalyptus</i> spp	645	Hummock grasslands, shrub steppe; kanji and snakewood over soft spinifex and <i>Triodia wiseana</i>	18.68
Total			58,402.42

2.7 Threatened and Priority Ecological Communities

While no Threatened Ecological Communities (TEC) occur within the Survey Area, one Priority Ecological Community (PEC) has been mapped; namely the Freshwater claypans of the Fortescue Valley (Priority 1) PEC (**Figure 2-7**). It should be noted that this PEC has a buffer applied to it by the DBCA (DBCA, 2021a). It is located downstream of the Fortescue



Marsh below Goodiadarrie Hills on Mulga Downs Station and is considered important for waterbirds with an exceptionally high diversity and abundance of invertebrates (DBCA, 2021b).

The Four plant assemblages of the Wona Land System (Priority 1) PEC (previously the 'Cracking clays of the Chichester and Mungaroona Range' PEC) occurs approximately 2 km north of the Survey Area (**Figure 2-7**). This PEC is a stony gibber community occurring on the tablelands. It lacks shrubs and has very little vegetative cover during the dry season. During the wet season an array of ephemerals/annuals and short-lived perennials may be observed, many of which are poorly known and range-end taxa (DBCA, 2021b).

2.8 Ground and Surface Water Values

The DCCEEW Protected Matters Search Tool and the DBCA managed lands and waters database were queried for Ramsar Wetlands, Nationally Important Wetlands, and DBCA managed waters occurring near the Survey Area. No Ramsar wetlands occur near the Survey Area. The closest Ramsar listed wetlands to the MDIOM is Eighty Mile Beach.

The Fortescue Marsh, upstream from the Goodiadarrie Hills, is a Nationally Important Wetland (WA066) and is defined by the DBCA's Draft Fortescue Marsh Management Strategy 2018-2024.

The Survey Area also occurs within a section of the Fortescue River that forms part of the Freshwater Claypans of the Fortescue Valley P1 PEC (**Figure 2-7**), which is discussed in **Section 2.7**. Several springs, pools and associated claypans occur within the wider PEC. Two of these occur within the Survey Area including Koodjeepindarranna (small claypan) and Gnalka Gnoona (large claypan). The wetlands associated with the Fortescue Valley have very diverse aquatic invertebrate communities and most of the restricted elements of the Pilbara riparian flora (Pinder *et al.*, 2017).

Aerial imagery was also reviewed to determine whether any additional groundwater and surface water values (i.e., wetlands) are present within the Survey Area. Excluding bores and watering points for cattle, no permanent water bodies have been identified as persisting within the Survey Area.



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3.0 Implemented Methodologies

3.1 Desktop Assessment

3.1.1 Database Searches

Previous assessments undertaken for the MDIOM have included comprehensive database searches and literature reviews (**Section 3.1.3**), consistent with EPA guidance (EPA, 2020). Contemporary searches of mapping resources and databases (**Table 3-1**) were completed for this report to identify any changes to records of conservation significant species recorded within, or in the vicinity of the Survey Area.

Table 3-1	Databases revie	ewed as part of	f desktop asses	sment
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Database	Search Details
EPBC Act Protected Matters Database	Records of MNES under the EPBC Act within 40 km of the Survey Area
DBCA Threatened and Priority Fauna Database	Records of significant fauna species within 40 km of the Survey Area
DBCA NatureMap	All fauna records within 40 km of the Survey Area
BirdLife Birdata	Bird records within 40 km of the Survey Area
Atlas of Living Australia	All fauna within 40 km of the Survey Area

3.1.2 Likelihood of Occurrence Criteria

Conservation significant fauna species with the potential to occur in the Survey Area were assigned a likelihood of occurrence rating according to the criteria in **Table 3-2**. For relevant species, the likelihood of occurrence was determined by investigating the following:

- Fauna habitats likely to exist within the Survey Area based on the desktop study;
- Distance of previously recorded conservation significant species based on publicly available records;
- Frequency of occurrence of conservation significant species records; and
- Time passed since conservation significant species were recorded.

Table 3-2 Criteria used to assess the likelihood of occurrence for significant fauna species

Rating	Criterion
Recorded	The species has been recorded within the Survey Area previously or during the current survey
Likely	The species may occur within the Survey Area as suitable habitat is known to be present and there are existing records very close to the Survey Area (within 10 km).
Possible	The species may occur within the Survey Area as there are existing records in the vicinity of the Survey Area, and suitable habitat is likely to be present, OR the species may occur within the Survey Area as there is insufficient information available to exclude the possibility of occurrence.



Rating	Criterion
Unlikely	The species is unlikely to occur within the Survey Area as suitable habitat is not present or is not likely to be present, OR suitable habitat is present within the Survey Area, but the taxon/community has not been recorded despite reasonable survey effort

3.1.3 Literature Review

In addition to consideration of desktop information, previous fauna assessments also included a comprehensive review of additional fauna assessments that had either previously been conducted within the Survey Area or within the areas adjacent to the Proposal. A total of 14 terrestrial vertebrate studies and five targeted SRE invertebrate studies were reviewed, comprising detailed (formerly Level 2) and basic (formerly Level 1) surveys of which several had a targeted survey component. A summary of these literature sources is provided in **Table 3-3**.

Table 3-3	Literature sources	reviewed as	part of the	overall desktop	o assessment
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Database	Search Details
Vertebrate Fauna	
Bell <i>et al.</i> (2014). Winter bird assemblages of the Fortescue Marshes and surrounding vegetation, Pilbara Region, Western Australia.	Targeted
Coffey (2008) Level 2 terrestrial vertebrate fauna assessment for the Solomon Project.	Detailed
Coffey (2010) Level 1 vertebrate fauna assessment - Solomon Rail Project	Basic
Coffey (2011) Targeted surveys - Northern Quolls, Mulgara and Pilbara Olive Pythons. Solomon Rail Project.	Targeted
ecologia (2009). Murray's Hill level 1 fauna survey.	Detailed
ecologia (2010). Solomon Project: Kings Area vertebrate fauna assessment.	Detailed
ecologia (2014). Investigator Project terrestrial vertebrate fauna assessment.	Detailed
Ecoscape (2010a). Solomon Project - Rail camp sites 1, 2 and 3, fauna assessment.	Basic & Targeted
Ecoscape (2010b). Solomon Project - Rail realignment fauna assessment.	Basic & Targeted
Ecoscape (2010c). Vertebrate fauna and fauna habitat assessment for the Firetail Project.	Detailed
Terrestrial Ecosystems (2013). Level 2 fauna assessment for the Mulga Downs Survey Area.	Detailed & Targeted
Thompson <i>et al.</i> (2010). Spatial and temporal variations in the trapped terrestrial vertebrate fauna of the Hamersley Range, Western Australia.	Detailed
Trainor <i>et al.</i> (2016). New bird records from the Fortescue Marsh and nearby claypans, Pilbara bioregion, Western Australia.	Targeted
Bell <i>et al.</i> (2014). Winter bird assemblages of the Fortescue Marshes and surrounding vegetation, Pilbara Region, Western Australia.	Targeted
SRE Invertebrate Fauna	
ecologia (2009b) Murray Hills short range endemic pilot survey.	Detailed
ecologia (2019) Mulga East baseline terrestrial fauna assessment.	Detailed
ecologia (2020) Mulga East short-range endemic invertebrate fauna assessment.	Detailed



Database	Search Details
Phoenix (2010) Short-range endemic invertebrate fauna survey at Murray's Hill Transport Corridor final report.	Detailed
Wilson and Harvey (2020) Molecular identification of terrestrial arthropods from Mulga Downs Station, Western Australia	N/A

3.2 Survey Timeframes

The fauna assessments included in this consolidated fauna report include both basic and detailed surveys, conducted between October 2018 and March 2022. A summary of the individual surveys is provided in **Table 3-4**.

The detailed surveys were conducted in Autumn following the period of maximum rainfall for the Pilbara region as per the EPA technical guidance (EPA, 2016a and 2020). All survey methods employed were undertaken in accordance with EPA guidelines (EPA, 2016a; 2020).

Reference Document	Type of Survey	Survey Timeframe
	Level 1 – Fauna habitat assessment	8-12 Oct 2018
	Phase 1 – Level 2 Vertebrate fauna survey	4-16 Apr 2019
	Phase 1 – Targeted conservation significant fauna survey	22-30 Jul 2019
andaria 2021a h	Targeted Pilbara Leaf-nosed Bat Survey	25-2 Dec 2019
ecologia, 2021a, b	Long-term Pilbara Leaf-nosed Bat Survey	Dec 2019 - Mar 2020
	Phase 2 – Level 2 vertebrate fauna assessment	14-27 Apr 2020
	Phase 2 – Targeted conservation significant fauna survey	29-6 Jul 2020
	Targeted Pilbara Leaf-nosed Bat Surveys	5-9 Oct 2020 - March 2021
ecologia, 2020	Mulga East SRE Invertebrate Fauna Survey	16-23 Mar 2020
Piologic 2022	Dry Season (Basic) Survey	5-10 Nov 2021
Diologic, 2022	Wet Season (Detailed) Survey	15-25 Mar 2022

Table 3-4 Timeframes and types of surveys conducted within the Survey Area

3.2.1 Level 1 (Basic) Fauna Habitat Assessments

A basic fauna habitat assessment was initially conducted across the Survey Area to broadly describe areas of habitat that are distinguishable by its vegetation, soil characteristics, land features and are likely to host different fauna assemblages to those found in other fauna habitats. Habitat delineation and mapping was based on the interpretation of aerial photography, landforms, habitat site assessments, vegetation mapping and soil descriptions. The habitat assessment of the Survey Area paid particular attention to the likelihood that conservation significance fauna may be present in some habitat types. To ensure survey effort encompassed all fauna habitats present in the Survey Area, the following sources of information were used to delineate indicative broad fauna habitats before the Level 1 field survey commenced:

• Aerial imagery;


- Elevation modelling in Google Earth;
- Beard (1968, 1975, 1979) vegetation mapping; and,
- Land System mapping (van Vreeswyk et al. 2004).

Extensive ground truthing of habitat types during subsequent surveys allowed fauna habitat mapping within the Survey Area to be further refined.

3.2.2 Level 2 (Detailed) Terrestrial Vertebrate Fauna Assessments

Habitat mapping based on the results of the basic surveys identified the presence of eight distinct fauna habitat types occurring within the Survey Area (**Section 4.2.1**). Trapping sites were established within most of the available habitat types; however, some were deemed to not provide suitable niches for vertebrate fauna to reside. This methodology was replicated within each of the Survey component areas discussed in **Table 1-1** to ensure consistency and comparison of results. New sites were established for the *ecologia* (2021a) Phase 2 survey program. Where sites were established within areas with hard substrates that prevented the installation of pitfall traps, a combination of funnel traps, Elliott traps, cage traps and drift fences were used instead. This survey design and effort is considered to be comparable to that of a pitfall trap line (EPA, 2016 and EPA, 2020).

3.3 Vertebrate Survey Methodologies

Comprehensive survey methodologies were implemented by both *ecologia* (2021a) and Biologic (2022) to sample the fauna assemblages within the Survey Area. The following sections provide a brief discussion on these methodologies and what types of fauna these methods were hoping to detect.

3.3.1 Systematic Trapping

Systematic trapping involved a variety of trapping methods established across each site including:

- **Pitfall Traps:** 20 L bucket and/or 50 cm x 15 cm diameter PVC pipe traps. Each site was designed to have multiple trap lines established along drift fence with a total of 10 bucket or PVC pipe traps installed. Bucket and or PVC traps were interchanged with additional Funnel traps at sites where installation was not possible (i.e. too rocky). Drift fences lengths varied between *ecologia* (2021a) and Biologic (2022) methodologies, however both were 30 cm in height.
- **Funnel Traps:** Funnel traps were typically placed on either side of the pitfall traps along the established drift fence. The number of funnel traps varied between the *ecologia* (2021a) and Biologic (2022) methodologies with 16 and 20 traps deployed per site respectively. All funnel traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- Elliott Traps: Aluminum box traps were deployed around the pitfall and funnel trap lines at each site. The number of Elliot traps used varied between the *ecologia* (2021a) and Biologic (2022) methodologies with 10 and 20 traps deployed per site respectively. Traps were baited with a 'universal bait' (oats, peanut butter, sardines) to attract and capture smaller mammals and re-baited as necessary. All Elliott traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Cage Traps:** Two larger wire-frame box traps were deployed at each systematic trapping site. These traps were baited with the same 'universal bait' as the Elliott traps to capture medium sized mammals. Cage traps were



covered by hessian shades to reduce the likelihood of animals suffering from overheating, excess stress from being out in the open and protection from predators.

All traps were cleared within three hours of sunrise, closed during the day, and then reopened in the late afternoon to minimise potential heat stress to captured animals. All traps were removed, and holes were filled following the completion of the systematic trapping program. The locations of the trapping undertaken throughout the Survey Area are shown in **Figure 3-1**.





Mulga Downs Mine Fauna survey sites

Figure 3-1

Central Transport Corridor
🔜 Malay Well
Mulga East
Mulga East Southern Corridor
Mulga West Borefield
Mulga North
— Highway/Road



Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS, Esri, USGS, Maxar



3.3.2 Avifauna Surveys

Avifauna surveys involved 20 minute set-time searches undertaken at each systematic trapping site by experienced ecologists. During each set-time survey, the number of individuals of each species observed was recorded while actively searching similar habitat within a 2 ha area around the survey site. Avifauna surveys were conducted within three hours of dawn and dusk, which is deemed to be optimal for recording the majority of bird species.

Set-time surveys were conducted at each systematic trapping site for avifauna on a minimum of two occasions. Opportunistic surveys were also conducted at sites considered to potentially support a different avifauna assemblage, with a specific focus on areas containing surface water.

3.3.3 Acoustic Recording Units

SongMeter ultrasonic bat recorders were deployed at each systematic trapping site and at prospective foraging and or roosting locations (caves) potentially utilized by bat species throughout the Survey Area. These Acoustic Recording Units (ARUs) have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Bat calls were analyzed by suitability qualified ecologists to determine which species were present within the Survey Area.

SongMeter acoustic recorders were also deployed throughout the Survey Area in an effort to target the Night Parrot (*Pezoporus occidentalis*). These ARUs were deployed in potential habitat for this species, which according to DPaW (2017) includes "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." Opportunistic observations of other species were also captures using these ARUs.

3.3.4 Nocturnal Spotlighting

Spotlighting surveys were undertaken to detect the presence of any nocturnal fauna species within the Survey Area. Nocturnal surveys were undertaken after sunset (between approximately 6:30 pm and 10:00 pm) when activity levels were highest for most nocturnal species. These surveys consisted of searches using head torches and, where possible, road spotting to detect fauna from movement, eye shine and other evidence of species' presence.

3.3.5 Camera Traps

Individual motion sensor camera traps were deployed at numerous locations around the Survey Area to survey for larger and/or cryptic species (i.e. significant and introduced species) that may not be recorded using other sampling methods. The chosen locations prioritized suitable habitat for significant fauna species. Cameras established around water features required no baiting, whereas other sites were baited with 'universal bait' in a non-reward receptacle (i.e. perforated and capped PVC pipe).

3.3.6 Targeted Searches and Active Foraging

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments including:

- Bilby (*Macrotis lagotis*);
- Brush-tailed Mulgara (Dasycercus blythi);



- Northern Quoll (Dasyurus hallucatus);
- Western Pebble Mound Mouse (Pseudomys chapmani);
- Short-tailed Mouse (Leggadina lakedownensis);
- Ghost Bat (Macroderma gigas);
- Night Parrot (Pezoporus occidentalis);
- Pilbara Leaf-nosed Bat (Rhinonicteris aurantia ((Pilbara form));
- Pilbara Olive Python (Liasis olivaceus);
- Gane's Blind Snake (Anilios ganei);
- Grey Falcon (*Falco hypoleucos*);
- Peregrine Falcon (Falco peregrinus); and and
- Spotted Ctenotus (Ctenotus uber johnstonei).

These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats, shed skins and pebble-mounds) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. Unmanned Aerial Vehicles (UAVs) were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort.

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps, overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence.

3.3.7 Opportunistic Records

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly 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, diggings, tracks and/or scats) evidence.

3.4 SRE Invertebrate Sampling Methodologies

SRE invertebrate sampling was undertaken as part of the Biologic (2022) fauna report within the Mulga West Borefield and Mulga East Southern Corridor Project component areas. SRE invertebrate sampling was undertaken by *ecologia* (2019 and 2020) within the Mulga East Tenement, but no SRE sampling was undertaken within the Malay Well Tenement as this area was deemed depauperate in potential SRE habitats.

3.4.1 Site Selection

Habitats considered suitable for SRE terrestrial invertebrates in the Pilbara were targeted for the baseline SRE invertebrate fauna surveys, namely gorges/deep gullies, shallow/open gullies, ridges/breakaways, and drainage foci. Sampling was also undertaken in less suitable habitat types, including drainage lines, sandy or stony plains, and minor rocky outcrops.



The sampling techniques employed for SRE invertebrate fauna sampling included active searching under rocks and other debris, around the base of trees, through sifting of leaf litter and soil, under spinifex hummocks, and via ground searches for spider and scorpion burrows. The target taxonomic groups were mygalomorph and selenopid spiders, scorpions, pseudoscorpions, centipedes and millipedes, land snails, and terrestrial isopods. The sampling methods adopted were carried out in accordance with EPA (2016b) guidelines and are detailed below.

3.4.2 Active Foraging

Active SRE foraging was undertaken by both Biologic (2022) and *ecologia* (2019; 2020) and involved various techniques depending on the characteristics of the site, including:

- Presence of rocky outcropping and loose rocks: suitably sized rocks were overturned, and rocky microhabitats (cracks, crevices, and boulders) were actively searched for rock-dwelling species.
- Presence of woody debris: larger logs and woody debris were overturned and actively searched for detritivore species.
- Presence of trees and larger vegetation: trees such as *Ficus*, *Acacia* and *Eucalyptus* were actively searched, including underneath bark and in tree hollows.
- Presence of large *Triodia* hummocks: hummocks were turned over to expose accumulated soil and litter that could be searched and / or sifted.

3.4.2.1 Dry Pitfalls

A total of 18 dry pitfall sites were established during the *ecologia* (2019) SRE survey and a further ten sites were resampled in the *ecologia* (2020) report. This resulted in a combined total of 2040 trap nights of trapping effort within the Mulga East tenement.

3.4.2.2 Leaf Litter and Soil Sifting

Leaf litter, humus, and soil (to approximately 15 cm below surface where possible) sampling was undertaken by Biologic (2022), *ecologia* (2019) and *ecologia* (2020). Samples were either collected for later sieving or in the case of Biologic (2022) sampled at site. All samples were sieved and agitated to divide the sample into grades (10 mm, and 2 mm-3 mm). Each grade was thoroughly searched for target SRE species such as pseudoscorpions, millipedes, snails, and small scorpions. Multiple sifts (~ 1 L to 3 L of material) were conducted for each site, providing sufficient leaf litter and humus was available.

3.4.2.3 Burrow Searching

Active searches were undertaken for mygalomorph spider and scorpion burrows within each site. A leaf blower was utilised in some areas to blow away leaf litter to observe burrow lids more readily. Burrow searching is also conducted continuously while traversing the Survey Area. Time taken to excavate burrows is additional to foraging time.

3.4.2.4 Opportunistic Collections

Opportunistic collection of SRE invertebrate fauna was also undertaken at four of the vertebrate systematic trapping sites vertebrate representing the main habitat types of the Survey Area. Invertebrate fauna representing the target



groups was collected when present during checking and clearing of the pit-traps each morning. Some invertebrate specimens were also collected during active foraging for vertebrate fauna.

3.4.3 SRE Invertebrate Specimen Preservation and Identification

All specimens were euthanized in 100% ethanol on site. Specimen vials were put on ice as soon as possible and once returned to the lab, stored at -21°C to preserve DNA for sequencing. Specimen identification was generally performed in-house by ecologists and taxonomists using available keys and expertise. A DNA analysis was undertaken by Alacran Environmental to verify or improve the level of taxonomic identity, with 24 DNA sequences obtained.

3.5 Consolidated Survey Effort

Fauna survey methodologies are described in detail **Section 3.3** and **Section 3.4**. The following summary has been prepared to outlined the consolidated survey effort undertaken as part of the *ecologia* (2020, 2021a) and Biologic (2022) survey programs across the Survey Area. This summary includes the following:

- Baseline vertebrate fauna survey effort (Table 3-5);
- Total survey effort for the Northern Quoll (Table 3-6);
- Total survey effort for the Pilbara Olive Python (Table 3-6);
- Total survey effort for the Pilbara Leaf-nosed Bat (Table 3-7);
- Total survey effort for the Ghost Bat (Table 3-7);
- Total survey effort for the Night Parrot (Table 3-8);
- Total survey effort for the Bilby (Table 3-9); and
- Total survey effort for SRE invertebrate species (Table 3-10).

Reference Document	Type of Survey	Systematic Trap Sites	Avifauna Surveys	Acoustic Recording Surveys ¹	Nocturnal Surveys	Active Forages
	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	18 sites 5,652 trap nights	22 sites 23.3 hrs surveyed	21 sites 42 recording night	12 hrs surveyed	-
ecologia (2021a)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	18 sites 6,160 trap nights	15 sites 12.3 hrs surveyed	25 sites 60 recording nights	36 hrs surveyed	-
	Basic Survey (Nov, 2021)	-	6 sites 2.3 hrs surveyed	2 sites 8 recording nights	-	2 sites 0.8 hrs surveyed
BIOIOGIC (2022)	Detailed Survey (Mar, 2022)	5 sites 1,820 trap nights	6 sites 9.1 hrs surveyed	12 sites 65 recording nights	7 hours surveyed	12 sites 11.3 hrs surveyed
Total baseline survey effort		41 sites 13,632 trap nights	49 sites 47 hrs surveyed	60 sites 175 recording nights	55 hrs surveyed	14 sites 21.1 hrs surveyed

¹ Includes SongMeter ultrasonic bat recorders and acoustic recorders. "-" denotes that survey method was not undertaken



Table 3-6 Total survey effort for the Northern Quoll (Dasyurus hallucatus) and the Pilbara Olive Python (Liasis olivaceus)

Reference Document	Type of Survey	Motion Sensor Camera Traps	Cage Traps	Targeted Searches	Unmanned Aerial Vehicle Searches
	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	10 sites 48 trap nights	-	20 hrs targeted searches	-
	Phase 1 – targeted significant fauna survey (Jul, 2019)	42 sites 207 trap nights	45 sites 315 trap nights	20 hrs targeted searches 12 hrs nocturnal searches	-
ecologia (2021a)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	Cameras deployed at 39 sites	-	60 hrs targeted searches	-
	Phase 2 – Targeted significant fauna survey (Jul, 2020)	Cameras retrieved from 39 sites 3,982 trap nights	-	100 hrs targeted searches (during cave assessments) 36 hrs nocturnal searches	107 kms of UAV flight pathways
Piologic (2022)	Basic Survey (Nov, 2021)	3 sites 10 trap nights	-	1.25 hrs targeted searches	-
вююдіс (2022)	Detailed Survey (Mar, 2022)	13 sites 88 trap nights	5 sites 70 trap nights	9.6 hrs targeted surveys 7 hrs nocturnal searches	_
Total survey effort for the Northern Quoll and the Pilbara Olive Python		107 sites 4,335 trap nights	50 sites 385 trap nights	210.85 hrs targeted surveys 55 hrs nocturnal searches	107 km of UAV flight pathways

"-" denotes that survey method was not undertaken



Table 3-7Total survey effort for the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and the Ghost Bat(Macroderma gigas)

Reference Document	Type of Survey	Acoustic Recording Surveys	Cave Habitat Assessments	Unmanned Aerial Vehicle Searches
	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	31 sites 59 recording nights	-	_
	Phase 1 – targeted significant fauna survey (Jul, 2019)	57 sites 75 recording nights	-	_
	Targeted Pilbara Leaf-nosed Bat Survey (Dec, 2019)	70 sites 70 recording nights	-	-
ecologia (2021a)	Long-term Pilbara Leaf-nosed Bat Survey (Mar, 2020)	6 sites 212 recording nights	-	-
	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	18 sites 18 recording nights	-	107 km of UAV flight pathways
	Phase 2 – Targeted significant fauna survey (Jul, 2020)	42 sites 42 recording nights	81 cave habitat assessments	_
	Targeted Pilbara Leaf-nosed Bat Survey (Oct, 2020)	28 sites 28 recording nights	1 cave habitat assessment	_
<i>ecologia</i> (2021b)	Targeted Pilbara Leaf-nosed Bat Gap Survey (March 2021)	16 sites 16 recording nights	_	_
Biologic	Basic Survey (Nov, 2021)	2 sites 8 recording nights	-	-
(2022)	Detailed Survey (Mar, 2022)	12 sites 65 recording nights	-	_
Total surve	y effort for the Pilbara Leaf-nosed and Ghost Bats	272 sites 593 recording nights	82 cave habitat assessments	107 km of UAV flight pathways

"-" denotes that survey method was not undertaken

Table 3-8 Total survey effort for the Night Parrot (*Pezoporus occidentalis*)

Reference Document	Type of Survey	Acoustic Recording Surveys	Unmanned Aerial Vehicle Searches
Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)		3 sites 24 recording nights	-
(2021a)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	7 sites 42 recording nights	33 kms of UAV flight pathways
Biologic (2022) Detailed Survey (Mar, 2022)		7 sites 40 recording nights	-
Total survey effort for the Night Parrot		17 sites 106 recording nights	33 kms of UAV flight pathways



Reference Document	Type of Survey	Targeted Searches	Unmanned Aerial Vehicle Searches
ecologia	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	42 habitat assessments undertaken	-
(2021a)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	-	228 kms of UAV flight pathways
Total survey effort for the Bilby		42 habitat assessments undertaken	228 kms of UAV flight pathways

Table 3-9 Total survey effort for the Bilby (Macrotis lagotis)

Table 3-10 Total SRE invertebrate survey effort

Reference Document	Type of Survey	Dry Pitfall	Active Foraging	Leaf litter and Soil Sampling
Biologic	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	-	6 sites 9 hrs active foraging	6 sites
(2022)	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	-	18 sites 27 hrs active foraging	18 sites
ecologia (2019)	Level 2 SRE Invertebrate Fauna Survey	18 sites 1,340 trap nights	30 Sites 100 hrs of Foraging	18 Sites
ecologia (2020)	Mulga East Short-range Endemic Invertebrate Assessment (2020)	10 Sites 700 trap nights	22 sites 44 hrs foraging	10 Sites
Total survey effort for SRE invertebrate taxa			76 sites 180 hrs active foraging	52 sites

3.6 Limitations

As per EPA guideline for terrestrial fauna surveys (2020) limitations for each of the previous fauna assessments were identified. In terms of availability of data and information, competency/experience of the survey team, including experience in the bioregion surveyed, scope of the survey, adequacy of the survey intensity and proportion of survey achieved, and any problems with data and analysis, including sampling biases there were no constraints for the surveys. Partial or minor constraints were primarily in respect to access (weather or distance), disturbance of survey area and SRE identifications. The constraints for the terrestrial fauna surveys uundertaken from 2019-2022 for the MDIOM are stated in **Table 3-11**. A statement of limitations is provided in each of the survey reports listed in **Table 3-11**.



Reference Document	Type of Survey	Limitations
ecologia (2021a)	Phase 1 – Level 2 vertebrate fauna survey (Apr, 2019)	Timing/weather/season/cycle: Partial (minor) constraint. A Level 2 survey was undertaken in April following the season when the maximum rainfall typically falls and surface water was present due to 40mm of rain falling two weeks prior to undertaking survey. The previous two "wet seasons" in the region have been dry within the Project Area. Access: Partial (minor) constraint. Remoteness and/or access restrictions did not affect results. Some Rocky Hill habitat areas in the north-eastern portion of the Project Area had limited access.
	Phase 2 – Level 2 vertebrate fauna survey (Apr, 2020)	 Timing/weather/season/cycle: Partial(minor) constraint. Both phases of the Level 2 surveys were conducted during April (2019 and 2020) following the season of maximum rainfall. Targeted surveys were conducted to comply with specific target species survey guidelines. Surface water was present in the Claypans during both phases due to rainfall events prior to the survey. The two previous "wet seasons" (2017/2018, 2018/2019) in the region have been dry within the Project Area and average summer rains fell over the 2019/2020 season. Access: Minor (negligible) constraint. Limited access along to the northern portion of the proposed Rail corridor within the Yandeyarra Aboriginal Reserve. The western portion of the Malay Well tenement falls within the Wittenoom Asbestos Management Area (WAMA). Access to this area is prohibited and no survey work was undertaken in this area.
Biologic (2022)	Basic Survey (Dry Season) (Nov, 2021)	 Disturbance that may have affected the results: Partial constraint. Within the Mulga East northern corridor, evidence of recent fire was recorded in the eastern portion of the Study Area (sampling site VMUE-13). However, this is unlikely to have effected results and regeneration was evident. Large portions of the Mulga West borefield have been impacted by cattle grazing. Most of the southern half of Study Area (south of the Roebourne-Wittenoom Road) has been significantly impacted by cattle. Of particular note, degradation was severe in the south-western portion (within Drainage Area/Floodplain habitat south east of the Fortescue River) as well as in the eastern arm of the Study Area (within Drainage Area/Floodplain habitat). Access: Partial constraint. Most of the Mulga East northern corridor was accessible by either vehicle or foot. The central portion of the Mulga East southern corridor was only accessible on foot. Several access issues prevented full coverage of the Mulga West borefield. a single track occurs in the northern portion of the Study Area (north of the Roebourne-Wittenoom Road that runs through the centre of the Study Area) preventing accessibility. An asbestos exclusion zone occurs in the south eastern corner of the Study Area preventing safe access. Most of the south-western corner of the Study Area was blocked by fencing from the Mount Florance Pastoral Station.
	Detailed Survey (Wet Season) (Mar, 2022)	Disturbance that may have affected the results : Partial constraint. Evidence of fire in eastern portion of Mulga East Southern Corridor.

Table 3-11 Limitations identified for terrestrial fauna surveys 2019-2022.



Reference Document	Type of Survey	Limitations
		Large portions of Mulga West Borefield have been impacted by cattle. Large expanses of Drainage Area/Floodplain degraded as a consequence.
		Access: Partial Constraint. Lack of vehicle tracks within the central portion of the Mulga East Southern Corridor limited access. Efforts were made to assess the area via foot. Several access issues prevented full coverage of the Mulga West Borefield. - a single track occurs in the northern portion of the Study Area (north of the Roebourne-Wittenoom Road that runs through the centre of the Study Area) preventing accessibility. - An asbestos exclusion zone occurs in the south eastern corner of the Mulga West Borefield Study Area preventing safe access. Some of the south-western corner of the Mulga West Borefield Study Area could not be accessed during the survey, due to pastoral boundary fencing of the Mount Florance Pastoral Station. Identifications: Partial Constraint. Identification of some SRE invertebrates was limited by a lack of taxonomic framework for certain groups (mygalomorph spiders and pseudoscorpions), or limited collections in the region for morphological comparison (isopods). Molecular analysis was used to help overcome this



4.0 Results

4.1 Desktop Results

4.1.1 Vertebrate Fauna Desktop Results

The consolidated desktop and literature assessment undertaken as part of the *ecologia* (2021a) and Biologic (2022) fauna assessments identified 384 species of vertebrate fauna, which have previously been recorded or have the potential to occur within the Survey Area (**Table 4-1**). This comprised 49 mammals, 188 birds, 134 reptiles and 13 amphibians. Of these, 39 species are considered significant and have been outlined in **Table 4-2**.

Table 4-1 Summary of fauna species recorded in desktop and literature assessme
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Source	Mammals	Birds	Reptiles	Amphibians	Total	
iterature Sources						
Bell at al. (2014)	0	122	0	0	122	
Coffey (2008)	21	68	62	3	154	
Coffey (2010)	1	2	0	0	3	
Coffey (2011)	7	3	1	0	11	
ecologia (2009)	13	64	21	0	98	
ecologia (2010)	29	79	73	4	185	
ecologia (2014)	21	65	25	1	112	
ecologia (2019)	22	85	46	1	154	
ecologia (2020)	22	85	44	0	151	
Ecoscape (2010a)	3	14	6	0	23	
Ecoscape (2010b)	3	17	2	0	22	
Ecoscape (2010c)	17	52	38	0	107	
Terrestrial Ecosystems (2013)	16	76	37	1	130	
Thompson <i>et al.</i> (2010)	8	0	65	0	73	
Trainor et al. (2016)	0	99	0	0	99	
Database Searches	Database Searches					
ecologia (2020)	49	188	134	13	384	
Biologic (2022)	44	184	111	11	350	
Significant Species recorded from all sources combined	10	23	6	0	39	



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2020)	Biologic (2022)
Bird Species						
Australian Painted Snipe	Rostratula australis	EN	EN	-	-	~
Barn Swallow	Hirundo rustica	MI	MI	-	-	~
Caspian Tern	Hydroprogne caspia	МІ	MI	-	-	~
Common Greenshank	Tringa nebularia	МІ	MI	-	~	~
Common Sandpiper	Actitis hypoleucos	МІ	MI	-	-	~
Curlew Sandpiper	Calidris ferruginea	CE, MI	CE, MI	-	-	~
Eastern Osprey	Pandion haliaetus cristatus	MI	MI	-	-	~
Fork-tailed Swift	Apus pacificus	MI	MI	-	~	~
Glossy Ibis	Plegadis falcinellus	MI	MI	-	-	~
Grey Falcon	Falco hypoleucos	VU	VU	-	~	~
Grey Wagtail	Motacilla cinerea	МІ	MI	-	-	~
Gull-billed Tern	Gelochelidon nilotica	MI	MI	-	-	~
Letter-winged Kite	Elanus scriptus		-	P4	-	~
Little Tern	Sternula albifrons	MI	MI	-	-	~
Night Parrot	Pezoporus occidentalis	EN	CE	-	~	~
Oriental Plover	Charadrius veredus	МІ	MI	-	-	~
Oriental Pratincole	Glareola maldivarum	MI	MI	-	-	\checkmark
Pectoral Sandpiper	Calidris melanotos	МІ	MI	-	-	~
Peregrine Falcon	Falco peregrinus	-	OS	-	~	~
Red-necked Stint	Calidris ruficollis	МІ	MI	-	~	~
Sharp-tailed Sandpiper	Calidris acuminata	МІ	MI	-	-	~
Wood Sandpiper	Tringa glareola	МІ	MI	-	~	~
Yellow Wagtail	Motacilla flava	МІ	MI	-	-	~
Mammal Species						
Bilby	Macrotis lagotis	VU	VU	-	~	~
Brush-tailed Mulgara	Dasycercus blythi	-	-	P4	~	~
Ghost Bat	Macroderma gigas	VU	VU	-	~	\checkmark
Long-tailed Dunnart	Sminthopsis longicaudata	-	-	P4	~	~
Northern Quoll	Dasyurus hallucatus	EN	EN	-	~	~
Northern Short-tailed Mouse	Leggadina lakedownensis	-	-	P4	~	~
Pilbara Leaf-nosed Bat	Rhinonicteris aurantia Pilbara form	VU	VU		~	~
Western Pebble-mound Mouse	Pseudomys chapmani	-	-	P4	~	~
Reptile Species						

Table 4-2 Significant species identified from desktop and literature assessments



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2020)	Biologic (2022)
Gane's Blind Snake	Anilios ganei	-	-	P1	✓	✓
Lined Soil-Crevice Skink	Notoscincus butleri		-	P4	-	✓
Pilbara Barking Gecko	O Underwoodisaurus seorsus		-	P2	-	✓
Pilbara Olive Python	Liasis olivaceus	VU	VU	-	✓	✓
Pin-striped Finesnout Ctenotus	Ctenotus nigrilineatus	-	-	P1	✓	✓
Spotted Ctenotus	Ctenotus uber johnstonei	-	-	P2	-	✓

¹ CE = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory, OS = Other Specially Protected Fauna, P1-4 = Priority

4.1.2 SRE Invertebrate Desktop Results

SRE invertebrate desktop assessments undertaken as part of the Biologic (2022) faunal assessment yielded 888 records of specimens collected in 144 taxa. Comparing these records and those found through the literature review, a total of 15 Confirmed and 91 Potential SRE invertebrate taxa occur within a 40 km search area around the Survey Area. Of the potentially occurring taxa, 12 have previously been recorded within the Survey Area.

A summary of the confirmed and potentially occurring SRE invertebrate taxa that have been recorded within the Survey Area are provided in **Table 4-3**.

Table 4-3	Confirmed and Potentially	y occurring	g SRE taxa identified	in Biologic	(2022) [Desktop	Assessments
	-				· · ·		

Higher Taxon	Taxon	SRE Status	Biologic (2022)
Araneae			
Actinopodidae	<i>Missulena</i> sp. indet.	Potential	✓
Anamidae	Kwonkan `MYG325`	Confirmed	\checkmark
	Aurecocrypta `chichester`	Potential	\checkmark
Barychelidae	Synothele `MYG237`	Confirmed	\checkmark
	Synothele `MYG311`	Confirmed	\checkmark
Halonoproctidae	Conothele `MYG279`	Confirmed	\checkmark
	Anidiops `sp. B02`	Potential	\checkmark
	Idiosoma `MYG083`	Confirmed	\checkmark
аюріаае	Idiosoma `MYG085`	Confirmed	\checkmark
	Idiosoma `MYG300`	Confirmed	\checkmark
	Karaops banyjima	Confirmed	\checkmark
Selenopidae	Karaops forteyi	Confirmed	\checkmark
Pseudoscorpiones			
Garypidae	Synsphyronus gracilis	Confirmed	✓
Scorpiones			
Buthidae	Lychas `SCO036`	Potential	\checkmark



Higher Taxon	Taxon	SRE Status	Biologic (2022)
	Lychas `bituberculatus complex`	Potential	\checkmark
	Lychas `splendens ms`	Potential	\checkmark
	<i>Lychas</i> sp. indet.	Potential	\checkmark
Urodacidae	Urodacus `firetail`	Confirmed	\checkmark
	Antichiropus antius	Confirmed	✓
Paradoxosomatidae	Antichiropus nimbus	Confirmed	\checkmark
	Acanthodillo `sp. B14`	Potential	\checkmark
	Buddelundia `sp. 20`	Confirmed	\checkmark
	Buddelundia `sp. B47`	Potential	\checkmark
Armadillidae	Buddelundia `sp. B48`	Potential	\checkmark
	Buddelundia `sp. B49`	Potential	\checkmark
	Buddelundia `sp. B50`	Potential	\checkmark
	Buddelundia `sp. B53`	Potential	\checkmark
Gastropoda			
Camaenidae	Quistrachia `cancellate` n.sp.	Confirmed	\checkmark

4.2 Field Results

4.2.1 Terrestrial Fauna Habitat Types Identified within the Survey Area

Fauna habitat surveys undertaken as part of the *ecologia* (2021a) and the Biologic (2022) faunal assessments identified and mapped eight distinct habitat types within the Survey Area (**Figure 4-1**). Descriptions of vegetation and habitat characteristics within these habitat types has been provided below in **Table 4-4**. Identified habitats were generally classified as being in 'Good', 'Very Good' or 'Excellent' condition, however several threatening processes were acknowledged from the Survey Area, including:

- Grazing by introduced herbivores;
- Clearing of native vegetation;
- Fires;
- Impacts of introduced predators; and
- Weed invasion.

Table 4-4 Fauna habitat types identified within the Survey Area

Habitat Type	Vegetation Description	Habitat Description	ecologia (2021)	Biologic (2022)	Photograph of Habitat Type	Area (ha)
Drainage Line/Floodplain	Scattered Eucalyptus victrix or Corymbia hamersleyana over an open shrubland of Acacia tumida and A. pyrifolia over hummock and tussock grasses.	The banks provide quality burrowing substrates for monitors while trees and shrub species provide habitat for birds such as honeyeaters and corellas. Drainage lines are of low to moderate conservation value as they provide foraging and dispersal habitat for fauna. Conservation significant species known to utilize drainage lines to forage include Pilbara Leaf-nosed bats (VU – EPBC, BC Act) and Ghost Bats (VU – EPBC, BC Act) utilise drainage lines for dispersal and foraging. This habitat is considered widespread in the Pilbara	✓	~		10,845.26
Calcrete Stony Plain	Mixed sparse shrubland of <i>Melaleuca</i> <i>glomerata</i> , <i>Eremophila</i> <i>longifolia</i> , <i>Acacia</i> spp., with either <i>Triodia epactia</i> hummock grasslands or tussock grasslands of annual <i>Eragrostis</i> <i>pergracilis</i> .	Stony orange sandy/clay/loam soils exhibit some outcropping and a moderate percentage of competent rock fragments through the surface soil profile increasing with depth. These substrates permit shallow burrowing by small species but is unsuitable for the deep, extensive burrowing exhibited by species such as the Bilby (VU – EPBC, BC Act). Shrubs provide foraging and nesting habitat for bird species. Calcrete Stony Plains support pygmy monitors, kalutas, desert mouse, Pilbara ningaui and multiple species of geckos and skinks. This habitat is widespread in the Pilbara and offers minimal refugia for species of conservation significance.	✓			2,101.99

Habitat Type	Vegetation Description	Habitat Description	ecologia (2021)	Biologic (2022)	Photograph of Habitat Type	Area (ha)
Rocky Hills	Isolated Eucalyptus leucophloia and/or Corymbia hamersleyana over sparse shrubland of mixed Acacia spp., Grevillea wickhamii, Hakea lorea and over open Triodia sp. Hummock grassland.	The Rocky Hills provides quality refugia, shelter and caves for conservation significant species. Ridgelines, boulders, crevices and caves provide shelter, denning and roosting habitat for species including Northern Quolls (VU – EPBC, BC Act), Pilbara Leaf-nosed Bat (VU – EPBC, BC Act), Pilbara Leaf-nosed Bat (VU – EPBC, BC Act), Pilbara Olive Python (VU – EPBC, BC Act), Pilbara Olive Python (VU – EPBC, BC Act), Rothschild's Rock Wallaby, rock rats, monitor lizards and <i>Pseudantichinus</i> sp. Rocky Hills are considered common and widespread throughout the Pilbara.	¥	¥		4,627.44
Mulga Woodland	Open woodland of Acacia aneura, A. xiphophylla with isolated A. pruinocarpa over Acacia spp., Eremophila spp., Dodonaea petiolaris and Hakea sp. over sparse soft grasses or Triodia hummock grasslands.	Compacted alluvial loamy clay soils with occasional surface stones are generally not favourable for burrowing species with few burrows recorded during the surveys. Dead wood, peeling bark, stumps and leaf litter provide shelter for marsupials, monitors, geckos and skinks. The Mulga Woodland has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Regionally this habitat type is generally well represented although it is of low value to conservation significant fauna except for the Gane's Blind Snake (P1 DBCA).	✓	✓		17,916.83

Habitat Type	Vegetation Description	Habitat Description	ecologia (2021)	Biologic (2022)	Photograph of Habitat Type	Area (ha)
Chenopod/Cracking Clay Floodplain	Sparse chenopod shrubland of <i>Sclerolaena</i> <i>trigona, S. bicornis,</i> <i>S. densiflora</i> over low tussock grasses of <i>Eragrostis</i> <i>xerophila</i> on a substrate of cracking clays.	This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. This habitat type is not considered widespread in the Pilbara.	✓			522.00
Stony Spinifex Plains and Hillslopes	Isolated <i>Eucalyptus</i> <i>leucophloia</i> over sparse shrubland of mixed <i>Acacia</i> spp. over open spinifex hummock grassland. The <i>Triodia</i> hummocks found are generally small and few isolated long unburnt patches are present.	Coarse stony red clay soils provide habitat for the Western Pebble-mound Mouse (P4, DBCA) which has been recorded multiple times during surveys conducted within the Survey Area. The substrates and vegetation present support termitaria which are a known refuge for vertebrate fauna. Stony Spinifex Plains and Hillslopes are considered as low value offering minimal refugia to species of conservation significance. However, the Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat (all VU – EPBC, BC Act) are known to forage in these areas. Stony Spinifex Plains and Hillslopes are widespread in the Pilbara.	V	¥		13,866.90

Habitat Type	Vegetation Description	Habitat Description	ecologia (2021)	Biologic (2022)	Photograph of Habitat Type	Area (ha)
Mixed Eucalypt/Mulga Floodplain	Isolated to dense <i>Eucalyptus victrix</i> and <i>Acacia distans</i> over scattered understory over low grasses.	Some open areas are associated with scattered tall trees with grasses and woody debris around the base and expanses of red sandy/clay soils in between. Woody debris is present, and the large mature trees provide large hollows for nesting and shelter. This habitat type is considered widespread within the Fortescue valley and is of low value to species of conservation significance as it does not provide significant refugia to sustain any permanent populations. The Northern Quoll (VU – EPBC, BC Act) is known to inhabit woody areas and may infrequently utilise shelter in large trees and hollows as they traverse the landscape. Isolated to dense <i>E.victrix</i> and <i>A. distans</i> over scattered understory over low grasses.	V			8,128.73
Claypan	Supporting very few isolated trees and little ground vegetation due to seasonal inundation.	This habitat type is considered to have high conservation value due to its importance as habitat for water birds, including migratory species, and aquatic invertebrates. This habitat forms part of the Freshwater Claypans of the Fortescue Valley P1 PEC.	✓			393.19
Total				58,402.34		



	Malay Well
	Mulga West Borefield
	Mulga East
	Mulga East Southern Corridor
	Central Transport Corridor
	Mulga North
	Highway/Road
	Watercourse
Fauna	a Habitat
	Calcrete Stony Plain
	Chenopod/ Cracking Clay Floodplain
	Claypan
	Mixed Eucalypt/ Mulga Floodplain
	Mulga Woodland
	Rocky Hills
	Stony Spinifex Plains and Hillslopes
	Drainage Lines/ Floodplains



4.2.2 Cave Assessments

A total of 82 cave habitat assessments were undertaken within the Survey Area as part of the *ecologia* (2021a; b) faunal surveys to determine whether they could provide potential habitat for the Ghost Bat or the Pilbara Leaf-nosed Bat. Cave habitats were categorised in accordance with the following classification framework:

- Category 1 diurnal roost caves with permanent occupancy, critical to the species
- Category 2 diurnal roost caves with regular occupancy, critical to the species
- Category 3 roost caves with occasional occupancy, important habitat for the long-term survival of the species in the area
- Category 4 nocturnal roosts with opportunistic usage, not important habitat for the long-term preservation of the species in the area

Whilst no Ghost Bats or Pilbara Leaf-nosed Bats were directly observed during these assessments, three caves were identified as nocturnal feeding caves for the Ghost bat based on the presence of scats and feeding debris (bird feathers). Opportunistic observations made during the Biologic (2022) faunal surveys confirmed the presence of two additional caves within the Survey Area, both of these were identified as likely Ghost Bat opportunistic nocturnal roost sites.

A total of 51 caves within the MDIOM area were assessed as being characteristic of a Category 4 cave (nocturnal refuge) with the potential for these caves to be used at night for resting, feeding or other purposes (ecologia 2023) by the Ghost Bat or Pilbara Leaf-nosed Bat. These Category 4 caves are not considered critical habitat but may play a role for the persistence of the species in the local area, with the majority of moderately deep caves in the Pilbara falling into this category (Bat Call WA 2021b). Of the caves assessed, six were identified as potential roosts for the Ghost Bat, with an additional 26 caves providing potential nocturnal refuges for this species. Similarly, 44 caves were identified as potential roosts of nocturnal refuges for the Pilbara Leaf-nosed Bat, with an additional 73 caves providing potential nocturnal refuges was observed in five of the caves assessed.

No known or suspected Category 1, 2 or 3 caves exist within the MDIOM area or documented within a 30 km radius. There is anecdotal evidence of roost caves south of the Fortescue Valley within the Hamersley Ranges (*ecologia* 2023) outside of the Survey Area.

4.2.3 Vertebrate Fauna Records

The cumulative survey effort undertaken by *ecologia* (2021a) and Biologic (2022) recorded a total of 233 vertebrate fauna species within the Survey Area, including 28 mammals, 119 birds, 84 reptiles and two amphibians. Of these, 11 species are listed as species of conservation significance under the EPBC Act, BC Act or the DBCA (**Table 4-5**).

Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2021)	Biologic (2022)
Ghost Bat	Macroderma gigas	VU	VU	-	-	Recorded
Pilbara Leaf-nosed Bat	<i>Rhinonicteris aurantia</i> (Pilbara form)	VU	VU	-	Recorded	Recorded
Northern Quoll	Dasyurus hallucatus	EN	EN	-	Recorded	-
Western Pebble-mound Mouse	Pseudomys chapmani	-	-	P4	Recorded	Recorded
Gane's Blind Snake	Anilios ganei	-	-	P1	Recorded	-

Table 4-5	Conservation significant s	pecies recorded within the	he Survey Area	(2019-2022 surveys)



Common Name	Scientific Name	EPBC Act Status ¹	BC Act Status ¹	DBCA Listing	ecologia (2021)	Biologic (2022)
Pilbara Olive Python	Liasis olivaceus	VU	VU	-	Recorded	-
Grey Falcon	Falco hypoleucos	VU	VU	-	Recorded	-
Peregrine Falcon	Falco peregrinus	-	OS	-	-	Recorded
Common Greenshank	Tringa nebularia	MI	MI	-	Recorded	-
Red-necked Stint	Calidris ruficollis	MI	MI	-	Recorded	-
Wood Sandpiper	Tringa glareola	MI	MI		Recorded	-

4.2.3.1 Mammals

In total, the surveys undertaken throughout the Survey Area identified 28 terrestrial vertebrate fauna species. For the purposes of this report, these have been separated into ground dwelling species (14 species recorded), bat species (nine species recorded) and introduced species recorded (five species recorded).

The species recorded during field surveys are outlined below.

Native Ground Dwelling Mammals

The desktop assessment identified 49 native ground dwelling mammals as potentially occurring within or adjacent to the Survey area. In total, 14 mammals were recorded during the field surveys of the Survey Area:

- Dasykaluta rosamondae (Little Red Kaluta);
- Dasyurus hallucatus (Northern Quoll);
- Ningaui timealeyi (Pilbara ningaui);
- Sminthopsis macroura (Froggatt's Stripe-faced Dunnart);
- Notomys alexis alexis (Spinifex Hopping Mouse);
- Tachyglossus aculeatus (Short-beaked Echidna);
- Osphranter robustus (Common Wallaroo);
- Osphranter rufus (Red Kangaroo);
- Planigale sp.;
- Pseudantechinus woolleyae (Woolley's False Antechinus);
- Pseudomys chapmani (Western Pebble-mound Mouse);
- Zyzomys argurus (Common Rock-rat)
- Pseudomys desertor (Desert Mouse); and
- Pseudomys hermannsburgensis (Sandy Inland Mouse).

Of these species, *Pseudomys chapmani* (Western Pebble-mound Mouse) is a Priority 4 species and *Dasyurus hallucatus* (Northern Quoll) identified is an Endangered species under both the BC Act and the EPBC Act. No other conservation significant species were identified during the field surveys. These species are discussed in more detailed in **Section 4.3** and **4.4** of this report.



Bats

The literature review identified the potential occurrence of 12 species of bat within or in the vicinity of the Survey Area. In total, nine bat species were identified during the field surveys of the Survey Area. The following bat species were identified:

- Chaerephon jobensis colonicus (Greater Northern Free-tail Bat);
- Saccolaimus flaviventris (Yellow-bellied Sheath-tailed Bat);
- Chalinolobus gouldii (Goulds Wattle Bat);
- Macroderma gigas (Ghost Bat);
- Rhinonicteris aurantia (Pilbara form) (Pilbara Leaf-nosed Bat);
- Scotorepens greyii (Little Broad-nosed Bat);
- Taphozous georgianus (Common Sheath-tailed Bat);
- Taphozous hilli (Hills Sheath-tailed Bat); and
- Vespadelus finlaysoni (Finlayson's Cave Bat).

Of these, two were identified as species of conservation significance - *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat; Vulnerable under the BC Act and the EPBC Act) and *Macroderma gigas* (Ghost Bat; Vulnerable under the BC Act and the EPBC Act). These species are discussed further in **Section 4.3** of this report.

Introduced Mammals

In total, five introduced terrestrial mammal species were detected during the field surveys. These species are further discussed in **Section 4.3.2.5** of this report.

- Bos taurus (cattle);
- Mus musculus (House Mouse);
- Felix cattus (Domestic Cat);
- Vulpes vulpes (Red Fox); and
- Canis familiaris (Domestic Dog/Dingo).

4.2.3.2 Avifauna

The literature review identified the potential occurrence of 188 bird species within or in the vicinity of the Survey Area. **Table 4-6** contains the avian species identified during the field surveys broken into woodland/shrubland passerine, ground dwelling, nocturnal birds of prey, raptor and wading species.



Table 4-6 Bird species identified within the Survey Area

Scientific Name	Common Name
Predominantly Woodland/Shrubland Canopy Species	
Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Acanthiza robustirostris	Slaty-backed Thornbill
Acanthiza uropygialis	Chestnut-rumped Thornbill
Artamus cinereus	Black-faced Woodswallow
Artamus minor	Little Woodswallow
Artamus personatus	Masked Woodswallow
Barnardius zonarius	Australian Ringneck
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
Chalcites basalis	Horsfield's Bronze-cuckoo
Chalcites osculans	Black-eared Cuckoo
Cincloramphus cruralis	Brown Songlark
Cincloramphus mathewsi	Rufous Songlark
Climacteris melanurus	Black-tailed Treecreeper
Colluricincla harmonica	Grey Shrike-thrush
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Corvus bennetti	Little Crow
Corvus orru	Torresian Crow
Cracticus nigrogularis	Pied Butcherbird
Cracticus torquatus	Grey Butcherbird
Dacelo leachii	Blue-winged Kookaburra
Emblema pictum	Painted Finch
Epthianura aurifrons	Orange Chat
Epthianura tricolor	Crimson Chat
Gavicalis virescens	Singing Honeyeater
Geopelia cuneata	Diamond Dove
Geopelia placida	Peaceful Dove
Geopelia striata*	Zebra Dove
Grallina cyanoleuca	Magpie-lark



Scientific Name	Common Name
Gymnorhina tibicen	Australian Magpie
Heteroscenes pallidus	Pallid Cuckoo
Lalage tricolor	White-winged Triller
Lichmera indistincta	Brown Honeyeater
Malurus assimilis bernieri	Purple-backed Fairy-wren
Malurus lamberti	Variegated fairywren
Malurus leucopterus	White-winged Fairy-wren
Manorina flavigula	Yellow-throated Miner
Melanodryas cucullata	Hooded Robin
Melithreptus gularis	Black-chinned Honeyeater
Melopsittacus undulatus	Budgerigar
Merops ornatus	Rainbow Bee-eater
Mirafra javanica	Horsfield's Bushlark
Neochmia ruficauda	Star Finch
Neopsephotus bourkii	Bourke's Parrot
Nymphicus hollandicus	Cockatiel
Acyphaps lophotes	Crested Pigeon
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Petrochelidon ariel	Fairy Martin
Petrochelidon nigricans	Tree Martin
Petroica goodenovii	Red-capped Robin
Phaps chalcoptera	Common Bronzewing
Pomatostomus superciliosus	White-browed Babbler
Pomatostomus temporalis	Grey-crowned Babbler
Ptilotula keartlandi	Grey-headed Honeyeater
Ptilotula penicillata	White-plumed Honeyeater
Purnella albifrons	White-fronted Honeyeater
Rhipidura leucophrys	Willie Wagtail
Smicrornis brevirostris	Weebill
Taeniopygia castanotis	Zebra Finch



Scientific Name	Common Name
Todiramphus pyrrhopygius	Red-backed Kingfisher
Todiramphus sanctus	Sacred Kingfisher
Ground Dwelling Bird Species	
Tringa glareola	Wood Sandpiper
Amytornis striatus whitei	Rufous Grasswren
Ardeotis australis	Australian Bustard
Bburhinus grallarius	Bush Stone-curlew
Charadrius ruficapillus	Red-capped Plover
Chlamydera guttata	Western Bowerbird
Cinclosoma marginatum	Western Quail-thrush
Coturnix pectoralis	Stubble Quail
Dromaius novaehollandiae	Emu
Geophaps plumifera	Spinifex Pigeon
Pardalotus rubricatus	Red-browed Pardalote
Pardalotus striatus	Striated Pardalote
Poodytes carteri	Spinifex bird
Ptilonorhynchus maculatus	Spotted Bowerbird
Ptilonorhynchus nuchalis	Great Bowerbird
Synoicus ypsilophora	Brown Quail
Turnix velox	Little Button-quail
Vanellus tricolor	Banded Lapwing
Nocturnal Birds of Prey	
Aegotheles cristatus	Australian Owlet-nightjar
Eurostopodus argus	Spotted Nightjar
Ninox boobook	Boobook
Nycticorax caledonicus	Nankeen Night-Heron
Podargus strigoides	Tawny Frogmouth
Tyto alba	Barn Owl
Accipiter fasciatus	Brown Goshawk
Aquila audax	Wedge-tailed Eagle
Circus assimilis	Spotted Harrier



Scientific Name	Common Name
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen kestrel
Falco hypoleucos	Grey Falcon
Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Haliastur sphenurus	Whistling Kite
Hieraaetus morphnoides	Little Eagle
Milvus migrans	Black Kite
Wading Birds	
Anas gracilis	Grey Teal
Anas superciliosa	Pacific Black Duck
Anhinga novaehollandiae	Australasian Darter
Anthus australis	Australian Pipit
Anthus novaeseelandiae	Australasian Pipit
Ardea modesta	Great Egret (Eastern Great Egret)
Ardea pacifica	White-necked Heron
Calidris ruficollis	Red-necked Stint
Chenonetta jubata	Australian Wood Duck
Cladorhynchus leucocephalus	Banded Stilt
Dendrocygna eytoni	Plumed Whistling-Duck
Egretta novaehollandiae	White-faced Heron
Elseyornis melanops	Black-fronted Dotterel
Erythrogonys cinctus	Red-kneed Dotterel
Malacorhynchus membranaceus	Pink-eared Duck
Platalea flavipes	Yellow-billed Spoonbill
Platalea regia	Royal Spoonbill
Recurvirostra novaehollandiae	Red-necked Avocet
Stictonetta naevosa	Freckled Duck
Threskiornis spinicollis	Straw-necked Ibis
Tribonyx ventralis	Black-tailed Native-hen
Tringa nebularia	Common Greenshank



* Introduced Species

Of these species Grey Falcon (*Falco hypoleucos*) is identified as Vulnerable under the EPBC Act and the BC Act, and the Wood Sandpiper, the Red Stint and the Common Greenshank are identified as Migratory species under the EPBC Act. These species are discussed further in **Section 4.4** of this report.

The Zebra dove (Geopelia striata) was the only introduced species recorded.

4.2.3.3 Reptiles

The literature review identified the potential occurrence of 134 species of reptile on or within a 40 km radius of the Survey Area. In total, 84 reptile species were identified during the field surveys of the Survey Area. This represents 63% of the potential species identified from the literature review.

The reptile species identified during the field surveys of the Survey Area are identified in Table 4-7.

Table 4-7 Reptile species identified within the Survey Area

Scientific Name	Common Name
Tiliqua multifasciata	Central Blue-tongue
Antaresia childreni	Children's Python
Tympanocryptis fortescuensis	Fortescue pebble-mimic dragon
Demansia psammophis cupriceps	Yellow-faced Whipsnake
Varanus giganteus	Perentie
Anilios grypus	Long-beaked Blind Snake
Anilios pilbarensis	Pilbara Blind Snake
Aspidites melanocephalus	Black-headed Python
Brachyurophis approximans	North-western Shovel-nosed Snake
Carlia munda	Shaded-litter Rainbow Skink
Carlia triacantha	Desert Rainbow Skink
Ctenophorus isolepis isolepis	Yellowy Military Dragon
Ctenotus grandis	Grand Ctenotus
Ctenotus hanloni	Nimble Ctenotus
Ctenotus helenae	Clay-soil Ctenotus
Ctenotus pantherinus	Leopard Ctenotus
Ctenotus saxatilis	Rock Ctenotus
Ctenotus schomburgkii	Barred Wedge-snout Ctenotus
Ctenotus sp.	Ctenotus
Diplodactylus conspicillatus	Variable Fat-tailed Gecko



Scientific Name	Common Name
Diplodactylus laevis	Desert Fat-tailed Gecko
Eremiascincus richardsonii	Broad-banded Sand Swimmer
Gehyra variegata	Variegated gehyra
Heteronotia binoei	Bynoe's Gecko
Lialis burtonis	Burtons Legless Lizard
Lucasium wombeyi	Pilbara Ground Gecko
Morethia ruficauda	Lined Firetail Skink
Nephrurus cinctus	Northern Banded Knob-tailed Gecko
Parasuta monachus	Inland Hooded Snake
Proablepharus reginae	Western Soil-crevice Skink
Pseudechis australis	Mulga Snake
Pseudonaja mengdeni	Western Brown Snake
Rhynchoedura ornata	Western Beaked Gecko
Suta fasciata	Rosen's Snake
Varanus brevicauda	Short-tailed Pygmy Goanna
Varanus eremius	Pygmy Desert Goanna
Acanthophis wellsi	Pilbara Death Adder
Anilios ammodytes	Sand-diving Blind Snake
Anilios ganei	Gane's Blind Snake
Anilios hamatus	Pale-Headed Blind Snake
Antaresia perthensis	Pygmy Python
Antaresia stimsoni	Children's Python
Chelidonia steindacherii	Flat-shelled Turtle
Cryptoblepharus buchananii	Buchanan's snake-eyed skink
Ctenophorus caudicinctus	Western Ring-tailed Dragon
Cyclodomorphus melanops	Spinifex Slender Blue-tongue
Delma desmosa	Desert Delma
Delma nasuta	Sharp-snouted Delma
Delma tincta	Excitable Delma
Diplodactylus galaxias	Northern Pilbara Beak-faced Gecko
Diplodactylus pulcher	Fine-faced Gecko



Scientific Name	Common Name
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko
Egernia cygnitos	Western Pilbara Spiny-tailed Skink
Egernia formosa	Goldfields Crevice-Skink
Gehyra macra	Large Pilbara rock gehyra
Gehyra micra	Small Pilbara spotted rock gehyra
Gowidon longirostris	Long-nosed Dragon
Heteronotia spelea	Pilbara Cave Gecko
Lerista jacksoni	Jackson's Three-toed Slider
Lerista muelleri	Wood Mulch-Slider
Liasis olivaceus barroni	Pilbara Olive Python
Lucasium stenodactylum	Western Sandplain Gecko
Menetia greyii	Common Dwarf Skink
Pedura fimbria	Western Marbled Velvet Gecko
Pogona minor mitchelli	Dwarf Bearded Dragon
Pseudonaja modesta	Ringed Brown Snake
Pygopus nigriceps	Western Scaly-foot
Varanus acanthurus	Spiny-tailed Goanna
Varanus hamersleyensis	Southern Pilbara Rock Goanna
Varanus panoptes	Yellow-spotted Monitor
Varanus tristis	Racehorse Goanna
Vermicella snelli	Western Bandi-bandi
Ctenotus inornatus	Rock Ctenotus
Lucasium woodwardi	Pilbara Ground Gecko
Varanus sp.	Monitor
Lerista verhmens	Powerful Three-toed Slider
Lerista amicorum	Fortescue Three-toed Slider
Ctenotus uber uber	Spotted Ctenotus
Ctenophorus reticulatus	Western Netted Dragon
Diplodactylus bilybara	Western Fat-tailed Gecko
Ctenotus duricola	Eastern Pilbara Lined Ctenotus
Strophurus wellingtonae	Western Shield Spiny-tailed Gecko



Scientific Name	Common Name
Suta gaikhorstorum	Pilbara Hooded Snake
Pogona minor minor	Western Bearded Dragon

Two conservation significant reptile fauna species were identified during the field survey, the Pilbara Olive Python and the Gane's Blind Snake. The Pilbara Olive Python is identified as Vulnerable under the BC Act and the EPBC Act. Gane's Blind Snake is identified as a P1 (DBCA) species. These species are further discussed in **Section 4.3** and **4.4** of this report. No additional conservation significant species are expected to occur in the Survey Area.

4.2.3.4 Amphibians

The desktop assessments undertaken by *ecologia* (2021a) and Biologic (2022) for the combined Survey Area identified 13 amphibian species as occurring within 40 km of the Survey Area. The field survey results identified two amphibian species consisting of:

- Litoria rubella (Little Red Treefrog); and
- Cyclorana maini (Sheep Frog).

No conservation significant amphibian species were recorded during the field surveys of the Survey Area.

4.2.3.5 Introduced Species

Five introduced species were recorded within the Survey Area including the cat, wild dog/dingo, the house mouse, and the red fox and the zebra dove. Cats and foxes are classed as declared pests under the *Biosecurity Agriculture Management Act 2007* (BAM Act) and appear to have an affinity for Rocky Hills habitat, occupying the same niches as the Northern Quoll.

As the Survey Area is located on active pastoral leases, cattle were regularly observed during all surveys.

4.2.3.6 Data Analysis

To allow some validation of the survey effort undertaken across the Survey Area, all data records were combined into a dataset so that a Species Accumulation curve could be developed.

The desktop analysis of the Survey Area indicated that 384 vertebrate fauna taxa have previously been recorded from within 40 km of the Survey Area.

The combined field surveys for the Survey Area identified a total of 233 vertebrate fauna species including 28 mammals, 119 birds, 84 reptiles and two amphibians. As shown below, the species curve indicates that the maximum number of species statistically detected (i.e., the asymptote shown as Red Line) was found to be 240.9. The combined field surveys for terrestrial vertebrate fauna identified a total of 233 taxa. The Species Accumulation Curve (**Figure 4-2**) for the combined surveys therefore indicates that the apparent maximum number of species in the locality was achieved.



Figure 4-2 Combined Data for Species Accumulation Curve



4.2.4 SRE Invertebrate Records

Biologic (2022) found a total of 140 invertebrate specimens, identified as representing 28 morphological and molecular taxa, collected from sites within the Bore-field component of the Survey Area. The specimens collected were comprised of mygalomorph spiders, pseudoscorpions, scorpions, a polyxenid millipede, aquatic and land snails, and terrestrial isopods. Fifty specimens were sequenced for further elucidation of their identification by Biologic (2022).

Ecologia (2020) found a total of 496 invertebrate specimens across both phases of SRE invertebrate fauna surveys from seven target SRE groups including 152 isopods, 129 spiders, one harvestmen, 75 pseudoscorpions, 58 scorpions, 33 millipedes and 48 land snails. Of the specimens recorded, a single isopod species collected within the Survey Area during Phase 2 was considered an SRE species, while 17 species were considered potential SRE species including eight isopods, one spider, one harvestman, five pseudoscorpions, one millipede and one terrestrial snail.

Nine specimens which were unidentifiable down to species level due to a lack of morphological features and were from known or likely SRE groups were sent for molecular investigation at the Western Australian Museum (WAM) to determine identity. Single specimens of *Dampetrus* 'OPI001', *Conothele* 'MYG716', *Beierolpium* 'PSE173', *Indolpium* 'PSE175', *Indolpium* 'PSE174' and Genus 7/4 'PSE176' were selected for molecular analysis. In addition, specimens from each of the scorpion species complexes Lychas 'SCO024', Lychas 'hairy tail complex' and Lychas 'SCO046'.

The results of molecular investigations were cross referenced against WAM databases to confirm SRE status. *Dampetrus* 'OPI001', *Conothele* 'MYG716', *Beierolpium* 'PSE173', *Indolpium* 'PSE175', *Indolpium* 'PSE174' represent newly discovered species and are all considered potential SREs due to data deficiencies regarding their distributions. Genus 7/4 'PSE176', *Lychas* 'SCO046' and *Lychas* 'SCO024' do not represent newly discovered species; however, they are considered potential SRE species due to data deficiencies relating to their distribution. *Lychas* 'hairy tail complex' was unable to be identified using molecular analysis due to sample contamination.

Isopod and scorpion specimens from SRE target groups were collected from all habitat types surveyed. Pseudoscorpion and millipede specimens were collected from all habitat types besides the Chenopod/Cracking Clay Floodplains. Spider specimens were collected from all habitat types besides the Rocky Hills and Chenopod/Cracking Clay Floodplains. Land snail specimens were only collected from Calcrete Stony Plain, Rocky Hills, Mulga Woodland and Stony Spinifex Plains and Hillslopes. The results of this survey indicate that the target SRE groups collected, utilise a range of different habitat types within the Survey Area, with some species exhibiting higher levels of dispersal between habitats than others.

Habitat preferences for target SRE groups were highly variable, with different invertebrate groups exhibiting habitat preferences likely to be associated with variations in microhabitat requirements. The greatest diversity of isopods (four species) and terrestrial snails (three species) was recorded within the Calcrete Stony Plains habitat type. Drainage Lines were found to support the greatest diversity of scorpions (eight species), Rocky Hills provided the greatest diversity of pseudoscorpions (six species) and millipedes (three species) and the Mulga Woodland habitat yielded three species of spider. The only harvestman specimen obtained during the survey was collected from the Rocky Hills, indicating that this SRE target group has more specific microhabitat requirements. Drainage Lines yielded the largest number of species from target SRE invertebrate groups, whilst the Rocky Hills yielded the largest number of potential SRE species (**Figure 4-3**).



Potential SRE species were recorded in all habitat types (aside from Claypans) with the Rocky Hills habitat (recorded 15 potential SRE species) determined to be most conducive for short-range endemism within the Survey Area. As a consequence, the Rocky Hills habitat was classified post-survey as having a SRE suitability ranking of 'High'. Eleven potential SRE species were recorded from the Drainage Lines habitat while Mulga Woodland (nine potential SRE species), Calcrete Stony Plain (eight potential SRE species) and Mixed Eucalypt/Mulga Floodplain (five potential SRE species) were also favorable SRE habitat types. Drainage Lines were assessed as having a post-survey SRE suitability ranking of 'Moderate/High' and Mulga Woodland and Calcrete Stony Plain were assessed as having a 'Moderate' suitability. The Chenopod/Cracking Clay Floodplain and Stony Spinifex Plains and Hillslopes habitat types were identified as being the least conducive for short-range endemism, with four potential SRE species recorded in each of these habitats across both phases of the survey. The Mixed Eucalypt/Mulga Floodplain, Chenopod/Cracking Clay Floodplain, Stony Spinifex Plains and Hillslopes and Claypan habitat types were each given a post-survey SRE suitability ranking of 'Low'.


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Altexó

Mulga Downs Mine Short-range endemic invertebrates Figure 4-3

Malay Well

- Mulga West Borefield
 - Mulga East
- Mulga East Southern Corridor
- Central Transport Corridor
- Mulga North
 - Watercourse

Short-range endemic species Confirmed

Possible





4.3 Matters of National Environmental Significance

Species listed as threatened or migratory under the EPBC Act that were recorded, historically confirmed, or deemed likely to occur within the Survey Area are MNES in accordance with DoE (2013). Significant impacts to MNES are described as impacts which are important, notable or of consequence having regard to its context or intensity.

For MNES, habitat critical to the survival of a species and important populations is considered important. According to DoE (2013), critical habitat to the survival of a species refers to areas that are necessary:

- for activities such as foraging, breeding, roosting or dispersal;
- for the long-term maintenance of the species;
- to maintain genetic diversity and long-term evolutionary development; or
- for the reintroduction of populations or recovery of the species.

Similarly, DoE (2013) outlines important populations necessary for a species' long-term survival and recovery, which may include:

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

More specific critical habitat criteria and definitions surrounding important populations have been outlined for many MNES species in government documents such as conservation plans, recovery plans and Threatened Species Scientific Committee listing advice documentation.

Profile summaries have been provided below for the seven MNES fauna listed under the EPBC Act recorded within the Survey Area including:

- Northern Quoll (Dasyurus hallucatus) (Endangered EPBC Act and BC Act);
- Ghost Bat (Macroderma gigas) (Vulnerable EPBC Act and BC Act);
- Pilbara Leaf-nosed Bat (Rhinonicteris aurantia (Pilbara form)) (Vulnerable EPBC Act and BC Act);
- Pilbara Olive Python (Liasis olivaceus) (Vulnerable EPBC Act, BC Act);
- Common Greenshank (Tringa nebularia) (Migratory EPBC Act and BC Act);
- Red-necked Stint (Calidris ruficollis) (Migratory EPBC Act, BC Act);
- Wood sandpiper (Tringa glareola) (Migratory EPBC Act, BC Act); and
- Grey Falcon (*Falcos hypoleucos*) (VU EPBC, BC Act).

Whilst not recorded during surveys across the Survey Area, profile summaries have also been provided for several species that are either known from the Survey Area or have high priority areas mapped for them across this area. These species include:

- Glossy Ibis (Plegadis falcinellus) (Migratory EPBC Act and BC Act);
- Bilby (Macrotis lagotis) (Vulnerable EPBC Act and BC Act); and



• Night Parrot (*Pezoporus occidentalis*) (Endangered EPBC Act, Critically Endangered BC Act).





Altexó

Mulga Downs Mine MNES fauna records within the Survey Area Figure 4-4

- Central Transport Corridor
- 🔲 Malay Well
 - Mulga East
 - Mulga East Southern Corridor
- Dulga West Borefield
- Mulga North
 - Highway/Road
 - Watercourse



Environment and Water 2022 Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS, Esri, USGS, Maxar



4.3.1 Northern Quoll (Dasyurus hallucatus)

The Northern Quoll's range once extended contiguously across the north of Australia but is now restricted to six separate land units including the Pilbara (DoE, 2019). The Pilbara is regarded as the stronghold population for the species given that the cane toad is not expected to make its way across the desert into parts of the Pilbara (Woinarski, *et al.*, 2014). Preferred habitat for the Northern Quoll is rocky escarpments, but it also inhabits riverine habitats. Rocky habitats with rock crevices and caves support higher densities of Northern Quoll (van Dyck and Strahan, 2008a). Predominantly inhabiting dissected rocky escarpments, a male quoll can have a home range of more than 100 ha while a female occupies territories of up to 35 ha (van Dyck and Strahan, 2008b).

This species is predominantly nocturnal but may be observed during the day during the breeding season and on overcast days (Oakwood, 2008). Northern Quolls are opportunistic omnivores and feed primarily on small vertebrates (mammals, amphibians and reptiles), invertebrates and soft fruits. Breeding occurs once per year, with juveniles deposited in dens once they reach eight to nine weeks of age and can no longer fit in the pouch. Northern Quolls are the smallest of the Australian quolls but are the largest mammal species in the world to undergo male die-off events following the breeding season. Lifespan of females in the wild is typically less than three years, with most females only surviving a single breeding season.

According to this species' referral guidelines (Commonwealth of Australia (CoA), 2016), a low density population is characterized by infrequent captures of one or two individuals confined to one or two traps or where no trapping has identified a Northern Quoll, but latrine evidence remains. A high-density population may be characterized by numerous camera triggers by multiple individuals across multiple cameras and/or traps on the site.

Two Northern Quolls (one male and one female) were captured in cage traps and three individuals were captured on motion sensor camera traps at six locations within the Rocky Hills habitat of the Mulga East component area (**Figure 4-4**). After analysing data including location, time and date of captures combined with spot pattern identification, it is anticipated that a low-density population occurs within the broader Rocky Hills habitat in the northern and north-eastern portions of the Survey Area. The Survey Area received below average rainfall for the two seasons (2017-2019) prior to the surveys being undertaken, where the male and female quoll were recorded. Multiple seasons of below average rainfall may potentially impact the size of the population and it is possible that the population may increase/recover under favorable conditions.

Northern Quoll populations considered important for the long-term survival of the species occur in habitats that are free of cane toads and unlikely to support cane toads upon arrival, e.g. granite habitats in WA, populations surrounded by desert and without permanent water (CoA, 2016). The Northern Quoll population within the Survey Area occurs in habitats that are currently free of cane toads and are unlikely to support any future cane toad invasion due to a lack of water. No natural permanent water sources were recorded within the Survey Area and therefore, the population recorded is considered important for the long-term survival of this species.

Habitat critical to the survival of this species applicable to the Survey Area includes rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines (CoA, 2016). Multiple patches of suitable habitat for this species were identified in the Rocky Hills habitat area which would be considered habitat critical to the survival of this species. These micro-habitats provide shelter for breeding, refuge from fire/predation and potential poisoning from cane toads in the future (CoA, 2016). Drainage lines likely offer Northern Quoll populations with suitable dispersal habitat,

Foraging habitat is recognized to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA, 2016). It is therefore considered possible for quolls to utilize any habitat type (all habitat types are comprised of native vegetation) for foraging within 1 km of the critical core habitat identified for this species (breakaway, gorge and gully habitat).



The most common cause of adult mortality (excluding post-reproduction die-off) is predation by dingoes, foxes, feral cats, snakes, owls and kites (Maxwell *et al.*, 1996; Oakwood, 2008). The main threats to the Northern Quoll as outlined in the national recovery plan (Hill and Ward, 2010) include; cane toads, feral predators, inappropriate fire regimes, habitat degradation, weeds, disease, hunting and persecution, and population isolation. The main threats to the Northern Quoll applicable to the Survey Area are feral predators (cat, fox and wild dog/dingo) and loss of habitat. Feral predators were recorded occupying the same Rocky Hills habitat as where Northern Quoll was recorded from. The Northern Quoll national recovery plan (Hill and Ward, 2010) recommends implementing best-practice techniques for feral predator control at sites with remnant Northern Quoll populations and potential refuge habitats. There is some evidence to suggest that the presence of a healthy dingo population in an area has positive impacts on the local native mammal populations through suppression of feral predator numbers (Hill and Ward 2010).

4.3.2 Ghost Bat (Macroderma gigas)

The Ghost Bat is the largest Microchiroptera bat in Australia, is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (van Dyck and Strahan 2008b). The Ghost Bat has a patchy but widespread distribution across northern Australia. Preferred roosting habitat in the Pilbara includes caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles (Woinarski *et al.* 2012). Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill 1998). Ghost Bats disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong and Anstee 2000).

During daylight hours, Ghost Bats roost in large caves, mines or deep rock fissures (van Dyck and Strahan 2008b). In some parts of its range, the Ghost Bats shares roosts with the Pilbara Leaf-nosed Bat, Finlayson's Cave bat (*Vespadelus finlayson*), Common Heath-tailed bat (*Taphozous georgianus*), and possibly Hill's sheath-tailed bat (*Taphozous hilli*) (DoE, 2020). Ghost Bats are known to move between several caves seasonally or as dictated by weather conditions (Hutson *et al.* 2001) and disperse widely when not breeding but concentrate in a relatively few roost sites when breeding (DoEE, 2016a).

Ghost Bats are surface foragers ambushing prey either on the ground or in the air (Woinarski *et al.* 2012). Hunting behavior within foraging areas consisted of observing and locating prey from stationary vantage points with brief flights to catch prey before intermittently changing vantage point (Tidemann *et al.* 1985). No studies have been undertaken to accurately define foraging habitat within the Pilbara.

A single Ghost Bat call was recorded during the initial surveys (*ecologia*, 2019) indicating the presence of this species within the Survey Area. The DoE (2020) states that surveying for the Ghost Bat simultaneously with surveys for the Pilbara Leaf-nosed Bat can simplify strategies and reduce costs. To this end, survey effort undertaken for Ghost Bats included recording echolocation calls using ARUs at 272 sites (593 recording nights), 82 cave habitat assessments and 107 kms of UAV flights. No Ghost Bats were directly observed or recorded within the Survey Area. Of the caves assessed, six were identified as potential roosts or nocturnal refuges for the Ghost Bat, with an additional 26 caves providing potential nocturnal refuges for this species.

Although they were not observed during the cave assessment, Ghost Bat middens, comprising scat and feeding debris, were recorded at three caves indicating the intermittent utilization of caves within the Survey Area, particularly while feeding. As this species is known to travel distances greater than 15 km a night to forage, it is likely that Ghost Bats utilize habitats within the Survey Area whilst foraging and feeding.



There is anecdotal evidence of a known roost occurring approximately 20 km south of the MDIOM across the Fortescue Valley, near Wittenoom in the Hamersley Ranges (Bob Bullen *pers. Comm* in *ecologia 2023*). The Ghost Bat has previously been recorded on 13 occasions in the vicinity to the MDIOM according to DBCA data (*ecologia* 2023).

Ghost Bat occurrence and habitation within the MDIOM area is low with only a few records of this species occurring. A lack of deep caves limits the suitability for diurnal roosting for this species within the MDIOM. Twenty-eight cave structures within the MDIOM area are considered (strictly by the guidelines) as Category 4 (nocturnal refuges). No Category 1 or 2 roosts are present and no Category 3 caves (associated with "apartment blocks") are present within the MDIOM area (ecologia 2023).

Critical habitat for this species within the Survey Area overlaps with the Northern Quoll and Pilbara Olive Python in the form of breakaway, gorge and gully habitat within the Rocky Hills which is used for denning. This species has the potential to forage in all habitat types within the Survey Area. Armstrong and Anstee (2000) suggested that Ghost Bats occur in small groups within the Hamersley Ranges and may move about in a local area, possibly in response to disturbance, microclimate or social factors.

4.3.3 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form)

This small insectivorous bat occurs throughout the Pilbara and adjacent upper Gascoyne regions of Western Australia (DoEE, 2016b). The species was listed as Vulnerable in April 2001 because it had undergone a substantial reduction in numbers, its geographic distribution is precarious for its survival (being limited to the Pilbara), and the estimated total number of mature individuals is limited, and the number is likely to continue to decline. The Pilbara Leaf-nosed Bat has very restrictive habitat requirements, including caves and disused mines with hot to very hot and humid roost sites at 28° to 32° C with 96% to 100% relative humidity (Armstrong, 2001; Churchill, 2008). During the Pilbara winter dry months, preceding the heavy rains of summer, Pilbara leaf-nosed bat colonies are thought to contract to the deepest mines and caves that maintain microclimates suitable for roosting (Armstrong, 2001; van Dyck and Strahan, 2008a; Bullen and McKenzie, 2011). During the hotter wetter and more humid summer months, the species has a greater ability to disperse through the landscape. The Pilbara leaf-nosed bat has been observed foraging in a variety of habitats such as *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (DoE, 2020). This species is most commonly encountered over small pools of water in rocky gullies and gorges.

Given the deficiency of information around what habitats are required to sustain a roosting colony, it is often difficult to definitively define critical foraging habitat of the Pilbara Leaf-nosed Bat (DoEE, 2016b). Foraging habitats, as outlined by DoEE (2016b), that are considered to be important for sustaining a nearby Pilbara Leaf-nosed Bat colony include five habitat categories (Priority 1-5) including:

- Gorges with pools (Priority 1) watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves.
- Gullies (Priority 2) primary drainage with limited riparian development in upland rocky habitats, sometimes containing small pools that may last for weeks, with less biomass production than Priority 1 gorge habitat.
- Rocky outcrop (Priority 3) areas of exposed rock at the top of rocky outcrop and mesa hills that contain caves and overhangs, and boulder piles in the granite terrains.
- Major watercourses (Priority 4) riparian vegetation on flat land plus the main gravelly or sandy channel of the riverbed, sometimes containing pools that persist for weeks or months, and generally supporting higher productivity of biomass than the surrounding habitats.



• Open grassland and woodland (Priority 5) - dominated by *Triodia* spp., on lowland plains, colluvial slopes and hilltops.

The Survey Area was assessed as supporting Gullies (Priority 2), Rocky Outcrop (Priority 3), and open grassland and woodland (Priority 5) foraging habitat. Rocky Hills and Drainage Lines within the Newman land system supports Priority 2 and Priority 3 foraging habitat while Drainage Lines (not within Newman land system) and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. These habitat types are considered widespread in the Survey Area and in a regional context.

Pilbara Leaf-nosed Bat echolocation calls were recorded at 103 locations within the Survey Area with the earliest calls recorded at two creek line sites eight minutes after the end of civil twilight, indicating bats roosted nearby that day (**Figure 4-4**). Regular detections (in all seasons) in a particular valley of the Mulga East component area indicates that the creek line is a preferred commuting and foraging area and is considered critical foraging habitat. Call times recorded at cave entrances within target areas did not strongly suggest diurnal roosting. Data gathered to date indicates that some of the surveyed caves may function as nocturnal refuges or as sites of occasional visitation, and year-round presence of this species has been clearly demonstrated indicating a diurnal roost somewhere in the vicinity. Extensive searches for caves within the target valley and call times analysed from cave entrances indicate that the caves surveyed are highly unlikely to be utilised as diurnal roosts.

The long-term ARU detector deployed in this valley (at MEC016) between December 2019 and March 2020 (for a total of 79 nights) recorded low activity (10 or less calls) on most nights with relatively high levels of activity recorded on three nights. On two occasions, with specific reference to 16 February 2020, activity recorded very close to the beginning of critical recording time may suggest diurnal roosting or the presence of a diurnal roost in the vicinity (Specialised Zoological 2021).

Overall activity patterns recorded at MEC016 are not suggestive of long-term consistent diurnal roosting and instead consistent with the cave being used as a nocturnal refuge (Category 4) or place of occasional visitation (Specialised Zoological 2021b). Following up with entrance sheeting method was not considered necessary from the survey observations and all observations were consistent with usage as Priority 4 nocturnal refuges (Specialised Zoological 2023).

Nocturnal refuges are caves occupied or entered by Pilbara Leaf-nosed Bats at night for resting, feeding or other purposes and are not considered critical habitat, but are important for local level population persistence (DoEE, 2016b). A total of 51 structures within the MDIOM area were assessed as being characteristic of a Category 4 cave (nocturnal refuge) with the potential for these caves to be used at night for resting, feeding or other purposes (ecologia 2023). These Category 4 caves are not considered critical habitat but may play a role for the persistence of the species in the local area, with the majority of moderately deep caves in the Pilbara falling into this category (Bat Call WA 2021b).

The population of Pilbara Leaf-nosed Bats recorded consistently within the Survey Area is considered important as the Pilbara and the upper Gascoyne represent a single interbreeding population with individuals showing evidence of genetic divergence from those further north (DoEE, 2016b). The nearest known Pilbara Leaf-nosed Bat roost locations to MDIOM are at Rio Tinto Iron Ore's Koodaideri mine and to the south of Millstream, approximately 70 km to the south-east and 150 km west of the MDIOM in the Hamersley Ranges, respectively. The Mt Webber roost is approximately 80 km to the north-east of the MDIOM. There is a Category 1 or 2 roost in the vicinity of Wittenoom (as shown in Figure 1, Bat Call WA (2021b), approximately 25-35 km to the southwest of the MDIOM.

This species is highly susceptible to disturbances and will abandon roost caves when startled (Threatened Species Scientific Committee 2016a). Colonies in mines in the eastern Pilbara are subject to several pressures, including human visitation, the collapse and flooding of disused mines and exploration activities by mining companies (Armstrong 2008); (Threatened Species Scientific Committee 2016a).



In respect to Mulga Downs being a genetic link between the eastern and western populations of the Pilbara Leafnosed Bat, this has been dispelled by a study undertaken by Umbrello *et al.* (2022). The study used reduced representation genomic sequencing of over 150 individuals from eight roost sites throughout the Pilbara and tested for landscape-scale population differentiation associated with the two major subregions — the Hamersley and Chichester. This study found evidence of high rates of dispersal and low population structure within the Pilbara, indicating one panmictic population, with mtDNA results suggesting evidence of some female philopatry.

4.3.4 Pilbara Olive Python (*Liasis olivaceus*)

One of Australia's largest snakes, the Pilbara Olive Python is restricted to gorges, rocky habitats and escarpments of the Pilbara (Wilson and Swan 2017). Bush and Maryan (2011) noted that Pilbara Olive Pythons have been observed from locations some distance from water sources including granite outcrops, elevated mesas and spinifex plains on stony ground, preferring to shelter in caves, crevices and beneath large boulders. Pilbara Olive Pythons have been known to eat prey as large as rock wallabies and the Pilbara subspecies is larger and can grow up to 6.5 m in length (Wilson and Swan 2017). Two distinct populations of the Pilbara Olive Python exist (not including the northern subspecies *L. olivaceus olivaceus*) with one isolated around Mt Augustus in the Gascoyne, and the other occurring across a vast area from the Burrup Peninsula, Ord Ranges and Meentheena south to Nanutarra and Newman (Storr *et al.* 2002).

Population size estimates are difficult due to the Pilbara Olive Python's cryptic nature and lack of reliable trapping or census techniques (DoEE, 2008). The main threats to this subspecies come from predation by feral cats and foxes, particularly of juveniles, competition with foxes for food, and destruction of habitat (Pearson, 2006).

Within the Survey Area, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills habitat type, specifically the rocky outcrops, breakaways and small gorges, although it has also been known to inhabit spinifex grasslands and travel large distances, suggesting the species has a large home range (Tutt *et al.*, 2002). The Survey Area does not contain deep gorges or permanent sources of water considered as preferred habitat by DoEE (2008). One Pilbara Olive Python was opportunistically recorded at the Mulga East camp (**Figure 4-4**). However, despite considerable survey effort for the species, no additional Pilbara Olive Pythons were recorded, and it is considered unlikely to be present in high numbers within the Survey Area.

Of the 15 records of the species within 40 km of the Survey Area, the most recent, in 2018, occurred at Fortescue's Solomon mine (40 km west). This species has also been recorded 13 km south of Malay Well in Wittenoom Gorge in 2013, 10 km north of Mulga East in 2013 and in the Chichester Ranges 7 km north-west of the proposed rail corridor in 2012. The distribution of this species to the south, west, north and north-east of the Survey Area indicates this species occurs widely across the broader landscape and is not restricted to specialized habitats within the Survey Area.

4.3.5 Common Greenshank (Tringa nebularia)

The Common Greenshank is a large, pale, nervous wader with a medium-long slightly upturned bill growing to between 30 cm and 34 cm (Pizzey *et al.* 2013). This migratory bird breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and salt water (estuaries, mangroves, lakes, reef flats) (Johnstone and Storr, 1998). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain.

This highly mobile species was recorded on several occasions utilizing the surface water in the Gnalka Gnoona Claypan PEC (**Figure 4-4**) and is considered likely to be an infrequent visitor to the Claypans and Drainage Lines within the Survey Area when inundated after rainfall.



4.3.6 Red-necked Stint (Calidris ruficollis)

Breeding in arctic Siberia and northern Alaska, this small (13-16 cm) wading species is an abundant summer migrant to coastal and inland Australia (Pizzey *et al.*, 2013). This species is a common to very common visitor on most coasts, coastal plains and larger west-coast islands and is considered rare to moderately common to the interior usually in small flocks (Johnstone and Storr 1998). Red-necked stints frequent a variety of habitats including tidal mudflats, saltmarshes, sandy and shelly beaches, and coastal and inland saline or freshwater wetlands (Pizzey *et al.* 2013).

A total of eight red-necked stints were recorded within the Gnalka Gnoona Claypan PEC on two separate occasions during surveys across the Mulga East component area (**Figure 4-4**). It is considered likely that this species will be an infrequent visitor to the Claypan habitats in the Survey Area when inundated after rainfall.

Although not previously recorded within the database search area, this species is highly mobile and is known to inhabit inland water bodies after rain.

4.3.7 Wood Sandpiper (Tringa glareola)

This species is of a similar size and has similar habits to the common greenshank. The wood sandpiper is migratory bird that breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and is less likely to occur in salty or brackish waters (Johnstone and Storr, 1998). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain.

Database searches identified three records of this species within 40 km of the Survey Area. The wood sandpiper was recorded during surveys across the Mulga East component area within the Gnalka Gnoona Claypan PEC (**Figure 4-4**) and is considered likely to be an infrequent visitor to the Claypan habitats in the Survey Area when inundated after rainfall.

4.3.8 Grey Falcon (Falco hypoleucos)

The Grey Falcon is a widely distributed but infrequently recorded species which appears to have a distribution centered on ephemeral or permanent creek lines (Garnett & Crowley, 2000). The species tends to prefer sparsely treed, open plains and creek lines for foraging (Olsen & Olsen, 1986), while nesting often occurs in the abandoned nest of a raptor or corvid in trees or tall infrastructure such as tall power line or communications towers (Schoenjahn *et al.*, 2019).

This species was recorded during *ecologia*'s (2021) survey efforts across the Mulga East component area (**Figure 4-4**) and has previously been recorded eight times within 40 km of the Survey Area. Grey falcons have the potential to overfly all habitat types within the Survey Area and the Mixed Eucalypt/Mulga Floodplain and Drainage Line habitats provide potential nesting locations for this species. The frequency of occurrence of the species within the Survey Area is likely to be dependent on the proximity of nesting individuals to the Survey Area.

4.3.9 Glossy Ibis (Plegadis falcinellus)

The Glossy Ibis is a small dark ibis with rich purplish brown, glossed bronze or green feathers with a distinctive white line bordering facial skin (Pizzey *et al.*, 2013). Habitat preferences include well vegetated wetlands, wet pastures, rice fields, floodwaters, floodplains and brackish or occasionally saline wetlands (Pizzey *et al.*, 2013). Known to visit well-watered flatlands and adjacent flats to freshwater lakes this species is a casual or vagrant in drier and hillier parts of Western Australia (Johnstone and Storr, 1998).



Two records of this species were identified by database searches within 40 km of the Survey Area including one historical record from within the Survey Area at the Gnalka Gnoona Claypan PEC in 2004. Although this species was not recorded within the Survey Area during this survey, it is likely to be an infrequent visitor to the Claypan habitat in the Survey Area when inundated.

4.3.10 Bilby (Macrotis lagotis)

The Bilby is listed as a Vulnerable species under the EPBC Act and BC Act. Bilbies occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils which are typically sandy, for burrow excavation. The Bilby suffered a sudden and widespread population crash in the early 20th Century and is now confined to the driest and least fertile parts of its former range and its distribution is negatively correlated with that of the fox.

The Bilby is an omnivorous burrowing marsupial. It is generally solitary, strictly nocturnal and can breed throughout the year (Southgate, 1990). An individual bilby may have over a dozen regularly used burrows which are used as shelter during the day and rest at night. One of the three major vegetation types outlined in the national recovery plan for the bilby (Pavey, 2006) is hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems and other alluvial areas.

Seventy Bilby records were identified from database searches within 40 km of the Survey Area and one anecdotal, verbal record from 2001 exists from within the Survey Area (Mulga Downs homestead). The verbal record lacks some credibility as the associated data indicates the record locality is 'Telfer' and the sites are listed as 'Mulga Downs Station', which covers a relatively large range.

Most database records are from rail corridor surveys conducted by FMG, BHP and Roy Hill and occur near the northern tip of the proposed project rail corridor. As access to this area was limited, surveys were not conducted within these areas. The nearest record of this species is from 2015 approximately 4 km north of the proposed rail corridor. It is considered possible that this species will occur within the Drainage Line habitat in the northern portion of the rail corridor.

Despite considerable survey effort, no suitable habitat for Bilbies was identified within the Survey Area nor was any evidence (primary or secondary) of this species recorded during any previous surveys conducted by *ecologia*. Furthermore, (Terrestrial Ecosystems, 2013) did not record burrows, scats or diggings and stated that the Survey Area was generally unsuitable for Bilbies. Therefore, based upon the survey effort employed, it is considered unlikely that Bilbies occur within the Survey Area. The presence of cats, foxes and wild dogs/dingoes, which are known predators of the Bilby (Pavey 2006), further decreases the likelihood of bilbies occurring within the Survey Area. Fox presence is negatively correlated with the presence of greater Bilbies (Southgate, 1990).

4.3.11 Night Parrot (Pezoporus occidentalis)

The Night Parrot is listed as Endangered species under the EPBC Act and Critically Endangered under the BC Act. The Survey Area occurs within the classified "high priority area" for occurrence of the night parrot (DCBA, 2017). Interrogation of aerial imagery and UAV video footage identified small patches of sparsely distributed long unburnt spinifex that is considered suitable habitat for the Night Parrot. These areas are confined to the north-eastern portion of the Mulga Downs component area.

Additionally, ARUs were deployed in seven locations within the long unburnt spinifex for a minimum of six nights, with three ARUs also deployed within the Chenopod/Cracking Clay Floodplain and Stony Spinifex Plains and Hillslopes habitat types during the initial targeted survey (*ecologia*, 2019). Although potentially suitable foraging habitat for Night Parrots is found in Chenopod/Cracking Clay Floodplains, it is unlikely that this habitat is utilised due to degradation from long-term overgrazing and trampling by cattle.



This species is known to occur at the Fortescue Marsh (Davis and Metcalf, 2008). A call was also recorded in WA in 2017 (Jackett *et al.*, 2017) indicating that the species is present in some areas and more recently from FMG Cloudbreak mine area (Fortescue Metals Group, 2021).

Night Parrot calls were not recorded during any surveys undertaken within the Survey Area and this species is considered unlikely to occur within the Survey Area due to the historic and on-going grazing activities occurring on this property.

4.4 State Significant Fauna Species

In addition to the MNES species discussed above, profile summaries have also been provided for several state significant fauna species (listed under the BC Act or the DBCA) that were observed within the Survey Area, including:

- Gane's Blind Snake (Anilios ganei) (DBCA Priority 1 species);
- Western Pebble-mound Mouse (*Pseudomys chapmani*) (DBCA Priority 4 species); and
- Peregrine Falcon (Falco peregrinus) (Other Specially Protected Fauna BC Act).

Whilst not recorded during surveys across the Survey Area, profile summaries have also been provided for several state significant fauna species that are either known from the broader surveys undertaken by *ecologia* (2020) or Biologic (2022) or that are considered likely to occur within the Survey Area. These species include:

- Short-tailed Mouse (Leggadina lakedownensis) (DBCA Priority 4 species); and
- Spotted Ctenotus (Ctenotus uber johnstonei) (DBCA Priority 2 species).



4.4.1 Gane's Blind Snake (Anilios ganei)

Very little is known about this elusive blind snake due to its fossorial lifestyle. Blind snakes are exclusively insectivorous, and like other members of their genus and probably burrow into social insect colonies to feed on termites and ants, as well as their eggs and pupae (Wilson and Swan, 2017). This elongate and moderately stout bodied species does not appear to be particularly closely related to any other species in the genus (Aplin, 1998). Four individual Gane's Blind Snakes were recorded during *ecologia*'s (2021) survey efforts across the Mulga East component area (**Figure 4-5**). This species was recorded within Mulga Woodlands and Stony Spinifex Plains and Hillslopes habitat types. No records of this species were identified within 40 km of the Survey Area according to DBCA database search results. However multiple records of this species were made during the field surveys.

4.4.2 Western Pebble-mound Mouse (Pseudomys chapmani)

The Western Pebble-mound Mouse is a species endemic to the Pilbara region, though was previously distributed through the Gascoyne and Murchison regions (Start *et al.*, 2000). Using a readily available supply of stones, this species builds an above ground mound atop underground tunnels (Anstee & Armstrong, 2001; Dunlop & Pound, 1981). The Western Pebble-mound Mouse appears to inhabit a single primary mound during the day and visit secondary mounds within their home range during the night (Anstee, 1996). Due to the need for mound construction, the species almost exclusively occurs on gentle slopes of rocky ranges and undulating plains, where the ground is covered with a stony mantle and is vegetated by hard spinifex and often sparse overstorey of eucalypts and scattered shrubs (Anstee & Armstrong, 2001; Dunlop & Pound, 1981).

The Western Pebble-mound Mouse has been recorded on numerous occasions within the vicinity of the Survey Area including from seven records within Mulga East Southern Corridor component area (Terrestrial Ecosystems, 2013). As part of Biologic's (2022) survey effort across both the Mulga West Borefield and the Mulga East Southern Corridor component areas, the species was recorded from secondary evidence (pebble-mounds) on 24 occasions in Stony Plains and Slopes habitats, Drainage Area/Floodplain and Rocky Hills, comprising two active, one recently inactive and 21 inactive mounds (**Figure 4-5**). The species is most likely to occur within the Survey Area as a resident and its occurrence is likely to be common and widespread across Stony Plains and Slopes and the lower slopes of Rocky Hills habitats. The species may also forage more broadly into Drainage Area/Floodplain habitat where adjacent to habitat permitting burrowing and mound construction.

4.4.3 Peregrine Falcon (Falco peregrinus)

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 from the top of the cliff, possibly to avoid predators. Nesting also occasionally occurs in tall trees along drainage lines, including use of abandoned nests of other large bird species.

This species has previously been recorded on multiple occasions within the vicinity of the Survey Area (DBCA, 2021a). A Peregrine Falcon was also recorded opportunistically approximately 5.km east of the Mulga West Borefield area during a survey that ran concurrently with Biologic (2022). The Peregrine Falcon is a highly mobile species which may intermittently utilise breakaways within Rocky Hills and large trees in the Mixed Eucalypt/Mulga Floodplain provide potential nesting habitat for this species.

Because of the species broad foraging range and the widespread occurrence of these habitats in the broader vicinity of the Proposal, foraging is likely to occur over a much broader area and will not be confined to the Survey Area. The frequency of occurrence of the species within the Survey Area is likely to be dependent on the proximity of available nesting habitat. No suitable nesting habitat was recorded within the Survey Area.



4.4.4 Short-tailed Mouse (Leggadina lakedownensis)

The Short-tailed Mouse occurs across northern Australia, from Cape York to the Pilbara, with one population on Thevenard Island (Western Australia). It is a nocturnal species found in areas of open tussock and hummock grassland, acacia shrubland, and savanna woodland, on alluvial clay or sandy soils (Lee, 1995; Moro & Kutt, 2008).

Fifty records occur within 40 km of the Survey Area (DBCA, 2021a). The species has previously been recorded in two locations within Mulga West Borefield component area (in Mulga Woodland habitat) (DBCA, 2021a; *ecologia*, 2014). Although the Short-tailed Mouse was not recorded within the Survey Area as part of these faunal assessments, it was recorded 7.1 km north of the Mulga East Southern Corridor component area during a survey that ran concurrently with Biologic (2022).

Like many rodent species, Short-tailed Mouse populations can be subject to boom-bust or eruptive population dynamics, particularly following fire and rainfall events when resources are less or more abundant (Bennison *et al.*, 2018; van Dyck & Strahan, 2008a). Suitable habitat likely to support the species occurs within Drainage Area/Floodplain and Mulga Woodland habitats of the Survey Area. The species is considered to occur as a resident, with abundance likely to fluctuate, particularly following rainfall events when resources are most abundant.

4.4.5 Spotted Ctenotus (Ctenotus uber johnstonei)

Habitat preferences of this subspecies of 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).

The species has previously been recorded approximately 1 km west of Mulga West Borefield component area (DBCA, 2021a) and is considered Highly Likely to occur as a resident in Mulga Woodland, Stony Plains and Slopes and Drainage Area/Floodplain habitats. 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. No evidence of this subspecies of Spotted Ctenotus was recorded in the Survey Area as part of these faunal assessments.



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5.0 Discussion

For the purpose of EIA, the EPA's broad objective for the key environmental factor terrestrial fauna is to 'protect biological diversity and maintain ecological integrity' (EPA, 2020). The aim of this assessment was to determine vertebrate fauna and SRE species assemblages and habitats present or likely to be present to inform the environmental impact assessment of the MDIOM.

5.1 Fauna Habitat Assessment

Eight broad fauna habitat types were identified within the Survey Area: Claypan, Chenopod/Cracking Clay Floodplain, Drainage Line/Floodplain, Mulga Woodland, Mixed Eucalypt/Mulga Floodplain, Rocky Hills, Stony Spinifex Plains and Hillslopes, and Calcrete Stony Plain. The habitats were mapped using aerial imagery and vegetation survey data from Maia (2022) and from extensive ground truthing. The majority of the fauna habitats mapped during the 2019 – 2022 assessments are not restricted to the Survey Area and are considered widespread at both a local and regional scale. Fauna habitat assessments undertaken across the Survey Area identified habitat condition which varied from 'Good' to 'Excellent' with some areas allocated a lower rating of 'Good' having been grazed by cattle. The suitability of these habitats to conservation significant fauna species is described in **Section 4.3** and **Section 4.4** above.

The Claypan habitat includes the Freshwater Claypans of the Fortescue Valley Priority 1 Priority Ecological Community (Claypan PEC) which are located within the Survey Area. Two of the claypans – the Gnalka Gnoona and Koodjeepindarranna claypans areas have been excluded from the MDIOM Development Envelope to avoid direct impacts and protect these habitats. This habitat type has limited extent in the Survey Area, however there are claypans dispersed along the Fortescue Valley area forming a mosaic of wetlands which is characteristic of the arid interior of Western Australia.

The Claypan PECs only fills after significant rainfall and provide foraging habitat for a number of waterbirds, including migratory species. The significance of these claypans when inundated is recognised, the area classified in the Directory of Important Wetlands (WA066). Three migratory wading species, the Common Greenshank, the Red-necked Stint and the Wood Sandpiper were recorded foraging in surface water in the Gnalka Gnoona Claypan PEC during the 2019 survey (*ecologia* 2021a).

Chenopod/Cracking Clay Floodplain habitat type also has limited extent in the Survey Area and compared to the other habitats was considered restricted. It was only mapped within the Mulga East tenement during these surveys. This habitat type condition was rated as 'Good' as long term grazing from cattle had caused degradation. This habitat type is considered suitable Night Parrot foraging habitat, however the condition mapped in the Survey Area was degraded. Three recording devices did not detect any Night Parrot calls (*ecologia* 2021a). The habitat has low leaf litter and is generally sparse, generally it is not considered to have high value for fauna.

The Drainage Line/Floodplain habitat within the Survey Area is generally considered small and common at a local and regional scale. Extensive Drainage Line/Floodplain habitat extends across the Mulga West Borefield and the Central Transport corridor. Within the Mulga East tenement the drainage lines are less broad and closer to the Chichester subregion. It often occurs as the intervening area between other habitat types such as the Rocky Hills and Stony Spinifex Plains and Hillslopes in Mulga East. The Drainage Line/Floodplain habitat aligns with the Mulga Woodland habitat and the Mixed Eucalypt/Mulga Floodplain habitat within the Fortescue Valley IBRA subregion. This habitat type functions as fauna corridors throughout the Survey Area and is relatively common throughout the Pilbara bioregion. This habitat type is considered important foraging habitat for Northern Quolls and the Pilbara Leaf-nosed Bat as Priority 5 foraging in the floodplain and potentially Priority 2 toward the gullies and hillslopes.

Mulga Woodland is extensive across the Survey Area but has been disturbed through exploration activities and grazing. It is well represented regionally. The Mulga Woodland habitat is considered to be of low value to



conservation significant species except for the Gane's Blind Snake which was recorded at several locations within Mulga East area. This habitat type is not favourable to burrowing species. Mulga Woodlands have been noted as supporting Bilbies. However, extensive UAV searches did not find secondary evidence of the Bilby in the Mulga Woodland across the Survey Area.

The Mixed Eucalypt/Mulga Floodplain occurs along the Fortescue Valley surrounding the Claypan PEC and is considered widespread along the valley. This habitat contains large woody trees which can provide suitable habitat to Northern Quolls and hollows for nesting birds.

The Rocky Hills habitat was assessed to be of high conservation value to species of conservation significance. Breakaways, gorges and gullies within the Rocky Hills habitat type provide high quality refugia such as caves, denning and foraging habitat considered to be critical habitat for the survival of Northern Quolls, Pilbara Leaf-nosed Bats and Ghost Bats (Priority 2 to 3 foraging). This is important habitat for the Pilbara Olive Python. Rocky Hills habitat is common and widespread in the Pilbara.

The coarse stony red clay soils of the Stony Spinifex Plains and Hillslopes habitat was found to provide habitat for the Western Pebble-mound Mouse to construct mounds in the Survey Area. Several other conservation significant species are also known to forage within this type of habitat, which is widespread throughout the Pilbara, including the Northern Quoll, Pilbara Leaf-nosed Bat, and the Ghost Bat. This habitat type occurs with the Rocky Hills and Drainage Lines and is widespread in the Pilbara. The substrates and vegetation present support termitaria which are a known refuge for vertebrate fauna, though generally there is minimal refugia to conservation species. This habitat supports Priority 5 foraging for the Pilbara Leaf-nosed and Ghost bats.

Calcrete Stony Plain habitat is restricted to the Mulga East and Malay Well areas of the MDIOM Survey Area. It occurs within the valley area and aligns with the claypans along the river floodplain. Shallow burrowing is permitted in this habitat type for the smaller species; however it is unsuitable for deeper burrowing species such as the Bilby. The spinifex provides foraging and nesting for many bird species. This habitat type is widespread throughout the Pilbara region.

Considerable survey effort undertaken within the MDIOM area has failed to locate a permanent water source. Semipermanent water sources within creek lines (small pools) may be found within the area following rain, which may persist for weeks to months. Surveys in the Mulga West Borefield tenement located waterholes which had standing water following heavy rain (Biologic 2022). These could persist up to 3 months. They were dry when visited in the drier months. In respect to Pilbara Leaf-nosed and Ghost Bats, available data suggests that the longest distance from a roost to a permanent water source should be no more than 8.7 km (Bat Call WA 2021b).

5.2 SRE Invertebrate Fauna

Rocky Hills and Mulga Woodlands provide important microhabitat for many SRE invertebrates including mygalomorph spiders, selenopid spiders, polydesmid millipedes, and terrestrial isopods. From the desktop assessment, 15 Confirmed SRE invertebrate taxa have been identified for the region and 10 Potential SRE species have been recorded from within the Survey Area. Recent surveys adjacent to the Survey Area (*ecologia*, 2020) have also yielded one additional Confirmed SRE, *Buddelundia* sp. 56. This indicates a high level of regional endemism in comparison to other areas of the Pilbara.

Out of a total of 140 invertebrate specimens were collected from within the Survey Area, representing 28 morphological and molecular taxa, ten were considered to represent Potential SRE species, 17 were considered to be Widespread species. One Confirmed SRE species was collected in this current survey, *Buddelundia* `56` (including *Buddelundia* `sp. SJ_56_DNA`). Four of the eight Potential SRE taxa were olpiid pseudoscorpions. Olpiidae require extensive phylogenetic review and hence it is not unusual to produce sequences without regional references. However, the habitat within which all four taxa were collected was widespread through the Survey Area and hence, it



is unlikely that these taxa will be restricted in range. The remaining four Potential SRE taxa were represented by armadillid isopods, also collected in widespread habitats and appear to be locally spread through the Mulga Downs region.



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