North Jimblebar:

Targeted Northern Quoll Assessment

Biologic Environmental Survey

Report to BHP Western Australia Iron Ore

October 2022

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EXECUTIVE SUMMARY

BHP Western Australia Iron Ore (BHP WAIO) are investigating the presence of northern quoll (*Dasyurus hallucatus*) within the northern and central Jimblebar area (hereafter referred to as the Study Area). The Study Area is located approximately 22 kilometres (km) east of Newman in the Pilbara region of Western Australia and covers an area of approximately 13,932.98 hectares (ha). The northern quoll is listed as Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*.

A fresh northern quoll scat was recently recorded on a waste dump undergoing the early stages of rehabilitation at Orebody 18 in August 2021. At the time of collection, it was not known whether this record was representative of a transient individual, or if there is a population of northern quolls using the Study Area. To further investigate this, BHP WAIO commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake an assessment of northern quoll presence within the Study Area. The objective of this assessment was to identify the occurrence of northern quoll, and the presence of critical and supporting habitats for the species within the Study Area.

The assessment involved a desktop assessment, which included a review of three databases and 47 relevant fauna survey reports within the vicinity of the Study Area, and a targeted survey completed over two field surveys. Trip 1 was completed between 21st and 27th February 2022 and trip 2 was completed between 9th and 13th June 2022. Sampling methods over the two field surveys included 15 habitat assessments, 52.2 hours of targeted searches and 5,390 camera trap nights across five camera trap transects.

The desktop assessment identified very few records of the species in the surrounding region. The closest records of the species are located ~30 km west of the Study Area, from the Whaleback mine site in 2007 and the Western Ridge exploration tenement (within cave CWER-10 located near the eastern edge and cave CWER-16 located near the southern edge of Western Range) in 2020 (Biologic, 2020b). Records from both of these locations have questions with regard to the permanency of the species in the area. No evidence of northern quoll was recorded within the Study Area during the targeted searches, or via the camera trap transects.

The August 2021 scat record within the Study Area suggests that suitable habitat is present in or near the Study Area. Critical habitat (i.e. denning/ shelter habitat as defined by DoE (2016)) for the species is represented in the Study Area by Gorge/ Gully (4.63%, 645.76 ha) and Breakaway/ Cliff (1.20%, 166.60 ha) habitats. Supporting habitat for foraging and dispersal, is represented by Major Drainage Line (0.76%, 106.17 ha), Minor Drainage Line (3.31%, 460.97 ha) and Hillcrest/ Hillslope (43.13%, 6,009.43 ha) habitat. These supporting habitats are more likely to be used when adjacent to critical habitats.

The few, isolated records within 100 km of the Study Area are likely transient or dispersing males. A population of northern quolls is unlikely to occur within or nearby the Study Area at anything other than very low densities and / or intermittently. Therefore it is highly unlikely that the species, if present at all, represents an 'important population' as defined by DoE (2016).

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1 INTRODUCTION

1.1 Background

BHP Western Australia Iron Ore (BHP WAIO) are investigating the presence of northern quoll (*Dasyurus hallucatus*) within the northern and central Jimblebar area (hereafter referred to as the Study Area). The Study Area is located approximately 22 kilometres (km) east of Newman in the Pilbara region of Western Australia and covers an area of approximately 13,932.98 hectares (ha) (Figure 1.1). The northern quoll is listed as Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016*. A fresh northern quoll scat was recorded on a recently rehabilitated waste dump at Orebody 18 in August 2021. At the time of collection, it was not known whether this record was representative of a transient individual, or if there is a population of northern quolls using habitats within the Study Area. To further investigate this, BHP WAIO commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake an assessment of northern quoll presence within the Study Area.

1.2 Survey Objectives

The objective of this assessment was to identify the occurrence of northern quoll and presence of critical and supporting habitats for the species within the Study Area. This was achieved by completing a desktop assessment and a targeted survey of the species, in accordance with the *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus* (DoE, 2016).

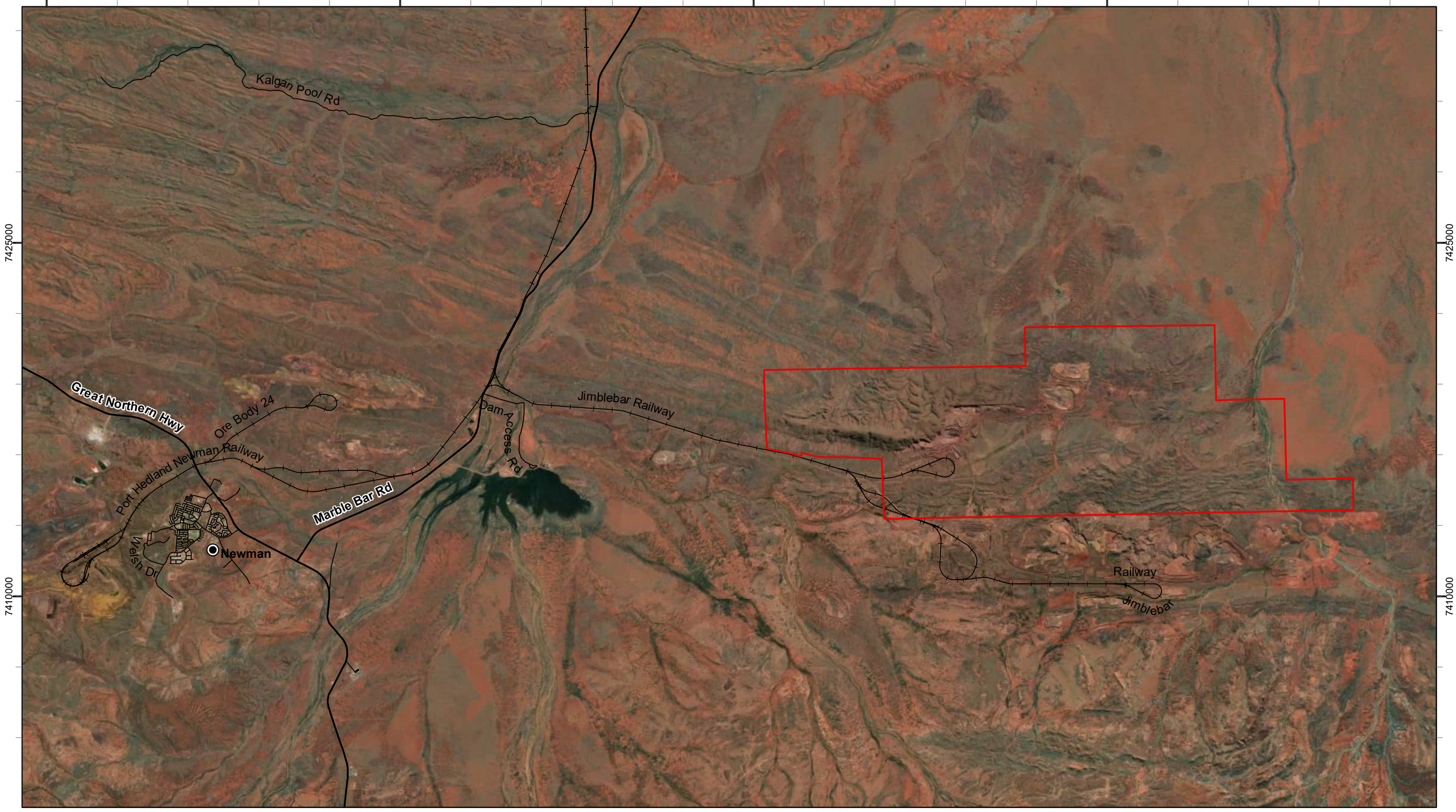
1.3 Northern Quoll (*Dasyurus hallucatus*) Species Profile

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

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

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

The species has experienced a precipitous decline in much of its former range in northern Queensland and the Northern Territory in direct association with the spread of the cane toad (*Bufo marinus*) (Braithwaite & Griffiths, 1994; Fitzsimons *et al.*, 2010). Other threats include predation from feral predators such as foxes and cats, inappropriate fire regimes, disease, habitat degradation through grazing and weed invasion, and habitat destruction through mining and agriculture (Woinarski *et al.*, 2011). The potential invasion of the Pilbara by the cane toad is regarded as the most significant future threat to the northern quoll in the Pilbara; however, there is little knowledge of the relative impact of the other key threats, and their interactive effects, currently and in the future (Cramer *et al.*, 2016).



Legend

- Study Area
- Local Road
- State Road
- Rail

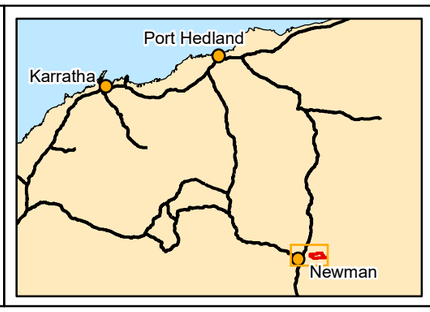
N

biologic Environmental Survey

Scale: 1:150,000

0 3 6 Km

Coordinate System: GDA2020 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA2020 Created 31/08/2022



BHP WAIO

North Jimblebar Northern Quoll Assessment

Figure 1.1: Study Area and regional context

2 METHODS

2.1 Guidelines

This assessment was carried out in a manner consistent with the following documents developed by the Western Australian Environmental Protection Authority (EPA), the Department of Agriculture, Water and the Environment (DAWE - formerly the Department of Environment [DoE]) and Department of Sustainability, Water, Population, and Communities [DSEWPaC]), and BHP WAIO:

- BHP (2020) Guidance for vertebrate fauna surveys in the Pilbara (SPR-IEN-EMS-012, Version 8.0);
- BHP WAIO (2020) Biodiversity survey spatial data requirements (SPR-IEN-EMS-015, Version 11.0);
- DoE (2013) Matters of national environmental significance: significant impact guidelines;
- DoE (2016) EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus*);
- DSEWPaC (2011) Survey guidelines for Australia's threatened mammals;
- EPA (2016) Environmental factor guideline: Terrestrial fauna;
- EPA (2020a) Statement of environmental principles, factors and objectives; and
- EPA (2020b) Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment.

2.2 Desktop Assessment

A desktop assessment, comprising relevant database searches and a literature review, was undertaken prior to the field survey. The purpose of the desktop assessment was to gain an understanding of northern quoll presence within the Study Area and surrounding region.

2.2.1 Database Searches

Three databases were searched for northern quoll records within and surrounding the Study Area (Table 2.1).

Table 2.1: Details of database searches conducted

Database	Data Access/ Receival Date	Search Area
BHP WAIO (2022) Fauna Records	28/01/2022	Pilbara bioregion (and surrounds)
DBCA (2022) Threatened and Priority Fauna	03/05/2022	Pilbara bioregion (and surrounds)
DAWE (2022) Protected Matters	22/02/2022	Study Area

2.2.2 Literature Review

A review of available literature relevant to the Study Area was reviewed for northern quoll records within and surrounding the Study Area. A total of 47 assessments were reviewed, ten overlapping the Study Area, and the remaining 37 within 40 km of the Study Area (Table 2.2).

Table 2.2: Literature sources used for the review

Report Title	Survey Type	Distance from Study Area
BHP (1994) Jimblebar mine site biological survey	Detailed	Overlapping
Biologic (2014a) Orebody 19 level 2 vertebrate fauna survey	Detailed	Overlapping
Biologic (2014c) Orebody 31 vertebrate fauna survey	Detailed	Overlapping
ecologia (2006a) Jimblebar Marra Mamba exploration biological survey	Detailed	Overlapping
ecologia (1995a) Orebody 18 biological assessment survey	Detailed	Overlapping
ENV (2007a) Orebody 18 fauna assessment survey phase II	Detailed	Overlapping
GHD (2019a) Jimblebar East and Caramulla fauna survey	Detailed	Overlapping
GHD (2019b) North Jimblebar fauna survey	Detailed	Overlapping
Onshore (2019) Jimblebar North level 1 vertebrate fauna survey	Basic	Overlapping
Outback Ecology (2009b) Jimblebar linear development terrestrial vertebrate assessment	Detailed	Overlapping
ecologia (2005a) East Jimblebar exploration project biological survey	Basic	Adjacent (E)
Eco Logical (2013) Ninga level 1 vertebrate fauna assessment	Basic	Adjacent (W)
ENV (2009a) Jimblebar Spur 2 fauna assessment	Basic	Adjacent (W)
Outback Ecology (2009a) Jimblebar iron ore project: terrestrial vertebrate fauna assessment	Detailed	Adjacent (S)
Biologic (2013b) South West Jimblebar vertebrate fauna assessment	Detailed	400 m (S)
ENV (2007b) West Jimblebar lease fauna assessment	Detailed	400 m (S)
Biologic (2016) Dynasty level 1 vertebrate fauna survey	Basic	2 km (SW)
Biologic (2016) Dynasty level 2 vertebrate fauna survey	Detailed	2 km (SW)
Biologic (2018) Dynasty vertebrate fauna monitoring 2018	Detailed	2 km (SW)
Biota (2004) Jimblebar - Wheelarra Hill 3 flora and fauna assessment	Basic	2 km (S)
ecologia (2004a) Jimblebar-Wheelarra Hill biological survey	Detailed	2 km (S)
ENV (2011c) Orebody 42/43 Flora, vegetation and fauna assessment summary letter and recommendations	Basic	7 km (W)
ecologia (1996) Jimblebar rail spur biological assessment survey	Detailed	11 km (W)
Biologic (2021c) Western Ridge Pipelines vertebrate fauna survey	Basic	14 km (W)
Eco Logical (2012) Orebody 37 level 1 vertebrate fauna assessment	Basic	14 km (W)
ecologia (1998) Orebody 23 extension biological assessment survey	Detailed	16 km (W)
ENV (2011a) Eastern Ridge (OB23/24/25) fauna assessment	Basic	16 km (W)

Report Title	Survey Type	Distance from Study Area
Biologic (2013a) Orebody 24 targeted vertebrate fauna survey	Targeted	17 km (W)
ecologia (2004b) Orebody 24 expansion biological survey	Detailed	17 km (W)
ENV (2011b) Mt Whaleback East flora, vegetation and fauna assessment	Basic	17 km (W)
ENV (2006b) OB24 flora and fauna assessment phase 2	Detailed	17 km (W)
ENV (2006a) Mount Whaleback fauna assessment survey phase III	Detailed	17 km (W)
Onshore and Biologic (2009a) Mt Whaleback mine site flora and vegetation survey and fauna assessment	Basic	17 km (W)
Biologic (2021a) Western Ridge Creeks targeted MNES species survey	Targeted	19 km (SW)
Biologic (2014b) Orebody 25 targeted vertebrate fauna survey	Targeted	19 km (W)
ecologia (1995b) Orebody 25 biological assessment survey	Detailed	19 km (W)
ENV (2009b) Orebody 25 to Newman fauna assessment	Basic	19 km (W)
GHD (2008) Myopic project area, Newman: Flora and fauna assessment	Basic	20 km (W)
Onshore and Biologic (2009b) Myopic exploration leases biological survey	Basic	20 km (W)
ecologia (2008) RGP5 fauna survey Newman to Jimblebar junction	Basic	25 km (W)
ENV (2010) Orebody 35 vegetation clearing permit area flora and fauna assessment	Basic	31 km (SW)
Biologic (2021b) Western Ridge matters of national environmental significance fauna study	Targeted	33km (SW)
Biologic (2020b) Western Ridge targeted vertebrate fauna survey	Targeted	33km (SW)
ecologia (2006b) Western Ridge exploration project biological survey	Basic	33km (SW)
ecologia (2005b) Western Ridge exploration project biological survey	Basic	33km (SW)
Onshore (2014) Western Ridge biological survey	Basic	33km (SW)
Biologic (2020a) Coombanbunna Well level 2 vertebrate fauna survey	Detailed	35 km (SW)

2.3 Field Survey

2.3.1 Survey Timing

The field component of the assessment was completed over two separate surveys. Trip 1 was completed between 21st and 27th February 2022 and comprised the deployment of camera trap transects and targeted searches. Trip 2 was completed between 9th and 13th June 2022, and comprised camera trap retrieval and further targeted searches. Habitat assessments were conducted during both Trip 1 and 2.

Trip 1 was undertaken by zoologists Christopher Knuckey, Thomas Rasmussen, Aidan Williams, Jari Cornelis, Georgina Mattner and Samuel Edwards, who collectively have over 30 years of experience

undertaking surveys in the Pilbara region, including targeted surveys for northern quoll. Trip 2 was completed by Christopher Knuckey and Jari Cornelis.

2.3.2 Climate and Weather

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Thackway & Cresswell, 1995). Summer rainfall is usually the result of tropical storms in the north or tropical cyclones that impact upon the coast and move inland (van Vreeswyk *et al.*, 2004). The winter rainfall is generally lighter and is the result of cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall ranges from 200–350 mm, although there are significant fluctuations between years, with some locations receiving up to 1,200 mm in some years (McKenzie *et al.*, 2009).

Long-term climatic data is not available for the Study Area itself; however, long-term data is available from the Bureau of Meteorology (BoM) weather station at Newman Aero (Station 007176), located approximately 19.76 km south-west of the Study Area (BoM, 2022).

In the 12 months prior to the survey, mean minimum and maximum were comparable to long-term averages; however, were regularly warmer and dryer on average (Figure 2.1). Rainfall in the 12 months prior to the surveys was below long-term averages for most months, with the exception of May 2022, which recorded well above the long-term average for the month (Figure 2.1). This above average rainfall occurred as a result of a cold front and low-pressure system occurring in the north-west. The total rainfall recorded 12 - 24 months prior to the survey was 356.2 mm, which is at the higher end of the average annual rainfall range.

Observed minimum temperatures during trip 1 were similar to long-term averages on most days, with minimum temperatures averaging 22.5°C (1.6°C below long-term average), and maximum temperatures averaging 41.4°C (4.1°C above long-term average) (BoM, 2022). Observed temperatures during trip 2 were above long-term averages on most days, with minimum temperature averaging 13.5°C (5.9°C above long-term average) and maximum temperature averaging 24.1°C (1.0°C above long-term average) (BoM, 2022). No rainfall was recorded during trip 1; however, 0.4 mm was recorded during trip 2 (BoM, 2022).

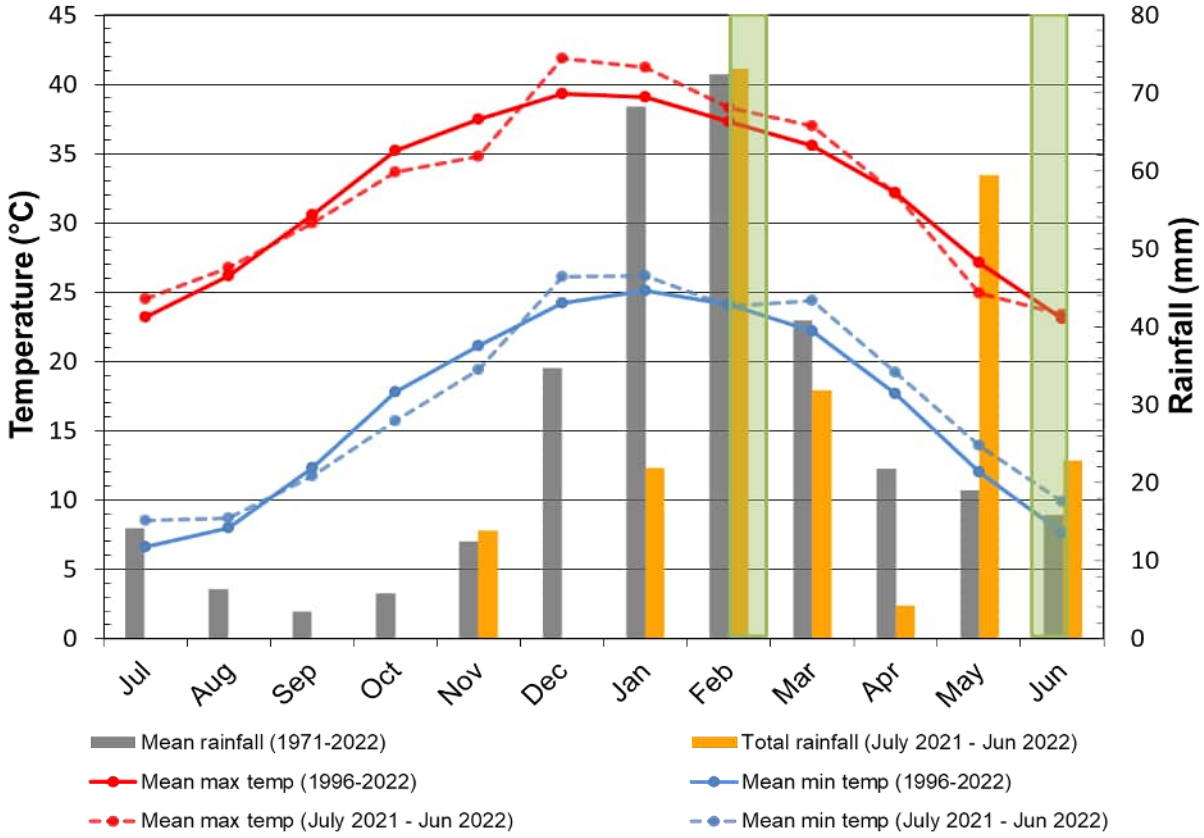


Figure 2.1: Long-term and current climatic data for Newman

Note: approximate survey timing shown in shaded box

2.3.3 Sampling Techniques

The field survey was carried out in a manner consistent with the guidelines and recommendations listed in Section 2.1, and defined below. Survey effort and sampling locations were selected based on the following principles:

a) survey effort was focused in areas deemed most likely to record the target species based on the type and quality of habitat present;
b) survey effort was, where possible, spread across the Study Area to ensure adequate geographical coverage;
c) survey effort focussed on areas that had not been subject of any prior sampling effort; and
d) sampling was often focussed at or near previous records of the target species, and within instances of the same habitat.

Habitat Assessments and Mapping

Habitat assessments were undertaken in the field to characterise and define habitats and their value for northern quoll. Assessments were undertaken at 15 sampling locations across the Study Area (Figure 2.2). Habitat assessments were conducted and attributes assessed using attribute terminology prescribed by BHP WAIO, which have been modified from the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009).

The characteristics recorded during the habitat assessments were:

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

Fauna habitat mapping was completed over the Study Area using the vertebrate fauna habitat assessments conducted during the field survey, as well as previous mapping and habitat assessments completed by GHD (2019b). Note, mapping by GHD (2019b) did not cover the entire Study Area. Following the field surveys, this dataset was heavily revised to better reflect value to northern quoll specifically. Additionally, high-resolution aerial imagery, vegetation, topographical, land system and drainage mapping was used, in areas not accessed in the field. Habitats of the northern quoll were delineated and mapped across the Study Area at a scale of approximately 1:20,000.

Targeted Searches

Targeted diurnal searches for northern quoll were conducted during trip 1 and trip 2. Targeted searches focused on areas providing suitable denning/ shelter and/or foraging/ dispersal habitat, particularly within Gorge/ Gully, Breakaway/ Cliff and Hillcrest/ Hillslope habitats (Table 2.3; Figure 2.2). Searches were also undertaken at the location of the recent scat recorded within the rehabilitated waste dump, site VJMB-05 (Table 2.3; Figure 2.2). Searches focused primarily on detecting the species from secondary evidence, including scats, tracks, foraging remains or remains of deceased individuals. A total of 23 targeted searches were undertaken at 15 sites over the two trips, equating to a total of 52.2 person hours of targeted searches (Table 2.3).

Table 2.3: Targeted searches completed for northern quoll within the Study Area

Targeted Search ID	Trip No.	Date	Targeted Habitat	Search Hours
TCAV-04	1	24/02/2022	Breakaway/ Cliff	2
TCAV-04	2	10/06/2022	Breakaway/ Cliff	3
TCAV-05	2	10/06/2022	Breakaway/ Cliff	1
TCAV-05	1	24/02/2022	Breakaway/ Cliff	1
TCAV-09	1	22/02/2022	Gorge/ Gully	3
TCAV-14	2	10/06/2022	Breakaway/ Cliff	1
TCAV-15	2	22/02/2022	Gorge/ Gully	1
TCAV-17	2	10/06/2022	Gorge/ Gully	1
TCAV-18	2	10/06/2022	Breakaway/ Cliff	1
TJBW-01	1	22/02/2022	Gorge/ Gully	2
TJBW-19	1	22/02/2022	Gorge/ Gully	1
TJBW-19	2	9/06/2022	Gorge/ Gully	1
TJBW-31	1	24/02/2022	Gorge/ Gully	2
TJMB-01	1	22/02/2022	Gorge/ Gully	3.2
TJMB-01	2	10/06/2022	Gorge/ Gully	2
TJMB-03	1	22/02/2022	Gorge/ Gully	4
TJMB-03	2	10/06/2022	Gorge/ Gully	3
TJMB-04	1	22/02/2022	Gorge/ Gully	4
TJMB-04	2	10/06/2022	Gorge/ Gully	2
TJMB-05	1	22/02/2022	Rehabilitated Area	4
TJMB-05	2	9/06/2022	Rehabilitated Area	2
TJMB-06	1	22/02/2022	Gorge/ Gully	5
TJMB-06	2	13/06/2022	Gorge/ Gully	3
			Total	**52.2**

Camera Trap Transects

Camera trap transects were established at five sites within the Study Area, all deployed during trip 1 and retrieved during trip 2 (Table 2.4; Figure 2.2). In line with methods recommended by DoE (2016), each transect comprised ten camera traps placed approximately 50 to 100 m apart. Sites remained deployed for between 104 and 110 nights, for a total of 5,390 camera trap sampling nights (Table 2.4).

Where possible, cameras were oriented to facilitate differentiation of individuals via spot patterning (as demonstrated by Hohnen *et al.*, 2012) and baited with universal bait mixture (comprising oats, peanut butter and sardines or sardines only) contained within a non-reward receptacle (perforated and capped PVC pipe). Transects were established within habitats providing denning/ shelter and/or foraging/ dispersal habitats where the species was most likely to be recorded (Table 2.4; Figure 2.2).

Table 2.4: Camera transects sampled for northern quoll within the Study Area

Site	Habitat	Latitude	Longitude	Deployment	Retrieval	Sampling nights	Total trap nights
VJMB-01	Gorge/ Gully	-23.3316	120.0185	22/02/2022	10/06/2022	108	1,080
VJMB-03	Gorge/ Gully	-23.3243	120.1379	22/02/2022	10/06/2022	108	1,080
VJMB-04	Gorge/ Gully	-23.3479	120.1245	22/02/2022	10/06/2022	108	1,080
VJMB-06	Rehabilitated Area	-23.3388	120.0314	25/02/2022	09/06/2022	104	1,040
VJMB-06	Gorge/ Gully	-23.3228	120.0103	22/02/2022	13/06/2022	110	1,110
						Total	**5,390**

192000 200000 208000 216000

7424000 7416000 7408000

VJBW-01
VJBW-19
VJBW-31
VJMB-06
VJMB-01
VJMB-05
VJMB-03
VJMB-04
VCAV-15
VCAV-17
VCAV-05
VCAV-18
VCAV-04
VCAV-14
VCAV-09
Jimblebar Railway
Jimblebar Railway

Legend

Study Area
Rail

Sampling Method

Camera Trap
Habitat Assessment
Targeted Search

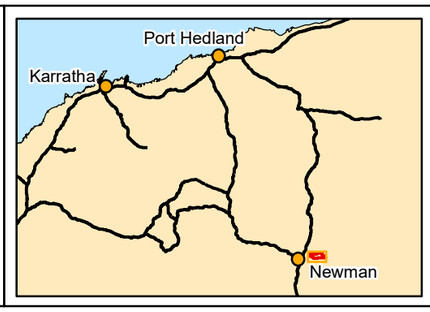
N

biologic Environmental Survey

Scale: 1:75,000

0 1 2 3 Km

Coordinate System: GDA2020 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA2020 Created 31/08/2022



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North Jimblebar Northern Quoll Assessment

Figure 2.2: Northern quoll sampling completed within the Study Area

3 RESULTS AND DISCUSSION

3.1 Fauna Habitats

A total of nine broad fauna habitat types were mapped across the Study Area, extrapolated from the 15 habitats assessments completed (Appendix A), comprising in order of extent of occurrence: Hillcrest/ Hillslope (43.13%, 6,009.43 ha), Drainage Area/ Floodplain (21.03%, 2,930.64 ha), Stony Plain (8.62%, 1,200.80 ha), Gorge/ Gully (4.63%, 645.76 ha), Mulga Woodland (3.59%, 500.83 ha), Minor Drainage Line (3.31%, 460.97 ha), Sand Plain (1.22%, 169.58 ha), Breakaway/ Cliff (1.20%, 166.60 ha), and Major Drainage Line (0.76%, 106.17 ha) (Table 3.1, Figure 2.2). The remaining 12.50% (1,742.20 ha) comprised areas mapped as Cleared/ Disturbed.

Table 3.1: Habitat types within the Study Area

Habitat type and extent	Habitat description	Representative photo
Hillcrest/ Hillslope • 6,009.43 ha • 43.13 %	This habitat comprises hills and undulating plains on the tops of ranges, supporting hard spinifex with a mantle of gravel and pebbles. Vegetation was dominated by a *Triodia* hummock grassland with scattered *Eucalyptus* trees and mallee and *Acacia* and *Grevillea* shrubs. The primary microhabitat is the spinifex hummocks. This habitat was differentiated from the remaining habitat types by limited rocky outcropping and vegetation diversity. Provides supporting habitat for northern quolls where proximal (i.e. within 1 km) to denning habitat. This supporting habitat is used for foraging and dispersal.	
Drainage Area/ Floodplain • 2,930.64 ha • 21.03%	Lower lying plain often subjected to sheet flow following large rainfall events. Vegetation of this habitat was variable, often comprising scattered *Eucalyptus* over *Acacia* and/or *Grevillea* shrubs with an understory dominated by *Triodia* hummock grasses on alluvial substrates, often comprising heavy clays and gravel. Nil habitat for northern quolls.	

Habitat type and extent	Habitat description	Representative photo
Stony Plain • 1,200.80 ha • 8.62 %	Stony Plain habitat comprises flat to low undulating areas with vegetation dominated by *Triodia* hummock grasses of various life stages and scattered patches of various small to medium shrub species on gravelly clay loam substrates. Nil habitat for northern quolls.	
Gorge/ Gully • 645.76 ha • 4.63%	This habitat comprises rugged, sometimes steep-sided rocky valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are shallower and more open. Vegetation within this habitat is variable depending on position in landscape and can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred. The vertical or near vertical faces offer consistent shade, plenty of sheltered aspects, complex microhabitats, and higher persistence of moisture. Provides critical habitat for the northern quoll. This critical habitat is used for breeding, denning, foraging and dispersal.	
Mulga Woodland • 500.83 ha • 3.59%	Low lying areas on heavy alluvial soils, often heavy clays. Vegetation very patchy, dominated by open Mulga patches with sparse to no understory of mixed small shrubs and tussock grasses. Mulga woodland of varying density, often associated with minor Drainage Area/ Floodplain landforms or minor drainage systems subject to sheet flow following rainfall. Nil habitat for northern quolls.	

Habitat type and extent	Habitat description	Representative photo
Minor Drainage Line • 460.97 ha • 3.31%	Minor Drainage Line comprises low lying or sloping topography, particularly in Hillcrest/ Hillslope landforms where water flowing from higher to lower elevation follows existing sloping topography. Vegetation is often variable and dependent on the occurrence of water within the drainage line. Vegetation often sparsely vegetated with scattered *Corymbia* and/or *Eucalyptus* over a mixed small or medium shrub understory and patchy cover of hummock and/or tussock grasses on stony or gravelly substrates. Provides supporting habitat for northern quoll where proximal (i.e. within 1 km) to denning habitat. This supporting habitat is used for foraging and dispersal.	
Sand Plain • 169.58 ha • 1.22%	Sand Plain habitat is characterised by sandy soils, often supporting Triodia hummock grassland and open Acacia shrubland vegetation. Vegetation is often dominated by *Triodia* hummocks of varying density and life stages, with scattered *Acacia* shrubs on sandy to sandy loam substrates. Nil habitat for northern quolls.	
Breakaway/ Cliff • 166.60 ha • 1.20%	Breakaway/ Cliffs are rugged, incised rocky hills and ranges. They tend to contain large rock fragments and more rock outcropping than other fauna habitats. Significant habitat features such as caves were sometimes encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred. Breakaway/ Cliff habitat provides critical habitat for northern quoll. This critical habitat is used for breeding, denning, foraging and dispersal.	

Habitat type and extent	Habitat description	Representative photo
Major Drainage Line • 106.17 ha • 0.76%	Within the Study Area, Major Drainage Line habitat is variable in structure and condition. Vegetation is often dominated by *Eucalyptus* species over a variable understory comprising mixed small to medium shrubs and tussock grasses. Provides supporting habitat for northern quoll, where proximal (i.e. within 1 km) to denning habitat. This supporting habitat is used for foraging and dispersal.	

192000 200000 208000 216000

7424000 7424000

7416000 7416000

Legend

Study Area

Habitat Type

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

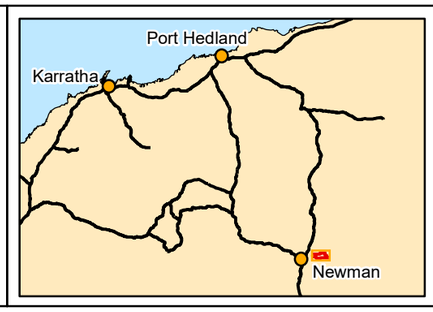
N

biologic Environmental Survey

Scale: 1:70,000

0 1 2 3 Km

Coordinate System: GDA2020 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA2020 Created 31/08/2022



BHP WAIO

North Jimblebar Northern Quoll Assessment

Figure 3.1: Fauna habitats mapped in the Study Area

3.2 Previous Records

The Study Area falls within the current distribution of the northern quoll, whereby 'the species or species habitat may occur', as defined by (DAWE, 2022). A total of 5,139 northern quoll records were returned from the database searches, comprising 4,604 records from DBCA (2022) and 535 from BHP WAIO (2022) (Figure 3.2). Note that many of these records are likely to represent duplicates of the same record. The majority of these records were located north or north-west of the Study Area in the northern Pilbara, with very few of these records situated within 100 km of the Study Area (Table 3.2). Those records within 100 km of the Study Area range in date between 2007 and 2021 (Table 3.2). Most of the records within 200 km of the Study Area were taken recently: 205 records in 2016, 170 records in 2017, and 95 records in 2018. Of the 47 relevant fauna assessments reviewed within 40 km of the Study Area, only two returned records of the northern quoll (Table 3.2).

The most recent and relevant record is that of a northern quoll scat recorded within the Study Area, on the Orebody 18 rehabilitated waste dump. The scat was recorded by rehabilitation specialist Todd Erickson as part of rehabilitation work within the area in August 2021. Following preliminary identification, the scat was subsequently sent to Georgeanna Story (ScatsAbout) and considered highly likely to have originated from the northern quoll based on morphological characteristics (i.e. shape, size) and the presence of a northern quoll hair. The next closest northern quoll records were detailed by Onshore and Biologic (2009c) (also reported in BHP WAIO, 2022). The first of these records was of a roadkill juvenile individual which was reported near the main access bridge into the Whaleback mine site in 2007. The second record was of a trapped individual at the Whaleback offices (date of record unknown). The Whaleback access bridge is located approximately 28 km west of the Study Area. While never proven, it was postulated at the time, that these individuals may have been transported into the area during the relocation of mine site accommodation from the BHP Redmont Camp in the Chichester Ranges (M. O'Connell *pers. comm.*).

Additionally, there are three records of northern quoll recorded south of Whaleback mine, approximately 33–38 km west of the Study Area Biologic (2020b). All three records were of scats from within two caves (CWER-10 and CWER-16). One scat collected within cave CWER-10 was confirmed by Georgeanna Story as belonging to the northern quoll based on morphological characteristics (i.e. shape, size) and the presence of a northern quoll hair, with scat age determined to be greater than 12 months old. The remaining scats (collected from CWER-10 and CWER-16) were determined to be probable northern quoll (based on morphological characteristics); however, due to their very old age (>36 months) and degraded condition, identification could not be confirmed. Given that a confirmed scat was recorded within the same cave (CWER-10), it was assumed that the remaining scats were also belonging to the northern quoll. Biologic (2020b) also noted that the stable microclimate in the two caves may have facilitated a degree of preservation of the scats, and therefore it was possible the scats were older than would usually be expected. Extensive camera trapping during and following (Biologic, 2021b) did not record any contemporary evidence of the species. Based on these results, it was concluded that these scat records were representative of a historical population, potentially transient individuals and/or a declining population that no longer or rarely occurs within the Study Area" (Biologic, 2021b).

The nearest northern quoll records outside of the Whaleback and Western Ridge area, are located south of the Hope Downs 1 mine, approximately 100 km north-west of the Study Area. The most recent records comprise a camera record from 2017 (BHP WAIO, 2022) and a unknown record type from 2010 (DBCA, 2022) (Table 3.2).

Plate 3.1: Northern quoll scat recorded in the Orebody 18 waste dump (photo: T. Erickson)

Table 3.2: Previous records of northern quoll within 100 km of the Study Area

Reference	Date	Description	Distance from Study Area
BHP WAIO (2022)	August 2021	Northern quoll scat recorded on Orebody 18 waste dump. Scat confirmed by Georgeanna Story	Within
BHP WAIO (2022); Onshore and Biologic (2009a)	June 2007	Juvenile northern quoll roadkill recorded on vehicle bridge into Whaleback mine.	~28 km west
BHP WAIO (2022); Onshore and Biologic (2009a)	2007	Individual trapped at the Whaleback site office.	~28 km west
Biologic (2020b)	March 2020	One old (>12 months) scat found in a cave in Gorge/ Gully habitat (confirmed by Georgeanna Story). Another unconfirmed scat recorded at same location.	~33 km west
Biologic (2020b)	March 2020	One very old (>36 months) scat found in a cave in Gorge/ Gully habitat.	~38 km west
BHP WAIO (2022)	November 2017	Northern quoll recorded on camera trap	~98 km north-west
DBCA (2022)	June 2010	Unknown	~98 km north-west

-400000 -200000 0 200000 400000

7600000

7400000

Shellborough
Finucane
Port Hedland
Goldsworthy
Shay Gap
Wickham
Point Samson
Cossack
Roebourne
Dampier
Karratha
Balla Balla
Mallina
Marble Bar Rd
Great Northern Hwy
Bamboo
Marble Bar
Ripon Hills Rd
Manuwarra Red Dog Hwy
North West Coastal Hwy
Pannawonica
Onslow
Onslow Rd
Nullagine
Karijini Dr
Tom Price
Nanutarra Munjina Rd
Paraburdoo Rd
Tom Price Rd
Paraburdoo
Burkett Rd
Newman

Legend

- Study Area
- State Road
- Rail

BHP (2022)

- Camera
- Individual (alive)
- Scat
- Track
- Unknown

DBCA (2022)

- Camera trap
- Individual (alive)
- Individual (dead)
- Scat
- Specimen
- Unknown
- Unknown secondary evidence

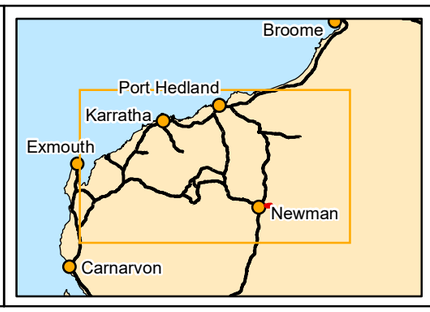
N

biologic Environmental Survey

Scale: 1:2,200,000

0 30 60 90 Km

Coordinate System: GDA2020 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA2020 Created 01/09/2022



BHP WAIO

North Jimblebar Northern Quoll Assessment

Figure 3.2: Previous northern quoll records for the Study Area and region

3.3 Current Survey

No evidence of northern quoll was recorded within the Study Area during the 52.2 person hours of targeted searches, including at locations of previous records, or opportunistically during other targeted sampling undertaken during the current survey. Additionally, camera transects deployed at five sites within the Study Area, for a total of 5,390 sampling nights (including at Site VJMB-05 which is the Orebody 18 waste dump where the scat was previously recorded), did not record any northern quoll. Thirty-six species were however recorded via camera traps during the sampling period (Appendix B).

3.4 Occurrence in the Study Area

Although the Study Area falls within the current distribution of the northern quoll, whereby the species or species habitat may occur (DoE, 2016), the species was not recorded during the current survey and only one record has previously been recorded within the Study Area (at the recently rehabilitated waste dump Orebody 18), and only five records were present from two out of 47 relevant fauna assessments reviewed within 40 km of the Study Area (Figure 3.2). There is uncertainty regarding all of these previous records, particularly with regard to the species long-term occurrence and persistence in the broader area. Both records from the Whaleback mine site are possibly representative of individuals which had been transported to the area, and the Western Ridge records are believed to be representative of historical and/or intermittent population presence, based on uncertainty regarding the potential preservation of scats collected from caves. This suggests that the species' occurrence within the Study Area is extremely rare. This may be due to the species occurring in very low densities within, or nearby the Study Area, or the record being from a transient individual.

Within the Study Area, critical habitat (i.e. denning/ shelter habitat as defined by DoE (2016)) for the species occurs in Gorge/ Gully (4.63%, 645.76 ha) and Breakaway/ Cliff (1.20%, 166.60 ha) habitats. Gorge/ Gully and Breakaway/ Cliff habitats also provide critical foraging and dispersal habitat for the species. Rocky habitats (such as these, typically offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; Hernandez-Santin *et al.*, 2016; Hernandez-Santin *et al.*, 2022; Oakwood, 2000). Importantly, in the Pilbara, these areas often provide a higher abundance of possible denning features (Hernandez-Santin *et al.*, 2022). The Gorge/ Gully and Breakaway/ Cliff habitats mapped within the Study Area (Figure 3.2) are consistent with this definition and offer microhabitat features comparable in extent and quality to those which support northern quoll elsewhere in the region (Hernandez-Santin *et al.*, 2016).

Major Drainage Line (0.76%, 106.17 ha), Minor Drainage Line (3.31%, 460.97 ha) and Hillcrest/ Hillslope (43.13%, 6,009.43 ha) habitats can provide supporting habitat for foraging and dispersal, particularly when they are adjacent to critical habitats (i.e. Gorge/ Gully and Breakaway/ Cliff habitats). Foraging or dispersal habitat is recognised to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of denning/ shelter habitat (DoE, 2016). As the definition by DoE (2016) suggests, the presence of northern quoll within these habitats is tied to their occurrence relative to critical denning/ shelter habitat (i.e. Gorge/ Gully and Breakaway/ Cliff habitat), and they are unlikely to support the species where not proximal to these habitats. Supporting habitat for foraging and

dispersal within 1 km of critical habitat in the Study Area, is represented by Major Drainage Line (32.43 ha), Minor Drainage Line (413.22 ha) and Hillcrest/ Hillslope (5,050.78 ha) habitats (Figure 3.3).

Based on aerial imagery and previous habitat mapping in the area, a greater portion of suitable habitat for the species occurs in the Gorge/ Gully and Breakaway habitat north of Orebody 18, compared to the majority of areas accessed during the current survey (Figure 3.3). Due to access constraints (no vehicle access and ongoing mining operations), much of this area could not be adequately accessed and surveyed during the current survey.

192000 200000 208000 216000

7424000 7416000

Orebody 18

Legend

Study Area
Rail

Northern Quoll Habitat
Critical
Nil
Supporting

Most Suitable Habitat
Supporting habitat within 1km of critical habitat

BHP (2022)
Scat

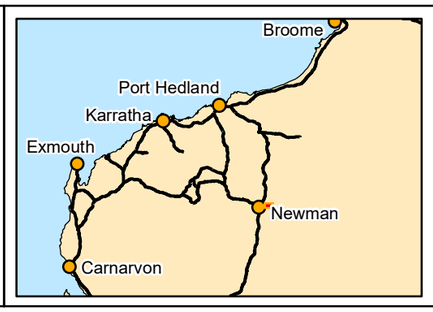
N

biologic Environmental Survey

Scale: 1:70,000

0 1 2 3 Km

Coordinate System: GDA2020 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA2020 Created 01/09/2022



BHP WAIO
North Jimblebar Northern Quoll Assessment

Figure 3.3: Northern quoll habitat in the Study Area

3.5 Constraints and Limitations

The EPA (2020b) outlines several potential limitations to vertebrate fauna surveys. These aspects are assessed and discussed in Table 3.3 below. Three partial constraints were identified as part of the survey; rainfall received in the area prior to trip 2; a large wildfire recorded in the Study Area in the years prior to the survey, and access to areas of suitable habitat (Table 3.3).

Table 3.3: Survey limitations and constraints

Potential limitation or constraint	Constraint	Applicability to this survey
Sources/availability of data and information (recent or historic) and availability of contextual information	No	A significant amount of survey work has been undertaken in the local area and the surrounding region, and most of these previous survey results were available for review. These reports were available at the time of reporting.
Competency/ experience of the survey team	No	Field personnel involved in the survey are experienced in undertaking fauna surveys of similar nature, including those targeting northern quoll.
Scope (faunal groups sampled and whether any constraints affect this)	No	The species was sampled following survey guidelines in relation to survey design and effort, site coverage, and detectability (DoE, 2016). Five camera transects, of ten cameras each, were deployed in the Study Area. Each transect was left in place (with a non-reward bait), for over 100 nights.
Timing, weather, and season	No	Field surveys occurred over appropriate or optimal periods for sampling the target species. Rainfall in the 12 months prior to the surveys was below long-term averages for most months. A high amount of rainfall was recorded in the weeks prior to trip 2. While in general this is likely to have increased animal activity in the broad sense, it may have degraded or washed away any scats that were present in the area, making detection difficult.
Disturbances (e.g., fire or flood)	Partial	Much of the northern section of the Study Area (including Site VJMB-06), which contains a high proportion of suitable habitat, was noted as being recently burnt (1-3 years old). Despite this, the northern quoll was recorded at Orebody 18 after a scat was deposited following the fires. Nonetheless, fire is a factor known to impact species such as the northern quoll (Oakwood, 2002), which may have resulted in population numbers being lower than usual.
Proportion of the task achieved	No	A targeted fauna survey of the Study Area was completed and related to the results of surveys in the broader area.
Proportion of fauna identified	No	All fauna recorded via camera traps were able to be accurately identified.
Intensity of survey	No	A targeted survey was undertaken across the Study Area to investigate the presence of northern quoll. The intensity of the survey followed recommendations in accordance with federal survey guidelines and advice.
Completeness of survey	No	The survey was adequately completed to meet the requirements of a targeted survey.
Resources (e.g., degree of expertise available)	No	All resources required to complete the survey were available.
Remoteness or access issues	Partial	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used during this survey were unconstrained by accessibility or remoteness. However, large sections of potentially suitable habitat located north of Orebody 18 were inaccessible by vehicle or foot (due to distance from nearby tracks and ongoing mining activity) (Figure 3.3).

4 CONCLUSION

The northern quoll has only been recorded in the Study Area once. A fresh northern quoll scat was recorded on a recently rehabilitated waste dump at Orebody 18 in August 2021, which initiated the targeted survey work to understand this species' presence in the Study Area as well as the general locality. No records of the northern quoll were recorded during the current survey. Furthermore, there are very few northern quoll records in the surrounding area despite the numerous surveys undertaken. This indicates that the species' occurrence locally is extremely rare.

The closest records of the species are located approximately 30 km west of the Study Area, two from the Whaleback mine site in 2007 and three from the Western Ridge exploration tenement (within cave CWER-10 located near the eastern edge and cave CWER-16 located near the southern edge of Western Range) in 2020 (Biologic, 2020b). There is uncertainty regarding all of these previous records, particularly with regard to the species long-term occurrence and persistence in the broader area. Both records from the Whaleback mine site are possibly representative of individuals which had been transported to the area, and the Western Ridge records are believed to be representative of historical and/or intermittent population presence, based on uncertainty regarding the potential preservation of scats collected from caves.

Critical habitat (i.e. denning/ shelter habitat as defined by DoE (2016)) for the species represented by Gorge/ Gully (4.63%, 645.76 ha) and Breakaway/ Cliff (1.20%, 166.60 ha) habitats occurs in the Study Area. Major Drainage Line (0.76%, 106.17 ha), Minor Drainage Line (3.31%, 460.97 ha) and Hillcrest/ Hillslope (43.13%, 6,009.43 ha) habitats can provide supporting habitat for foraging and dispersal, particularly when they are adjacent to critical habitats. Foraging or dispersal habitat is recognised to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of denning/ shelter habitat (DoE, 2016). As the definition by DoE (2016) suggests, the presence of northern quoll within these habitats is tied to their occurrence relative to critical denning/ shelter habitat (i.e. Gorge/ Gully and Breakaway/ Cliff habitat), and they are unlikely to support the species where not proximal to these habitats. Supporting habitat for foraging and dispersal within 1 km of critical habitat in the Study Area, is represented by Major Drainage Line (32.43 ha), Minor Drainage Line (413.22 ha) and Hillcrest/ Hillslope (5,050.78 ha) habitats (Figure 3.3).

A population of northern quolls is unlikely to occur within or nearby the Study Area at anything other than very low densities and / or intermittently. Therefore, it is highly unlikely that the species, if present at all, represents an 'important population' as defined by DoE (2016).

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6 APPENDICES

Appendix A: Habitat Assessments

Site ID	Latitude	Longitude	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Hollows count	Disturbances	Last Fire	Notes
VCAV-04	-23.3573	120.163	24/02/22	Gorge/ Gully	Undulating Low Hills	North	Low	Clay Loam	Many Small Patches	Moderate Outcropping, BIF	Small Rocks (11-20cm)	Many Small Patches	0	Mining Exploration	Old (6+ yr.)	
VCAV-05	-23.35	120.1368	10/06/22	Gorge/ Gully	Gully	West	Low	Clay Loam	Few Small Patches	Major Outcropping, BIF	Large Rocks (21-60cm)	Scarce	0	None Discernible	Old (6+ yr.)	
VCAV-09	-23.3636	120.1409	22/02/22	Gorge/ Gully	Gully	South/ West	Moderate	Clay Loam	None Discernible	Major Outcropping, BIF	Large Rocks (21-60cm)	Many Small Patches	4	None Discernible	Old (6+ yr.)	
VCAV-14	-23.3599	120.1483	10/06/22	Breakaway/ Cliff	Breakaway	North	Steep	Clay Loam	Scarce	Major Outcropping, BIF	Large Rocks (21-60cm)	None Discernible	2	None Discernible	Old (6+ yr.)	
VCAV-15	-23.3504	120.117	10/06/22	Gorge/ Gully	Gully	South	Moderate	Clay Loam	Few Small Patches	Major Outcropping, BIF	Large Rocks (21-60cm)	Few Small Patches	3	Mining Exploration	Old (6+ yr.)	
VCAV-17	-23.3504	120.1171	10/06/22	Gorge/ Gully	Gully	South	Moderate	Clay Loam	Few Small Patches	Major Outcropping, BIF	Large Rocks (21-60cm)	Few Small Patches	3	Mining Exploration	Old (6+ yr.)	
VCAV-18	-23.353	120.1396	10/06/22	Breakaway/ Cliff	Breakaway	South	Very Steep	Clay Loam	Scarce	Major Outcropping, BIF	Large Rocks (21-60cm)	Scarce	6	None Discernible	Old (6+ yr.)	
VJBW-01	-23.3182	119.9452	22/02/22	Gorge/ Gully	Gully	South	Steep	Clay Loam	Many Small Patches	Major Outcropping, BIF	Boulders (>61cm)	Few Large Patches	2	None Discernible	Old (6+ yr.)	
VJBW-19	-23.3232	119.9815	22/02/22	Gorge/ Gully	Gully	South	Moderate	Clay Loam	Scarce	Extensive Outcropping, BIF	Large Rocks (21-60cm)	Scarce	0	None Discernible	Old (6+ yr.)	
VJBW-31	-23.3281	119.9957	24/02/22	Gorge/ Gully	Gully	South	Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Boulders (>61cm)	Few Small Patches	3	Road/ Access Track	Old (6+ yr.)	
VJMB-01	-23.3317	120.0185	22/02/22	Gorge/ Gully	Gorge	West	Steep	Clay Loam	Few Small Patches	Major Outcropping, BIF	Large Rocks (21-60cm)	Few Small Patches	0	None Discernible	Moderate (3 to 5 yr.)	
VJMB-03	-23.3243	120.138	22/02/22	Gorge/ Gully	Gully	South/ West	Moderate	Clay Loam	Many Large Patches	Moderate Outcropping, BIF	Large Rocks (21-60cm)	Few Large Patches	1	None Discernible	Old (6+ yr.)	
VJMB-04	-23.3479	120.1246	22/02/22	Gorge/ Gully	Gorge	North	Very Steep	Silty Clay Loam	Scarce	Extensive Outcropping, BIF	Boulders (>61cm)	Many Small Patches	0	None Discernible	Old (6+ yr.)	
VJMB-05	-23.3388	120.0314	25/02/22	Rehabilitated Area	Other	Flat	Flat	Clay Loam	Evenly Spread	Limited Outcropping, BIF	Pebbles (5-10cm)	Scarce	0	Other	Old (6+ yr.)	Rehabilitated Waste dump, NQ scat record here 2021
VJMB-06	-23.3228	120.0104	22/02/22	Gorge/ Gully	Gorge	East	Steep	Clay Loam	Few Small Patches	Major Outcropping, BIF	Large Rocks (21-60cm)	Few Small Patches	0	Frequent Fire	Recent (0 to 2 yr.)	

Appendix B: Species Recorded During the Current Survey

Scientific Name	Common Name	VJMB-01	VJMB-03	VJMB-04	VJMB-05	VJMB-06
MAMMALS						
CANIDAE						
Canis familiaris subsp. *familiaris*	*Dog	1	2		1	
DASYURIDAE						
Dasykaluta rosamondae	Little-red kaluta			3		2
Pseudantechinus woolleyae	Woolley's pseudantechinus	18	9			
FELIDAE						
Felis catus	*Cat	4	3	1	13	6
LEPORIDAE						
**Oryctolagus cuniculus*	*European rabbit				3	
MACROPODIDAE						
Osphranter robustus subsp. *erubescens*	Euro	1	4			8
Petrogale rothschildi	Rothschild's rock-wallaby	27			1	12
MURIDAE						
Zyzomys argurus	Common rock rat	67	85	11	88	14
TACHYGLOSSIDAE						
Tachyglossus aculeatus subsp. *acanthion*	Short-beaked Echidna	2				
AVES						
AEGOTHELIDAE						
Aegotheles cristatus	Australian owlet-nightjar	4				1
ARTAMIDAE						
Artamus minor	Little woodswallow	2				
Cracticus nigrogularis	Pied butcherbird			1	1	7
COLUMBIDAE						
Geophaps plumifera subsp. *ferruginea*	Spinifex pigeon				2	19
Phaps chalcoptera	Common bronzewing	4	2			1
CORVIDAE						
Corvus orru subsp. *cecilae*	Torresian crow			4		1
ESTRILDIDAE						
Emblema pictum	Painted finch			1		
FALCONIDAE						
Falco cenchroides	Nankeen kestrel					1
MALURIDAE						
Amytornis striatus subsp. *whitei*	Striated grasswren	10				
Malurus lamberti subsp. *assimilis*	Variegated fairywren		1			
MELIPHAGIDAE						
Gavicalis virescens subsp. forresti	Inland Singing Honeyeater		1			
Lichmera indistincta	Brown honeyeater		1			
Ptilotula keartlandi	Grey-headed Honeyeater		3			
PACHYCEPHALIDAE						
Colluricincla harmonica subsp. *rufiventris*	Grey shrike thrush	51	65	3		27

Scientific Name	Common Name	VJMB-01	VJMB-03	VJMB-04	VJMB-05	VJMB-06
PTILINORHYNCHIDAE						
Ptilonorhynchus maculatus subsp. guttatus	Western bowerbird	1	5	1		
RHIPIDURIDAE						
Rhipidura leucophrys subsp. *leucophrys*	Willie wagtail	2	32	3	2	13
STRIGIDAE						
Ninox boobook	Boobook owl		1			
REPTILES						
AGAMIDAE						
Ctenophorus caudicinctus	Ring-tailed dragon				2	3
ELAPIDAE						
Demansia rufescens	Rufous whipsnake			2		1
SCINCIDAE						
Ctenotus inornatus	Skink	9	17	1	1	2
Cryptoblepharus ustulatus	Russet snake-eyed skink	6				
Morethia ruficauda subsp. *exquisita*	Fire-tailed skink		1	1		
VARANIDAE						
Varanus acanthurus	Spiny-tailed monitor	7	3	1		3
Varanus giganteus	Perentie	3	13	1	1	5
Varanus hamersleyensis	Southern Pilbara rock goanna	1				1
Varanus panoptes	Yellow spotted monitor				1	
Varanus tristis subsp. *tristis*	Racehorse goanna	2		1		2

*Introduced