



Terrestrial Fauna Assessment





O'Neil Mine Development

Alcoa of Australia Limited

14 May 2024

→ **The Power of Commitment**



Project name		Alcoa Holyoake Environmental Assessments					
Document title		Terrestrial Fauna Assessment O'Neil Mine Development					
Project number		12565572					
File name		12565572-00000-EN-RPT-015_1					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S0	Rev A	D. Goldspink, G. Gaikhorst	J Collins		Mat Brook		23/02/24
S3	Rev B	D. Goldspink, G. Gaikhorst	J Collins				10/05/24
S4	Rev 1	D. Goldspink, G. Gaikhorst	J Collins		Mat Brook		14/05/24
[Status code]							
[Status code]							

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Executive Summary

The O'Neil survey area is located within the Peel region, Western Australia (WA). Approximately 27 kilometres (km) south east of Jarrahdale town site in the south-west of Western Australia. The Survey Area lies in State Forest and covers an area of approximately 12719.25 hectares (ha), Shown in Figure 1 (Appendix A). This report also includes a 10 km area beyond the Survey Area which defines the Study Area.

The purpose of this report is to describe the terrestrial fauna attributes of the Survey Area via systematic and targeted methods with specific focus on significant fauna of local and regional occurrence occurring within the Survey Area.

Scope of works

This scope of work addresses the O'Neil mining region and O'Neil Infrastructure (including Lake Banksiadale).

The scope of work includes:

- Complete a desktop assessment and literature review of the Study Area.
- Undertake a basic fauna survey to determine the suite of fauna species that occur within the Survey Area including undertaking fauna habitat mapping
- Undertake a targeted fauna survey for all locally and regionally relevant significant vertebrate fauna species.
- Provide a fauna assessment report and data detailing the methods and findings.

Methods

Methodology involved an initial comprehensive desktop assessment to compile fauna database records and reports and understands all the local fauna occurrence for consideration. The desktop assessment informed on the field survey to target relevant significant fauna using specialised detection methods over several trapping phases. Seven survey events were undertaken by GHD Staff between June 2023 to January 2024.

Targeted survey methods included: Fauna habitat assessments; Pitfall and funnel traps; Elliot box traps; Remote cameras; Acoustic bat and bird call recorders; Diurnal and nocturnal searches; opportunistic observations; comprehensive assessment of Black Cockatoo habitat quality and quantity.

Finding

Nine broad fauna habitat types were identified during the field survey and via recent vegetation mapping: Jarrah – Marri forest, Wandoo woodland, Mixed shrub dampland, Bullich forest, Blackbutt forest, Granite Outcrop, Water bodies/reservoirs, Rehabilitation areas, and Cleared areas.

The combined fauna surveys (Reconnaissance to Camera collection) recorded a total of 121 vertebrate fauna species utilising the Survey Area, including 19 mammals (four introduced), 68 Birds, 27 reptiles and seven frogs.

Twelve significant fauna species were recorded within the survey area. This includes:

- Baudin's Black Cockatoo (*Zanda baudinii*) listed as Endangered under the BC Act and the EPBC Act.
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) listed as Vulnerable under the BC Act EPBC Act.
- Carnaby's Black Cockatoo (*Zanda latirostris*) listed as Endangered under the BC and EPBC Act.
- Chuditch (*Dasyurus geoffroii*) listed as Vulnerable under the BC Act and the EPBC Act.
- Quokka (*Setonix brachyurus*) listed as Vulnerable under the EPBC Act and BC Act
- Carter's Freshwater Mussel (*Westralunio carteri*) listed as Vulnerable under the EPBC Act and BC Act
- Rakali (*Hydromys chrysogaster*) Listed as Priority 4 by DBCA
- Western Bush Wallaby (*Notamacropus irma*) listed as Priority 4 by the DBCA.
- Dell's Skink (*Ctenotus delli*) listed as Priority 4 by the DBCA
- Quenda (*Isoodon fusciventer*) listed as Priority 4 by the DBCA.
- Masked Owls (*Tyto novaehollandiae novaehollandiae*) listed as Priority 3 by the DBCA

- The Western False Pipistrelle (*Falsistrellus mackenziei*) listed as Priority 4 by the DBCA

The Carter's Freshwater Mussel and Rakali were only recorded in the vicinity of Lake Banksiadale with the remainder of the survey area unsuitable for these species due to no habitat being present.

Five additional significant fauna species were not recorded but are considered likely to occur based on the desktop and field assessment. These include:

- Woylie (*Bettongia penicillata ogilbyi*) listed as Critically endangered under BC Act and Endangered under EPBC Act
- Numbat (*Myrmecobius fasciatus*) listed as Endangered under BC Act and EPBC Act
- Peregrine Falcon (*Falco peregrinus macropus*) listed as Specially protected fauna by DBCA
- Southwestern Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) Conservation Dependent under the BC Act
- Southern Death Adder (*Acanthophis antarcticus*) listed as Priority 3 by the DBCA

The Black Cockatoo habitat assessment results concluded that:

- Breeding habitat is extensive across the Survey Area and three known nesting trees were confirmed within the Jarrah-Marri forest habitat.
- Foraging habitat is extensive and of high quality throughout the Jarrah-Marri forest, other forest and woodland habitats are considered moderate foraging quality with relatively low density of primary food plant species.

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Acronyms

DCCEEW	The Department of Climate Change, Energy the Environment and Water
DAWE	The Department of Agriculture Water and Energy
DBCA	Department of Biodiversity, Conservation and Attractions
DBH	Diameter Breast Height
DE	Development Envelope
DEE	Department of the Environment and Energy
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EMRC	Environmental Management and Research Consultants
EPA	Environmental Protection Authority
EPBC	Environment Protection Biodiversity Conservation
EP	Environmental Protection
ERD	Environmental Review Document
ESD	Environmental Scoping Document
FRTBC	Forest Red-tail Black Cockatoo
GoWA	Government of Western Australia
IBSA	Index of Biodiversity Surveys for Assessments
LOO	Likelihood of Occurrence
LTFMP	Long Term Fauna Monitoring Program
MNES	Matters of National Environmental Significance
PMST	Protected Matters Search Tool
SM	Song Meter
SOP	Standard Operating Procedure
SRE	Short-Range Endemic

1. Introduction

1.1 Purpose of this report

The Purpose of this report is to describe the terrestrial fauna attributes of the O'Neil Survey area collected via systematic and targeted methods with focus on conservation significant species within the area.

1.2 Survey Area location

The O'Neil survey project is located in the Peel region, Western Australia, approximately 27 kilometres (km) east from the township of Jarrahdale, Western Australia (WA). The Survey Area covers approximately 12719.25 hectares (ha) of State Forest, Shown in Figure 1, Appendix A. This report also includes a 10 km area beyond the Survey Area which is defined as the desktop Study Area.

The O'Neil Survey Area is a collection of smaller areas. These areas are Contingency Area A, Contingency Area A – Haul Road Corridor (McCoy), Contingency Area B – Haul Road Corridor (McCoy) and Additional Haul Road. This collective of areas is known as the O'Neil Survey area. During the surveys O'Neil Infrastructure (including Lake Banksiadale) was also sampled however this is no longer part of the O'Neil mine area.

1.3 Scope and limitations

This scope of works addresses the O'Neil mining region, one of four mining regions part of the project. The scope of work includes:

- Complete a desktop assessment and literature review of the Study Area
- Undertake a reconnaissance survey to determine approach
- Undertake a basic fauna survey to determine the suite of fauna species that occur within the Survey Area including undertaking fauna habitat mapping
- Undertake a targeted fauna survey of significant fauna species focusing on the Chuditch, Quokka, South-west Brush-tailed Phascogale, Quenda, Western Brush Wallaby, Western Ringtail Possum, Numbat, Western False Pipistrelle, Carnaby's Black Cockatoo, Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo, Masked Owl (southern), Southern Death Adder and Dell's Skink.
- Provide a fauna assessment report (this document) detailing the methods and results of the assessment
- Provide a survey data package consistent with the Index of Biodiversity Surveys for Assessment (IBSA)

1.4 Limitations and assumptions

This report: has been prepared by GHD for Alcoa of Australia Limited and may only be used and relied on by Alcoa of Australia Limited for the purpose agreed between GHD and Alcoa of Australia Limited as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Alcoa of Australia Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 2.6.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.5 Terminology

Common terminologies are described below in Table 1.

Table 1 *Terminology and definitions*

Term (Abbreviation)	Definition/Use
Alcoa of Australia Limited	Proponent of the Proposal and Client of GHD for this Survey
GHD Pty Ltd (GHD)	Consultant engaged by Alcoa to prepare the environmental approvals documentation and supporting technical studies.
Survey Area	The area in which Alcoa propose for future mining development activities that will be assessed by regulators
Study Area	The Survey Area with a 10 km buffer used to define the limits of the desktop investigations.
Basic Fauna Survey	As per EPA 2020 describing the type of survey required, replaces wording from EPA 2016 for Level 1 assessment.
Targeted Fauna Survey	As per EPA 2020 describing the type of survey required, refers to undertaking targeted assessments for specific fauna species

1.6 Relevant legislation, conservation codes and background information

An overview of key legislation and guidelines, conservation codes and background information relevant to this fauna survey are provided in Appendix B.

2. Methods

2.1 Desktop assessment

Prior to the field survey a desktop assessment of the study area to identify environmental values and constraints was undertaken by viewing geographic information system (GIS) spatial files largely sourced from Government of Western Australia (GoWA) (2023a) and reviewing publicly available, government managed databases. The information sources utilised in this assessment are presented below in Table 2.

Table 2 Desktop Information Sources

Aspect	Information sources/Government Dataset
Climate	Bureau of Meteorology (BoM) Climate Data Online (2023)
Regional biogeography	Interim Biogeographic Regionalisation for Australia (IBRA) (DAWE 2012).
Geology, land systems and soils	1:500 000 State linear structures (DMIRS-015) (DMIRS 2018) Soil Landscape Mapping – Systems (DPIRD-064) (Geoscience 2019)
Environmentally Sensitive Areas (ESAs)	Clearing Regulations - Environmentally Sensitive Areas (DWER-046)
Conservation reserves and areas	Department of Biodiversity, Conservation and Attractions (DBCA) – Legislated Lands and Waters (DBCA-011) DBCA – Lands of Interest (DBCA-012)
Hydrology	Public Drinking Water Source Areas (DWER- 033) <i>Rights in Water and Irrigation Act 1914</i> (RIWI Act), Surface Water Areas and Irrigation Districts (DWER-037) RIWI Act, Ground Water Areas (DWER-034) RIWI Act, Rivers (DWER – 036) Waterways Conservation Act Management Areas (DWER-072) Ramsar Sites (DBCA-010) Directory of important wetlands in Australia- Western Australia (DBCA-045)
Vegetation	Pre- European vegetation (DPIRD 2020) (DPIRD-006) Native Vegetation Extent (DPIRD 2020) (DPIRD-005) Vegetation Mapping (Mattiske 2024)
Significant fauna	Department of Agriculture, Water and the Environment (DCCEEW 2023) Protected Matters Search Tool (PMST) database to identify fauna species listed under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) potentially occurring within the Study Area (Appendix C) DBCA <i>NatureMap</i> database (DBCA 2007–) (Appendix C) DBCA Threatened fauna database (DBCA 2021)
Literature review	31 fauna papers, reports, internal data of Alcoa as presented in Table 21.

The fauna desktop assessment included a review of:

- DCCEEW PMST database to identify fauna species listed under the EPBC Act potentially occurring within the desktop study area (refer Appendix C, Desktop Searches)
- The DBCA Threatened and Priority Fauna database for the Study Area
 - The DBCA *NatureMap* (DBCA 2007–) database for fauna species previously recorded within the study area
- *NatureMap* Species Report. This database comprises the following composite datasets:
 - Atlas of Australian birds
 - Bird data -Birdlife Australia
 - Fauna Survey Returns Database (New)
 - WA Museum (WAM) databases (mammals, birds, reptiles)

- Aerial photography, geology/soils, land systems and hydrology information to provide background information on the variability of the environment and likely habitat types present.
 - A fauna likelihood of occurrence assessment (Appendix D, Fauna Likelihood of occurrence assessment of significant species relevant to the Survey Area)

2.1.1 Previous studies

A literature review was performed on previous terrestrial fauna studies considered relevant to the current region, to inform the basis of the fauna surveys. The review focusses on all locally and regionally relevant significant species recorded during surveys on Alcoa mining lease and surrounding areas. A review of 31 reports that are considered relevant to the current study is provided in Table 21.

2.2 Field survey

2.2.1 Survey timing and personnel

The terrestrial fauna assessment comprised a multi-phase field program comprising a reconnaissance survey, a camera rotation, three targeted surveys with basic fauna assessment, single targeted survey for Additional Haul Road and a final site visit for remote camera collection. All phases are detailed below in Table 3. The field survey was led by Technical Director - Zoology Glen Gaikhorst and assisted by other GHD Zoologists. The experience of these staff members is presented in Table 4.

Table 3 Field Survey timing type and details

Phase/Survey Type	Date	Tasks	Personnel
Reconnaissance Survey	27/06/2023 – 30/06/2023	Preliminary habitat assessment, assessment of access tracks, target significant species remote camera deployment, selection of target trapping sites, opportunistic fauna observations	Glen Gaikhorst Lucas Hurst
Remote Camera Rotation	24/07/2023 – 28/07/2023	Remote camera rotation	Glen Gaikhorst Jack Eastwood
Phase 1 Targeted and Basic Survey	15/08/2023 – 25/08/2023	Install Trapping sites, targeted fauna remote equipment collection and redeployment (camera, bird acoustic, bat detector), significant fauna target searches and habitat mapping, black cockatoo assessment, basic fauna survey/opportunistic species inventory observations	Glen Gaikhorst Robert Browne-Cooper Brad Maryan Sarah Flemington Lucas Hurst Jack Eastwood Dylan Goldspink Kiara De Landgraft
Phase 2 Targeted and Basic Survey	6/09/2023 – 15/09/2023	Run target trapping sites, targeted fauna remote equipment collection and redeployment (camera, bird acoustic, bat detector), significant fauna target searches and habitat mapping, black cockatoo assessment, basic fauna survey/opportunistic species inventory observations.	Glen Gaikhorst Jack Eastwood Dylan Goldspink Sam Patton
Phase 3 Targeted and Basic Survey	17/10/2023 – 26/10/2023	Run targeted trapping sites, remote camera collection and redeployment, significant fauna target searches and habitat mapping, black cockatoo assessment, basic fauna survey/opportunistic species inventory observations.	Glen Gaikhorst Brad Maryan Lucas Hurst Dylan Goldspink Kiara De Landgraft Sam Patton
Single Target Additional Haul Road	14/12/2023 – 15/12/2023	Black Cockatoo assessment. Deployment of remote device (cameras, bat and bird acoustic). Basic fauna assessment and basic flora assessment.	Brad Maryan Sarah Flemington

Phase/Survey Type	Date	Tasks	Personnel
			Dylan Goldspink Sam Patton
Remote Gear Collection	29/01/2024	Remote camera collection	Brad Maryan Dylan Goldspink

Table 4 Personnel experience

Name	Years of experience	Role	Phase
Glen Gaikhorst	25+	Technical Director - Zoology and field lead	Reconnaissance, Camera rotation, Phase 1, Phase 2 and Phase 3.
Robert Browne-Cooper	25+	Senior Zoologist	Phase 1
Brad Maryan	25+	Senior Zoologist	Phase 1, Phase 3, Single Target & Camera Collection
Sarah Flemington	5+	Ecologist	Phase 1 & Single Target
Lucas Hurst	5+	Zoologist	Reconnaissance survey, Phase 1 & Phase 3
Jack Eastwood	3+	Zoologist	Camera Rotation, Phase 1 & Phase 2
Dylan Goldspink	2+	Graduate Zoologist	Phase 1, Phase 2, Phase 3, Single Target & Camera Collection.
Kiara De Landgraft	2+	Environmental Scientist	Phase 1 & Phase 3
Sam Patton	1+	Ecology Field Hand	Phase 2, Phase 3 and Single Target.

2.2.2 Guiding documents

The survey method and data collection that GHD employed was conducted in accordance with:

- EPA Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (2020)
- DEHWA (2010a) Survey Guidelines for Australia’s Threatened Bats
- DEHWA (2010b) Survey Guidelines for Australia’s Threatened Mammals
- DEHWA (2010c) Survey Guidelines for Australia’s Threatened Reptiles
- National Heritage Trust (NHT) National manual for the Malleefowl monitoring system standards (2007)
- Other published literature, including recent advances in species habitat and survey techniques.

2.2.3 Permits and animal ethics

A Regulation 27 Licence for Fauna Taking (Biological Assessment) was obtained from DBCA prior to undertaking the fauna survey (Licence Number: BA27000881). An Authorisation to take or disturb threatened species was also obtained (Authorisation number: TFA 2324-0025).

Fauna survey activities, specifically trapping, capture and animal handling, was undertaken in accordance with DBCA Standard Operating Procedures (SOPs) which were required to be followed under the conditions of GHD’s fauna trapping permit. At the time of survey, compliance with these SOPs was accepted by DBCA as evidence of ethical treatment of animals.

This project was approved by GHD’s ethics committee on the 23/5/2023 under ethics number 12565572-202305231713. This approval is covered under GHD’s Standard Operating Procedures (SOP) which mostly aligns to DBCA’s SOP’s as part of our trapping permit. Where differentiation occurs GHD adopts the most relevant action according to the task.

2.2.4 Data collection

All field data methods and results including points locations, tracks and polygons were collected via the ArcGIS off-line platform (Field maps) This includes all systematic and targeted fauna sampling sites, significant fauna record locations, and all other spatial data required for delineation and mapping of major fauna habitat types throughout the Survey Area

2.2.5 Habitat assessment

Fauna habitat assessments were undertaken to document and map the type, ecological value and extent of habitat throughout the Survey Area.

Broad habitats within the Survey Area were identified, mapped and described based on the following:

- Location within study
- Landscape position
- Geomorphology, topography, and substrate
- Photos of representative habitat types
- Vegetation description and dominant structure
- Values to associated fauna including significant species (e.g., refuge, foraging, shelter)
- Ecological processes of importance
- Disturbances (weeds, fire, ground disturbance)
- Wider extent and connectivity of habitat type based on previous mapping
- Comparison between broad habitat types
- Evaluation of the likelihood of occurrence of significant fauna within the environments present (based on presence of suitable habitats and species recorded)
- Reconciliation with recently mapped vegetation community types Mattiske (2024)

2.2.6 Fauna identification and nomenclature

Fauna was identified in the field using reference books, field guides and electronic guides (Table 5). Where identification was not possible, specific publications were utilised or photographs of specimens were collected to be later identified. Nomenclature used in this report follows that used by Western Australian Museum (WAM) as reported on *NatureMap*. This nomenclature is deemed the most up-to-date species information for WA fauna.

Table 5 Fauna reference books

Fauna group	Field Guide
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2013)
Bats	Churchill (2008), Menkhorst and Knight (2010)
Birds	Morcombe (2014)
Reptiles	Wilson and Swan (2021), Storr <i>et. al.</i> (1999), Storr <i>et.al.</i> (2002)
Amphibians	Tyler and Doughty (2009)

2.3 Basic fauna assessment

A GHD Technical Director - Zoology undertook a basic fauna survey during both targeted survey phases (Table 3). The Survey Area was traversed by vehicle and by foot over the entirety of the survey to identify and describe the dominant fauna habitat types present and their condition, assess habitat connectivity, and identify and record opportunistic fauna species occurring within the Survey Area (Appendix D, Combined species list).

Opportunistic fauna searches

Opportunistic and active fauna searches were conducted while traversing the Survey Area which involved:

- Searching the Survey area for indirect signs of native and invasive fauna; tracks, scats, bone, diggings and feeding areas.
- Searching through microhabitats including turning over logs or rocks, turning over leaf litter and examining tree hollows and hollow logs
- Visual and aural detection of birds which accounted for many bird species utilising the Survey Area.
- Recording GPS locations for all significant fauna species.
- A fauna Inventory was compiled from species recorded during all phases of the survey from opportunistic fauna searches and targeted fauna assessment (Appendix D, Combined species list).

The targeted fauna survey comprised a comprehensive set of methods tailored for the locally relevant significant fauna species. Methods and survey effort and described in Table 6 and presented in Figure 3, Appendix A.

Table 6 Targeted fauna survey method

Trap Type	Description, habitat type and location	Target species
Pit-fall traps: Buckets with drift fence	Pit-fall traps were established as part of targeted sampling. These were 20 litre plastic buckets (25 cm diameter, 40 cm deep) set as a linear series of transects, each with seven pits spaced approximately 10 m apart and set with a continuous flywire drift fence (30 cm high) bisecting the pits to channel fauna into pits. Soil and egg crate is placed within each pit to provide shade and shelter. Trap sites were selected based on habitat type to maximise detection of the target species group. Suitable habitat characteristics included areas fringing granite outcrops, lateritic gravel or sandy substrates supporting low myrtaceous shrubs. In habitat types where soils are shallow or absent pitfall traps may be substituted with additional funnel traps where digging is not possible. Six trap transects were established, each with seven pit-fall traps.	Dell's Skink, Southern Death Adder
Funnel Traps	Twelve to fourteen funnel traps were installed between pit-fall traps along drift fences at each trap transect. Funnels were placed such that animals were channelled into pits along the drift fence. Funnel traps were covered with shade panels or vegetation to minimise heat exposure to animals. Trap sites were selected based on habitat type to maximise detection of the target species group, as per pit-fall traps.	Dell's Skink, Southern Death Adder
Elliot ® box traps	Elliot box traps (type A: 33 x 10 x 9 cm) were placed in selected locations with potential habitat for target significant fauna group. These were placed in linear series of 10 traps spaced 2 to 30 m apart. Traps are baited with universal bait: a mixture of peanut butter, rolled oats and sardines. Elliot traps are positioned within shady areas or covered with vegetation to minimise heat exposure to animals. Trap sites were selected based on habitat type to maximise detection of the target species group. Suitable Phascogale habitat characteristics included Jarrah – Marri open forest over Sheoak – Banksia with understory canopy connectivity. Box traps were positioned at least 1 m above ground on large fallen trees or attached to branches suitable for the arboreal target species.	South-west Brush-tailed Phascogale.
Remote Cameras	Remote cameras were deployed in selected locations in areas of suitable habitat for target significant species. Remote cameras have proved very effective at detecting target species groups and a range of bird, reptile, and mammal species also recorded opportunistically as bi-catch. Targeted habitat locations include rocky outcrops, riparian areas with dense low vegetation cover, well vegetated low-lying ephemeral damp areas, Jarrah-Marri forest, fringing areas of reservoirs. All cameras deployed during the survey (Table 7 & Table 8) have the potential to record multiple species groups. Data (images/video) was collected to SD card and downloaded in office to database. Images were then screened for fauna species present and identified to species level. Where species level could not be achieved then species group or best determination to highest level made. Species identification was classified as an event with one event occurring every 24	South-west Brush-tailed Phascogale, Chuditch, Quokka, Quenda, Brush Wallaby, Western Ringtail Possum.

Trap Type	Description, habitat type and location	Target species
	hours unless individual specimens can be identified (ie Chuditch with spots or animal sizes or injury marks). By restricting data to one event every 24 hours assumes independence over species.	
Full Spectrum SM4BAT @ or Anabat Swift @ (bat detectors)	Ultrasound bat detector/recorders deployed in selected locations in areas of suitable habitat (flyways, in proximity of water bodies, potential roost locations) to detect micro-chiropteran bats. Each detector set to record from 30 minutes pre-dusk to 30 minutes post-dawn.	Western False Pipistrelle
Song Meter SM4 (acoustic recorder)	SM4 units deployed in selected locations in areas of suitable habitat. Target areas included riparian habitat, and interface areas between forest and clearings that are favoured hunting sites for owls. Acoustic recorders were set to record from 30 minutes pre-dusk to 30 minutes post-dawn.	Masked Owl
Nocturnal Searches	Nocturnal surveys were conducted using handheld spotlights to target significant fauna via eyeshine during the survey. Spotlight is utilised to detect a range of nocturnal species that may not be trapped in the above techniques. Nocturnal searching can account for a significant proportion of the recorded fauna assemblage during favourable conditions. Nocturnal searches were subject to risk assessment based on fatigue management and in consultation with Alcoa site responsible personnel.	Western Ringtail Possum, South-west Brush-tailed Phascogale, Quenda, Masked Owl
Diurnal Active Searches	Transect searches on foot were undertaken is for significant fauna in selected potential habitat. This involved searching for presence of secondary evidence such as scats, tracks, diggings, nests, burrows, dens and remains, as well as scratch marks on tree trunks, and hollow-bearing trees for arboreal and avian species. All species observed during these searches will be recorded	Quokka, Malleefowl, Western Ringtail Possum, Numbat, Black Cockatoo habitat assessment
Opportunistic observations	Opportunistic detection of fauna was recorded throughout the field survey activities. These include all confirmed sightings and calls heard. Whilst this method is non-systematic, it generally accounts for a large proportion of fauna recorded and contributes a large proportion of the total fauna recorded during survey.	Numbat, Black Cockatoos, Malleefowl

2.3.1 Chuditch assessment

Chuditch (*Dasyurus geoffroii*) are known to occur locally and are predominately associated with Jarrah (*Eucalyptus marginata*) forests and woodlands, mallee shrublands and heathlands (DBCA 2017). They are readily recorded via remote camera and also caught in cage traps in past surveys in the area surrounding the Survey Area (GHD 2021a, GHD 2021b).

Remote cameras were deployed at locations deemed suitable to support Chuditch. Suitability of camera location was determined by habitat characteristics and / or presence of or proximity to secondary evidence (scats, tracks). Both densely vegetated forest and open forest with adequate numbers of suitable den and refuge sites (horizontal hollow logs) were targeted as these habitats provide suitable shelter for Chuditch. Cameras targeting Chuditch were set as linear transects of 10 cameras set 400 m intervals and baited with chicken pieces and/or sardines. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates and habitat summary were recorded. Table 7 details the locations of all cameras deployed those targeting Chuditch as well as other significant target mammal species. Cage traps were not used for this species, so as not to disturb female Chuditch with pouch or den young.

Table 7 Chuditch line camera deployment

Phase	Camera Number	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Phase 1	CAM 19	Jarrah-Marri forest	-32.5840	116.3146	17/08/2023	25/08/2023	8
Phase 1	CAM 28	Jarrah-Marri forest	-32.5812	116.3142	17/08/2023	25/08/2023	8
Phase 1	CAM 16	Jarrah-Marri forest	-32.5782	116.3140	17/08/2023	25/08/2023	8
Phase 1	CAM C(42)	Jarrah-Marri forest	-32.5757	116.3147	17/08/2023	25/08/2023	8
Phase 1	CAM 53	Jarrah-Marri forest	-32.5727	116.3149	17/08/2023	25/08/2023	8
Phase 1	CAM R59	Jarrah-Marri forest	-32.5695	116.3146	17/08/2023	25/08/2023	8
Phase 1	CAM 5	Jarrah-Marri forest	-32.5668	116.3147	17/08/2023	25/08/2023	8
Phase 1	CAM GHD GERO F (17)	Jarrah-Marri forest	-32.5613	116.3145	17/08/2023	25/08/2023	8
Phase 1	CAM 20	Jarrah-Marri forest	-32.4791	116.0864	17/08/2023	25/08/2023	8
Phase 1	CAM HP14	Jarrah-Marri forest	-32.4826	116.0862	17/08/2023	25/08/2023	8
Phase 1	CAM NO NAME	Jarrah-Marri forest	-32.4864	116.2723	17/08/2023	25/08/2023	8
Phase 1	CAM 55	Jarrah-Marri forest	-32.4909	116.2722	17/08/2023	25/08/2023	8
Phase 1	CAM P6	Jarrah woodland	-32.5985	116.1155	17/08/2023	25/08/2023	8
Phase 1	CAM P4	Jarrah woodland	-32.6023	116.1122	17/08/2023	25/08/2023	8
Phase 1	CAM P1	Jarrah woodland	-32.6063	116.1091	17/08/2023	25/08/2023	8
Phase 1	CAM 77	Jarrah woodland	-32.6112	116.1109	17/08/2023	25/08/2023	8
Phase 1	CAM P5	Jarrah woodland	-32.6163	116.1104	17/08/2023	25/08/2023	8
Phase 1	CAM 4	Jarrah woodland	-32.6188	116.1150	17/08/2023	25/08/2023	8
Phase 1	CAM 7	Bullich forest	-32.6225	116.1152	17/08/2023	25/08/2023	8
Phase 1	CAM 14B	Jarrah woodland	-32.6271	116.1160	17/08/2023	25/08/2023	8
Phase 1	CAM P2	Jarrah woodland	-32.6316	116.1140	17/08/2023	25/08/2023	8
Phase 1	CAM HF12	Jarrah woodland	-32.6335	116.1093	17/08/2023	25/08/2023	8
Phase 1	CAM 14	Jarrah-Marri forest	-32.4947	116.2712	18/08/2023	25/08/2023	7
Phase 1	CAM 21	Jarrah-Marri forest	-32.4978	116.2715	18/08/2023	25/08/2023	7
Phase 1	CAM R57	Jarrah-Marri Forest	-32.4995	116.2676	18/08/2023	25/08/2023	7

Phase	Camera Number	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Phase 1	CAM 12	Jarrah-Marri Forest	-32.5023	116.2665	18/08/2023	25/08/2023	7
Phase 1	CAM HF10	Jarrah-Marri Forest	-32.5057	116.2654	18/08/2023	25/08/2023	7
Phase 1	CAM 31	Jarrah-Marri forest	-32.5093	116.2659	18/08/2023	25/08/2023	7
Phase 1	CAM HP3	Dampland	-32.5378	116.3167	21/08/2023	5/09/2023	15
Phase 2	CAM P6	Jarrah-Marri Forest	-32.5612	116.2342	5/09/2023	14/09/2023	9
Phase 2	CAM HP4	Jarrah -Marri forest	-32.5589	116.2374	5/09/2023	14/09/2023	9
Phase 2	CAM 14	Jarrah -Marri forest	-32.5562	116.2401	5/09/2023	14/09/2023	9
Phase 2	CAM HF12	Jarrah -Marri forest	-32.5521	116.2439	5/09/2023	14/09/2023	9
Phase 2	CAM 20	Jarrah -Marri forest	-32.5492	116.2481	5/09/2023	14/09/2023	9
Phase 2	CAM 31	Jarrah -Marri forest	-32.5483	116.2527	5/09/2023	14/09/2023	9
Phase 2	CAM NO NAME	Rehab area	-32.5453	116.2569	5/09/2023	14/09/2023	9
Phase 2	CAM 55	Jarrah -Marri forest	-32.5404	116.2592	5/09/2023	14/09/2023	9
Phase 2	CAM P2	Jarrah -Marri forest	-32.5364	116.2621	5/09/2023	14/09/2023	9
Phase 2	CAM 21	Jarrah -Marri forest	-32.5334	116.2649	5/09/2023	14/09/2023	9
Total recording nights							317

Table 8 Targeted camera deployment (Chuditch, Woylie, Western Brush Wallaby, Brush-tailed Phascogale, Western Ringtail Possum, Quenda, Quokka, Numbat and Mallefowl).

Phase	Camera Number	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Reconnaissance	CAM G	Jarrah -Marri forest	-32.6080	116.1946	27/06/2023	24/07/2023	27
Reconnaissance	CAM 11	Jarrah -Marri forest	-32.6140	116.2007	27/06/2023	24/07/2023	27
Reconnaissance	CAM 14	Jarrah -Marri forest	-32.6186	116.2071	27/06/2023	24/07/2023	27
Reconnaissance	CAM R57	Jarrah -Marri forest	-32.6177	116.2209	27/06/2023	24/07/2023	27
Reconnaissance	CAM 4	Jarrah -Marri forest	-32.6012	116.1894	27/06/2023	24/07/2023	27
Reconnaissance	CAM HF12	Minor drainage line	-32.5885	116.1895	27/06/2023	24/07/2023	27
Reconnaissance	CAM 8	Minor drainage line	-32.5897	116.1895	27/06/2023	24/07/2023	27
Reconnaissance	P1	Jarrah -Marri forest	-32.5863	116.2065	27/06/2023	27/07/2023	30
Reconnaissance	CAM 7	Minor drainage line	-32.5807	116.1920	27/06/2023	27/07/2023	30
Reconnaissance	CAM 23	Jarrah -Marri forest	-32.5528	116.3274	29/06/2023	27/07/2023	28
Reconnaissance	CAM 7	Jarrah -Marri forest	-32.5710	116.3274	29/06/2023	27/07/2023	28
Reconnaissance	CAM 77	Jarrah -Marri forest	-32.5862	116.3128	29/06/2023	27/07/2023	28
Reconnaissance	CAM YALGOO	Jarrah -Marri forest	-32.5545	116.2861	29/06/2023	27/07/2023	28
Reconnaissance	CAM 1	Dampland	-32.5142	116.1927	29/06/2023	27/07/2023	28
Reconnaissance	CAM HP3	Dampland	-32.5276	116.2170	29/06/2023	27/07/2023	28
Single target	CAM 14	Jarrah -Marri forest	-32.6311	116.2243	24/07/2023	16/08/2023	23
Single target	CAM 11	Jarrah -Marri forest	-32.6265	116.2283	24/07/2023	16/08/2023	23
Single target	CAM R57	Jarrah -Marri forest	-32.6150	116.2194	24/07/2023	16/08/2023	23
Single target	CAM GERO	Jarrah -Marri forest	-32.6099	116.2003	24/07/2023	16/08/2023	23
Single target	CAM 4	Jarrah -Marri forest	-32.5838	116.1843	24/07/2023	16/08/2023	23
Single target	CAM HF12	Jarrah -Marri forest	-32.5758	116.1797	24/07/2023	16/08/2023	23
Single target	CAM 8	Minor drainage line	-32.5670	116.1712	24/07/2023	19/10/2023	87
Single target	CAM 77	Jarrah -Marri forest	-32.5560	116.2984	27/07/2023	16/08/2023	20
Single target	CAM YALGOO	Jarrah -Marri forest	-32.5572	116.3114	27/07/2023	16/08/2023	20
Single target	CAM P1	Dampland	-32.5663	116.2356	27/07/2023	16/08/2023	20
Single target	CAM PRO 4	Dampland	-32.5661	116.2338	27/07/2023	16/08/2023	20

Phase	Camera Number	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Single target	CAM 1	Dampland	-32.5403	116.2296	27/07/2023	16/08/2023	20
Single target	CAM HP3	Dampland	-32.5471	116.2405	27/07/2023	18/08/2023	22
Phase 2	CAM 12	Bullich forest	-32.6334	116.0864	5/09/2023	18/10/2023	43
Phase 2	CAM P5	Melaleuca dampland	-32.5606	116.2883	7/09/2023	18/10/2023	41
Phase 2	CAM R57	Large water body	-32.6322	116.0862	8/09/2023	18/10/2023	40
Single target	CAM 53	Jarrah -Marri forest	-32.4788	116.2701	15/12/2023	29/01/2024	45
Single target	CAM P5	Jarrah -Marri forest	-32.4771	116.2673	15/12/2023	29/01/2024	45
Single target	CAM W5	Jarrah -Marri forest	-32.4753	116.2641	15/12/2023	29/01/2024	45
Single target	CAM W8	Jarrah -Marri forest	-32.4740	116.2606	15/12/2023	29/01/2024	45
Single target	CAM W12	Jarrah -Marri forest	-32.4724	116.2571	15/12/2023	29/01/2024	45
Single target	CAM P4	Jarrah -Marri forest	-32.4726	116.2537	15/12/2023	29/01/2024	45
Single target	CAM YALGOO	Jarrah -Marri forest	-32.4818	116.2717	15/12/2023	29/01/2024	45
Single target	CAM HF10	Jarrah -Marri forest	-32.4843	116.2722	15/12/2023	29/01/2024	45
Single target	CAM W2	Jarrah -Marri forest	-32.4878	116.2738	15/12/2023	29/01/2024	45
Total recording nights							1290

2.3.2 Western Brush Wallaby assessment

The Western Brush Wallaby (*Notamacropus irma*) is known from the area, predominantly associated with dry sclerophyll forest and woodlands in the southwest of WA (Menkhorst & Knight 2010). It is readily recorded via remote camera and has successfully been recorded in local Jarrah Marri Forest habitat during recent surveys (GHD 2021a, GHD 2021b).

Targeted remote cameras were deployed at locations deemed suitable to support Brush Wallaby to confirm their presence. Suitability of camera location were assessed by habitat characteristics and presence of / proximity to secondary evidence (scats, diggings, track). For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (Table 7 and Table 8).

Opportunistic sightings and records of any evidence of Western Brush Wallaby presence was recorded. Secondary evidence of species was verified by Glen Gaikhorst in the form of scat.

2.3.3 Brush-tailed Phascogale assessment

South-west Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) have previously been recorded in the region in dry sclerophyll Jarrah-Marri forests and woodlands with canopy connectivity that contain hollow bearing trees and sparse ground cover. They have recently been recorded via remote cameras as demonstrated by recent surveys in the area surrounding the Survey Area (GHD 2021a, GHD 2021b).

South-west Brush-tailed Phascogales will be targeted utilising modified arboreal Elliot box traps. The trapping program was in accordance with the methodology and recommendations outlined by DSEWPC (2011b). South-west Brush-tailed Phascogale are predominantly an arboreal (tree dwelling) species however will traverse habitats on the ground. Therefore, Elliot box traps were set in transect lines of 10 traps at approximately 30 m intervals. Traps were adapted by being strapped into trees and onto elevated logs. The Elliot box traps were baited with universal bait and covered with bark, leaves or Sheoak needles. Trap site location trap effort and other details from Phases 1 and 3 are recorded in Table 10. Trapping was split over 3 phases due to weather events at the time.

Remote cameras were deployed at locations deemed suitable to support South-west Brush-tailed Phascogale to confirm their presence. Remote camera placement was focused on key habitat features important to Brush-tailed Phascogale including placement in trees and facing onto elevated logs. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (Table 7 and Table 8)

Nocturnal transects were undertaken targeting potential South-west Brush-tailed Phascogale habitat searching for eyeshine. Habitat including suitable hollow-bearing trees / hollow logs as possible nest sites and suitable foraging were targeted. Any evidence of Brush-tailed Phascogale presence including scratches on tree trunks or scats on the ground nearby potential nesting sites was recorded and verified by Glen Gaikhorst. The locations and survey effort for nocturnal transects are recorded in Table 9. All other species observed during nocturnal searches were noted.

Table 9 Nocturnal transect survey effort for South-west Brush-tailed Phascogale, Western Ringtail Possum, Quenda and Southern Death Adder.

Phase	Date Conducted	Habitat type	Latitude	Longitude	Effort (minutes)
Phase 3	21/10/2023	Jarrah -Marri forest	-32.4998	116.2288	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5117	116.2428	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5261	116.2511	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5375	116.2617	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5156	116.1961	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5254	116.2139	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5334	116.2320	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5383	116.2480	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5464	116.2614	60

Phase	Date Conducted	Habitat type	Latitude	Longitude	Effort (minutes)
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5631	116.2604	60
Phase 3	21/10/2023	Jarrah -Marri forest	-32.5069	116.2913	60
Total effort					660

Table 10 Total fauna trapping effort

Trap site number	Coordinates		Habitat description	Trapping nights	Pit traps/Buckets		Elliot traps		Funnel traps	
	Easting	Northing			Per site	Trap nights	Per site	Trap nights	Per site	Trap nights
Phase 1										
Elliot Line 1	-32.5710	116.2597	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 2	-32.5107	116.2876	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 3	-32.5132	116.2682	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 4	-32.5308	116.2547	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 5	-32.5835	116.3154	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 6	-32.5380	116.3161	Jarrah -Marri forest	3	0	0	10	30	0	0
Elliot Line 7	-32.6102	116.1967	Sheoak woodland	3	0	0	10	30	0	0
Elliot Line 8	-32.6160	116.2059	Sheoak woodland	3	0	0	10	30	0	0
Total for Phase 1				24	0	0	80	240	0	0
Phase 2										
Trap site 1	-32.5430	116.2584	mixed shrub over scattered jarrah	5	7	35	0	0	10	50
Trap site 2	-32.5009	116.2312	Jarrah -Marri forest	5	7	35	0	0	10	50
Trap site 3	-32.5671	116.2599	Mix shrub dampland	5	7	35	0	0	10	50
Trap site 4	-32.5742	116.3000	Dampland	5	7	35	0	0	10	50
Trap site 5	-32.5502	116.3149	Jarrah -Marri forest	5	7	35	0	0	10	50
Trap site 6	-32.5083	116.2884	Jarrah -Marri forest	5	7	35	0	0	10	50
Total for phase 2				30	42	210	0	0	60	300
Phase 3										
Trap site 1	-32.5430	116.2584	mixed shrub over scattered jarrah	7	7	49	10	70	10	70
Trap site 2	-32.5009	116.2312	Jarrah -Marri forest	7	7	49	10	70	10	70
Trap site 3	-32.5671	116.2599	Mix shrub dampland	7	7	49	10	70	10	70
Trap site 4	-32.5742	116.3000	Dampland	7	7	49	10	70	10	70
Trap site 5	-32.5502	116.3149	Jarrah -Marri forest	6	7	42	0	0	10	60
Trap Site 6	-32.5083	116.2884	Jarrah -Marri forest	7	7	49	10	70	10	70
Total for phase 3				41	42	238	50	280	60	340

2.3.4 Western Ringtail Possum assessment

The Western Ringtail Possum (*Pseudocheirus occidentalis*) has previously been recorded regionally in Lane Pool Reserve, a known past translocation site for the species. The Western Ringtail Possum is predominantly associated with coastal/near coastal Peppermint Tree (*Agonis flexuosa*) forest and Tuart (*Eucalyptus gomphocephala*) dominated forest with a Peppermint Tree understorey. The species also occurs in Jarrah (*E. marginata*) forest and Jarrah-Marri (*Corymbia calophylla*) forest associated with Peppermint Trees (Van Dyck & Strahan 2013).

Targeted remote cameras were deployed at locations deemed suitable to support Western Ringtail Possum to confirm their presence. Remote camera placement focused on key habitat features important to Western Ringtail Possum including placement in trees and facing onto logs according to methodology outlined by DSEWPC (2011b) known to be effective in locations where possum densities are low or the species' presence requires confirmation. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 7 and Table 8).

Active searches were done in areas of potential Western Ringtail Possum habitat. Searching involved looking for possible den sites in hollow-bearing trees and nests (dreys) in trees. Any evidence of Western Ringtail Possum presence in the form of scratches on tree trunks or scats on the ground nearby potential nesting sites to be recorded and verified by Glen Gaikhorst. The locations and survey effort for targeted searches are recorded in Table 11.

Nocturnal transects were undertaken targeting potential Western Ringtail Possum habitat searching for eyeshine in accordance with methodology and recommendations outlined by DSEWPC (2011b). Habitat supporting suitable hollow-bearing trees, possible nest sites and suitable foraging will be targeted. All other opportunistic species observations during these searches were recorded. The locations and survey effort for nocturnal transects are recorded in Table 9.

2.3.5 Woylie assessment

Woylie (*Bettongia penicillata ogilbyi*) have previously been recorded regionally in the Dwellingup area and recorded in the adjacent O'Neil East Survey Area (GHD 2024b). It is associated with open forest and woodland with a tussock grass ground layer or understorey of woody scrub and the presence of thickets of the plant genus *Gastrolobium* (Van Dyck & Strahan 2013).

Targeted remote cameras were deployed at locations deemed suitable to support Woylie to confirm their presence. Suitability of camera location was determined by habitat characteristics and presence of /proximity to secondary evidence (scats, diggings, tracks and nests). Habitat consisting of dense undergrowth, logs and rock-cavities was targeted as these habitats provide suitable shelter and cover from predators for Woylie. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 8).

During the field survey any evidence of Woylie presence detected via opportunistic sighting was recorded. Records determined via secondary evidence are verified by Glen Gaikhorst, in the form of scats, diggings and tracks. Cage trapping was not undertaken due to risks of trapping reproductive Chuditch. Consequently, remote cameras were utilised as a highly effective replacement.

2.3.6 Quokka assessment

Quokka (*Setonix brachyurus*) have previously been recorded in the region where they tend to be associated with riparian areas and damp lands supporting low dense vegetation favourable to Quokkas. They are readily recorded via remote cameras locally as demonstrated by recent surveys in the area surrounding the Survey Area (GHD 2021a, GHD 2021b).

Remote cameras were deployed at locations deemed suitable to support Quokkas to confirm their presence. Suitability of camera location were determined by habitat characteristics and presence of /proximity to secondary evidence (scats, runnels and tracks). Habitat with relatively high density of low shrubs associated with creek lines were targeted as these habitats provide suitable shelter and under cover movement corridors for Quokka. For

each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (Table 7 & Table 8).

Opportunistic detection of Quokka presence via evidence will be recorded. Records will be determined via secondary evidence and verified in the form of scats, tracks, runnels and remains by Glen Gaikhorst

2.3.7 Quenda assessment

Quenda (*Isoodon fusciventer*) have previously been recorded locally within Jarrah forest. The Quenda prefers low dense vegetation along drainage lines and damp lands and is readily recorded via remote cameras as demonstrated by recent surveys in the area surrounding the Survey Area (GHD 2021a, GHD 2021b).

Targeted remote cameras were deployed at locations deemed suitable to support Quenda to confirm their presence. Suitability of camera location was determined by habitat characteristics and presence of /proximity to secondary evidence (forage digs, runnels, scats). Habitat consisting of low dense vegetation along drainage lines and ephemeral damp lands was targeted as these habitats provide suitable shelter and cover from predators for Quenda. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 7 & Table 8).

During the field survey opportunistic sighting of Quenda presence via secondary evidence was recorded and verified by Glen Gaikhorst (e.g. foraging digs, runnels. scats, tracks). All observations were and logged via GPS.

Nocturnal transects were undertaken targeting potential Quenda habitat searching for eyeshine. Habitat along drainage lines and damp lands with suitable vegetation were targeted. The locations and survey effort for nocturnal transects are recorded in Table 9.

The use of cage traps for Quenda was avoided during the survey due to risk of bi-catch capture of Chuditch, Quokka and Woylie.

2.3.8 Numbat assessment

The Numbat (*Myrmecobius fasciatus*) occupies several different habitat types including upland Jarrah Forest, open Eucalypt woodland, Banksia woodland, and tall closed shrubland, preferring habitats with an abundance of termites in the soil, hollow logs, burrows and branches for shelter (DAWE 2022; Van Dyck & Strahan 2013). The only remaining original subpopulation are at Dryandra Woodland and the Upper Warren area, with nine translocation sites across WA (DAWE 2022). The Numbat appears capable of dispersing away from sites where they have been released, particularly in areas not surrounded by farmland (Friend & Thomas 2003). An individual was recorded via monitoring camera in 2021 at Boddington, approximately 30 km southeast of the Survey Area.

Active targeted searches of potentially suitable Numbat habitat resources were conducted, particularly in mature Wandoo woodland (if present) and areas with hollow logs and termite mounds (if present). Searches were conducted in accordance with methodology and recommendations outlined by DSEWPC (2011b). Any evidence of Numbat presence in the form of tracks, scats and dens will be recorded and verified by Glen Gaikhorst. All other opportunistic species observed during these searches will be recorded. The locations and survey effort for targeted searches are recorded in Table 11.

Targeted remote cameras were deployed at locations potentially suitable for Numbat determined by habitat characteristics and presence of / proximity to secondary evidence (tracks, scats and dens). Habitat consisting of fallen hollow logs was targeted as these habitats provide suitable dens. For each remote camera deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 7 and Table 8).

Table 11 Targeted transects for Numbats, Western Brush Wallaby, Malleefowl and Black Cockatoo's

Phase	Habitat type	Latitude	Longitude	Date Conducted	Effort (minutes)
Phase 1	Jarrah -Marri forest	-32.5551	116.2425	9/08/2023	30
Phase 1	Jarrah -Marri forest	-32.5327	116.2828	21/08/2023	90
Phase 1	Jarrah -Marri forest	-32.5327	116.2828	21/08/2023	90
Phase 1	Wandoo Woodland	-32.5392	116.3330	21/08/2023	60
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	6/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5067	116.2915	6/09/2023	45
Phase 1	Jarrah -Marri forest	-32.5659	116.2607	6/09/2023	45
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	7/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5067	116.2915	7/09/2023	45
Phase 2	Jarrah -Marri forest	-32.5565	116.3146	7/09/2023	120
Phase 1	Jarrah -Marri forest	-32.5327	116.2828	7/09/2023	45
Phase 1	Jarrah -Marri forest	-32.5704	116.2892	7/09/2023	45
Phase 2	Mixed shrub dampland	-32.5582	116.2894	8/09/2023	30
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	10/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5565	116.3146	10/09/2023	120
Phase 2	Jarrah -Marri forest	-32.5564	116.3151	10/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	11/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5067	116.2915	11/09/2023	45
Phase 2	Jarrah -Marri forest	-32.5428	116.3335	11/09/2023	30
Phase 2	Jarrah -Marri forest	-32.5502	116.3155	11/09/2023	60
Phase 2	Jarrah -Marri forest	-32.5327	116.2829	12/09/2023	45
Phase 2	Jarrah -Marri forest	-32.5605	116.2275	12/09/2023	45
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	12/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5086	116.2885	13/09/2023	180
Phase 2	Jarrah -Marri forest	-32.5067	116.2915	13/09/2023	45
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	17/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	18/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5288	116.2243	18/10/2023	120
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	19/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	20/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	21/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	22/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5429	116.2583	22/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	23/10/2023	180
Phase 3	Jarrah -Marri forest	-32.5334	116.2320	23/10/2023	45
Phase 3	Jarrah -Marri forest	-32.5334	116.2320	23/10/2023	60
Phase 3	Jarrah -Marri forest	-32.5086	116.2885	24/10/2023	180
Total effort					3675

2.3.9 Dell’s Skink assessment

The Dell’s Skink (*Ctenotus delli*) is known from the Darling Range, associated with Jarrah-Marri woodland that has a shrub dominated understorey on lateritic clay soils, as well as granite outcrops, stony hills and ranges (Wilson & Swan 2021)

The Dell’s Skink assessment used a combination of targeted systematic trapping techniques, including pit-traps and funnel traps with drift fences, and active searches. There are no specific guidelines on the assessment of this species specifically in WA, however detection methods will be derived from DSEWPC (2011a). Trapping sites were selected on habitat likely suitable habitat characteristics of low shrubby vegetation strata and/or lateritic substrate. The trap site’s location, trapping nights and trapping effort from phases 2 and 3 are recorded in Table 10. The targeted active search locations are recorded in Table 12.

Table 12 Targeted Dell’s Skink and Southern Death Adder active search

Phase	Latitude	Longitude	Habitat	Date conducted	Effort (minutes)
Phase 1	-32.5369	116.3284	Rocky outcrop	21/08/2023	60
Phase 1	-32.5421	116.2966	Granite outcrop	24/08/2023	45
Phase 1	-32.5792	116.3090	Rocky outcrop	18/08/2023	45
Phase 1	-32.5753	116.3222	Rocky outcrop	21/08/2023	60
Phase 1	-32.5380	116.3115	Rocky outcrop	22/08/2023	60
Phase 1	-32.5792	116.3111	Rocky outcrop	18/08/2023	45
Phase 1	-32.5754	116.3219	Rocky outcrop	23/08/2023	60
Phase 2	-32.5635	116.2812	Granite outcrop	10/09/2023	15
Phase 2	-32.5483	116.3129	Granite outcrop	11/09/2023	45
Total					435

2.3.10 Southern Death Adder assessment

The Southern Death Adder (*Acanthophis antarcticus*) is known to be associated with a broad range of habitats including rainforest, shrubland and heath habitat (Wilson & Swan 2021). Within the southwest region, sub-population are known to occur in dry sclerophyll forests and woodlands to the north (Serpentine-Canning) and to the east (Dryandra-Narrogin) of the Survey Area. The Southern Death Adder is highly cryptic using thick litter to shelter and concealment from prey and is generally only visible when active or during whilst thermoregulation. It has been previously recorded regionally during recent survey near Serpentine Reservoir to the north (GHD 2021b).

The Southern Death Adder assessment involved targeted trapping techniques including a combination of pit-traps and funnel traps with drift fences. There are no specific guidelines on the assessment of this species specifically in WA, however detection methods were derived from DSEWPC (2011a). The trap location, trapping nights, trap type and trapping effort from phases 2 and 3 are recorded in Table 10. In conjunction with trapping targeted diurnal and nocturnal searches were conducted, with targeted searches recorded in Table 9 & Table 12.

During the field survey any opportunistic sign of Southern Death Adder presence are recorded. This may include secondary evidence (slough) and verified by Glen Gaikhorst, Robert Browne-Cooper or Brad Maryan.

2.3.11 Malleefowl assessment

Malleefowl (*Leipoa ocellata*) have been historically recorded regionally from a past tentative recording in Dwellingup, approximately 25km southwest of the survey area. The Malleefowl is associated with long unburnt thick vegetation and occupies shrublands and low woodlands that are dominated by mallee vegetation, native pine Callitris woodlands, Acacia shrublands, Broombush vegetation and/or coastal heathlands. The breeding habitat is

characterised by light soil and an abundance of leaf litter, which is used in the construction of a large conspicuous nesting mound (Marchant & Higgins 1993).

Target searches for Malleefowl were conducted by undertaking targeted transects in areas of potential Malleefowl habitat, searching for and recording evidence of prints, scats, feathers, and mounds in accordance with the guidelines outlined by Benshemesh (2017). Transects were recorded via GPS and secondary evidence verified by Glen Gaikhorst. The locations and survey effort for targeted searches are recorded in Table 11.

2.3.12 Masked Owl assessment

Masked Owls (*Tyto novaehollandiae novaehollandiae*) have been recorded in the region in Jarrah Marri Forest and woodlands and nearby permanent water body. They are readily recorded via acoustic recorder as demonstrated by recent surveys in the area surrounding the Survey Area (GHD 2021b).

The Masked Owl were targeted using Song Meter SM4 ® acoustic recorders, deployed during both survey phases. Acoustic recorders were positioned in areas where the Masked Owl is likely to occur i.e. utilising water bodies and flyways and forest habitat adjacent potential hunting clearings such as paddocks and orchards. Acoustic recorders were set to record from 30 minutes pre-dusk to 30 minutes post-dawn. For each bird acoustic deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 13). All data collected was assessed by Dr Nicholas Leseberg a recognised Avian data analysis specialist.

Nocturnal search transects were undertaken targeting potential Masked Owl habitat searching for eyeshine and listening for the species' call. Habitat along drainage lines and nearby water bodies and clearings was targeted. Records were sightings and / or calls verified by Glen Gaikhorst. Opportunistic nocturnal species observed during these searches were also recorded. Table 9 shows the locations and survey effort for nocturnal transect.

2.3.13 Western False Pipistrelle assessment

The Western False Pipistrelle (*Falsistrellus macenziei*) has been recorded in the region in dry sclerophyll eucalypt forest and woodland habitat and are readily recorded via ultrasonic detector as demonstrated by recent regional surveys (GHD 2021a, GHD 2021b).

The Western False Pipistrelle survey approach was based on guidance from DEWHA (2010) and Burgar et al. (2017). Bat detectors (SM2 ® and SM4 SongMeters ®) were deployed during both survey phases. Bat detectors were positioned in areas where the Western False Pipistrelle is likely to occur, i.e. utilising water bodies, fly ways, such as clearings and along forest tracks, hill tops or open areas associated with damp lands or granite outcrops. Bat detectors were set to record from 30 minutes pre-dusk to 30 minutes post-dawn and left for two to four nights per location. For each bat detector deployed, the time and date deployed and recovered, as well as the GPS coordinates were recorded (refer Table 14). All data collected was stored and analysis by Dr Erin Westerhuis to extract species or call group results. Erin is a in-house GHD specialist on Bat data analysis.

Table 13 *Bird detector deployment*

Phase	Bird acoustic	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Reconnaissance	SM4-AC4	Jarrah -Marri forest	-32.6083	116.1944	27/06/2023	30/06/2023	3
Reconnaissance	SM4-AC1	Jarrah -Marri forest	-32.6011	116.1895	27/06/2023	30/06/2023	3
Reconnaissance	SM4-AC3	Dampland	-32.5648	116.2314	27/06/2023	30/06/2023	3
Single target	SM4-AC4	Jarrah -Marri forest	-32.6206	116.2244	24/07/2023	27/07/2023	3
Single target	SM4-AC1	Jarrah -Marri forest	-32.5642	116.1674	24/07/2023	27/07/2023	3
Phase 1	SM4-AC3	Jarrah -Marri forest	-32.5082	116.2888	16/08/2023	21/08/2023	5
Phase 1	SM4-AC3	Jarrah -Marri forest	-32.4810	116.2695	21/08/2023	25/08/2023	4
Phase 1	SM4-AC2	Jarrah -Marri forest	-32.4983	116.2494	21/08/2023	25/08/2023	4
Phase 1	SM4-AC1	Jarrah -Marri forest	-32.5007	116.2311	21/08/2023	25/08/2023	4
Phase 2	SM4-AC3	Bullich Forrest next to dam	-32.6321	116.0862	5/09/2023	8/09/2023	3
Phase 2	SM4-AC3	Edge of eucalyptus and sheoak woodland	-32.5767	116.2852	8/09/2023	12/09/2023	4
Single target	SM4-AC3	Jarrah – Marri forest	-32.4869	116.2738	14/12/2023	19/12/2023	5
Total recording nights							44

Table 14 *Bat detector deployment*

Phase	Bat detector	Habitat type	Latitude	Longitude	Date deployed	Date collected	Nights deployed
Reconnaissance	SM4-6	Jarraah -Marri forest	-32.6011	116.1898	27/06/2023	30/06/2023	3
Reconnaissance	SM2-1	Dampland	-32.5649	116.2316	27/06/2023	30/06/2023	3
Single target	SM4-6	Jarraah -Marri forest	-32.5641	116.1675	24/07/2023	27/07/2023	3
Single target	SM2 Unit 1	Jarraah – Marri forest	32.6205	116.2242	24/07/2023	27/07/2023	3
Phase 1	SM4-6	Jarraah -Marri forest	-32.5083	116.2881	16/08/2023	21/08/2023	5
Phase 1	SM4-6	Jarraah -Marri forest	-32.4807	116.2702	21/08/2023	25/08/2023	4
Phase 1	SM4-10	Jarraah -Marri forest	-32.4983	116.2492	21/08/2023	25/08/2023	4
Phase 1	SM4-4	Jarraah -Marri forest	-32.5007	116.2311	21/08/2023	25/08/2023	4
Phase 2	SM4-10	Edge of dam	-32.6321	116.0863	5/09/2023	8/09/2023	3
Phase 2	SM4-10	Edge of sheoak and eucalyptus woodland	-32.5767	116.2851	8/09/2023	12/09/2023	4
Reconnaissance	SM2 Unit 4	Jarraah -Marri forest	-32.6081	116.1944	27/06/2023	30/06/2023	3
Single target	SM4-10	Jarraah -Marri forest	-32.4870	116.2738	14/12/2023	19/12/2023	5
Total nights							44

2.3.14 Carter’s Fresh Water Mussel assessment

The Carter’s Freshwater Mussel (*Westralunio carteri*) survey approach was based on methods used by Kluzinger et al. (2012) to study Carter’s Freshwater Mussel populations in the lower Vasse River. This method is aimed at detecting species presence. Due to the ephemeral nature of water bodies assessed in this study, this method assumed low density of individuals.

Targeted searching on foot was done within areas selected for assessment prior to field survey based available water bodies and stream zone areas. Potential survey locations focussed on streams likely to have year-round water present, to maximise detection to confirm presence / absence. At each survey location, ecologists / zoologists walked 100 m upstream and 200 m downstream assessing ten (1 m by 1 m) quadrats at regular 30 m intervals. While traversing the stream zone opportunistic searching for mussels was completed between each quadrat. In situations where stream zones become inaccessible due to dense riparian vegetation, the maximum number of quadrats was surveyed along the accessible stream zone. The locations and survey effort for targeted searches are recorded in Table 15.

The following data were recorded:

- Any evidence of Carter’s Freshwater Mussel including live mussels and dead shell remains within the water, as well as any shell evidence on banks
- Presence of water and if so, still or flowing, size of water body and depth if determinable
- Riparian vegetation, bank/bed condition including evidence of bank erosion, bed sediment deposition and disturbance (i.e. tramping by pigs, dumped material etc.)
- Riparian vegetation condition
- Evidence of riparian terrestrial fauna including Rakali middens, Quokka tracks, runnels, scats etc.

For standing water the following will be recorded:

- Approximate depth, width and (for pools) length
- Substrate (rocky, sandy etc.)
- Water quality (clear, turbid, sheen etc.)
- Opportunistic observations for aquatic fauna (fish, crayfish, frogs etc.)

Table 15 Carter’s Fresh Water Mussel transect effort

Phase	Date	Habitat Type	Latitude	Longitude	Survey effort (minutes)
Reconnaissance	27/06/2023	Large water body	-32.6547	116.0802	30
Phase 2	8/09/2023	Large water body	-32.6323	116.0879	30
Total Survey effort					60

2.3.15 Black Cockatoo assessment

A Black Cockatoo habitat assessment for Baudin’s Black Cockatoo (*Zanda baudini*), Carnaby’s Black Cockatoo (*Z. latirostris*), Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*) was undertaken across the Survey Area to assess the presence, quality, and extent of habitat foraging and breeding habitat and assess roosting habitat. The assessment involved visual and aural assessment of the Survey Area, identifying breeding habitat (presence/absence of actual and potential breeding trees), foraging habitat, roosting areas, current species’ activity, and any other signs of use by Black Cockatoos. The assessment approach was carried out based on DAWE (2022) Black Cockatoo referral guidelines and used to define breeding, foraging and night roosting habitat.

Breeding habitat

Breeding habitat: Defined by DAWE (2022) as 'habitat that contains known, suitable, or potential nesting trees'. For most tree species such as Jarrah, Marri, Blackbutt, and Flooded Gum, suitable DBH is 500 mm. For Wandoo suitable DBH is 300 mm. On average, Carnaby's Black Cockatoos are known to nest in hollows with an entrance diameter greater than 20 cm (Johnstone & Storr 1998; Groom 2011). While the Forrest Red-tailed Black Cockatoo is known to nest in hollows with an entrance of greater than 12 cm (Johnstone & Storr 1998). Therefore, hollow suitability was assessed in consideration of these hollow requirements.

Breeding habitat was assessed by surveying the three Haul Roads (Contingency Area A – Infrastructure, Contingency Area B – Haul Road Corridor (McCoy) and Additional Haul Road) and 26 plots, each measuring approximately 40 m by 500 m (2 ha) across the Contingency Area A Survey Area. The location of plots was selected to sample across all the broad-scale vegetation complexes occurring locally based on vegetation mapping by Mattiske and Havel (1998). The number of plots within each vegetation complex was roughly proportional to the relative area amount of each vegetation complex within the Survey Area. For example, the extensive Jarrah Marri forest habitat type was allocated proportionately more plots than Flooded Gum habitat type which comprised a smaller limited proportion of the Survey Area. Throughout all plots, all potential nest trees, suitable nest trees, and known nesting trees were assessed based on Diameter Breast Height (DBH) suitability within plots. Each plot was traversed on foot and all potential trees (DBH>500 mm) was recorded.

Breeding habitat was extrapolated using averaged results from these plot surveys per fauna habitat type throughout the Survey Area. This method was undertaken due to the large extent of the Survey Area and the commitment by Alcoa to undertaking detailed pre-clearing surveys of potential breeding trees in mining and haul road footprints once these footprint areas are confirmed. For each potential nesting tree, details of the tree location, species, DBH, size and number of hollows observed, evidence of use and any other significant observations were recorded. All identified potential nesting trees within plots were further checked visually using binoculars for suitable nest hollows. Where trees were recorded to have a suitable large hollow that could be used or had signs of being used (potential or likely), trees were revisited by Tony Kirkby (Black Cockatoo Specialist) where the hollows were checked for Black Cockatoo use by using a drone, pole camera and telephoto lens.

Foraging habitat

Foraging habitat: Defined by DAWE (2022) as 'Plant species known to support foraging within the range of the cockatoo species'. Foraging habitat was assessed to determine if the vegetation within the Survey Area constitutes foraging habitat, and to qualify its value for Black Cockatoos. Foraging scores were calculated using the forage score tool outlined within the DAWE (2022) referral guidelines.

The flora species identified within the Survey Area from on-site habitat assessment and recent vegetation mapping by Mattiske (Mattiske 2024) were compared with known foraging species (Valentine and Stock 2008). As part of the foraging assessment, the ground below known food plants and trees present was searched for any evidence of Black Cockatoo foraging residue such as chewed seed pods, cones and foliage.

The DAWE foraging quality scoring tool is based on a set of site attributes:

- Foraging potential.
- Connectivity.
- Proximity to breeding and roosting.
- Habitat health/disease presence.
- Appraisal comments to explain and justify score.

Giving consideration to the above DAWE guidance, the Main Roads (2020) Black Cockatoo environmental factsheet scoring approach was applied, based on the scope of works requirements, and to account for the composition of regrowth vegetation and corresponding low density of foraging plant species within habitats present. To provide an accurate assessment of Black Cockatoo foraging habitat quality, the following criteria were applied to calculate the foraging quality score of the fauna habitat present:

- Vegetation condition: quantity (density) and diversity of preferred foraging plant species (score out of 3)
- Local habitat context (importance): based on proportion of habitat to be cleared, proximity to breeding and roosting locations, and local land tenure/security (score out of 3)

- Utilisation: known foraging or evidence (score out of 4).

The location and extent of plant species suitable for Black Cockatoo species foraging habitat was identified and mapped for the Survey Area, based on the vegetation assemblages and fauna habitat types, and presence/absence of known foraging species. During the field surveys any Black cockatoo foraging activity (actual or evidence) was recorded via GPS. Vegetation and foraging data was used to calculate foraging quality score for all fauna habitat types across the Survey Area as detailed in DAWE (2022).

The foraging score tool and field data collected and associated forage score calculations are summarised in Appendix D, Black Cockatoo foraging assessment.

Roosting habitat

Night roosting habitat: Defined by DAWE (2022) as habitat that contains one, or a group of, known or potential roosting trees. Potential night roosting habitat was assessed based on the presence of suitable tall trees within proximity to water. Roosting habitat was also assessed on evidence of roosting activity i.e., feathers, twig clips, and proximity of known local or regional roosting sites available from the desktop assessment.

Opportunistic observations - both visual and aural observations of Black Cockatoos within the Survey Area were noted during the survey.

This data was used to calculate estimates of the amount of breeding habitat, amount and quality of foraging habitat, and extent of night roosting habitat within the Survey Area. This information is presented in Appendix D, Black Cockatoo foraging assessment

2.4 Fauna survey limitations

2.4.1 Desktop limitations

The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual recorded locations of the species present within the Survey Area or wider Study Area. The records from Western Australian Government fauna data sources such as the DBCA searches of Threatened and Priority flora and fauna provide more accurate information for the general area and local occurrence. The accuracy of these publicly available datasets is dependent on up to date data management via state government, and recent significant fauna records may be absent due to delayed database management. Additionally, some collections, sighting or trapping records are from historical sources and cannot be dated and often misrepresent the current range of Threatened and Priority species. Not with standing, questionable fauna records relevant to desktop assessments are interrogated on a case by case basis.

2.4.2 Field survey limitations

The EPA (2016, 2020) Technical Guidance states that flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field survey are discussed in Table 16. Based on this assessment, the survey effort has not been subject to any major constraints, which affect the accuracy or thoroughness of the assessment or conclusions formed.

Table 16 Field Survey Limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the Survey Area, this includes: Broadscale (1:1,000,000) mapping by Beard (1979) and digitised by Shepherd et al. (2002) Database searches (DBCA and <i>NatureMap</i>). Previous surveys (GHD 2021a and 2021b). Previous broadscale vegetation mapping (Mattiske and Havel 1998)
Scope (what life forms were sampled etc.)	Nil	Significant terrestrial vertebrates were sampled during the survey. Basic fauna assessment sampled significant and non-significant species opportunistically. Terrestrial invertebrate fauna were not surveyed.
Proportion of fauna collected and identified (based on sampling, timing and intensity)	Minor	The Targeted fauna survey included undertaking specific tasks to focus on desired species. In permit application GHD applied for the use of cage traps to undertake trapping transects throughout the Survey Area. DBCA at the time declined the use of cage traps requesting substitution of camera transects instead. Camera transects replicated cage trapping design i.e. 10 units spaced at 200 meter intervals and baited with a desirable lure. The advantage of cameras enabled continual data collection of a range of species over time rather than a one of per day. However the identification of individuals was more difficult despite using the spotted pelage marking identification method. The survey timing was considered appropriate for the purpose of the assessment with four survey periods undertaken from June to November. The fauna recorded is detailed in Section 4.2 and a full fauna species list is provided in Combined species list. A species inventory was compiled for this report as it assists in demonstrating effort when some species are not located. For example, during nocturnal surveys no possums were recorded despite Boobook owl and frogs listed demonstrating effort but species is not present. The portion of fauna collected and identified was considered representative for the Survey Area.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	The Survey Area was accessed by vehicle and on foot. The Survey Area was adequately surveyed during the field survey in line with the scope. Additional opportunistic sampling was undertaken to develop a comprehensive species inventory although the primary goal of the survey was to target significant fauna. Habitats considered suitable for significant fauna were traversed by foot.
Mapping reliability	Nil	The fauna habitats were mapped using high-resolution aerial imagery obtained from Landgate, topographical features, previous broad scale mapping (Beard 1976) and field data from Mattiske 2023. Data was recorded in the field using hand-held GPS tools. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units and GPS enabled tablets used for this survey are accurate to within 2 to 5 m on average.
Timing/weather/season/cycle	Minor	The field survey was conducted in June to November. The fauna survey was planned for spring and summer to accommodate the activity of reptiles as well as mammals and birds. Phase 1 received a prolonged cold wet period in which the trapping effort was modified to over three phases rather than two.
Disturbances (e.g. fire, flood, accidental human intervention)	Moderate	Some of the Survey Area has been subjected to historical disturbance events (e.g. clearing – logging and fire – prescribed burning); in some areas these events are having a big impact to fauna diversity. Despite all the survey effort no Brushtail Possum were recorded and large hollow bearing trees retained by loggers burnt down due to prescribed burning. This is reducing the amount of large trees are present in the forest. It is likely that these two human impacts are modifying the presence of species within the Survey Area. A large prescribed burn did occur in the survey area in Autumn (directly before the surveys) and spring during the surveys. This did limit the access and amount of assessment that could be undertaken during this time due to human health risks.
Intensity (in retrospect, was the intensity adequate)	Nil	The fauna of the Survey Area was sampled in accordance with EPA (2020). The Survey Area was sufficiently covered by the Senior and Principal zoologists during the survey.

Aspect	Constraint	Comment
Resources	Nil	Adequate resources were employed during the field survey which included nine staff over 170 person days were spent undertaking the survey using two senior and one Principal zoologist.
Access restrictions	Nil	The Survey Area was accessible by vehicle and on foot. There were no access restrictions.
Experience levels	Nil	The Senior zoologists and Technical Director - Zoology who executed the survey are practitioners suitably qualified and experienced in their respective fields: Senior zoologist, Brad Maryan, was a field team lead with more than 25 years' experience leading and conducting fauna surveys. Senior zoologist, Robert Browne-Cooper, was a field team lead with more than 25 years' experience leading and conducting fauna surveys. Zoologist Sarah Flemington has over 7 years' experience undertaking fauna surveys. Technical Director - Zoology Glen Gaikhorst was a field team lead with more than 25 years' experience leading and conducting fauna surveys.

3. Desktop assessment

3.1 Climate

The Study Area is located within the Dwellingup State Forest subregion of Western Australia. The regions climate is classified as Warm Mediterranean, with two distinct seasons: a warm and dry summer (December to February) and a cool wet winter (June to August) (Williams & Mitchell 2001).

The region is characterised spatially by rainfall, with rainfall being greatest on the scarp and decreasing to the east and north (Williams & Mitchell 2001). The majority of rainfall received during winter months and is a result of low-pressure system associated with the westerly wind systems. The closest operating weather station is Dwellingup (Station ID: 009538) located approximately 30km west of the O'Neil Survey Area. Climate data from this station indicate:

Climate data (Bureau of Meteorology 2023) at this station indicates:

- Mean maximum temperature in July reaches 15.8°C to 32.1°C in January.
- Mean minimum temperature in July reaches 6.8°C and reaches 14.7°C in January.
- Annual total rainfall to October 2023 is 948.4 mm.

The Site weather conditions was generally cool with low maximums and some rainfall during Phase 1, mild temperatures with little rainfall during Phase 2 and mild weather with no rainfall during Phase 3. The weather data over the survey Period is presented in Table 17. Temperature data was obtained from the Bureau of Meteorology website, closest weather station to the site, Dwellingup station (No. 009538) which is approximately 30 km west of the O'Neil Survey Area.

Table 17 Weather data for survey period (Phase 1-3)

Date	Minimum temp (°C)	Maximum Temp (°C)	Rainfall (mm)
Phase 1			
14/08/2023	3.9	17.7	0
15/08/2023	11.5	17	25.8
16/08/2023	7.7	13.9	17.2
17/08/2023	6.1	16.3	0.2
18/08/2023	4.9	17.1	0.2
19/08/2023	4	18.2	0.2
20/08/2023	4.1	16.1	0
21/08/2023	7.5	17	1.2
22/08/2023	1.4	14.6	0
23/08/2023	6.7	16.5	0
24/08/2023	6.7	19.7	0.2
25/08/2023	4.4	24.2	0
Phase 2			
5/09/2023	10.8	17.4	3
6/09/2023	8.9	15.3	6.6
7/09/2023	0.7	17	2.2
8/09/2023	3.7	21.8	0
9/09/2023	11.5	20.4	2

Date	Minimum temp (°C)	Maximum Temp (°C)	Rainfall (mm)
10/09/2023	9.5	19.1	1.4
11/09/2023	10.6	20.9	0.2
12/09/2023	11.2	21.2	0
13/09/2023	13.6	16	1
14/09/2023	8.1	17.4	0
15/09/2023	13.4	14.1	0.2
16/09/2023	11.1	18.3	0
Phase 3			
17/10/2023	11.2	31.2	0
18/10/2023	11.3	23.6	0
19/10/2023	9.7	24.2	0
20/10/2023	10.3	26.7	0
21/10/2023	14.3	28.7	0
22/10/2023	13.5	20.5	0
23/10/2023	8.2	20.3	0
24/10/2023	5.3	23.8	0
25/10/2023	9.6	31	0

3.2 Geology and land systems

3.2.1 Geology

3.2.1.1 Regional geology

The region lies within the Darling Plateau, an undulating lateritic regolith over Archaean granite with dolerite intrusions. The regional geology is described in the Pinjarra Refinery Revised Proposal as follows.

The regolith that covers the bedrock was formed through a long period of bedrock weathering, and averages about 30 m thick over the Darling Plateau. The upper layers of the regolith are lateritic, being rich in iron and aluminium derived from the bedrock, with a characteristic rusty-red colour. The regolith has a complex vertical sequence which is generalised as follows (from surface to bedrock):

- Overburden, comprising sandy gravels about 0.2 to 4 m thick (average 0.5 m)
- Lateritic bauxite about 4-6 m thick comprising two distinct layers:
- Duricrust or caprock, comprising iron or aluminium cemented rock about 1 to 2 m thick
- Friable fragmental layer about 2 m or more thick
- Mottled and pallid clays (saprolite) about 20 to 30 m thick
- Saprock, comprising rock fragments about 2 to 5 m thick that define a basal interface between saprolite and bedrock.

The regolith is partially or fully eroded in valleys that dissect the Darling Plateau, with the upper lateritic layers often absent and replaced by colluvial or alluvial deposits. In some areas the regolith is fully eroded to expose bedrock.

3.2.1.2 Local geology

The surficial geology of the region is based on 1:250,000 regional geological mapping (Pinjarra sheet GSWA 1980).

The superficial geology is consistent with the wider geology of the Huntly Mine and Darling Plateau, predominantly comprising lateritic regolith interspersed by quaternary deposits in streams and swamps and Archaean rock outcrops in hills and incised valleys.

There is limited data from bore logs to support the regionally mapped geology: The DWER Water Information Reporting (WIR) database only contains bore records without lithological records, and the only bore logs available from the Alcoa records are those for the Jayrup Catchment in the far southwest of the region.

The Jayrup Catchment data supports the generalised vertical profile of the regolith as present above. Based on the Jayrup catchment data (which includes bores outside the region), the depth of 4 to 59 m, likely dependent on locations within the slope profile (excluding one bore where granite was encountered at 0.9m – L4502-1A). It is noted that the majority of bores do not extend the basement depth and are completed within the saprolite profile. Possible shallower gravel and laterite mottled and pallid clays over saprolite.

3.2.2 Landforms

The region mostly lies over the Darling Plateau System and a small portion lies over the Murray Valleys System. The Darling Plateau System which comprises an undulating lateritic plateau. The Darling Plateau system is associated with the predominant lateritic surficial geology of the region.

The Murray Valleys System is found in the Northwestern portion of the survey area and comprises of deep incised valleys of loamy soil, shallow duplex, and rock outcrops.

3.3 Hydrology

The Darling Plateau is characterised by sharply incised drainage lines forming dense drainage networks in the western rainfall zone (HRZ), with these transitioning to open, flat-floored valleys in the eastern intermediate rainfall zone (IRZ) (Churchward and Dimmock 1989). The IRZ is noted to occur between the 900 –to 1,100 mm/year long term rainfall isohyets with the western

The region is located within the Serpentine River System and Dandalup River System. The majority of the region occurs in the Serpentine River System, a proclaimed surface water area under the RIWI Act, and the Southwestern portion falling under the Dandalup River System, also a proclaimed surface water is under the RIWI Act.

3.3.1 Local catchments

The region drains through several catchment areas. A summary of local catchments and the tributaries is provided in Table 18.

Table 18 Local Catchment Areas of the O’Neil Survey area,

Management area	Sub management area	Rivers	Sub catchment name	Sub catchment area (ha)	Proportion of catchment with region (%)
Contingency Mining Region A					
Serpentine River Catchment	Upper Serpentine	Serpentine River	River Rd	3085	30.8
Serpentine River Catchment	Upper Serpentine	Big Brook	O’Neil Rd	5310.7	53
Serpentine River Catchment	Upper Serpentine	Big Brook	Jayrup	923.7	9.2
Serpentine River Catchment	Upper Serpentine	Big Brook	075	701.6	7.0
Contingency Area A Haul Road					

Management area	Sub management area	Rivers	Sub catchment name	Sub catchment area (ha)	Proportion of catchment with region (%)
Serpentine River Catchment	Upper Serpentine	Big Brook	O'Neil Rd	1662	29
Serpentine River Catchment	Upper Serpentine	Big Brook	Jayrup	3347	11
Serpentine River Catchment	Upper Serpentine	Big Brook	Jayrup	1356	9.7
Dandalup River System	North Dandalup	North Dandalup River	North Rd	8722	2.73
Dandalup River System	South Dandalup	South Dandalup River	614	2418	1.0
Contingency Area B Haul Road					
Serpentine River Catchment	Upper Serpentine	Big Brook	Jayrup	1992	14
Dandalup River System	South Dandalup	South Dandalup River	Duncan Rd	975	9.0
Dandalup River System	South Dandalup	South Dandalup River	614	2418	3.5

3.3.2 Regional hydrology

3.3.3 Groundwater dependent ecosystems

Assessment of potential groundwater dependent ecosystems (GDE) is based on key indicator species that are generally accepted as indicators of moister soil, and therefore potential groundwater dependence.

Based on the vegetation complex mapping, potential GDEs within O'Neil region are likely to occur as an extension of the potential GDEs identified in the O'Neil DE, including parts of the valley floors of the Yg1 and Yg2 vegetation complex as well as the Swamp (S) vegetation complex within the valley floors of the upper South Dandalup River, central South Dandalup River tributary and upper 34 Mile Brook. The vegetation complexes are described as:

- **Swamp (S):** Mosaic of low open woodland of *Melaleuca preissiana* – *Banksia littoralis*, closed scrub of *Myrtaceae spp.*, closed heath of *Myrtaceae spp.* and sedgelands of *Baumea* and *Leptocarpus spp.* on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones.
- **Yarragil 1 (Yg1):** Open forest of *Eucalyptus marginata* subsp. *marginata* - *Corymbia calophylla* on slopes with mixtures of *Eucalyptus patens* and *Eucalyptus megacarpa* on the valley floors in humid and subhumid zones.
- **Yarragil 2 (Yg2):** Open forest of *Eucalyptus marginata* subsp. *thalassica* – *Corymbia calophylla* on slopes, woodland of *Eucalyptus patens* – *Eucalyptus rudis* with *Hakea prostrata* and *Melaleuca viminea* on valley floors in subhumid and semiarid zones.

The Yarragil 2 vegetation complex is broadly mapped and the potential GDEs are likely to form a portion of the complex along the lower valley slopes and valley floors. Accordingly, the Yarragil 2 complex is not mapped as a potential GDE, with the potential GDEs of valleys mapped through a nominal 50 m buffer along mapped streams.

Topographic mapping and review of aerial imagery identifies two river pools as occurring with the region: Kennedy's Pool and Mundalup Pool which are located on the South Dandalup River. The pools may be permanent or semi-permanent and may potentially be refuges for aquatic fauna, including the threatened species Carters Freshwater Mussel.

No geomorphic wetlands are mapped within the region, due to that dataset being limited to within 5 km east of the Swan Coastal Plain. No wetlands of national or international importance are mapped within or in the vicinity of the region.

The region lies predominantly within the catchment of the Serpentine River system, a tributary of the Murray River which discharges into the Peel Inlet near Mandurah on the Swan Coastal Plain. The Peel Inlet forms part of the Peel-Yalgorup System Ramsar wetlands of international importance. However, the South Dandalup Dam downstream of the region diverts all flow from its catchment for drinking water supply. The southeast portion of the river discharges into Swamp Oak Brook and the Hotham River, which are tributaries to the unregulated Murray River downstream, which discharges into the Peel Inlet. Mining within the unregulated catchment of the Murray River is expected to pose a very low risk to the Peel-Yalgorup Ramsar wetlands, due to existing salinity of the river and the small area of catchment affected. Accordingly, the region is not considered constrained by the presence of the Ramsar wetlands downstream.

3.4 Land use and environmental constraints

Land use within the region and surrounding region buffer is primarily comprised of State Forest, reserved for conservation and recreational activities. The remaining areas within and surrounding region is comprised as Rural areas along with primary regional roads, local roads, railways, waterways, and regional open spaces.

3.5 Significant environmental constraints

Resulting from the desktop assessment undertaken, a number of potential significant environmental constraints have been identified within each of the three EPA themes. These constraints are based on known occurrences and the list does not include potential constraints for which additional studies are required to confirm presence.

3.5.1 Conservation reserves and estates

The Monadnocks Conservation Park (R 39826) is located to the North of the Survey boundary within the Study Area, only State Forest resides inside the Survey Area, Dwellingup State Forest (F14) and Jarrahdale State Forest (F22).

Table 19 Reserves within the Study Area

Reserve Number	Name	Class	Use	Approximate Location relative to survey Area	Within the Study Area?
R 39826	Monadnocks Conservation Park	Class C	Conservation Park	Adjacent to Survey Area on northwestern boundary.	Yes
F14	Dwellingup State Forest	Class C	State Forest	Majority of the Survey Area, extending into the Study Area.	Yes
F22	Jarrahdale State Forest	Class C	State Forest	Located with the northern portion of the Survey Area extending into the Study Area	Yes

3.5.2 Environmentally sensitive areas

No Environmentally Sensitive Areas (ESAs) lie within the Study Area.

3.5.3 Regional ecological linkages

Regional Ecological Linkages data doesn't exist for the O'Neil survey area However, Link ID 145 lies within the Study Area to the Northwest of the Survey Area.

3.5.4 Land

Significant constraints were identified from both Flora and Vegetation and Fauna values from the O’Neil region. They are presented in Table 20 and shown in Figure 2.

Table 20 Significant constraint identified within the Study Area

Constraint	Definition	Description	Occurrence in region
Granite outcrop communities	These communities are defined by the mapped granite outcrops (incorporating a 50m buffer as well as the potential to occur within the Cooke vegetation complex	These communities represent restricted vegetation and potential habitat for significant flora and fauna species. Clearing over these areas will be subject to survey of significant flora and may potentially not be approved. While mining does not occur over granite outcrops (due to lack of bauxite), infrastructure may be developed over outcrops. The Cooke complex also represents an area of potential shallow regolith that may result in a lower rehabilitation resilience to drought once mining removes the majority of the regolith. This may be regarded as significant by some stake holders.	Scattered occurrences within the region.
Potential GDEs	These communities are defined by the presence of the Swamp vegetation complex and a nominal 50m radius buffer zone around mapped streams.	These communities represent restricted vegetation and potential habitat for significant fauna and flora species. Clearing over these areas will be subject of survey of significant flora and fauna and if found, infrastructure may need to be realigned to avoid. While mining does not occur over swamps and streams (due to lack of bauxite), infrastructure may be developed over these areas.	Present in association with Serpentine River System
Old growth forest	These areas are formally mapped by DBCA based on their assessment criteria which are areas that have not been subject to timber harvesting, are not infested with <i>Phytophthora</i> dieback and where human disturbance is negligible.	These areas contain habitat for threatened fauna for which long periods without disturbance are required before they are able to form. This forest is regarded as significant by agencies and stakeholders. Alcoa has committed to not clear DBCA mapped old growth forest. These are represented as no go zones.	Not present
Mature age forest	These areas are mapped based on interpretation of DBCA harvesting data and are areas of forest that have not been harvested for more than 70 years.	These areas contain habitat for threatened fauna for which long periods without disturbance are required before they are able to form. This forest may be regarded as significant by some stakeholders.	Present in pockets along valleys and hills.
CAR and non-CAR reserves	These areas are mapped by DBCA and area areas of forest that have been set aside from timber harvesting for conservation purposes.	These areas have been protected from forest harvesting and represents high quality patches of forest. The informal reserves are regarded as conservation significant by DBCA.	Informal reserves are primarily mapped in association with GDEs.

3.6 Terrestrial fauna

3.6.1 Fauna diversity

The *NatureMap* database search identified 166 terrestrial vertebrate fauna species previously recorded within the region. This total included 31 mammals, 83 birds, 41 reptiles and 11 frogs. Of the 166 species three are Introduced species. The PMST search identified 10 additional species occurring within the region.

The Southern Death Adder is not recorded in the *NatureMap* or DBCA database searches. However, it is known to occur in the region by GHD Zoologists. Therefore, it has been included in the significant fauna list in Section 3.6.2.

Please note that *NatureMap* data contains some inaccuracies, with nomenclature and accuracy of records.

3.6.2 Significant fauna

Based on the *NatureMap* and PMST search, 26 significant terrestrial vertebrate taxa were identified to potentially occurring within the Survey Area and wider Study Area.

These species included:

- Carnaby's Black Cockatoo (*Zanda latirostris*) listed as Endangered under the EPBC Act and BC Act
- Baudin's Black Cockatoo (*Zanda baudinii*) listed as Endangered under the EPBC Act and BC Act.
- Numbat (*Myrmecobius fasciatus*) listed as Endangered under the EPBC Act and BC Act
- Western Ringtail Possum (*Pseudocheirus occidentalis*) listed as Vulnerable under the EPBC Act and Critically Endangered under the BC Act
- Australian Painted snipe (*Rostratula australis*) listed as Endangered under the EPBC Act and BC Act
- Curlew Sandpiper (*Calidris ferruginea*) listed as Critically Endangered under the EPBC Act and BC Act
- Far Eastern Curlew (*Numenius madagascariensis*) listed as Critically Endangered and as a Migratory Species under the EPBC Act and BC Act.
- Woylie (*Bettongia penicillata ogilbyi*) listed as Endangered under the EPBC Act and Critically Endangered under the BC Act
- Malleefowl (*Leipoa ocellata*) listed as Vulnerable under the EPBC Act and BC Act
- Carter's Freshwater Mussel (*Westralunio carteri*) listed as Vulnerable under the EPBC Act and BC Act
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*) listed as Vulnerable under the EPBC Act and BC Act
- Chuditch (*Dasyurus geoffroi*) listed as Vulnerable under the EPBC Act and BC Act
- Quokka (*Setonix brachyurus*) listed as Vulnerable under the EPBC Act and BC Act
- Peregrine Falcon (*Falco peregrinus macropus*) listed as 'Other specially protected' under the BC Act.
- Dell's skink (*Ctenotus Delli*) listed as Priority 4 by DBCA.
- Western Brush wallaby (*Notamacropus irma*) listed as Priority 4 by DBCA.
- Western False Pipistrelle (*Falsistrellus mackenziei*) listed as Priority 4 by DBCA.
- Quenda (*Isoodon fusciventer*) listed as Priority 4 by DBCA.
- Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) listed as 'Conservation Dependent' by DBCA.
- Fork-tailed Swift (*Apus pacificus*) listed as Migratory under the EPBC Act and BC Act
- Grey Wagtail (*Motacilla cinerea*) listed as Migratory under the EPBC Act and BC Act
- Common Sandpiper (*Actitis hypoleucos*) listed as Migratory under the EPBC Act and BC Act
- Sharp-tailed Sandpiper (*Calidris acuminata*) listed as Migratory under the EPBC Act and BC Act
- Pectoral Sandpiper (*Calidris melanotos*) listed as Migratory under the EPBC Act and BC Act
- Jarrah Forest Freshwater Snail (*Glacidorbis occidentalis*) Listed as Priority 3 by DBCA (Assessed under the SRE program)
- Southern Death Adder (*Acanthophs antarcticus*) listed as Priority 3 by the DBCA.

The above list is compiled from broad database parameters and has been refined further based on the field survey assessment within the Likelihood of Occurrence (LOO) assessment in Appendix D (Fauna Likelihood of occurrence assessment of significant species relevant to the Survey Area). and in section to accurately reflect the potential and actual occurrence of all locally relevant significant fauna.

3.7 Previous studies

Table 21 outlines previous studies identified within the O'Neil Study Area.

Table 21 Previous Studies

Study	Location and key findings	Location in relation to this region
GHD (2024) Unpublished, O'Neil East Targeted Woylie Assessment	<p>Location: O'Neil East</p> <p>This report outlines the findings from the Targeted Woylie Assessment. The targeted area was in the northwest of the O'Neil East Survey Area, extending into the Study Area. Approximately 75 ha of critical habitat.</p> <p>In total 49 Woylie events were recorded, and five additional conservation significant species was recorded: Chuditch, Quokka, Southwestern Brush-tailed Phascogale, Western Brush Wallaby and Quenda.</p>	Approximately 1.7 km from eastern boundary (within study area).
GHD (2023) Unpublished, O'Neil East targeted Terrestrial Fauna assessment.	<p>Location: O'Neil East</p> <p>This Report outlines the results of terrestrial vertebrate fauna survey of the O'Neil development envelope. The O'Neil Survey area is approximately 25 km from the township of Dwellingup in the Southwest of Western Australia. The O'Neil Survey area covers an area of approximate 2425.65 ha.</p> <p>In total Eight Significant Fauna Species were recorded in the Survey Area including: Woylie, Chuditch, Quokka, Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo, Western Brush Wallaby, Quenda and Dell's Skink. This Region has extensive foraging habitat for Baudin's Black Cockatoo and Forest Red-tailed Black Cockatoo.</p>	Abuts to the eastern boundary of the O'Neil Survey Area (extending up to 5 km east)
GHD (2022) Terrestrial Fauna Assessment Holyoake Mine Development – Holyoake East	<p>Location: Holyoake East</p> <p>This report outlines the results of a terrestrial vertebrate fauna survey of the Holyoake East Development Envelope. The Holyoake East Survey Area is approximately 20 kms east of the Town of Dwellingup in the Southwest of Western Australia. The Survey area covers an approximate area of 17,354 ha.</p> <p>In total nine significant fauna species were recorded in the Survey area including: Baudin's Black Cockatoo, Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo, Chuditch, Quenda, Western Brush Wallaby, Dell's Skink, Masked Owl and Rakali.</p> <p>The region had extensive foraging habitat for all three cockatoos as well as confirmed breeding habitat for Baudin's Black Cockatoo and Forest Red-tailed Black Cockatoos.</p>	Abuts the southwestern boundary of the O'Neil Survey Area
GHD (2022) Terrestrial Fauna Assessment Holyoake Mine Development – Holyoake East	<p>Location: Holyoake West</p> <p>This report outlines the results of a terrestrial vertebrate fauna survey of the Holyoake West Development Envelope. The Holyoake East Survey Area is within 10 km of the town of Dwellingup in the Southwest of Western Australia.</p> <p>In total seven conservation significant fauna were recorded within the survey area, including: Quokka, Chuditch, Western Brush Wallaby, Forest Red-tailed Black Cockatoo, Baudin's Black cockatoo, Carnaby's Black Cockatoo and Quenda.</p> <p>The survey area contained extensive foraging evidence from all three types of Black Cockatoo.</p>	Approximately 10km southwest of the main survey body. Approximately 1 km southwest of the Contingency Area A – infrastructure portion of the greater O'Neil Survey Area
GHD (2021b) Terrestrial Fauna Survey and Black Cockatoo Habitat Assessment for Huntly Mine - Holyoake	<p>Location: Holyoake</p> <p>This report details the results of a terrestrial vertebrate fauna survey of the Holyoake Development Envelope and adjacent conveyor and haul road corridors. The region is located approximately five kilometres east of the Dwellingup town site in the south-west of WA. The region covers approximately 10,541 ha.</p> <p>In total ten significant species were recorded in the region including the Quokka, Chuditch, Brush-tailed Phascogale, Western Brush Wallaby, Forest Red-tailed Black Cockatoo, Baudin's Black Cockatoo, Carnaby's Black Cockatoo, Western False Pipistrelle, Quenda and Peregrine Falcon. All significant species identified are</p>	Abuts the southern survey boundary.

Study	Location and key findings	Location in relation to this region
	<p>likely to have resident populations and habitat present within the region. Although recorded nearby and outside of the region the presence of Carter's Freshwater Mussel is unlikely due to the lack of permanent surface waterbodies present.</p> <p>The region has extensive foraging habitat for the three Black Cockatoo species, and potential breeding habitat (limited in extent) for Carnaby's and Forest Red-tailed Black Cockatoo. Regarding migratory shorebirds, the region lacks open water such as shallow shorelines or tidal zones for foraging habitat. The creek lines and vegetated dampland areas within the region are not Suitable for migratory shorebirds.</p>	
<p>Environmental Management and Research Consultants (EMRC) (1992) Long term fauna monitoring program 1992 (draft)</p>	<p>Location: 20 plots between Jarrahdale, Huntly and Karnet (control)</p> <p>Alcoa conducted numerous surveys as part of a monitoring program which included trapping (five successive trap nights in July, August and September), avifauna (quantitative and inventory surveys in summer and winter), reptile survey (trapping over five consecutive nights in Summer with toenail clippings to indicate recapture) opportunistic survey, nocturnal surveys and active searches.</p> <p>A total of 16 mammals, 61 birds, 21 reptiles, 6 frog and 80 and species were recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Quenda – trapped at Jarrahdale - Baudin's Black Cockatoo (recorded at all sites) - Red-eared Firetail (delisted) - Carpet Python (delisted) 	<p>8 survey plots established in Jarrahdale, 8 plots established in Huntly and four control plots at Karnet.</p> <p>Exact locations are not shown in report, but Jarrahdale plots are expected to be within 50 km north of the region. Huntly is within 20 km north and Karnet is within 50 km north of the region</p>
<p>EMRC (1995) Long term fauna monitoring program 1995</p>	<p>Location: 20 plots between Jarrahdale, Huntly and Karnet (control)</p> <p>Alcoa conducted numerous surveys as part of a monitoring program which included trapping (five successive trap nights in July, August and September), avifauna (quantitative and inventory surveys in summer and winter), reptile survey (trapping over five consecutive nights in Summer with toenail clippings to indicate recapture) opportunistic survey, nocturnal surveys and active searches.</p> <p>A total of 19 mammals (six introduced), 57 birds, 20 reptiles, 5 frog and 52 ant species were recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Quenda – four individuals were trapped - Chuditch – all opportunistic sightings (one near Phillips Road/Nettleton Road and seven ay Huntly Mine in 1995). 	<p>8 survey plots established in Jarrahdale, 8 plots established in Huntly and four control plots at Karnet.</p> <p>Exact locations are not shown in report but Jarrahdale plots are expected to be within 50 km north of the region. Huntly is within 20 km north and Karnet is within 50 km north of the region</p>
<p>EMRC (2003). McCoy Long Term Fauna Monitoring Program 2003</p>	<p>Location: six plots established, two in the Cameron catchment, two in the Gordon control catchment and two between these and the current Huntly Mine McCoy region crusher site.</p> <p>The monitoring program surveyed all terrestrial vertebrate species and ants. Mammal trapping occurred over four successive trap nights in both summer and winter using 10 pit traps, 16 medium Elliot traps, four large Elliot traps and four cage traps. Reptiles were targeted using five PVC pot traps with drift fence during summer. Traps were open on 29th Jan (summer) and 13 Aug (winter).</p> <p>Birds were surveyed using quantitative methods (two permanent bird transects surveyed on three consecutive days in summer and winter) and inventory methods (opportunistic recordings at each plot during the trapping program).</p>	<p>Huntly Mine approximately 10 km west of the Survey Area.</p>

Study	Location and key findings	Location in relation to this region
	<p>A total of six mammals (one introduced), 39 birds, 7 reptiles, 9 frog and 37 ant species were recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Chuditch – two trapped plus sightings or signs - Baudin’s Black Cockatoo - sightings 	
<p>EMRC (2006) Long term fauna monitoring program 2006</p>	<p>Location: 20 plots between Jarrahdale, Huntly and Karnet (control)</p> <p>Alcoa conducted numerous surveys as part of a monitoring program which included trapping (five successive trap nights in July, August and September), avifauna (quantitative and inventory surveys in summer and winter), reptile survey (trapping over five consecutive nights in Summer with toenail clippings to indicate recapture) opportunistic survey, nocturnal surveys and active searches.</p> <p>A total of 18 mammals (six introduced), 49 birds, 21 reptiles, 5 frog and 70 ant species were recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Chuditch – opportunistic sightings at Huntly - Quokka – opportunistic sighting at Huntly - Baudin’s Cockatoo – sighted at Jarrahdale, Huntly and Karnet - Carpet Python (delisted) - Quenda - trapped at Jarrahdale and Karnet - Western Brush Wallaby - sighted at Jarrahdale and Huntly 	<p>8 survey plots established in Jarrahdale, 8 plots established in Huntly and four control plots at Karnet.</p> <p>Exact locations are not shown in report but Jarrahdale plots are expected to be within 50 km north of the region. Huntly is within 20 km north and Karnet is within 50 km north of the region</p>
<p>EMRC (2007). McCoy Long Term Fauna Monitoring Program – results of the 2007 survey</p>	<p>Location: six plots established, two in the Cameron catchment, two in the Gordon control catchment and two between these and the current Huntly McCoy crusher site.</p> <p>Methods used were identical to those used in the 2003 survey (above).</p> <p>A total of seven mammal (two introduced), 41 bird, seven reptile, five frog and 54 ant species were recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Baudin’s Cockatoo –sightings - Western Brush Wallaby – multiple sightings 	<p>Huntly Mine approximately 10 km west of the survey area.</p>
<p>ALCOA World Alumina Australia (2010) No 40. Threatened fauna species management plans for Alcoa’s bauxite mining operations in the Jarrah forest</p>	<p>Location: Mining Lease ML1sa</p> <p>Management Plan for seven species of fauna known to occur within the mining lease:</p> <ul style="list-style-type: none"> - Noisy Scrub-bird - Chuditch - Quokka - Baudin’s Black Cockatoo - Forest Red-tailed Black Cockatoo - Peregrine Falcon - Carpet Python (delisted) 	<p>Huntly Mine approximately 10 km west of the survey area.</p>

Study	Location and key findings	Location in relation to this region
Stokes (2011) Orion Long Term Fauna Monitoring Program	<p>Location: six monitoring sites within Alcoa's Orion mine region comprising two typical upland forest areas, two associated with stream zones and two within rehabilitated forest (8 years old).</p> <p>Mammals, birds, reptiles and frogs were surveyed during both summer (March) and winter (July), and ground dwelling invertebrates were sampled in summer only. Survey methods were similar to those used in EMRC (2006) with the addition of a single large trapping transect designed to specifically target Chuditch and species of goanna. This transect covered approx. 880 ha and comprised 40 wire cage traps spaced 300 m apart and was trapped over four successive nights at the same time as the generic mammal survey.</p> <p>A total of 10 mammals (three introduced), 38 birds, 9 reptiles, two frogs, 22 ground invertebrates, 49 ant species was recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Chuditch – five males trapped in summer - Quenda – one trapped - Western Brush Wallaby – multiple sightings - Baudin's Black Cockatoo – sightings - Forest Red-tailed Black Cockatoo - sightings 	Within 20 km of the far southwestern boundary of the region
Stokes (2012) Vertebrate Fauna Survey of Planted Mining Areas at Alcoa's Keats Mining region 2011/2012	<p>Location: Keats mining region.</p> <p>Fauna was surveyed using a range of techniques, including trapping, remote sensitive cameras, tracking tunnels, observational surveys and spotlighting. Pitfall traps were not used. Five areas were trapped for mammals comprising two dieback free Jarrah forest areas and three stream zones. One landscape trapping transect was deployed to target Chuditch and goanna and this encompasses upland Jarrah forest, stream zones, low lying open forest, dieback graveyards and Sheoak forest.</p> <p>Black Cockatoo habitat survey was also undertaken. Surveys were only undertaken in summer due to time constraints.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> - Forest Red-tailed Black Cockatoo – flock sighted (up to 11 individuals) - Baudin's Black Cockatoo – 2 individuals sighted. - Western Brush Wallaby – sightings and recorded on remote camera. - Chuditch – one male trapped. - Carpet Python (delisted) 	Huntly Mine approximately 10 km west of the region.
Way <i>et al.</i> (2013), McCoy Long Term Fauna Monitoring Program Report of the 2013 Field Survey	<p>Location: six plots established, two in the Cameron catchment, two in the Gordon control catchment and two between these and the current Huntly McCoy crusher site and an additional three sites established in two-year-old rehabilitation within the McCoy Intermediate Rainfall Zone.</p> <p>In 2013 the McCoy Long Term Fauna Monitoring Program involved survey of terrestrial vertebrates (including mammals, birds and reptiles) and ground invertebrates, using the same methods used in previous LTFMP at McCoy (EMRC 2003, 2007). Mammals, birds, reptiles, and frogs were surveyed in both winter (July-August 2013) and summer December 2013-January 2014). Additional survey methods were also implemented including</p>	Huntly Mine approximately 10 km west of the region.

Study	Location and key findings	Location in relation to this region
	<p>a single large trapping transect to sample highly mobile species, remote sensor cameras and all invertebrates collected in pitfall traps were identified to taxonomic order.</p> <p>A total of 13 mammal species (four introduced), 46 birds, five frog, 31 invertebrates, and 64 ant species was recorded.</p> <p>Recorded threatened fauna comprise:</p> <ul style="list-style-type: none"> – Western Quoll – one adult male trapped. – Quenda – recorded on remote cameras. – Western Brush Wallaby – multiple sightings and on remote cameras – Baudin’s Black Cockatoo – multiple sightings – Forest Red-tailed Black Cockatoo – multiple sightings 	
Chuditch survey raw data Myara 2013	<p>This is an excel data file along with short summary document with the location description as ‘Myara west’ and ‘Myara east’.</p> <p>Shows details of eight quoll captures at ‘Myara west’ and one quoll captured at ‘Myara east’ between 18-22 March 2013.</p> <p>Myara West excel data provides 8 GPS capture locations (in cage traps). Myara East excel data provides 40 locations with coordinates however according to the report only 1 capture location was recorded at Cage 26. The coordinates of this location was unable to be identified.</p> <p>Total number of captures comprised of five males and four females.</p>	<p>Location described as Myara west and east and general area surrounding Karnet Prison which is approximately 15km northwest of the region.</p> <p>GPS coordinates provided:</p> <p>410458 E, 6409663 N 410839 E, 6408964 N 411357 E, 6408290 N 411766 E, 6410671 N 411138 E. 6407725 N 412384 E, 6408752 N 414231 E. 6408816 N 414362 E, 6409006 N</p>
McGregor <i>et al.</i> (2014). Does forest restoration in fragmented landscapes provide habitat for a wide-ranging carnivore?	<p>Location: Huntly and Willowdale mines</p> <p>Fourteen Chuditch trapping sessions (13 at Huntly, one at Willowdale) across 9 trapping transects (8 at Huntly, one at Willowdale) were undertaken between June 2009 and Dec 2010.</p> <p>Radio collars with a two-stage transmitter and mortality mode were attached to 14 adult Chuditch (9 female, 5 males – all trapped at Huntly). Chuditch were tracked to their dens during the day. Spool and line tracking was also used.</p> <p>In total 29 individual Chuditch were captured on 60 occasions. Of the 14 individuals fitted with radio collars, three were found dead on the Huntly mine access road with evidence of road trauma. Another three Chuditch were also found dead from vehicle strikes along this road.</p> <p>The study identified 138 den sites from 11 tracked animals: 75 in unmined forest and 63 in restored forest ranging from 2-32 years old. In unmined forest, dens were mostly in hollow logs and ground burrows beneath</p>	<p>Huntly Mine approximately 10 km north of the region. Willowdale (within 20 km south of the far southern boundary of the region)</p>

Study	Location and key findings	Location in relation to this region
	tree stumps, but these substrates were never used in restored forest where dens were mostly ground burrows, usually associated with rock piles at the surface.	
Burgar <i>et al.</i> (2015) The importance of mature forest as bat roosting habitat within the production landscape	<p>Location: forest surrounding Huntly mine site, for both restored and unmined forest.</p> <p><i>Nyctophilus gouldii</i> and <i>Vespadelus regulus</i> were trapped and tracked during maternity and mating seasons using harp traps and position-sensitive radio transmitters. Few bats were captured in restored forest, so traps were relocated to water sources.</p> <p>Study aimed at identifying roost habitat within restored forest vs unmined forest. Findings indicate that habitat restoration in production forest landscapes is unlikely to play a significant role in conserving species that rely on slow developing microhabitats such as tree hollows for decades or centuries and that retaining and managing forest remnants would be a more effective strategy to conserve populations of these species.</p>	Huntly mine, approximately 10 km west of the current region.
Burgar <i>et al.</i> (2017) Habitat features act as unidirectional and dynamic filters to bat use of production landscapes	<p>Location: five forest types around the Huntly mine (four restored forest with different stages of vegetation succession, and one unmined forest)</p> <p>Ultrasonic detectors (Anabat Titley Electronics) were set at 64 sites four times per year between Oct and March 2010/2011 and 2011/2012 for a total of 512 survey nights.</p> <p>31,347 bat call files were recorded over both years of which 22,520 were identified to species/species group. <i>Vespadelus regulus</i> was detected most frequently (15,833 call files) and <i>Falsistrellus mackenziei</i> least frequently (167 call files). Six species/groups were detected.</p> <p>Recorded threatened fauna comprise: Western False Pipistrelle</p>	Huntly Mine approximately 10 km west of the region.
Craig <i>et al.</i> (2017) Can postmining revegetation create habitat for a threatened mammal?	<p>Location: Jarrah Forest (Huntly mine site approximately 10 km north of Dwellingup)</p> <p>Most revegetation conducted for biodiversity conservation aims to mimic reference ecosystems present pre-disturbance. However, revegetation can overshoot or undershoot targets, particularly in the early stages of a recovery process, resulting in conditions different from the reference model. Revegetation that has, yet, failed to fully meet revegetation targets may, nonetheless, provide habitat for threatened species not present in reference ecosystems. To investigate this possibility a survey of the Quokka (<i>Setonix brachyurus</i>), a threatened macropod, in a mining landscape in south-western Australia was conducted. Four sites in each of riparian forest (the preferred habitat of quokkas) but is not mined, mid-slope forest, which is the pre-mining reference ecosystem but is not suitable habitat for quokkas, and revegetated forest on mine pits 16–21 years postmining.</p> <p>Quokkas were recorded in all riparian forest sites and two revegetated forest sites but not in any mid-slope forest sites. Occupied revegetated sites had greater cover between 0 and 2 m and were spatially closer to riparian forest than unoccupied revegetated sites, suggesting predation pressure was likely influencing which mine pits were occupied. The study demonstrated postmining revegetation can provide new habitat for a threatened species and suggested that revegetating a small proportion of sites to provide new habitat for threatened species could be considered as a management option in some scenarios. This could improve landscape connectivity and increase both the area of available habitat and between-site heterogeneity, which could all potentially increase the ability of revegetation to conserve biodiversity.</p>	Huntly Mine approximately 10 km west of the region.

Study	Location and key findings	Location in relation to this region
<p>EMRC (2015) Long Term Fauna Monitoring Program Summary of Results at Orion Mining region.</p>	<p>Location: Numerous plots over the Willowdale Mine area</p> <p>Results of the 3rd survey of the LTFMP. Same methodology and plot locations as 2010 survey of the area. Additionally, a large trapping transects targeting Chuditch and remote sensing cameras also deployed. Trapping conducted over 4 nights in both winter and summer seasons.</p> <p>The study results:</p> <ul style="list-style-type: none"> – Twelve mammal species were trapped. – Thirty-five bird species recorded. – Thirteen reptile species recorded. – Three frog species recorded. <p>Results were indicative of some species being affected (not present afterwards or in lower numbers) by the January 2016 wildfire that burnt through the Willowdale Mine and surrounding areas including four of the six Orion sites.</p>	<p>Willowdale (within 60 km south of the far southern boundary of the region)</p>
<p>Doherty <i>et al.</i> (2016). Successional changes in feeding activity by threatened cockatoos in revegetated mine sites.</p>	<p>Location: Numerous plots over the Huntly Mine, Boddington Bauxite Mine and Newmont Boddington Gold Mine. 232 plots were surveyed in revegetated forest and 480 plots were surveyed in unmined forest to determine whether there were successional patterns in cockatoo feeding activity in revegetation aged between 4 to 23 years.</p> <p>The study concludes that black cockatoos feed in vegetation at all three mine sites, despite variations in vegetation age, structure and floristics. Black cockatoos begun feeding on proteaceous and myrtaceous food plants within 4 and 7 years following revegetation, indicating that some food sources are restored quickly after mining disturbance of the Jarrah forest. The results highlight the importance of monitoring fauna recolonization over appropriate time scales to understand how successional processes in revegetation influence fauna persistence in production landscapes.</p>	<p>Huntly Mine approximately 10 km west of the region. Boddington Bauxite Mine approximately 18 km south east of the current region, Newmont Boddington Gold Mine approximately 25 km south east of current region.</p>
<p>Mastrantonis <i>et al.</i> (2019) Climate change indirectly reduces breeding frequency of a mobile</p>	<p>Location: The Northern Jarrah Forest of South- Western Australia over both the Swan and Murray River Catchments.</p> <p>Using a dataset of annual breeding frequency spanning 19 years, in combination with hydrological, climatological, and remotely sensed data, the effects of environmental variation on the annual breeding frequency of Forest Red-tailed Black Cockatoo's (FRTBC) were modelled.</p> <p>In total, 143 unique trees were surveyed over the 19-year period. A total of 173 breeding events were observed during this time with 104 and 71 events observed in the Swan and Murray River catchments respectively. On average there were 5.83 breeding events recorded per year with events ranging from 0 to 21 annually.</p> <p>Results found several significant relationships between annual breeding frequency of FRTBCs and environmental variation. While the model, which included a proxy for the availability of the cockatoo's primary food source and the previous season's rain, explained 49% of annual breeding frequency, there were also direct and indirect effects of heatwaves and forest productivity. FRTBC breeding was found to appear be linked to the spatiotemporal availability of its primary food sources, the fruit from the tree species, Marri <i>Corymbia calophylla</i> and Jarrah <i>Eucalyptus marginata</i>. However, due to climate change experienced and predicted to be experienced in the future in WA it is expected that the food resources during the breeding season for cockatoos will become increasingly limited in time and space, thus threatening their persistence</p>	<p>Approximately 10 km west of the northern boundary of the Study Area</p>

Study	Location and key findings	Location in relation to this region
Burn (2000) A survey of the impact of burning on mammals and birds in Alcoa's rehabilitated Bauxite mines at Jarrahdale	<p>Location: Jarrahdale forest (two unmined and four rehabilitated bauxite mine pits)</p> <p>To ascertain the impact of burning on birds and mammals at the above location pre burning monitoring took place 1997, and post burn monitoring commenced in 1998 in both burnt and unburnt, rehabilitated and unmined forest sites. Low numbers of mammals were caught making it difficult to conclude with certainty whether burning influenced most species. New epicormic growth may have attracted possums into one rehabilitated area, while mice invaded the dense rehabilitated site after the burn. There was a large decline in the numbers of birds and bird species following the burn in the dense rehabilitation. Burning sparse rehabilitation only resulted in a small decline while fire had little effect on bird populations of unmined forest.</p> <p>It was concluded that more time was needed to define the longer-term effects of burning on mammals and birds. The present survey was therefore undertaken in 2000 to assess the situation three years after burning.</p>	Approximately 10 km north of the northern boundary of the Study Area.
Huntly rehabilitation (2000), Alcoa internal data	<p>As no long-term monitoring of fauna has been conducted at Huntly since 1998, it was decided a repeat of the 1994 survey using identical methods would occur to gain a better understanding of the extent to which vertebrate fauna colonise older rehabilitation. The sites ranged from 14 to 22 years.</p> <p>Sixteen mammal species are known to inhabit rehabilitation at Huntly including 10 native and 6 feral species. Thirty-four bird species were recorded in the rehabilitated areas surveyed (like the 36 recorded in the 1994 survey. Eight reptile species and one frog species were recorded in the rehabilitated areas surveyed.</p> <p>Fourteen recommendations came about which if implemented should encourage the return of fauna species in similar number to which they occur in surrounding unmined forest. Some recommendations are identical to the 1994 study; they have either not been implemented or they should continue. Key recommendations include:</p> <p>Where it is not yet known about species recolonisation follow up monitoring in rehabilitated areas will reveal whether they have recolonised.</p> <p>Surrounding forest if the source of all fauna recruitment. It is important that fauna habitat be protected so that species are available to recolonise.</p>	Huntly mine, approximately 10 km west of the current region.
EMRC (2007a) A Vertebrate Fauna Survey of Rehabilitated Areas at Alcoa's Huntly Mine site. (Final report)	<p>Provides an overview of the 1994, 2000 and 2007 vertebrate fauna surveys of Alcoa's rehabilitated bauxite mines at Huntly. Mammals, birds and reptiles were surveyed in six rehabilitated pits ranging in age from 8 to 16 years.</p> <p>In total 16 mammal species (11 indigenous and 5 introduced), 34 birds and 8 reptiles were recorded. Rare or specially protected species either recorded in the present survey or recently sighted or trapped in rehabilitation at Huntly include the Brush-tailed Phascogale, Chuditch, Quokka, Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo and Carpet Python. Other species recorded in rehabilitation during the survey included the Echidna, Brush-tailed Phascogale and Common Brushtail Possum, while Western Brush Wallaby, Chuditch and Quenda have also recently been either trapped or sighted in rehabilitation at Huntly. Total bird species numbers recorded have remained like those in 2000 and in 1994, however in individual rehabilitated sites, the numbers of bird species and bird diversity have both decreased. Numbers of reptile species remained like those of previous years, with the Specially Protected Carpet Python seen in rehabilitation on a number of occasions. Thirteen recommendations were given as a result including protection of adjacent fauna habitat, construction of fauna habitats and corridors, control of feral species, construction of suitable habitat specific to mammals and reptiles.</p>	Huntly mine, approximately 10 km west of the current region.
EMRC (2001a) Alcoa World Alumina Australia Ltd. Long	The Alcoa Long Term Fauna Monitoring Program was designed in 1991. Monitoring events took place in 1992, 1995, 1998 and 2001 (Nichols 1992) using identical methods each time (except for the baseline). The program is designed to monitor fauna every three years at twenty plots located in rehabilitation and nearby forest at Jarrahdale, Huntly and Karnet (remote from mining). A total of 16 mammal (10 indigenous, six introduced), 50	Exact locations are not shown in report but Jarrahdale plots are expected to be within 40 km

Study	Location and key findings	Location in relation to this region
Term Fauna Monitoring Program. (V2)	<p>bird, 17 reptiles, 7 frog and 73 ant species was recorded. In 1998, the corresponding figures were 18 mammals, 53 bird, 21 reptiles, 7 frog and 56 ant species. Mammals recorded included one officially gazetted rare species, the Chuditch. Two of the species recorded in 1998 were not detected in 2001. These were the Brush-tailed Phascogale and an unidentified bat species. Numbers of several species appear to have changed significantly with some mammal and bird species declining, possibly due to very dry summer followed by very low winter rainfall. . Common brushtail possum and frog species increased. Baudin's Black Cockatoo was recorded at both Jarrahdale and Huntly. The reptile fauna included one 'Specially Protected' species, viz. the Carpet Python.</p> <p>Quantitative data showed that the composition of all rehabilitated sites was becoming more like that of the unmined sites. However, they remain linked to each other, particularly JR1 and JR2, which have become even more like each other.</p>	north of the region. Huntly is within 10 km west and Karnet is within 40 km north of the region.
EMRC (1998) Alcoa of Australis Ltd. Long Term Fauna Monitoring Program (1998)	<p>Location: Plots located in rehabilitation and nearby forest at Jarrahdale, Huntly and Karnet.</p> <p>This report provides the results of the 1998 fauna monitoring program. Methods used were identical to the 1995 monitoring program. Results are then compared to previous monitoring programs (1992 and 1995) in detail and the influence of mining and successional processes on fauna can be assessed. A total of 18 mammal (12 indigenous, six introduced), 53 bird, 20 reptiles, 5 frog and 56 ant species were recorded. Mammals recorded included two officially gazetted rare species, viz. the Chuditch and the Quokka. Two of the species recorded (Dunnart <i>Sminthopsis gilberti</i> and the Honey Possum) in 1995 were not detected in 1998. Several species have increased since the previous monitoring event (Mardo and Quenda). There wasn't any evidence of any mammal species declining due to proximity of mining. All bird species recorded in 1992 and 1995 were recorded in 1998. Only one rare bird species, Baudin's Black Cockatoo was recorded, and this was present at all sites. One new skink species was collected - <i>Glaphyromorphus gracilipes</i> was trapped at stream site HS1 (Banya Road) during the summer trapping program. Insufficient reptile numbers were collected to determine trends over time.</p>	Exact locations are not shown in report but Jarrahdale plots are expected to be within 40 km north of the region. Huntly is within 10 km west and Karnet is within 40 km north of the region.
EMRC (2004) Orion LTFMP report 2004 Final	<p>Location: Willowdale -northeast portion of Orion region (two healthy forest and two dieback forest plots, two steam zone plots and two plots in rehabilitation)</p> <p>The LTFMP was reviewed in 2003 (Majer, 2003) which included a recommendation for a similar program to be established at Orion so that any differences in faunal successional processes taking place at Willowdale could be detected. Similar techniques to those used at Jarrahdale, Huntly and McCoy. Mammals recorded during the survey included the Chuditch, Quokka, Mardo, Dunnart, Common Brushtail Possum, Western Brush Wallaby. Only one mammal species was recorded in the young rehabilitation (Feral Mouse). Forty-one bird species was recorded including the Baudin's Black Cockatoo. Bird numbers were highest at steam sites and lowest at rehabilitated sites. Six reptile species were recorded compared with 15 species recorded in the 1999 pre-mining survey. Three frog species were recorded. Fifty ant species were recorded. Further monitoring was recommended to determine successional patterns.</p>	Willowdale (within 40 km south of the far southern boundary of the region)
EMRC (1999) A fauna survey of planned mining areas at Alcoa's Orion Mining region	<p>Location: Orion mining region at Willowdale</p> <p>This report provides the results of the fauna survey conducted between February and November 1999. The habitats monitored were poorly surveyed in current mining areas, extensive dieback affected areas, small dieback free areas and on sites where mining operations are planned. A total of 46 bird species, nine mammals (6 native, 3 introduced), 13 reptiles and five frogs were recorded. These included three rare species (the Chuditch, Baudin's Black Cockatoo and possibly the Quokka) and one Specially Protected species (the Carpet Python). As well as these, the Noisy Scrub-bird has been reintroduced into the area and the uncommon Brush-tailed Phascogale is present albeit in low densities. The fauna of the Orion area was largely comparable to that of existing Willowdale mining areas. Results emphasise the need for ongoing fox control. Rehabilitation using</p>	Willowdale (within 40 km south of the far southern boundary of the region)

Study	Location and key findings	Location in relation to this region
	<p>Jarrah and other indigenous species offers the best prospects of successfully recreating suitable habitat for the species. Eleven recommendations were given for managing the area's faunal diversity including: protection of adjacent fauna habitat, construction of fauna habitats and corridors, control of feral species, construction of suitable habitat specific to mammals and reptiles.</p>	
<p>EMRC (2007b) A Vertebrate Fauna Survey of Rehabilitated Areas at Alcoa's Willowdale Minesite</p>	<p>Location: Willowdale (rehabilitated bauxite mine sites)</p> <p>This report details the 2007 results of the long-term fauna monitoring. Previous monitoring events occurred in 1994, 2000 (following fox control) and again in 2007.</p> <p>In the 2007 survey a total of 25 bird species, 10 mammals (seven indigenous, three introduced) and five reptiles was recorded in rehabilitation. They included three rare species, viz. the Chuditch, Brush-tailed Phascogale and Forest Red-tailed Black Cockatoo. Numbers of native mammals trapped in rehabilitation were higher than in previous years, with Yellow-footed Antechinus increasing from 0 in 1994 to 6 in 2007; Brush-tailed Phascogales increased from 0 to 1 and Chuditch increased from 0 to 3. Bird species had declined since the 2000 survey. Total numbers of both insectivores and honeyeaters both showed large declines between 1994 and 2000. There was a gradual decline in numbers of the skink <i>Acritoscincus trilineatus</i> as the rehabilitated sites become more like upland forest habitat and less suitable for this species.</p> <p>Fifteen recommendations were given for managing the area's faunal diversity including protection of adjacent fauna habitat, construction of fauna habitats and corridors, control of feral species, construction of suitable habitat specific to mammals and reptiles</p>	<p>Willowdale (within 40 km south of the far southern boundary of the region)</p>
<p>EMRC (2001b) A Vertebrate Fauna Survey of rehabilitated areas at Alcoa's Willowdale Mine site</p>	<p>Location: Willowdale (rehabilitated bauxite mine sites)</p> <p>This report details the 2000 fauna monitoring event results after the introduction of fox control following the 1994 monitoring event. A total of 31 bird species, nine mammals (five introduced, four indigenous) and five reptiles was recorded. Although not trapped or recorded in the present survey, both the rare Chuditch and the specially protected Carpet Python have been recently recorded in rehabilitation at Willowdale. Numbers of native mammals trapped in rehabilitation were low, as in 1994. Some evidence suggests that Fox predation may still be a problem near farmland. The 31 bird species recorded in the 2000 survey is less than the 45 recorded in 1994. The five reptile species recorded indicate that the rehabilitation has not yet become more suitable for this fauna group. Fifteen recommendations were given for managing the area's faunal diversity including protection of adjacent fauna habitat, construction of fauna habitats and corridors, control of feral species, construction of suitable habitat specific to mammals and reptiles.</p>	<p>Willowdale (within 40 km south of the far southern boundary of the region)</p>

4. Survey results

4.1 Fauna habitats

There were nine broad fauna habitats found within the Survey Area during the field surveys and included cleared areas. The habitat varies from extensive habitats (Jarrah-Marri forest) to very limited habitat. Water bodies occurred in limited areas with the O'Neil Survey Area, with small seasonal not permanent streams occurring. Two large bodies of water occurred within the Survey Area (Lake Banksiadale and South Dandalup Dam), which is included as relevant to significant fauna. The habitat types are categorised based on flora species, hydrology, landform, soil and topography. They have also been outlined to align broadly with vegetation types identified by Mattiske by grouping similar vegetation community types to form Broad fauna types. The habitat types recorded in the Survey Area are described below in Table 22 and mapped in Figure 6, Appendix A. The Broad fauna habitat types are:

- Jarrah – Marri forest
- Wandoo woodland
- Mixed shrub damplands
- Bullich woodlands
- Blackbutt forest
- Granite outcrop
- Water bodies
- Rehabilitation areas
- Cleared areas.

Cleared areas are highly disturbed areas, often with minimal to no remnant native vegetation, limited habitat value and comprising a portion of the Survey Area. Cleared areas include rehabilitation areas, roads, tracks, firebreaks, powerline easements, infrastructure, and the Solus mine. These areas are included in Figure 6, Cleared areas lack, or have very limited habitat values, however some species forage on the Juvenile/small rehabilitation plants, for example Western Brush Wallabies will browse on the *Eucalyptus* and *Acacia* saplings planted in the rehabilitation areas.

4.1.1 Fauna habitat linkages

The Survey Area represents a large continuous tract of forest and woodland with good connectivity to all habitats directly adjacent.

Impacts to all habitat types in the Survey Area include damage from fire, historical logging, mining (mineral/soil extraction), trampling of vegetation (public wood collection and camping), soil compaction along trails (recreational users), off road public use, small amounts of clearing for tracks and artificial water sources as well as grazing from feral animals (pigs) and native kangaroos.

4.1.2 Quality of Habitat


Whilst the vegetation is mostly intact the impact by logging, mine clearing, frequent and extensive fire in some areas were evident. Despite this the habitat presents a large contiguous forest with multiple habitat types suitable for highly mobile species such as Chuditch and Western Brush Wallaby. The lack of many species (such as Brushtail Possums and various small reptiles) demonstrates the impact of existing human activities mainly logging and prescribed fires.


Jarrah-Marri forest is by far the most extensive habitat type making up most of the Survey Area. Aside from some areas being affected by clearing and logging the habitat type was found to be relatively intact. The forest habitat provides an array of microhabitats such as logs, hollows, leaf litter, soft sand and dense foliage with a broad range of floristic species providing a range of foraging, roosting, denning and sheltering habitat.


Large bodies of water and small ephemeral drainage lines reside within the survey area. These habitats provide accessible drinking water to fauna with ephemeral water only portions of the year. Low dense vegetation which is often associated with drainage lines was identified as suitable habitat for Quokkas and where frogs were heard calling across all phases.

The granite outcrop habitat comprises to small portions of the Survey Area. The outcrops provide habitat for granite specialists species such as Ornate Crevice Dragon and Barking Gecko. Signs of disturbance included rock damage and frequent fires. Fauna habitats are described below is Table 22.


Table 22 Major habitat types within the Survey Area


Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Jarrah-Marri Forest</p> <p>The most extensive fauna habitat within the Survey Area. Habitat dominated by Jarrah (<i>Eucalyptus marginata</i>) and Marri (<i>Corymbia calophylla</i>) forest. With mixed understory of open to scattered to patchy Sheoak, <i>Banksia grandis</i> and Woody Pear and myrtaceous shrubs over Persoonia, Xanthorrhoea, Macrozamia and diverse low shrub layer, Soils are orange-brown lateritic sandy clay with pea gravel. There are very few well defined surface flow drainage lines as the soils tend to be porous and well-draining. Provides foraging, shelter and breeding habitat for a range of common locally occurring, mammals and reptiles such as Mardo, Grey kangaroo, and Rosenberg monitor, also habitat for a wide range of forest birds such as seasonal nectar feeding Purple-crowned Lorikeet, and Western Spinebill. Disturbance signs include intensive historical and current logging, dumped rubbish, frequent fire, localised dieback, and ground disturbance from pigs.</p> <p>Significant species recorded:</p> <p>Chuditch, Forest Red-tailed Black Cockatoo, Baudin's Black Cockatoo, Carnaby's Black Cockatoo, Quenda, Carnaby's Black Cockatoo, Masked Owl, Western Brush Wallaby, Western False Pipistrelle and Dell's skink.</p> <p>Habitat for significant species:</p> <p>Chuditch (foraging, denning, breeding), Forest Red-tailed Black Cockatoo (foraging, breeding, roosting), Baudin's Black Cockatoo (foraging, breeding, roosting), Carnaby's Black Cockatoo (foraging, breeding, roosting), Western Brush Wallaby (foraging, breeding - residing), Dell's Skink (foraging, breeding, residing), Southern Death Adder (foraging, breeding, residing),</p>	<p>D, P, PS, S, SW, PT, SP, DA, DG, ST, PW, E, TS, T</p>	<p>9487.93</p>	<p>74.6</p>	


Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Masked Owl (foraging, roosting, breeding, residing) and Western False Pipistrelle (foraging, roosting, residing).</p> <p>Foraging Value</p> <p>Forest Red-tailed Black Cockatoo – 9 Carnaby's Black Cockatoo – 9 Baudin's Black Cockatoo - 9</p>				
<p>Wandoo Woodland</p> <p>Tall wandoo woodlands with occasional Jarrah and Marri trees. There is extensive recruitment of young Wandoo dominating the understory due to low level of historical logging. Shrub layers dominated by Grass trees (<i>Xanthorrhoea preissii</i>), <i>Macrozamia riedlei</i> over mixed low shrubs including Grevillea, <i>Banksia dallanneyi</i>, and Hibbertia. Extensive habitat within easter portion of the Survey Area. Substrates consist of heavy pea-gravel sandy clay loam. Provides foraging and nesting habitat for many small insectivorous woodland birds including Thornbills, Robins, and Fairy-wrens. Disturbance factors include firewood removal, pigs, and trail bike activity.</p> <p>Significant species recorded:</p> <p>Baudin's Black Cockatoo and Western Brush Wallaby</p> <p>Habitat for significant fauna:</p> <p>Numbat (foraging, breeding, denning, residing), Baudin's Black Cockatoo (foraging, breeding, roosting), Carnaby's Black Cockatoo (foraging, breeding, roosting), Western Brush Wallaby (foraging, breeding - residing),</p> <p>Foraging value</p> <p>Forest Red-tailed Black Cockatoo – 7 Carnaby's Black Cockatoo – 7 Baudin's Black Cockatoo – 7</p>	AY, Y, YG, YS	67.39	0.52	


Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Mixed Shrub Dampland</p> <p>Mixed shrub dampland has occasional Flooded Gum, Blackbutt and/or Jarrah over open to sparse <i>Melaleuca persiana</i>, <i>Xanthorrhoea preissii</i> and <i>Banksia littoralis</i> over low mixed dense myrtaceous shrubs, and sedges. Associated with and restricted to poor drainage areas of ephemeral dampland associated with dark grey sandy clay and humus soils. Some areas appear head waters of small ephemeral creeks within the survey area. Disturbances include pig activity and frequent prescribed burning.</p> <p>Significant Species recorded: Baudin's Black Cockatoo, Quokka, Western Brush Wallaby, Dell's Skink</p> <p>Habitat for significant species: Black Cockatoos (foraging). Quokka (foraging, breeding, residing), Quenda (foraging, breeding, residing), and Western Brush Wallaby (foraging, breeding, residing).</p> <p>Foraging value scores Forest Red-tailed Black Cockatoo - 7 Carnaby's Black Cockatoo -7 Baudin's Black Cockatoo - 7</p>	AD, AX, AC, A	579.1	4.69	


Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Bullich Forest</p> <p>Bullich Forest is dominated by Bulich (<i>Eucalyptus megacarpa</i>) with an understory of Swamp peppermint (<i>Taxandria lineaifolia</i>), Angle Sword Sedge (<i>Lepidosperma tetraquetrum</i>). Substrate is dark clay loam soil. Associated with seasonal creeks and drainage lines. Bullich Forest are restricted to localised areas within the O’Neil Survey Area. Disturbance factors include frequent fires and feral pigs.</p> <p>Significant species recorded: Nil</p> <p>Habitat for significant fauna: Provides habitat for a range birds and frogs. Thick undergrowth provides suitable habitat for Black Cockatoos (foraging, roosting), Quokka (foraging, breeding, residing), Quenda (foraging, breeding, residing), and Western Brush Wallaby (foraging, breeding, residing).</p> <p>Foraging value: Forest Red-tailed Black Cockatoo – 6 Carnaby’s Black Cockatoo – 6 Baudin’s Black Cockatoo – 6</p>	W	216.15	1.7	

Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Blackbutt Forest</p> <p>Blackbutt forests are dominated by Blackbutt (<i>Eucalyptus pilularis</i>) and interspersed with scattered or occasional Jarrah- Marri and Flooded Gum over Melaleuca. Shrub layer comprised of <i>Xanthorrhoea preissii</i>, <i>Persoonia longifolia</i>, <i>Macrozamia riedlei</i> over mixed low shrubs (<i>Trymalium ledifolium</i>, <i>Grevillea wilsonii</i>, <i>Banksia dallanneyi</i>). and mixed, sedges, bracken fern and herbs. This habitat occupies a small proportion of the Survey Area and tends to be associated with seasonal creeks (drainage lines) and poor draining clay soils areas of low elevation. The vegetation of understory stratum varies from dense in long-unburnt areas, to sparse in areas subject to frequent prescribed burning. Where sufficient density of low shrub layer occurs, the habitat provides suitable movement corridor for Quokka and Quenda and a range of forest birds, mammals and reptiles. Disturbance includes frequent prescribed burning fires, pig disturbance and historical logging.</p> <p>Significant Species recorded:</p> <p>Quokka, All three Black Cockatoo</p> <p>Habitat for significant species:</p> <p>Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo (Foraging, roosting, breeding) but lower density of forage plants than Jarrah-marri forest. Provides refugia and movement corridors for Quokka (foraging, breeding, residing), Quenda (foraging, breeding, residing), and Western Brush Wallaby (foraging, breeding, residing).</p> <p>Foraging value scores</p> <p>Forest Red-tailed Black Cockatoo – 8 Carnaby's Black Cockatoo – 8 Baudin's Black Cockatoo - 8</p>	AW, C, CW	241.95	1.9	

Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Granite Outcrop</p> <p>Granite outcrop consisting of exfoliated slabs, boulders on exposed rock surfaces supporting scattered low herbaceous and myrtaceous shrubs, mosses, lichens, <i>Borya nitida</i> (Pyramid Plant) and other granite specialist flora. Outcrops are surrounded by Jarrah Marri forest. Granite also associated with seasonal watercourse due to seasonal rainfall run-off and associated shallow water table in some areas. Granite habitat represents a small proportion of the O'Neil Survey Area. But provides shelter and foraging habitat for a range of terrestrial vertebrates including granite-specialist species such as Ornate Crevice Dragon, and a diverse range of generalist species including Southern Carpet Python, Black-headed monitor, Southwestern cool-skink, Gould's hooded snake and Barking Gecko. The water courses associated with Granite outcrops provide breeding habitat for a range of common local frog species such as Quacking Frog, Lea's Frog, Moaning Frog, Signs of disturbance include rock damage, frequent fire and trail bike damage to vegetation. This habitat comprises a very small proportion of the Survey Area</p> <p>Significant species recorded: Nil</p> <p>Habitat for significant species: Chuditch (foraging, denning, breeding), Forest Red-tailed Cockatoo, Carnaby's Cockatoo (foraging only around the vegetated margins of rock areas)</p> <p>Foraging value: Forest Red-tail Black Cockatoo – 5 Carnaby's Black Cockatoo – 7 Baudin's Black Cockatoo – 5</p>	G, G1, R, R/G	237.64	1.87	

Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Water bodies/reservoirs</p> <p>Water bodies within O'Neil Survey Area are limited to two large and localised areas of water. Water bodies are associated with dampland and broad drainage areas within flooded gum woodland habitat and comprise either natural shallow swamp or areas where swamp has historically been partially excavated to provide water supply for the former timber industry. They are relatively shallow and seasonal to semi-permanent ponds of standing water or very slow drainage. They are fringed by myrtaceous shrubs and sedges and form part of the habitat connectivity of the flooded gum dampland.</p> <p>They provide seasonal habitat for several common wetland bird species, and breeding habitat for a range of frog genera including <i>Heleioporus</i>, <i>Litoria</i>, and <i>Crinia</i>.</p> <p>Significant species recorded.</p> <p>Rakali, Carter's Freshwater Mussel, Forest Red-tailed Black Cockatoo</p> <p>Habitat for significant fauna</p> <p>Habitat for Carter's Freshwater Mussel and Rakali (foraging, breeding, residing), migratory birds (temporary foraging, loafing) and drinking water for Black Cockatoos, Western Brush Wallaby and Chuditch and all other fauna</p> <p>Foraging value:</p> <p>Forest Red-tail Black Cockatoo – 3 Carnaby's Black Cockatoo – 2 Baudin's Black Cockatoo – 2</p>	-	15.23	0.12	

Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Cleared Area</p> <p>Cleared areas are highly disturbed areas, often with minimal to no remnant native vegetation and comprising a small proportion of the Survey Area. Cleared areas include roads, tracks, fire breaks, powerline easements and infrastructure, farm clearings on private property, and a portion of the Solus Mine Area.</p> <p>Significant species recorded: Western Brush Wallaby, Black Cockatoo (fly over) (opportunistic foraging)</p> <p>Foraging value: Forest Red-tailed Black Cockatoo – 2 Carnaby’s Black Cockatoo - 2 Baudin’s Black Cockatoo – 2</p>	CL	300.54	2.36	

Description	Corresponding Vegetation Type Code (Mattiske 2024)	Area (ha)	Percentage of Survey Area (%)	Representative images
<p>Rehabilitation Areas</p> <p>Rehabilitation areas were cleared areas (used for mining purposes) which have undergone rehabilitation in the form of log pile placements and native flora planting. Use is dependant on age with some areas rehabilitated recently (within 2 years) and others much older.</p> <p>Significant species recorded:</p> <p>Western Brush Wallaby (foraging), Black Cockatoo (fly over) or potential use of older rehabilitation, opportunistic use)</p> <p>Foraging Value:</p> <p>Forest Red-tailed Black Cockatoo – 0 Carnaby's Black Cockatoo – 0 Baudin's Black Cockatoo – 0</p>	Rehab	1573.31	12.37	

4.2 Fauna diversity

The combined fauna survey (Phase 1, Camera Rotation, Phase 2, Phase 3 and Single Target) recorded a total of 121 vertebrate fauna species utilising the Survey Area. Of the 121 species, 19 were mammals, 68 birds, 27 reptiles, seven frogs. One invertebrate species was recorded during the survey.

4.3 Significant fauna

Twelve significant fauna species were recorded within the survey area during the survey period;

- Baudin's Black Cockatoo (*Zanda baudinii*) listed as Endangered under the BC Act and the EPBC Act.
- Carnaby's Black Cockatoo (*Zanda latirostris*) listed as Endangered under the BC Act and EPBC Act.
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) listed as Vulnerable under the BC Act and the EPBC Act.
- Chuditch (*Dasyurus geoffroi*) listed as Vulnerable under the BC Act and the EPBC Act.
- Quokka (*Setonix brachyurus*) listed as Vulnerable under the EPBC Act and BC Act
- Rakali (*Hydromys chrysogaster*) Listed as Priority 4 by DBCA
- Western Bush Wallaby (*Notamacropus irma*) – listed as Priority 4 by the DBCA.
- Dell's Skink (*Ctenotus delli*) listed as Priority 4 by the DBCA
- Quenda (*Isoodon fusciventer*) listed as Priority 4 by the DBCA.
- Carter's Freshwater Mussel (*Westralunio carteri*) listed as Vulnerable under the EPBC Act and BC Act
- Masked Owls (*Tyto novaehollandiae novaehollandiae*) listed as Priority 3 by the DBCA
- The Western False Pipistrelle (*Falsistrellus mackenziei*) listed as Priority 4 by the DBCA

Likelihood of occurrence assessment

In addition to the field survey results, an assessment of the likelihood of significant species occurring in the Survey Area was undertaken. This assessment is based on species' biology, habitat requirements, the quality and availability of suitable habitat as determined during the field survey and records of the species in the Survey Area and locality. The database searches (*NatureMap*, PMST and DBCA) identified 166 terrestrial vertebrate fauna species previously recorded or likely to occur within the Study Area. Based on the above database searches and GHD observations, six significant terrestrial vertebrate taxa were identified as likely to occur or present within the Survey Area.

With regard to migratory shorebirds and marine species, the Survey Area lacks suitable foraging habitat, namely shorelines or extensive shallow open water. The creek lines and vegetated seasonal damp areas within the Survey Area are not considered suitable foraging habitat and in most cases are dry during the period of migratory bird use in the south west of WA. Therefore, they are unlikely to occur within the Survey Area, and any occurrence would be as rare vagrant. A number of Marine listed species were recorded in the database searches however these species are marine use and typically common in the environment. These species are not discussed within the LOO assessment.

In addition to the 12 recorded significant species, a further five significant fauna species are considered likely to occur within the Survey Area even though extensive and targeted surveys did not detect them. Table 23 summarises the summarises all species of significance that are either known or considered highly likely or likely to occur in the Survey Area. The parameters of assessment for this likelihood of occurrence assessment and the full likelihood of occurrence assessment are provided in Appendix D, Fauna Likelihood of occurrence assessment.

Table 23 Likelihood of occurrence assessment

Species	EPBC Act	BC Act/ DBCA	Assessment Outcome
Mammals			
Chuditch (<i>Dasyurus geoffroii</i>)	VU	VU	Known. This species was recorded numerous times via remote cameras in the Survey Area. Suitable habitat is found within the survey area.
Quenda (<i>Isoodon fusciventer</i>)		P4	Known. This species was recorded numerous times via remote cameras and suitable habitat is found within the Survey Area.
Quokka (<i>Setonix brachyurus</i>)	VU	VU	Known. This species was recorded numerous times via remote cameras and suitable habitat is found within the Survey Area.
Western Brush Wallaby (<i>Notamacropus irma</i>)		P4	Known. This species was recorded numerous times via remote cameras and suitable habitat is found within the Survey Area.
Rakali (<i>Hydromys chrysogaster</i>)		P4	Known. This species was recorded numerous times via remote cameras and suitable habitat is found within southwestern portion of the Survey Area.
Woylie (<i>Bettongia penicillata ogilbyi</i>)	EN	CR	Likely. Known from Study Area. Restricted to Mixed shrub dampland and observed via remote cameras only 1.6 km from this survey areas boundary. Due the close proximity and patches of suitable habitat it is likely that Woylies will be present within the survey area but at very low population density, below the level of detectability based on current survey effort
Western False Pipistrelle (<i>Falsistrellus mackenziei</i>)		P4	Known. This species had a single recording via SM4 ultrasonic song meter. Suitable habitat found within the Survey Area.
Numbat (<i>Myrmecobius fasciatus</i>)	EN	EN	Likely. Historical records include the region. A resident population occurs in Dryandra and re-introduced population at Boyagin Rock. Eastern portions of the Holyoake Survey Area have excellent open wandoo woodland representing suitable Numbat habitat within the species' former range. This species potentially occurs within this suitable habitat, but at very low population density, below the level of detectability based on current survey effort
Brush tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>)		CD	Likely. One individual was sighted in O'Neil East (GHD unpublished, 2024) and recorded on cameras at Holyoake East (GHD 2023) and Holyoake Central area by GHD in 2021. Suitable habitat occurs within Survey Area.
Birds			
Baudin's Black Cockatoo (<i>Zanda baudinii</i>)	EN	EN	Known. This species was recorded numerous times during the Survey period and suitable foraging and roosting habitat is found within the Survey Area.
Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>)	VU	VU	Known. This species was recorded during the Survey period and suitable foraging and roosting habitat is found within the Survey Area.
Carnaby's Black Cockatoo (<i>Zanda latirostris</i>)	EN	EN	Known. This species was recorded via recent foraging evidence within the Survey Area. Suitable Black Cockatoo habitat resides within the Survey Area.
Masked Owl (southwest) (<i>Tyto novaehollandiae novaehollandiae</i>)		P3	Known. This species was recorded via SM4 Bird acoustic. Suitable habitat is found within the Survey Area.
Peregrine Falcon (<i>Falco peregrinus macropus</i>)		SP	Likely. Species has been recorded within the Holyoake region which is near the O'Neil Survey Area. The survey area contains suitable habitat for the Peregrine falcon.
Reptiles			
Dell's Skink (<i>Ctenotus delli</i>)		P4	Known. Three individuals of this species were trapped using targeted methods over all phases of the survey. Suitable habitat such as granite and lateritic clay supporting forest occur within the survey.

Species	EPBC Act	BC Act/ DBCA	Assessment Outcome
This Common Death Adder (<i>Acanthophis antarcticus</i>)		P3	Likely. Common Death Adders are found within the region with sightings <20kms away from the survey area. Suitable habitat with thick leaf litter is found within the Survey Area.
Invertebrates			
Carter's Freshwater Mussel (<i>Westralunio carteri</i>)	VU	VU	Known. Old shells were found at Lake Banksiadale within the Survey Area. Lake Banksiadale and South Dandalup Dam is the only habitat suitable for this species in the survey area.

4.3.1 Significant fauna recorded.

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

The Forest Red tailed Black Cockatoo is listed as Vulnerable under the EPBC Act and BC Act.

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and sub-humid zones of WA (Mawson and Johnstone 1997). It inhabits the dense Jarrah (*Eucalyptus marginata*), Karri (*E. diversicolor*) and Marri (*Corymbia calophylla*) forests receiving more than 600 mm of annual average rainfall. The current distribution is north of Perth and east to Mount Helena, Christmas Tree Well, North Banister, Mt Saddleback, Rocky Gully and the upper King River (Johnstone 1997). More recently the species has been utilising and persisting on the northern portions of the Swan Coastal Plain and is now considered a regular sighting (Johnstone *et al* 2017). Habitats in which Forest Red-tailed Black Cockatoos occur are throughout the Northern Jarrah Forest and within Marri, Jarrah, Wandoo, Blackbutt, Bullich and Flooded Gum present. This region has a general understorey of Bull Banksia (*Banksia grandis*), Snottygobble (*Persoonia longifolia*), Sheoak (*Allocasuarina fraseriana*) and other *Banksia* species with scattered ephemeral areas of relevant species (Johnstone & Kirkby 1999). Forest Red-tailed Black Cockatoos roost in emergent Jarrah-Marri-Blackbutt habitat on roadsides, paddocks or forest blocks. While the Forest Red-tailed Black Cockatoo feeds on the seeds of other species, around 90 per cent of its diet is made up of the seeds from Marri and Jarrah fruits.

Forest Red-tailed Black Cockatoos were observed flying, calling, loafing and foraging at 27 locations observing 82 individuals. One form of secondary evidence, Forest Red-tail Black Cockatoo tail feather, was found at another location, Table 24. A total of 235 Forest Red-tailed Black Cockatoo foraging observations were made, with a total of 148 being marri nuts, 86 of the observations were jarrah nuts and one observation of Blackbutt foraging Table 25. However, foraging evidence is not an indication to the size of the population. All foraging locations and bird sightings are located in Appendix A, Figure 5.

Table 24 Forest Red Tailed Black Cockatoo records.

Phase	Date	Observation type	Latitude	Longitude	Number of Individuals
Reconnaissance	29/06/2023	Flying	-32.5217	116.2056	3
Recc.	29/06/2023	Feeding on jarrah nuts	-32.4958	116.2211	6
Recc.	29/06/2023	Calling	-32.4961	116.2178	2
Recc.	29/06/2023	Flying	-32.4973	116.2070	6
Phase 1	17/08/2023	Flying	-32.5697	116.2558	2
Phase 1	18/08/2023	Flying	-32.4948	116.2688	6
Phase 1	18/08/2023	Flying	-32.5846	116.1180	2
Phase 1	18/08/2023	Loafing	-32.5013	116.2690	4
Phase 1	19/08/2023	Calling	-32.5001	116.2821	2
Phase 1	21/08/2023	Flying	-32.5356	116.3158	1
Phase 1	24/08/2023	Calling	-32.5113	116.2875	2
Phase 1	24/08/2023	Feeding on jarrah nuts	-32.5294	116.2822	2
Phase 1	25/08/2023	Feeding on jarrah nuts	-32.4992	116.2702	4
Phase 1	25/08/2023	Feeding on jarrah nuts	-32.4974	116.2698	2
Phase 1	25/08/2023	Feeding on marri nuts	-32.4807	116.2674	2
Phase 2	8/09/2023	Flying	-32.5262	116.2752	8
Phase 2	8/09/2023	Calling	-32.5086	116.2881	2
Phase 2	8/09/2023	Tail feather	-32.6323	116.0880	1
Phase 2	8/09/2023	Calling	-32.6324	116.0880	1

Phase	Date	Observation type	Latitude	Longitude	Number of Individuals
Phase 2	10/09/2023	Calling	-32.5622	116.2819	1
Phase 2	10/09/2023	Flying	-32.5841	116.2729	4
Phase 2	10/09/2023	Flying	-32.5829	116.2731	5
Phase 2	12/09/2023	Juvenile calling	-32.5251	116.2759	1
Phase 3	18/10/2023	Flying	-32.568	116.2623	5
Phase 3	18/10/2023	Flying	-32.5398	116.2589	2
Phase 3	21/10/2023	Flying	-32.5038	116.2334	3
Phase 3	22/10/2023	Flying	-32.5448	116.2517	3
Total observations					82

Table 25 Forest Red tailed Black Cockatoo foraging evidence.

Phase	Date	Latitude	Longitude	Foraging evidence type
Reconnaissance	27/06/2023	-32.6539	116.0795	Chewed marri nuts
Reconnaissance	27/06/2023	-32.6534	116.0794	Chewed jarrah nuts
Reconnaissance	27/06/2023	-32.6327	116.1124	Chewed jarrah nuts
Reconnaissance	27/06/2023	-32.6200	116.1160	Chewed marri nuts
Reconnaissance	27/06/2023	-32.6139	116.1106	Chewed jarrah nuts
Reconnaissance	27/06/2023	-32.6071	116.1096	Chewed jarrah nuts
Reconnaissance	27/06/2023	-32.5912	116.1172	Chewed jarrah nuts
Reconnaissance	29/06/2023	-32.4950	116.2146	Chewed marri nuts
Reconnaissance	29/06/2023	-32.5024	116.2358	Chewed jarrah nuts
Reconnaissance	29/06/2023	-32.5030	116.2374	Chewed jarrah nuts
Reconnaissance	29/06/2023	-32.5033	116.2380	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5569	116.2403	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5658	116.2331	Chewed marri nuts
Reconnaissance	30/06/2023	-32.5647	116.2315	Chewed marri nuts
Reconnaissance	30/06/2023	-32.5967	116.1963	Chewed marri nuts
Reconnaissance	30/06/2023	-32.5926	116.2009	Chewed marri nuts
Reconnaissance	30/06/2023	-32.5432	116.2373	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5408	116.2339	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5310	116.2279	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5272	116.2744	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5260	116.2753	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5885	116.2044	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.5885	116.2044	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.6053	116.1923	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.6056	116.1925	Chewed marri nuts
Reconnaissance	30/06/2023	-32.6146	116.2024	Chewed jarrah nuts
Reconnaissance	30/06/2023	-32.6126	116.1987	Chewed jarrah nuts
Reconnaissance	24/07/2023	-32.6255	116.2110	Chewed marri nuts
Reconnaissance	24/07/2023	-32.6280	116.2152	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Reconnaissance	24/07/2023	-32.6268	116.2121	Chewed jarrah nuts
Reconnaissance	24/07/2023	-32.6266	116.2171	Chewed marri nuts
Reconnaissance	24/07/2023	-32.5980	116.1891	Chewed marri nuts
Reconnaissance	24/07/2023	-32.5661	116.2300	Chewed marri nuts
Reconnaissance	24/07/2023	-32.5646	116.2314	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5630	116.2911	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5608	116.2898	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5552	116.2861	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5551	116.2923	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5564	116.2984	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5586	116.3091	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5980	116.1891	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5396	116.2302	Chewed jarrah nuts
Reconnaissance	27/07/2023	-32.5395	116.2301	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5469	116.2408	Chewed marri nuts
Phase 1	14/08/2023	-32.5006	116.2311	Chewed marri nuts
Phase 1	14/08/2023	-32.5007	116.2313	Chewed jarrah nuts
Phase 1	17/08/2023	-32.4768	116.2726	Chewed marri nuts
Phase 1	17/08/2023	-32.4753	116.2673	Chewed marri nuts
Phase 1	17/08/2023	-32.4802	116.2695	Chewed marri nuts
Phase 1	17/08/2023	-32.4856	116.2728	Chewed jarrah nuts
Phase 1	17/08/2023	-32.4887	116.2728	Chewed jarrah nuts
Phase 1	17/08/2023	-32.4901	116.2723	Chewed marri nuts
Phase 1	17/08/2023	-32.4932	116.2721	Chewed jarrah nuts
Phase 1	17/08/2023	-32.4978	116.2713	Chewed marri nuts
Phase 1	17/08/2023	-32.4988	116.2719	Chewed marri nuts
Phase 1	17/08/2023	-32.4977	116.2712	Chewed marri nuts
Phase 1	18/08/2023	-32.5840	116.3067	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5844	116.3066	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5844	116.3066	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5826	116.3070	Chewed marri nuts
Phase 1	18/08/2023	-32.5825	116.3067	Chewed marri nuts
Phase 1	18/08/2023	-32.5838	116.1177	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5849	116.1184	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5850	116.1185	Chewed jarrah nuts
Phase 1	18/08/2023	-32.4989	116.2674	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5868	116.1178	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5869	116.1179	Chewed jarrah nuts
Phase 1	18/08/2023	-32.5858	116.1176	Chewed marri nuts
Phase 1	19/08/2023	-32.5313	116.2548	Chewed marri nuts
Phase 1	19/08/2023	-32.4984	116.2845	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Phase 1	19/08/2023	-32.4981	116.2848	Chewed marri nuts
Phase 1	19/08/2023	-32.5240	116.3015	Chewed marri nuts
Phase 1	19/08/2023	-32.5240	116.3015	Chewed jarrah nuts
Phase 1	19/08/2023	-32.5246	116.3011	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4983	116.2817	Chewed marri nuts
Phase 1	21/08/2023	-32.4986	116.2808	Chewed marri nuts
Phase 1	21/08/2023	-32.4780	116.2675	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4772	116.2685	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4769	116.2686	Chewed marri nuts
Phase 1	21/08/2023	-32.4759	116.2695	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4755	116.2694	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4754	116.2699	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4751	116.2700	Chewed jarrah nuts
Phase 1	21/08/2023	-32.4749	116.2702	Chewed jarrah nuts
Phase 1	22/08/2023	-32.5955	116.2793	Chewed marri nuts
Phase 1	22/08/2023	-32.5765	116.2198	Chewed jarrah nuts
Phase 1	22/08/2023	-32.5772	116.2230	Chewed jarrah nuts
Phase 1	22/08/2023	-32.5772	116.2229	Chewed marri nuts
Phase 1	23/08/2023	-32.5028	116.2376	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5029	116.2376	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5030	116.2376	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5030	116.2375	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5031	116.2375	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5032	116.2375	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5032	116.2375	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5033	116.2374	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5287	116.1909	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5292	116.1913	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5296	116.1917	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5296	116.1918	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5298	116.1918	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5299	116.1917	Chewed marri nuts
Phase 1	23/08/2023	-32.5300	116.1920	Chewed marri nuts
Phase 1	23/08/2023	-32.5301	116.1919	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5307	116.1923	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5314	116.1930	Chewed marri nuts
Phase 1	23/08/2023	-32.5316	116.1929	Chewed jarrah nuts
Phase 1	23/08/2023	-32.5326	116.1937	Chewed marri nuts
Phase 1	23/08/2023	-32.5404	116.2098	Chewed Blackbutt nuts
Phase 1	23/08/2023	-32.5384	116.2116	Chewed jarrah nuts
Phase 1	24/08/2023	-32.5289	116.2831	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Phase 1	24/08/2023	-32.5281	116.2838	Chewed marri nuts
Phase 1	24/08/2023	-32.5277	116.2838	Chewed jarrah nuts
Phase 1	24/08/2023	-32.5949	116.1174	Chewed jarrah nuts
Phase 1	24/08/2023	-32.5948	116.1175	Chewed marri nuts
Phase 1	24/08/2023	-32.5274	116.2840	Chewed jarrah nuts
Phase 1	24/08/2023	-32.5315	116.2832	Chewed marri nuts
Phase 1	24/08/2023	-32.6171	116.1112	Chewed jarrah nuts
Phase 1	24/08/2023	-32.6185	116.1135	Chewed marri nuts
Phase 1	24/08/2023	-32.6184	116.1131	Chewed marri nuts
Phase 1	24/08/2023	-32.6183	116.1124	Chewed marri nuts
Phase 1	24/08/2023	-32.5626	116.3039	Chewed marri nuts
Phase 1	24/08/2023	-32.5628	116.3040	Chewed marri nuts
Phase 1	24/08/2023	-32.5627	116.3051	Chewed marri nuts
Phase 1	24/08/2023	-32.5491	116.2929	chewed marri nuts
Phase 1	24/08/2023	-32.5434	116.2969	chewed marri nuts
Phase 1	25/08/2023	-32.5239	116.2766	Chewed marri nuts
Phase 1	25/08/2023	-32.5234	116.2762	Chewed marri nuts
Phase 1	25/08/2023	-32.5198	116.2749	Chewed marri nuts
Phase 1	25/08/2023	-32.5175	116.2752	Chewed marri nuts
Phase 1	25/08/2023	-32.5128	116.2676	Chewed marri nuts
Phase 1	25/08/2023	-32.5046	116.2659	Chewed marri nuts
Phase 1	25/08/2023	-32.6317	116.1138	Chewed marri nuts
Phase 1	25/08/2023	-32.6189	116.1147	Chewed marri nuts
Phase 1	25/08/2023	-32.6163	116.1106	Chewed jarrah nuts
Phase 1	25/08/2023	-32.6112	116.1107	Chewed marri nuts
Phase 1	25/08/2023	-32.6024	116.1123	Chewed jarrah nuts
Phase 1	25/08/2023	-32.4984	116.2623	Chewed jarrah nuts
Phase 1	25/08/2023	-32.4982	116.2589	Chewed jarrah nuts
Phase 1	25/08/2023	-32.4983	116.2550	Chewed jarrah nuts
Phase 1	25/08/2023	-32.5094	116.2411	Chewed marri nuts
Phase 1	25/08/2023	-32.5198	116.2487	Chewed marri nuts
Phase 1	25/08/2023	-32.5984	116.1154	Chewed jarrah nuts
Phase 1	25/08/2023	-32.4982	116.2514	Chewed marri nuts
Phase 2	5/09/2023	-32.5263	116.2750	Chewed marri nuts
Phase 2	5/09/2023	-32.5279	116.2740	Chewed marri nuts
Phase 2	7/09/2023	-32.5587	116.3090	Chewed marri nuts
Phase 2	7/09/2023	-32.5603	116.2893	Chewed jarrah nuts
Phase 2	7/09/2023	-32.5605	116.2856	Chewed marri nuts
Phase 2	7/09/2023	-32.5782	116.2825	Chewed marri nuts
Phase 2	7/09/2023	-32.5875	116.2906	Chewed jarrah nuts
Phase 2	7/09/2023	-32.5862	116.2909	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Phase 2	7/09/2023	-32.5844	116.2920	Chewed jarrah nuts
Phase 2	7/09/2023	-32.5728	116.2865	Chewed marri nuts
Phase 2	7/09/2023	-32.5732	116.2820	Chewed jarrah nuts
Phase 2	7/09/2023	-32.5722	116.2799	Chewed marri nuts
Phase 2	7/09/2023	-32.5717	116.2785	Chewed jarrah nuts
Phase 2	8/09/2023	-32.6320	116.0859	Chewed marri nuts
Phase 2	8/09/2023	-32.6326	116.0880	Chewed marri nuts
Phase 2	8/09/2023	-32.5597	116.2547	Chewed marri nuts
Phase 2	10/09/2023	-32.5606	116.2831	Chewed marri nuts
Phase 2	10/09/2023	-32.5641	116.3077	Chewed jarrah nuts
Phase 2	10/09/2023	-32.5647	116.3083	Chewed marri nuts
Phase 2	10/09/2023	-32.5650	116.3085	Chewed marri nuts
Phase 2	10/09/2023	-32.5529	116.2851	Chewed marri nuts
Phase 2	10/09/2023	-32.5488	116.2827	Chewed marri nuts
Phase 2	10/09/2023	-32.5488	116.2820	Chewed marri nuts
Phase 2	10/09/2023	-32.5488	116.2815	Chewed marri nuts
Phase 2	10/09/2023	-32.5488	116.2799	Chewed marri nuts
Phase 2	10/09/2023	-32.5460	116.2742	Chewed marri nuts
Phase 2	10/09/2023	-32.5435	116.2743	Chewed marri nuts
Phase 2	10/09/2023	-32.5430	116.2742	Chewed marri nuts
Phase 2	10/09/2023	-32.5466	116.2720	Chewed marri nuts
Phase 2	10/09/2023	-32.5457	116.2676	Chewed marri nuts
Phase 2	10/09/2023	-32.5456	116.2668	Chewed marri nuts
Phase 2	10/09/2023	-32.5820	116.2654	Chewed marri nuts
Phase 2	10/09/2023	-32.5841	116.2702	Chewed marri nuts
Phase 2	10/09/2023	-32.5841	116.2706	Chewed marri nuts
Phase 2	10/09/2023	-32.5814	116.2746	Chewed marri nuts
Phase 2	10/09/2023	-32.5802	116.2785	Chewed marri nuts
Phase 2	10/09/2023	-32.5586	116.2833	Chewed marri nuts
Phase 2	10/09/2023	-32.5570	116.2811	Chewed jarrah nuts
Phase 2	10/09/2023	-32.5537	116.2784	Chewed marri nuts
Phase 2	10/09/2023	-32.5502	116.2755	Chewed marri nuts
Phase 2	10/09/2023	-32.5494	116.2751	Chewed marri nuts
Phase 2	10/09/2023	-32.5481	116.2754	Chewed marri nuts
Phase 2	11/09/2023	-32.5439	116.2585	Chewed marri nuts
Phase 2	11/09/2023	-32.5455	116.3089	Chewed jarrah nuts
Phase 2	11/09/2023	-32.5461	116.3098	Chewed marri nuts
Phase 2	11/09/2023	-32.5486	116.3121	Chewed marri nuts
Phase 2	11/09/2023	-32.5564	116.3126	Chewed marri nuts
Phase 2	11/09/2023	-32.5390	116.2832	Chewed marri nuts
Phase 2	11/09/2023	-32.5322	116.2830	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Phase 2	11/09/2023	-32.5300	116.2832	Chewed marri nuts
Phase 2	11/09/2023	-32.5257	116.2849	Chewed marri nuts
Phase 2	11/09/2023	-32.5154	116.2891	Chewed marri nuts
Phase 2	12/09/2023	-32.5601	116.2894	Chewed marri nuts
Phase 2	12/09/2023	-32.5383	116.2838	Chewed marri nuts
Phase 2	12/09/2023	-32.5312	116.2791	Chewed marri nuts
Phase 2	12/09/2023	-32.5310	116.2778	Chewed marri nuts
Phase 2	12/09/2023	-32.5283	116.2758	Chewed marri nuts
Phase 2	12/09/2023	-32.5332	116.2852	Chewed marri nuts
Phase 2	12/09/2023	-32.5380	116.2852	Chewed marri nuts
Phase 2	14/09/2023	-32.5572	116.2398	Chewed marri nuts
Phase 3	17/10/2023	-32.5005	116.2313	Chewed jarrah nuts
Phase 3	17/10/2023	-32.5004	116.2312	Chewed jarrah nuts
Phase 3	21/10/2023	-32.5010	116.2307	Chewed jarrah nuts
Phase 3	22/10/2023	-32.5045	116.2873	Chewed marri nuts
Phase 3	22/10/2023	-32.5042	116.2307	Chewed marri nuts
Phase 3	22/10/2023	-32.5074	116.2292	Chewed marri nuts
Phase 3	22/10/2023	-32.5078	116.2292	Chewed marri nuts
Phase 3	22/10/2023	-32.5249	116.2412	Chewed marri nuts
Phase 3	22/10/2023	-32.5182	116.2355	Chewed marri nuts
Phase 3	22/10/2023	-32.5229	116.2162	Chewed jarrah nuts
Phase 3	22/10/2023	-32.5166	116.2295	Chewed marri nuts
Phase 3	22/10/2023	-32.5163	116.2232	Chewed marri nuts
Phase 3	22/10/2023	-32.5184	116.2193	Chewed marri nuts
Phase 3	22/10/2023	-32.5216	116.2168	Chewed marri nuts
Phase 3	22/10/2023	-32.5148	116.1999	Chewed marri nuts
Phase 3	22/10/2023	-32.5145	116.2029	Chewed marri nuts
Phase 3	22/10/2023	-32.5140	116.2120	Chewed marri nuts
Phase 3	22/10/2023	-32.5153	116.2128	Chewed marri nuts
Phase 3	22/10/2023	-32.5135	116.2149	Chewed marri nuts
Phase 3	22/10/2023	-32.5255	116.2709	Chewed marri nuts
Phase 3	22/10/2023	-32.5251	116.2708	Chewed marri nuts
Phase 3	22/10/2023	-32.5239	116.2701	Chewed marri nuts
Phase 3	22/10/2023	-32.5236	116.2699	Chewed marri nuts
Phase 3	22/10/2023	-32.5169	116.2603	Chewed marri nuts
Phase 3	22/10/2023	-32.5162	116.2596	Chewed marri nuts
Phase 3	22/10/2023	-32.5159	116.2590	Chewed marri nuts
Phase 3	22/10/2023	-32.4982	116.2589	Chewed jarrah nuts
Phase 3	23/10/2023	-32.5423	116.2238	Chewed marri nuts
Phase 3	23/10/2023	-32.5453	116.2209	Chewed jarrah nuts
Phase 3	23/10/2023	-32.5421	116.2360	Chewed marri nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Phase 3	23/10/2023	-32.5436	116.2382	Chewed marri nuts
Single target	15/12/2023	-32.4755	116.2648	Chewed jarrah nuts
Single target	15/12/2023	-32.4757	116.2643	Chewed jarrah nuts
Single target	15/12/2023	-32.4753	116.2639	Chewed jarrah nuts
Single target	15/12/2023	-32.4749	116.2631	Chewed jarrah nuts
Single target	15/12/2023	-32.4748	116.2625	Chewed jarrah nuts
Single target	15/12/2023	-32.4744	116.2617	Chewed jarrah nuts
Single target	15/12/2023	-32.4741	116.2607	Chewed jarrah nuts
Single target	15/12/2023	-32.4735	116.2585	Chewed jarrah nuts
Single target	15/12/2023	-32.4728	116.2581	Chewed jarrah nuts
Single target	15/12/2023	-32.4722	116.2567	Chewed jarrah nuts
Single target	15/12/2023	-32.4723	116.2561	Chewed jarrah nuts
Single target	15/12/2023	-32.4724	116.2549	Chewed marri nuts
Single target	15/12/2023	-32.4724	116.2543	Chewed marri nuts
Single target	15/12/2023	-32.4721	116.2537	Chewed jarrah nuts
Single target	15/12/2023	-32.4721	116.2534	Chewed jarrah nuts
Single target	15/12/2023	-32.4725	116.2536	Chewed jarrah nuts
Single target	15/12/2023	-32.4728	116.2537	Chewed jarrah nuts
Single target	15/12/2023	-32.4731	116.2538	Chewed jarrah nuts
Single target	15/12/2023	-32.4732	116.2542	Chewed jarrah nuts
Single target	15/12/2023	-32.4731	116.2559	Chewed jarrah nuts
Single target	15/12/2023	-32.4730	116.2573	Chewed jarrah nuts
Single target	15/12/2023	-32.4733	116.2576	Chewed jarrah nuts
Single target	15/12/2023	-32.4734	116.2578	Chewed jarrah nuts
Single target	15/12/2023	-32.4737	116.2584	Chewed jarrah nuts
Single target	15/12/2023	-32.4741	116.2587	Chewed marri nuts
Single target	15/12/2023	-32.4740	116.2600	Chewed jarrah nuts
Single target	15/12/2023	-32.4746	116.2610	Chewed jarrah nuts
Single target	15/12/2023	-32.4748	116.2614	Chewed jarrah nuts
Single target	15/12/2023	-32.4753	116.2629	Chewed jarrah nuts
Single target	15/12/2023	-32.4760	116.2650	Chewed jarrah nuts
Single target	15/12/2023	-32.4775	116.2675	Chewed marri nuts
Single target	15/12/2023	-32.4781	116.2684	Chewed jarrah nuts
Single target	15/12/2023	-32.4818	116.2712	Chewed jarrah nuts
Single target	15/12/2023	-32.4818	116.2715	Chewed jarrah nuts
Single target	15/12/2023	-32.4817	116.2717	Chewed jarrah nuts
Single target	15/12/2023	-32.4816	116.2714	Chewed marri nuts
Single target	15/12/2023	-32.4840	116.2727	Chewed jarrah nuts
Single target	15/12/2023	-32.4878	116.2741	Chewed jarrah nuts
Single target	15/12/2023	-32.4878	116.2733	Chewed marri nuts
Single target	15/12/2023	-32.4737	116.2588	Chewed jarrah nuts

Phase	Date	Latitude	Longitude	Foraging evidence type
Single target	15/12/2023	-32.4734	116.2577	Chewed jarrah nuts
Single target	15/12/2023	-32.4729	116.2528	Chewed jarrah nuts
Single target	15/12/2023	-32.4723	116.2544	Chewed jarrah nuts
Single target	15/12/2023	-32.4723	116.2562	Chewed jarrah nuts
Single target	15/12/2023	-32.4736	116.2598	Chewed jarrah nuts

Baudin's Black Cockatoo (*Zanda baudinii*)

The Baudin's Black Cockatoo is listed as Endangered under the EPBC Act and BC Act.

Baudin's Black Cockatoo is endemic to the south-west of WA. The range of Baudin's Black Cockatoo varies considerably between the breeding and non-breeding seasons. During the breeding season (from October to January), the species nests in isolated pockets of the far south-west of WA within Jarrah, Marri and Karri forests which receive an average of 750 mm of rainfall annually. In addition to the south-west there is an isolated patch of known breeding recorded at Perth Hills, east of Armadale (Johnstone & Storr 1998, Johnstone & Kirkby 2008). Breeding generally occurs in woodland or forest but may also occur in former woodland or forest now present as isolated trees withing partially cleared parkland or farmland. Nesting occurs in hollows of live or dead karri, marri, wandoo and tuart (*Eucalyptus gomphocephala*) trees (DSEWPaC 2012). During the breeding season feeding primarily occurs in native vegetation, particularly Marri (DSEWPaC 2012). The range then expands during the non-breeding season (from February) as flocks disperse to forage more widely, congregating on the central and northern parts of the Darling plateau, as far as Mundaring and Gidgegannup (DSEWPaC 2012; Saunders 1974 & 1979).

Baudin's Black Cockatoo were recorded in flight, foraging (Plate 1), loafing and perching at several locations within the Survey Area as shown in Table 26. In total Baudin's Black Cockatoo were recorded at 10 different locations with a total of 35 individuals observed. Baudin's Black Cockatoo foraging evidence was recorded at 21 different locations, with Marri nuts as the primary foraging evidence, Table 27 and Appendix A, Figure 5.



Plate 1 *Baudin's Black Cockatoo taken within the survey area.*

Table 26 *Baudin's Black Cockatoo observations*

Phase	Date	Observation type	Latitude	Longitude	Number of Individuals
Reconnaissance	29/06/2023	Perched with juvenile	-32.5422	116.2843	6
Phase 1	17/08/2023	Flying	-32.5377	116.3326	2
Phase 2	11/09/2023	Flying	-32.5739	116.3037	2
Phase 2	11/09/2023	Foraging	-32.5414	116.2834	11
Phase 2	11/09/2023	Flying	-32.5405	116.2833	2
Phase 2	11/09/2023	Flying	-32.5390	116.2833	1
Phase 2	12/09/2023	Flying	-32.5349	116.2826	6
Phase 2	12/09/2023	Flying	-32.5483	116.2178	2
Phase 3	22/10/2023	Flying	-32.5397	116.2566	2
Phase 3	18/10/2023	Flying	-32.5642	116.3153	1
Total observations					35

Table 27 *Baudin's Black Cockatoo foraging evidence recorded.*

Phase	Date	Latitude	Longitude	Foraging evidence type
Reconnaissance	30/06/2023	-32.5784	116.2166	Chewed marri nuts
Reconnaissance	30/06/2023	-32.6161	116.2107	Chewed marri nuts
Reconnaissance	30/06/2023	-32.6180	116.2202	Chewed marri nuts
Reconnaissance	30/06/2023	-32.6208	116.2243	Chewed marri nuts
Reconnaissance	30/06/2023	-32.6265	116.2284	Snotty gobble residue
Reconnaissance	24/07/2023	-32.5669	116.1714	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5854	116.3052	Chewed marri nuts
Reconnaissance	27/07/2023	-32.5556	116.2866	Chewed marri nuts
Phase 1	18/08/2023	-32.5595	116.2860	Chewed marri nuts
Phase 1	25/08/2023	-32.5330	116.2561	Chewed marri nuts
Phase 2	7/09/2023	-32.5594	116.2861	Chewed marri nuts
Phase 2	7/09/2023	-32.5838	116.2939	Chewed marri nuts
Phase 2	7/09/2023	-32.5796	116.2973	Chewed marri nuts
Phase 2	11/09/2023	-32.5395	116.2835	Chewed marri nuts
Phase 2	12/09/2023	-32.5383	116.2838	Chewed marri nuts
Phase 2	12/09/2023	-32.5311	116.2791	Chewed marri nuts
Phase 3	22/10/2023	-32.5113	116.2334	Chewed marri nuts
Phase 3	22/10/2023	-32.5223	116.2163	Chewed marri nuts
Phase 3	22/10/2023	-32.5172	116.2213	Chewed marri nuts
Phase 3	22/10/2023	-32.5140	116.2145	Chewed marri nuts
Phase 3	23/10/2023	-32.5423	116.2238	Chewed marri nuts

Carnaby's Black Cockatoo (*Zanda latirostris*)

The Carnaby's Black Cockatoo is listed as Endangered under the EPBC Act and BC Act.

Carnaby's Black Cockatoo is endemic to the south-west of WA from near Cape Arid on the south coast through the eastern Wheat Belt and north to about Kalbarri. Carnaby's Black Cockatoo nest in hollows of live or dead eucalypts, primarily smooth-barked Salmon Gum and Wandoo (Saunders 1979, 1982) though breeding has been reported in other Wheatbelt tree species and some tree species on the Swan Coastal Plain and Jarrah forest (Saunders 1979, 1982; Storr 1991; Johnstone & Storr 1998). Success in breeding is dependent on sufficient high quality foraging habitat located in proximity of nesting and is nominally a radius of up to 12 km of nesting sites (Saunders 1979, 1982; Saunders and Ingram 1987). Along with the trees that provide nest hollows, the protection and increase of this feeding habitat that supports the breeding of Carnaby's Black Cockatoo is a critical requirement for the conservation management of the species.

Carnaby's Black Cockatoos were rarely recorded within the Survey Area with only two observations during Phase 1 (Table 28). Foraging evidence was recorded within the Survey Area. Chewed marri nuts were recorded at two locations, Table 29 and Appendix A, Figure 5.

Table 28 Carnaby's Black Cockatoo observations

Phase	Date	Observation type	Latitude	Longitude	Number of individuals
Phase 1	22/08/2023	Flying	-32.5434	116.2484	1
Phase 1	22/08/2023	Perched	-32.5678	116.2377	2

Table 29 Carnaby's Black Cockatoo foraging evidence

Phase	Date	Latitude	Longitude	Foraging evidence type
Single target	15/12/2023	-32.4737	116.2589	Chewed marri nuts
Single target	15/12/2023	-32.4724	116.2558	Chewed marri nuts

Western Brush Wallaby (*Notamacropus irma*)

The Western Brush Wallaby is listed as Priority 4 by the DBCA.

The Western Brush Wallaby occurs widely through south-west WA although its former distribution was more extensive, having contracted due to habitat loss from historical and ongoing land clearing. It is a medium size macropod with a head body of 900mm and has distinctive pale stripes on its face with black and white ears and black feet and hands (Van Dyck et al., 2013). Western Brush Wallaby is locally common in dry sclerophyll forest and woodlands in the southwest of WA (Menkhorst & Knight 2010). They are predominantly diurnal, grazing on grasses and forbs.

During the Survey the Western Brush Wallaby had a total of 143 observations (161 individuals) with throughout the Survey Area. Observations mainly consisted opportunistic sightings and remote camera within Jarrah-marri forest Table 30. Opportunistic observations of Western Brush Wallaby accounted for 57 of the observations Remote cameras accounted for 11 Western Brush Wallaby observations (Plate 2). Locations of Western Brush Wallaby observations during the survey are presented In Table 30 and Appendix A, Figure 4.



Plate 2 Western Brush Wallaby recorded via remote camera.

Table 30 Western Brush Wallaby Records from the survey area

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Reconnaissance	29/06/2023	Individual	-32.5508	116.3301	1
Reconnaissance	29/06/2023	Individual	-32.5724	116.3276	1
Reconnaissance	29/06/2023	Individual	-32.5350	116.2844	1
Reconnaissance	30/06/2023	Individual	-32.5629	116.3154	1
Reconnaissance	30/06/2023	Individual	-32.5861	116.3150	1
Reconnaissance	30/06/2023	Fresh scat	-32.5666	116.2338	1
Reconnaissance	30/06/2023	Fresh scat	-32.5679	116.2345	1
Camera Rotation	27/07/2023	Individual	-32.5474	116.3300	1
Camera Rotation	27/07/2023	Fresh scat	-32.5575	116.3128	1
Phase 1	14/08/2023	Fresh scat	-32.5685	116.2594	1
Phase 1	14/08/2023	Individual	-32.5501	116.3156	1
Phase 1	16/08/2023	Remote camera	-32.5545	116.2861	2
Phase 1	18/08/2023	Individual	-32.5280	116.2740	1
Phase 1	18/08/2023	Individual	-32.5077	116.2663	1
Phase 1	20/08/2023	Remote camera	-32.5985	116.1155	1
Phase 1	20/08/2023	Remote camera	-32.5710	116.3274	1
Phase 1	20/08/2023	Individual	-32.5525	116.3155	1
Phase 1	20/08/2023	Individual	-32.5747	116.3151	1
Phase 1	20/08/2023	Individual	-32.5815	116.3151	1
Phase 1	21/08/2023	Individual	-32.5635	116.3154	1
Phase 1	22/08/2023	Individual	-32.4993	116.2281	2
Phase 1	22/08/2023	Individual	-32.5565	116.3155	1
Phase 1	22/08/2023	Individual	-32.5535	116.3155	1
Phase 1	22/08/2023	Individual	-32.5247	116.2502	1

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Phase 1	23/08/2023	Remote camera	-32.6316	116.1140	1
Phase 1	23/08/2023	Individual	-32.5289	116.2452	1
Phase 1	24/08/2023	Individual	-32.5120	116.2866	1
Phase 1	24/08/2023	Individual	-32.6308	116.0798	1
Phase 1	24/08/2023	Individual	-32.6328	116.1077	1
Phase 1	24/08/2023	Old scat	-32.5358	116.3336	1
Phase 1	25/08/2023	Individual	-32.4799	116.2715	1
Phase 1	25/08/2023	Individual	-32.5152	116.2451	1
Phase 2	5/09/2023	Fresh scat	-32.5407	116.2595	1
Phase 2	6/09/2023	Individual	-32.5783	116.3152	1
Phase 2	6/09/2023	Individual	-32.5387	116.3268	1
Phase 2	7/09/2023	Remote camera	-32.5364	116.2621	1
Phase 2	7/09/2023	Remote camera	-32.5453	116.2569	1
Phase 2	9/09/2023	Remote camera	-32.4978	116.2715	1
Phase 2	9/09/2023	Remote camera	-32.5589	116.2374	1
Phase 2	9/09/2023	Remote camera	-32.5589	116.2374	1
Phase 2	10/09/2023	Remote camera	-32.5483	116.2527	1
Phase 2	10/09/2023	Individual	-32.5117	116.2871	1
Phase 2	10/09/2023	Individual	-32.5241	116.2767	1
Phase 2	10/09/2023	Individual	-32.5690	116.2954	1
Phase 2	10/09/2023	Individual	-32.5695	116.2958	1
Phase 2	10/09/2023	Individual	-32.5731	116.3280	1
Phase 2	11/09/2023	Individual	-32.5144	116.2449	1
Phase 2	11/09/2023	Individual	-32.5192	116.2486	1
Phase 2	11/09/2023	Fresh scat	-32.5417	116.2837	1
Phase 2	12/09/2023	Remote camera	-32.5334	116.2649	1
Phase 2	12/09/2023	Deceased individual	-32.5584	116.2891	1
Phase 2	12/09/2023	Individual	-32.5310	116.2780	1
Phase 2	12/09/2023	Individual	-32.5026	116.2363	1
Phase 2	14/09/2023	Individual	-32.5455	116.2570	2
Phase 2	14/09/2023	Individual	-32.5362	116.2630	1
Phase 3	17/10/2023	Deceased individual	-32.5404	116.2604	1
Phase 3	18/10/2023	Individual	-32.5097	116.2882	1
Phase 3	18/10/2023	Individual	-32.5718	116.2984	2
Phase 3	18/10/2023	Individual	-32.5587	116.3041	1
Phase 3	18/10/2023	Individual	-32.5698	116.3153	1
Phase 3	18/10/2023	Individual	-32.5589	116.3155	1
Phase 3	18/10/2023	Individual	-32.5505	116.2601	1
Phase 3	19/10/2023	Individual	-32.5127	116.2854	1
Phase 3	19/10/2023	Fresh scat	-32.5082	116.2882	1

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Phase 3	19/10/2023	Individual	-32.5634	116.2913	1
Phase 3	20/10/2023	Individual	-32.5127	116.2853	1
Phase 3	20/10/2023	Fresh scat	-32.5529	116.3156	1
Phase 3	20/10/2023	Individual	-32.5239	116.2508	1
Phase 3	20/10/2023	Individual	-32.5263	116.2514	1
Phase 3	20/10/2023	Individual	-32.4980	116.2319	1
Phase 3	20/10/2023	Individual	-32.5323	116.2568	1
Phase 3	21/10/2023	Individual	-32.5653	116.2924	1
Phase 3	21/10/2023	Individual	-32.5727	116.3025	1
Phase 3	21/10/2023	Individual	-32.5440	116.2615	2
Phase 3	21/10/2023	Individual	-32.5035	116.2309	1
Phase 3	22/10/2023	Individual	-32.5273	116.2531	1
Phase 3	22/10/2023	Individual	-32.5183	116.2195	1
Phase 3	22/10/2023	Fresh scat	-32.5173	116.2348	1
Phase 3	23/10/2023	Individual	-32.5175	116.2477	1
Phase 3	23/10/2023	Individual	-32.5481	116.3157	1
Single target	14/12/2023	Individual	-32.4857	116.2731	1
Single target	14/12/2023	Individual	-32.4879	116.2735	1
Single target	16/12/2023	Remote camera	-32.4740	116.2606	1
Single target	17/12/2023	Remote camera	-32.4740	116.2606	2
Single target	18/12/2023	Remote camera	-32.4740	116.2606	1
Single target	19/12/2023	Remote camera	-32.4740	116.2606	2
Single target	20/12/2023	Remote camera	-32.4740	116.2606	2
Single target	21/01/2024	Remote camera	-32.4740	116.2606	1
Single target	24/12/2023	Remote camera	-32.4740	116.2606	1
Single target	26/12/2023	Remote camera	-32.4740	116.2606	1
Single target	27/12/2023	Remote camera	-32.4740	116.2606	1
Single target	1/01/2024	Remote camera	-32.4740	116.2606	1
Single target	10/01/2024	Remote camera	-32.4740	116.2606	1
Single target	13/01/2024	Remote camera	-32.4740	116.2606	1
Single target	18/01/2024	Remote camera	-32.4740	116.2606	2
Single target	21/01/2024	Remote camera	-32.4739	116.2606	1
Single target	22/01/2024	Remote camera	-32.4740	116.2607	1
Single target	17/12/2023	Remote camera	-32.4724	116.2571	1
Single target	18/12/2023	Remote camera	-32.4724	116.2571	1
Single target	19/12/2023	Remote camera	-32.4724	116.2571	1
Single target	22/12/2023	Remote camera	-32.4724	116.2571	1
Single target	26/12/2023	Remote camera	-32.4724	116.2571	1
Single target	27/12/2023	Remote camera	-32.4724	116.2571	1
Single target	30/12/2023	Remote camera	-32.4724	116.2571	1

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Single target	5/01/2024	Remote camera	-32.4724	116.2571	2
Single target	8/01/2024	Remote camera	-32.4724	116.2571	1
Single target	11/01/2024	Remote camera	-32.4724	116.2571	1
Single target	12/01/2024	Remote camera	-32.4724	116.2571	1
Single target	18/01/2024	Remote camera	-32.4724	116.2571	1
Single target	24/01/2024	Remote camera	-32.4724	116.2571	1
Single target	25/01/2024	Remote camera	-32.4724	116.2571	1
Single target	16/12/2023	Remote camera	-32.4753	116.2641	1
Single target	20/12/2023	Remote camera	-32.4753	116.2641	1
Single target	21/12/2023	Remote camera	-32.4753	116.2641	1
Single target	22/12/2023	Remote camera	-32.4753	116.2641	1
Single target	23/12/2023	Remote camera	-32.4753	116.2641	1
Single target	24/12/2023	Remote camera	-32.4753	116.2641	1
Single target	25/12/2023	Remote camera	-32.4753	116.2641	1
Single target	18/12/2023	Remote camera	-32.4843	116.2722	1
Single target	19/12/2023	Remote camera	-32.4843	116.2722	2
Single target	20/12/2023	Remote camera	-32.4843	116.2722	2
Single target	21/12/2023	Remote camera	-32.4843	116.2722	2
Single target	23/12/2023	Remote camera	-32.4843	116.2722	2
Single target	24/12/2023	Remote camera	-32.4843	116.2722	1
Single target	28/12/2023	Remote camera	-32.4843	116.2722	1
Single target	30/12/2023	Remote camera	-32.4843	116.2722	1
Single target	2/01/2024	Remote camera	-32.4843	116.2722	2
Single target	16/12/2023	Remote camera	-32.4771	116.2673	1
Single target	18/12/2023	Remote camera	-32.4771	116.2673	1
Single target	20/12/2023	Remote camera	-32.4771	116.2673	2
Single target	27/12/2023	Remote camera	-32.4771	116.2673	1
Single target	31/12/2023	Remote camera	-32.4771	116.2673	1
Single target	2/01/2024	Remote camera	-32.4771	116.2673	1
Single target	8/01/2024	Remote camera	-32.4771	116.2673	3
Single target	17/01/2024	Remote camera	-32.4771	116.2673	1
Single target	18/01/2024	Remote camera	-32.4771	116.2673	1
Single target	20/12/2023	Remote camera	-32.4818	116.2717	1
Single target	21/12/2023	Remote camera	-32.4818	116.2717	1
Single target	23/12/2023	Remote camera	-32.4818	116.2717	1
Single target	24/12/2023	Remote camera	-32.4818	116.2717	1
Single target	29/12/2023	Remote camera	-32.4818	116.2717	1
Single target	2/01/2024	Remote camera	-32.4818	116.2717	1
Total individuals sighted					161

**This number is events recorded on camera and does not imply to number of individuals.

Chuditch (*Dasyurus geoffroi*)

The Western Quoll or Chuditch is listed as Vulnerable under the BC Act and EPBC Act.

The Chuditch is WA's largest extant carnivorous marsupial and is endemic to the south-west. It has mostly brown fur with distinctive white spots (4 to 7 white spots on its body but not on its tail). The head body length is up to 40 cm and tail to 35 cm long. The Chuditch feeds mostly on large invertebrates. It also eats small lizards, birds and mammals. They are also known to consume the red pulp on *Zamia* seeds, small fruits and part of flowers. They utilise hollow logs or burrows for a den during the day and hunt at night. It is an excellent climber and will hunt for prey arboreally. Historically, Chuditch inhabited a wide range of habitats, but today it survives mostly in Jarrah (*E.marginata*) forests and heathlands of the south-west, and woodlands of the Great Southern (DBCA 2017a).

Chuditch were recorded on 16 remote cameras at several locations in Jarrah-Marri woodlands, Table 31. (see Appendix A, Figure 4). Physical assessments were conducted on the Chuditch, where camera trap images were analysed in detail to identify individuals from their spot patterns. From this assessment four different individuals were identified in the Survey Area (for analysis, Chuditch camera capture (*Dasyurus geoffroi*) physical assessment data). There is a likelihood that more individuals reside in the Survey Area as not all camera images show identifying features.



Plate 3 Chuditch recorded via remote camera

Table 31 Chuditch observations

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Reconnaissance	2/07/2023	Remote camera	-32.5862	116.3128	1
Reconnaissance	2/07/2023	Remote camera	-32.5862	116.3128	1
Reconnaissance	6/07/2023	Remote camera	-32.5862	116.3128	1
Reconnaissance	10/07/2023	Remote camera	-32.5862	116.3128	1
Reconnaissance	3/07/2023	Remote camera	-32.5545	116.2861	1
Phase 1	19/08/2023	Remote camera	-32.5695	116.3146	1
Phase 1	21/08/2023	Remote camera	-32.5695	116.3146	1

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Phase 1	24/08/2023	Remote camera	-32.5695	116.3146	1
Phase 1	24/08/2023	Remote camera	-32.5840	116.3146	1
Phase 1	25/08/2023	Remote camera	-32.5840	116.3146	1
Phase 1	17/08/2023	Remote camera	-32.5812	116.3142	1
Phase 1	18/08/2023	Remote camera	-32.5812	116.3142	1
Phase 1	25/08/2023	Remote camera	-32.5727	116.3149	1
Phase 1	25/08/2023	Remote camera	-32.5727	116.3149	1
Phase 1	17/08/2023	Remote camera	-32.5757	116.3147	1
Single Target	3/01/2024	Remote camera	-32.4878	116.2738	1
Total observations					16

**This number is events recorded on camera and does not imply to number of individuals.

Quokka (*Setonix brachyurus*)

The Quokka is listed as Vulnerable under the EPBC Act and BC Act.

The current distribution of the mainland quokka includes areas through the south-west forests from Jarrahdale to Walpole. The mainland quokka lives in the Darling Range and south-west regions of WA, mostly inhabiting densely vegetated swamps and sometimes tea-tree thickets on sandy soils along creek systems and dense heath on slopes. Mainland quokkas tend to hide in runs among vegetation during the day and forage along the swamp margins at night (Kitchener 1995).

In the southern forest, quokkas occupy a range of forest, woodland and wetland ecotypes. The most commonly occupied sites comprise Jarrah (*Eucalyptus marginata*), Marri (*Corymbia calophylla*), Karri (*E. diversicolor*) or Tingle (*E. jacksonii* or *E. guilfoylei*) forest and riparian habitats with a sedge dominated understorey (DEC 2013). Habitat supporting a low density of near-surface fuel, a complex vegetation structure and burn patchiness are the factors favouring quokka occupancy in the southern forest (DEC 2013). The habitat critical to survival for the south coast subpopulation includes a wider range of vegetation types (floristically and structurally) than in the northern Jarrah forest, including swamps, riparian areas, incised gullies and dense coastal heath (de Tores et al. 2007).

Quokkas were observed via remote cameras on 16 different occasions and locations with some camera events having three individuals in one image (Plate4). Secondary signs of Quokkas, Runnels and Scats, were found within the survey and recorded. Locations of Quokka observations are presented in Table 32 and Appendix A, Figure 4.



Plate4 Quokkas recorded via remote cameras.

Table 32 Quokka observations

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Reconnaissance	29/06/2023	Runnels	-32.5145	116.1925	
Reconnaissance	30/06/2023	Fresh tracks	-32.5677	116.2346	
Reconnaissance	1/07/2023	Remote camera	-32.5142	116.1927	1
Reconnaissance	2/07/2023	Remote camera	-32.5142	116.1927	1
Reconnaissance	2/07/2023	Remote camera	-32.5142	116.1927	2
Reconnaissance	3/07/2023	Remote camera	-32.5142	116.1927	3
Reconnaissance	3/07/2023	Remote camera	-32.5142	116.1927	2
Reconnaissance	3/07/2023	Remote camera	-32.5142	116.1927	2
Reconnaissance	5/07/2023	Remote camera	-32.5142	116.1927	1
Reconnaissance	6/07/2023	Remote camera	-32.5142	116.1927	1
Reconnaissance	7/07/2023	Remote camera	-32.5142	116.1927	1
Camera Rotation	11/07/2023	Remote camera	-32.5142	116.1927	1
Camera Rotation	11/07/2023	Remote camera	-32.5142	116.1927	1
Camera Rotation	11/07/2023	Remote camera	-32.5142	116.1927	1
Camera Rotation	12/07/2023	Remote camera	-32.5142	116.1927	2
Camera Rotation	19/07/2023	Remote camera	-32.5142	116.1927	1
Camera Rotation	21/07/2023	Remote camera	-32.5142	116.1927	2
Camera Rotation	27/07/2023	Fresh scat	-32.5807	116.1920	1
Camera Rotation	30/07/2023	Remote camera	-32.5663	116.2356	1
Phase 3	22/10/2023	Runnels	-32.5076	116.2316	
Phase 3	22/10/2023	Fresh scat	-32.5129	116.2340	1
Total observations					25

**This number is events recorded on camera and does not imply to number of individuals.

Dell's Skink (*Ctenotus dellii*)

The Dell's Skink is listed as Priority 4 by the DBCA.

The Dell's Skink has a uniform dark olive to coppery body with a pattern less back with a pale/white dorsal and mid lateral stripe broken into a series of dashes with brown limbs with specks of black. It has a snout-vent length of 63mm (Wilson & Swan 2021). Associated with Jarrah-Marri woodland that has a shrub-dominated understorey, on laterite, sandy or clay soils. It is found in the north Darling Range and inhabits dry sclerophyll forest on granite outcrops, stony hills, and ranges. It is absent from the Swan Coastal Plain (Cogger 2014; Wilson & Swan 2021).

During the trapping phases (Phase 2 and Phase 3) a total of three Dell's skinks were captured in Funnel and Bucket traps. During Phase 2 Dell's skink was only recorded at Quadrat 3, however during Phase 3 the single capture was at Quadrat 5. Observing the three captured Dell's Skinks (Plate5) there were no recaptures. Locations of these captures are presented below in Table 33 and Appendix A, Figure 4.

Table 33 Dell's Skink recorded in Survey Area

Phase	Date	Trap Site	Latitude	Longitude	Number of individuals
Phase 2	12/09/2023	Q3	-32.5671	116.2599	1
Phase 2	12/09/2023	Q3	-32.5671	116.2599	1
Phase 3	20/10/2023	Q5	-32.5502	116.3149	1
Total captures					3



Plate5 Dell's skink captured at trap site 3.

Quenda (*Isoodon fusciventer*)

The Quenda is listed as Priority 4 under the BC Act.

The Quenda has patchy distribution through a range of forest, woodland, shrubland and heathland habitats from east of Two People Bay through the Jarrah/Karri forests of lower south-west, and north to Perth region where several local re-introduction programs has successfully re-instated this species to some of its former northern range on the Swan Coastal Plain. Its habitat is generally dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses (Braithwaite, 1995). Unlike most other marsupials of similar size, this species appears to be quite resilient and able to survive in degraded and semi-developed lands, however it relies on suitable refuge habitat to avoid predators.

Quenda were observed via remote cameras once over the survey, with one quenda digging was also observed within the survey area. Quenda observations are recorded below in Table 34 and Appendix A, Figure 4.

Table 34 Quenda observations

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Camera Rotation	24/07/2023	Diggings	-32.5669	116.1713	
Camera Rotation	30/07/2023	Remote camera	-32.5403	116.2296	1
Total observations					1



Plate6 Quenda recorded via remote camera

Rakali (*Hydromys chrysogaster*)

The Rakali is listed as Priority 4 by DBCA

The Rakali, also known as the Water Rat, is identifiable by its large size, blunt nose and white tail-tip. It has thick otter-like fur and a thick tail. The Rakali's fur varies in colour depending on its locality from black to slate grey or white to orange (Van Dyck et al. 2013). The Rakali lives in the vicinity of permanent bodies of fresh, brackish estuarine, or marine water, lakes and farm dams, and on sheltered coastal beaches, mangroves and offshore islands. In the south-west of WA, they have been shown to prefer areas with riparian vegetation, better water quality and a degree of habitat complexity. Known to occur along major river systems of the south-west. Woody debris, rock ledges and wetland islands are likely to be important areas for feeding and refuge (DEC 2012). It is an

occasional vagrant to temporary waters. Rakali dens are made at the end of tunnels in banks and occasionally in logs (Van Dyck and Strahan 2013).

One Rakali was observed via remote camera (Plate7) on the banks of the large body of water along the N E Road. Camera location is recorded in Table 35 and Appendix A, Figure 4.

Table 35 Rakali observation during survey period

Phase	Date	Record type	Latitude	Longitude	Number of individuals
Phase 2	8/09/2023	Remote camera	-32.6322	116.0862	1



Plate7 Rakali observed via remote camera.

Carter's Fresh Water Mussel

Carter's Fresh Water Mussel (*Westralunio carteri*) listed as Vulnerable under the EPBC Act and BC Act

Carter's Freshwater Mussel is the only freshwater mussel species in the south-west of WA. Its range has contracted by 49% in less than 50 years, principally as a result of secondary salinisation (Klunzinger *et al.* 2011). The species is now confined to non-salinised rivers and streams, principally in forested catchments along the west and south coasts.

Two targeted transects along water bodies were conducted during the survey, with only a single observation of Carter's freshwater mussel being recorded. This included old remnant shells of Carter's Fresh Water Mussel observed on the banks of Lake Banksiadale, refer to Table 36 and Appendix A, Figure 4. No other observation of the species were made and no water bodies were present within the remainder of the survey area that could support the species. Lake Banksiadale and neighbouring Dandalup Dam are the only location this species is known to occur in the area, this is because the species requires permanent water present to persist and support the species lifecycle.

Table 36 Carter's Fresh Water Mussel survey effort

Phase	Date	Record type	Latitude	Longitude
Reconnaissance.	27/06/2023	Remnant shell	-32.65469	116.080259

Masked Owl (*Tyto novaehollandiae novaehollandiae*)

The Masked Owl listed as Priority 3 by the DBCA.

The Masked Owl is the largest owl in the South-west region of Western Australia. It is identified by its white circular facial disk, darker flecking, robust legs and hunched shoulders when perched (Nevill, 2013)

The Masked Owl is found in forests (wet and dry sclerophyll, non-eucalypt dominated), open woodlands, farmlands or scrub with large trees (12-20 m) and adjacent cleared country, timbered watercourses, paperbark woodlands, and caves (Pizzey & Knight 2012). It requires large hollows in old growth eucalypts or bare sand or the earth of a cave for nesting, and often favours areas with dense understorey or ecotones comprising dense and sparse ground cover. It is often recorded foraging within 100-300 m of the boundary of two vegetation types (Bell & Mooney 2002). The bird is restricted to the thicker humid forests of the southwest region, particularly in the Pemberton and Manjimup area and along the Murray River in the Lane Poole area. It nests in hollows in large Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*) and Jarrah (*E. marginata*) trees (Nevill 2013).

Masked Owls were recorded on three different SM4 Bird acoustic devices within the Survey Area, SM4-AC1 in the southwestern portion, SM4-AC3 in the Northeastern portion and SM4-A04 in the southeastern portion of the Survey Area, Table 37 and Appendix A, Figure 4. No sightings of masked owls were observed during nocturnal work.

Table 37 Masked Owl call recordings

Phase	Date	Acoustic device	Latitude	Longitude	No. of calls
Reconnaissance	28/06/2023	SM4-AC1	-32.6011	116.1895	6
Reconnaissance	29/06/2023	SM4-AC1	-32.6011	116.1895	1
Single target	24/07/2023	SM4-AC4	-32.6206	116.2244	3
Phase 1	16/08/2023	SM4-AC3	-32.5082	116.2888	5

Western False Pipistrelle (*Falsistrellus mackenziei*)

The Western False Pipistrelle is listed as Priority 4 under the BC Act.

The Western False Pipistrelle is a vespertilionid bat that occurs in Southwest Australia. It is an insectivore associated with old large trees that provides the species with its preferred foraging opportunities. Namely, flying insects are hunted around tall forest canopy in the valley between trees tops or the open areas above the mid-storey (Kitchener, Caputi and Jones, 1986). Their range is dominated by wet sclerophyll eucalypt forest and semi woodland of the southwest. Roosting sites are usually associated with old growth eucalypts containing hollows as well as within branches or tree stumps. The Western False Pipistrelle has been recorded on the Swan Coastal Plain in Banksia woodland (Kitchener, Caputi and Jones 1986).

A single recording of the Western False Pipistrelle was recorded on a SM4 Ultrasonic recording device in the Northeastern portion of the survey area Table 38 and Appendix A, Figure 4.

Table 38 Western False Pipistrelle call recordings

Phase	Date	Acoustic	Latitude	Longitude	No. of calls
Phase 1	20/08/2023	SM4-6	-32.5083	116.2881	1

4.3.2 Significant fauna likely to occur

Woylie (*Bettongia penicillate ogilbyi*)

The Woylie is listed as Critically Endangered under the BC Act and Endangered under the EPBC Act.

The Woylie is a small Potoroidae marsupial which is restricted to small remnant populations in the Southwest of Western Australia. Inhabiting dry sclerophyll forests with thick understoreys in the strongholds of Dryandra National Park, Tutanning Nature Reserve and Perup forest (Menkhorst & Knight, 2011). Identifiable by their grey brown with a distinctive brush like tail (Menkhorst & Knight, 2011).

Woylies were recorded via remote cameras in the adjacent survey area, O'Neil East, within the O'Neil Study Area (GHD 2024b). Areas with thick understories reside within the Survey Area in various locations. This species has been assessed as likely to occur within this suitable habitat, but at low densities, and potential below the level of detectability on current survey effort.

Numbat (*Myrmecobius fasciatus*)

The Numbat is listed as endangered under the BC Act, and EPBC Act.

Current Numbat populations, including source populations and re-introduced animals occupy eucalypt forest, woodland, and tall shrubland. Habitats generally require an abundance of termites (food) in the soil, and hollow logs, tree hollows, burrows and branches for shelter (DAWE 2021e; Van Dyck & Strahan 2008).

Sections of the southeastern portion of the O'Neil contains patches of open wandoo woodland representing suitable habitat within the species former range. This species has been assessed as likely to occur within this suitable habitat, but at low population density, and potentially below the level of detectability on current survey effort.

South-west Brush tailed Phascogale (*Phascogale tapoatafa wambenger*)

The South-west Brush-tailed Phascogale is listed as Conservation Dependant under the BC Act.

It occurs at low densities in the northern Jarrah forest with highest densities occurring in the Perup/Kingston area, Collie River valley and near Margaret River and Busselton. This species has been observed in dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover. Records are less common from wetter forests. They are most active between dusk and dawn (though emerging later in mid-winter) and forage almost exclusively among the tree canopies. Nest sites include hollow tree limbs, rotten stumps and even bird's nests. Lactating females show a preference for large tree cavities with small entrances. They are opportunistic feeders including invertebrates, nectar, small birds and small mammals (DBCA 2017b).

A South-west Brush tailed Phascogale was recorded via remote camera in the adjacent survey area, O'Neil East, approximately 1km from the O'Neil survey boundary. Suitable habitat is scattered throughout the Survey Area. This species has been assessed as likely to occur within this suitable habitat, but at low population density, and potentially below the level of detectability on current survey effort.

Peregrine Falcon (*Falco peregrinus macropus*)

The Peregrine Falcon is listed as specially protected under the BC Act.

The Peregrine Falcon is found on and near cliffs, gorges, timbered watercourses, riverine environments, wetlands, plains, open woodlands, and pylons and spires of buildings, though less frequently in desert regions (Morcombe 2004; Pizzey & Knight 2012). They are not common but can be found almost anywhere throughout WA and in the southwest, including particularly at Fitzgerald River, Stirling Range, Porongurup National Parks, Kondinin, and Peak Charles, with many more locations north of Perth (Nevill 2013).

This species has previously been recorded in the region, within the Holyoake block. Suitable habitat occurs within the Survey area. This species has been assessed as likely to occur within the survey area and possibly missed due to their efficient hunting skills, regardless of survey effort.

Southern Death Adder (*Acanthophis antarctius*)

The Southern Death Adder is listed as Priority 3 by the DBCA

The Southern Death Adder lives in forests, woodlands, grasslands and heaths. This species is highly cryptic as it sits in ambush in thick leaf litter and is often only visible when basking or active (Wilson and Swan, 2021). Altered fire regimes and habitat destruction are a cause of decline (Wilson and Swan, 2021)

This species is known from the region and was recorded in the Jarrahdale area West of the Survey Area in 2021 (GHD 2021a). Records of this species from Jarrahdale, Serpentine (hills) and East of Boddington. Habitat of Jarrah-Marri forest with patchy microhabitats of dense leaf litter and granitic areas are present within the survey area.

4.4 Black Cockatoo Use Assessment

The Black cockatoo habitat assessment focussed on qualifying and quantifying Black Cockatoo habitat values throughout the Survey Area. Due to the scale of the Survey Area habitat assessment plots were placed on aerial imagery across the Survey Area. With the sections of the Survey Area made up of haul roads (Contingency Area A – Infrastructure and Additional Haul Road).. The locations of plots were selected to sample all major broad vegetation associations previously mapped by Mattiske and Havel (1997). The twenty-six rectangular plots and two haul roads, each of the required two-hectare area and greater were sampled to determine quantify foraging and breeding habitat usage and potential value for Baudin’s, Carnaby’s, and Forest Red-tailed Black Cockatoo as described in section Black Cockatoo assessment. Table 39 presents a summary of black cockatoo habitat values and definitions as defined within the referral guidelines (DAWE 2022).

4.4.1 Breeding Habitat

The Survey Area contains several broad habitat types considered to be breeding habitats for all three locally occurring threatened Black cockatoo species. The broad fauna habitat types considered as breeding habitat include Jarrah-Marri forest and Wandoo woodland as shown in Table 22 and are extensive across the Survey Area. The Jarrah-Marri forest in particular also provides extensive high quality foraging habitat relevant to local cockatoo breeding.

4.4.2 Foraging Habitat

Foraging habitat for Baudin’s Black Cockatoo and Forest Red-tailed Black Cockatoo is extensive across the mapped habitat types and ranges from high for Jarrah-marri forest and low for Wandoo woodland. Whilst Foraging habitat was high for Carnaby’s Black Cockatoo, only a handful of foraging residue was observed within the Survey Area. A total of 303 signs of foraging evidence was recorded within the Survey Area, with 280 from Forest Red-tail Black Cockatoo, 21 from Baudin’s Black Cockatoo and two from Carnaby’s Black Cockatoo.

4.4.3 Roosting Habitat

No roosting trees were recorded within the Survey Area. However, potential roost trees are present within tall trees such as Jarrah-Marri and Blackbutt forests, and trees in proximity to water bodies. It is likely that roost locations are present particularly for the Forest Red-tailed Black Cockatoo in the Survey Area due to the large numbers of bird records. It is likely that location of any possible roosting site is dependent on habitat quality in relation to fire history, timber harvesting, dieback or other anthropomorphic behaviour.

Table 39 Black Cockatoo habitat usage

Habitat usage	Presence within the Survey Area	Evidence
Foraging habitat	Yes. Marri, Jarrah, Blackbutt, Grevillia and Snottygoble recorded	Extensive foraging evidence was found throughout the survey area for all three Black Cockatoo species. Forest Red-tailed Black Cockatoo had 280 observations of foraging evidence across the survey area, mainly in Jarrah-marri habitat. Baudin's Black Cockatoo 21 observations of foraging evidence and Carnaby's Black Cockatoo with two observations of foraging evidence observations.
Known nesting trees	Yes. Marri, Blackbutt	Three breeding trees were recorded during the survey period. Two hollows with signs of Black Cockatoo use were observed within the Survey Area. Refer Table 40
Suitable nesting trees	Yes, based off transect surveys only.	43 suitable nest trees recorded within the survey.
Suitable and priority nesting hollows	Yes	One suitable nesting hollow was recorded within the Survey Area which was checked by Tony Kirkby. However Tony was unable to access hollow to confirm Black Cockatoo usage, no external use by Black Cockatoo's were confirmed. Refer Table 40.

Legend:

Foraging habitat: Plant species known to support foraging within the species' range.

Known nesting trees: a tree that has a hollow in which black cockatoo breeding has been recorded.

Suitable nesting hollows: tree with suitable DBH range and with suitable nest hollow present but no evidence of nesting

Potential nesting tree: Trees with suitable DBH to develop a nest hollow, but currently lack hollows.



Breeding habitat: habitat that contains known, suitable or potential nest trees.

Priority nesting hollows: suitable nest hollows that have clear or possible signs of nesting activity such as chew marks at hollow entrance. Or cockatoo presence indicating possible breeding activity. During this survey priority hollows were labelled as requiring follow-up inspection Tony Kirkby via hollow camera or drone. Priority nest hollow is a hollow classification used in this report, but not defined within the guidelines (DAWE 2022).

Potential roost tree: Tall tree of any species, usually in close proximity to a freshwater water source

Known roosting tree: a tree (usually tallest) or any species usually in close proximity to fresh water that is confirmed to be used for night roosting either via cockatoo presence or strong evidence of roosting.

Table 40 Tony Kirkby Black Cockatoo hollow assessment

Tree specie	Latitude	Longitude	TK comments	Photo
Marri <i>(Corymbia calophylla)</i>	-32.6186	116.1135	No signs of use. No access to hollow. Possible black cockatoo hollow	
Marri <i>(Corymbia calophylla)</i>	-32.6185	116.1131	Well used black cockatoo hollow	


Tree specie	Latitude	Longitude	TK comments	Photo
Marri (<i>Corymbia calophylla</i>)	-32.5112	116.2806	Black cockatoo nest	
Marri (<i>Corymbia calophylla</i>)	-35.5862	116.3123	Blocked and not an actual hollow	No photo attached due to hollows not being present and or blocked.
Wandoo (<i>Eucalyptus wandoo</i>)	-32.5391	116.3335	Blocked and not an actual hollow	
Wandoo (<i>Eucalyptus wandoo</i>)	-32.5394	116.3335	Blocked and not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5307	116.1925	Not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5309	116.1926	Not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5833	116.3068	Blocked and not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5586	116.3263	Blocked and not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5472	116.3273	Blocked and not an actual hollow	
Jarraah (<i>Eucalyptus marginata</i>)	-32.5825	116.2946	Blocked and not an actual hollow	
Marri (<i>Corymbia calophylla</i>)	-32.5955	116.2793	Blocked and not an actual hollow	
Marri (<i>Corymbia calophylla</i>)	-32.5390	116.2832	Blocked and not an actual hollow	

Table 41 Black Cockatoo nesting breeding trees from transect data

	Area of habitat within Survey Area (ha)	Area of habitat within cockatoo assessment transects (ha)	Number of trees >50cm DBH within transects	Mean density trees >50cm DBH (trees/ha) within transects	Number of trees identified with potential hollows within transects	Number of trees identified with suitable breeding hollows within transects	Range of density potential breeding trees (DBH>50cm)/ha
Habitats							
Jarrah Marri Forest	9487.93	30	1596	53	29	3	8 - 166
Wandoo	67.39	4	40	10	3	0	8 - 32
Mixed Shrub Dampland	579.10	0	0	0	0	0	0
Bullich	216.15	0	0	0	0	0	0
Blackbutt	241.95	20	76	4	0	0	1-18
Granite Outcrop	237.64	0	0	0	0	0	0
Water body/reservoir	15.23	0	0	0	0	0	0
Rehabilitation	1573.31	0	0	0	0	0	0
Cleared areas	300.54	0	0	0	0	0	0
Total	12719.24	54	1712				

Table 42 Black Cockatoo tree type numbers across surveyed plots – O'Neill Contingency A

Tree Type – O'Neill Cont A	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	Plot 26
Jarrah	81	39	61	74	11	33	14	48	63	53	57	40	47	66	33	68	38	86	8	32	39	46	91	47	44	166
Marri	40	11	9	3	3	4	5	9	3	14	12	7	4	17	4	2	3	34	11	12	2	2	0	0	0	0
Blackbutt	4	0	5	0	6	0	7	12	5	0	18	6	1	0	0	0	6	0	5	0	0	0	0	0	0	0
Wandoo	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Flooded Gum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	1	2	1	0	0	4	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	125	50	75	77	52	38	28	70	71	67	91	61	53	83	37	70	55	120	24	44	41	48	91	47	44	166

Table 43 Black Cockatoo foraging quality habitat scores

Habitat types - Holyoake East Survey Area	Vegetation type (Mattiske)	Foraging quality score values and foraging habitat present		
		Baudin's Cockatoo	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Jarrah Marri Forest	D, P, PS, S, SW, PT, SP, DA, DG, ST, PW, E, TS, T	Foraging quality Score: 9 Jarrah, Marri nuts and blossom, sparse Banksia grandis and other banksia Grevillia species. Adjusted score due to fire in area	Foraging quality Score: 9 Wandoo blossom, very sparse banksia and Marri. Adjusted score due to fire in area	Foraging quality Score: 9 Wandoo blossom, sparse Allocasuarina and Marri. Adjusted score due to fire in area
Wandoo	AY, Y, YG, YS	Foraging quality Score: 7 Gum blossom, Grevillia. Sparse fringing Jarrah, Marri and Banksia	Foraging quality Score: 7 Gum blossom, Grevillia. Sparse fringing Jarrah, Marri and Banksia	Foraging quality Score: 7 Gum blossom, Grevillia. Sparse fringing Jarrah, Marri, Allocasuarina and Banksia
Mixed Shrubs Dampland	AD, AX, AC, A	Foraging quality Score: 7 Gum blossom, sparse Marri	Foraging quality Score: 7 Gum blossom, sparse Banksia, Jarrah and Marri	Foraging quality Score: 7 Gum blossom, sparse Banksia, Jarrah and Marri
Bullich	W	Foraging quality Score: 6 Bullich seed, Gum blossom, sparse Banksia, Jarrah and Marri	Foraging quality Score: 6 Bullich seed, gum blossom, sparse Banksia, Jarrah and Marri	Foraging quality Score: 6 Bullich seed, gum blossom, sparse Jarrah, Marri and Allocasuarina
Blackbutt	AW, C, CW	Foraging quality Score: 5 Limited foraging potential but has scattered Jarrah, Marri	Foraging quality Score: 5 Limited foraging potential but has scattered Jarrah, Marri	Foraging quality Score: 5 Limited foraging potential but has scattered Jarrah, Marri
Granite Outcrop Association	G, G1, R, R/G	Foraging quality Score: 7 Good supportive vegetation around outskirts of the granite including Grevillia, Callistemon and Banksia	Foraging quality Score: 7 Good supportive vegetation around outskirts of the granite including Grevillia, Callistemon and Banksia	Foraging quality Score: 5 Good supportive vegetation around outskirts of the granite including Grevillia and Allocasuarina.
Water body/reservoir	-	Foraging quality Score: 2. Some supportive vegetation for foraging also a water source	Foraging quality Score: 2. Some supportive vegetation for foraging also a water source	Foraging quality Score: 3. Some supportive vegetation for foraging also a water source
Rehabilitation	Rehab	Foraging quality Score: 4. Patches Jarrah and Marri just starting to fruit	Foraging quality Score: 4. Patches Jarrah and Marri just starting to fruit	Foraging quality Score: 4. Patches Jarrah and Marri just starting to fruit
Cleared areas	Cl	Foraging quality Score: 0.	Foraging quality Score: 0.	Foraging quality Score: 0.

5. Conclusion

Nine broad fauna habitat types were recorded within the Survey Area during the field survey based on flora species, hydrology, soil, and topography. They include, Jarrah-marri woodlands, Wandoo woodland, Mixed Shrub dampland, Bullich woodland, Blackbutt woodland, Granite formation associations, Water bodies, Rehabilitation areas and Cleared areas. Jarrah-Marri forest is the most extensive habitat covering an approximate 74.6% of the Survey Area. The remaining habitat types have relatively limited extent in the survey area, particularly Wandoo, Bullich, Blackbutt, Granite outcrop, Mixed Shrub damplands and Water body. The remaining cleared and rehabilitation areas make up 14.73% of the Survey Area.

The conservation value of each fauna habitat type is specific to the locally occurring significant fauna species and the type of usage by those species. For example, Jarrah-Marri forest provides extensive foraging habitat for Chuditch and all three Black Cockatoo species. Another example is Jarrah-Marri forest, Bullich, Blackbutt and Wandoo woodland provides foraging, roosting, and breeding habitat for the three locally occurring Black Cockatoos.

In total twelve significant fauna species was recorded within the Study Area during the field survey period including Baudin's Black Cockatoo, Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo, Chuditch, Quokka, Quenda, Western Brush Wallaby, Dell's Skink, Rakali, Masked Owl, Western False Pipistrelle and Carters Freshwater Mussels.

Baudin's Black Cockatoo, Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo are species that are resource dependant able to move through the environment targeting areas as required. At the time of the surveys good numbers of birds were recorded active and foraging particularly on Marri nuts. These species are able to breed within the survey area with two breeding hollows recorded during the survey. As the entire survey area was not traversed there is likely more breeding hollows scattered throughout the area.

Chuditch were recorded from 16 remote camera events with four individuals physically identify via spot pattern analysis. However, several events could not be attributed to an individual and not all animals would have been recorded, therefore it is likely that more than four individuals are present in the survey area.

Quokka were only recorded in damplands and ephemeral sections of Blackbutt forest where vegetation is most dense. These areas demonstrated runnels and scats and presented areas for remote camera placement. In total four locations recorded the presence of Quokkas and were all recorded on different drainage systems. Numbers in each population ranged from one to four animals but this is likely an underestimate due to the territorial nature of the species and linear habitat present. The population recorded on a tributary of Big Creek appeared to have the highest numbers with one remote camera image have three individuals recorded.

Only one Quenda was recorded in the survey area despite extensive remote cameras trapping effort within the survey area. The one recorded was within Jarrah Marri forest. We have found from other projects in the region (GHD 2021a, GHD 2021b, GHD 2024a, GHD 2024b) the Quenda are low in numbers and is likely due to extensive prescribed burning to key habitat within the region.

Western Brush Wallaby were common in the survey area with individuals recorded in most habitat areas. The high numbers of animals is likely attributed to the fox and cat control that is undertaken throughout the Jarrah forest. Therefore, the population is dependent on management actions undertaken.

Dell's Skink were recorded in two locations within Jarrah Forest and dampland habitat. Dell Skinks are a cryptic species and appear to be patchily distributed throughout the survey area. Population is likely to be localised in low numbers.

Rakali and Carters Freshwater Mussels were only recorded in Lake Banksiadale from single events. Both species require permanent water bodies to persist with Lake Banksiadale and South Dandalup Dam being the only permanent water body's in the region. Small isolated forest water dams are present however most dry up in the peak of summer or are not connected by any permanent or semi-permanent systems. The population of Rakali and Carters Freshwater Mussels in this area are sympatric and restricted with low/small populations present in the Lake Banksiadale system.

Masked Owl were recorded at three locations however two of these were relatively close together and be amalgamated as one location. The two remaining areas are separated by 13 km therefore are likely representing two family unit of which normally comprise a pair of birds. Therefore, based on our assessment two pairs are likely present within the survey area.

Western False Pipistrelle were recorded from one location within the survey area. This species was identified by calls, but no hollow/roost tree was identified. It is likely a population of the species is present in the survey area in a large hollow bearing tree.

A further five significant species were not confirmed present within the Study Area but are assessed likely to occur based on distribution patterns and habitat assessment including: Woylie, Numbat, Southwestern Brush-tailed Phascogale, Peregrine Falcon, and Southern Death Adder.

The most evident major threatening process to fauna habitat identified during the survey was the frequency, size and intensity of fire. Large areas of the Survey Area appeared to be burnt within the past three years impacting a large portion of the area in particular large mature hollow bearing habitat trees. Other threatening process include logging practices and feral pig activity.

6. References

- Allen, G.R., Midgley, S.H. and Allen, M. (2002). Field guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, Western Australia.
- ALCOA World Alumina Australia 2010, 'No 40. *Threatened fauna species management plans for Alcoa's bauxite mining operations in the Jarrah forest*'.
- Beard, JS 1979, Vegetation Survey of Western Australia: the Vegetation of the Pinjarra Area Western Australia, map and explanatory memoir 1:250,000 series, Applecross, Vegmap Publications.
- Bell, PJ & Mooney, N 2002, *Distribution, Habitat and Abundance of Masked Owls (Tyto novaehollandiae) in Tasmania*, In; *Ecology and Conservation of Owls*, Eds. Newton I, Kavanagh R, Olsen J, and Taylor I. CSIRO Publishing, Australia.
- Benshemesh, J. (2007). National Recovery Plan for Malleefowl. Department for Environment and Heritage, South Australia.
- Braithwaite, RW 1995, *Southern Brown Bandicoot*. In R. Strahan (Ed.) The Mammals of Australia. Australian Museum and Reed Books. Chatswood, NSW.
- Burbidge, AA 2004, '*Threatened Animals of Western Australia*'. Department of Conservation and Land Management, Perth.
- Bureau of Meteorology 2022, *Climate statistics for Australian locations*, retrieved June 2022, from <http://www.bom.gov.au/climate>
- Burgar, JM, Craig, MD & Stokes, VL 2015, '*The importance of mature forest as bat roosting habitat within a production landscape*', Forest Ecology and Management, vol 356, pp 112-123.
- Burgar, JM, Stokes, VL & Craig, MD 2017, '*Habitat features act as unidirectional and dynamic filters to bat use of production landscapes*', Biological conversations, vol 209, pp 280-288.
- Burn 2000, *A Survey of the impact of burning on mammals and birds in Alcoa's rehabilitated Bauxite mines at Jarrahdale*.
- Churchill, S 2008, *Australian Bats*, second edition, Milton, Australia, Allen & Unwin.
- Cogger, H 2014, *Reptiles and Amphibians of Australia*, Collingwood, Victoria, CSIRO Publishing.
- Craig, MD, White, DA, Stokes, VL & Prince, J 2017, '*Can postmining revegetation create habitat for a threatened mammal?*' Ecological Management & Restoration, vol 18 no. 2. Ecological Society of Australia and John Wiley & Sons Australia. Ltd.
- de Tores, P, Hayward, MW, Dillon, MJ & Brazell, RI 2007, '*Review of the distribution, causes for decline and recommendations for management of the quokka, Setonix bracyurus (Macropodidae: Marsupialia), an endemic macropodid marsupial from south-west Western Australia*', Conservation Science Western Australia, vol 6(1), pp 13-73.
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2023, *Environmental Protection and Biodiversity Conservation Act 1999 Protected Matters Search Tool Results*, retrieved May 2022, from <http://www.environment.gov.au/epbc/pmst/index.html>.
- Department of Agriculture, Water and the Environment (DAWE) 2021a, '*Atrichornis clamosus in Species Profile and Threats Database*', Department of the Environment, Canberra.
- Department of Agriculture, Water and the Environment (DAWE) 2021b, '*Calidris acuminata in Species Profile and Threats Database*', Department of the Environment, Canberra.
- Department of Agriculture, Water and the Environment (DAWE) 2021c, '*Calyptorhynchus banksii naso in Species Profile and Threats Database*', Department of the Environment, Canberra.

Department of Agriculture, Water and the Environment (DAWE) 2021d, '*Calyptorhynchus baudinii* in Species Profile and Threats Database', Department of the Environment, Canberra.

Department of Agriculture, Water and the Environment (DAWE) 2021e, '*Species Profile and Threats Database*', Department of the Environment, Canberra.

Department of Biodiversity, Conservation and Attractions (DBCA) 2007, '*NatureMap: Mapping Western Australia's Biodiversity*', retrieved May 2020, from <http://naturemap.dpaw.wa.gov.au/default.aspx/>.

Department of Biodiversity, Conservation and Attractions (DBCA) 2017a, '*Fauna profiles – Chuditch Dasyurus geoffroi*', retrieved from <http://www.dbca.wa.gov.au>

Department of Biodiversity, Conservation and Attractions (DBCA) 2017b, '*Fauna profiles – Brush-tailed Phascogale*', retrieved <http://www.dbca.wa.gov.au>

Department of Biodiversity, Conservation and Attractions (DBCA) 2021, Priority ecological communities for Western Australia, version 32, 05 2021, retrieved Month Year, from <https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority%20Ecological%20Communities%20list.pdf>

Department of Environment and Conservation (DEC) 2012a, '*Fauna Profiles. Water Rat (Rakali) Hydromys chrysogaster (Geoffrey, 1804)*', Department of Environment and Conservation, Perth, WA.

Department of Environment and Conservation (DEC) (2012b). Chuditch (*Dasyurus geoffroi*) Recovery Plan. Wildlife Management Program No. 54. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation (DEC) 2013, '*Quokka Setonix brachyurus Recovery Plan*', Wildlife Management Program No. 56, Department of Environment and Conservation, Perth, WA.

Department of Mines, industry Regulation and Safety (DMIRS) 18, GeoVIEW.WA, retrieved 05 2020, from <http://www.dmp.wa.gov.au/7113.aspx>.

Department of the Environment (DotE) (2015). Referral guideline for 14 birds listed as migratory species under the EPBC Act. Commonwealth of Australia.

Department of Primary Industries and Regional Development (DPIRD) 2020, Natural Resource Management Shared Land Information Portal (SLIP) Mapping, retrieved 05 2020, from <http://maps.agric.wa.gov.au/nrminfo/framesetup.asp>.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011a, '*Survey guidelines for Australia's threatened reptiles*', Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011b, '*Survey guidelines for Australia's threatened mammals*', Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2012, '*Referral guidelines for three species of Western Australian black cockatoos*', retrieved from: <http://www.environment.gov.au/epbc/publications/wa-black-cockatoos.html>.

Department of Agriculture Water and Energy (DAWE) 2022. Referral guidelines for 3 WA threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black-cockatoo. Department of Agriculture, Water and the Environment, Canberra.

Department of Water and Environmental Regulation (DWER) 2017, '*Water Information Reporting*', retrieved 05 2020, from <http://www.water.wa.gov.au/maps-and-data/monitoring/water-information-reporting>

Doherty, TS, Wingfield, BN, Stokes, VL, Craig, MD, Lee, JGH, Finn, HC & Calver, MC 2016, '*Successional changes in feeding activity by threatened cockatoos in revegetated mine sites*', Wildlife Research, vol 43, pp 93-104. CSIRO Publishing.

Environmental Management and Research Consultants (EMRC) 1992, '*Long Term Fauna Monitoring Program 1992*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 1995, '*Long term fauna monitoring program 1995*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 1998, '*Long Term Fauna Monitoring Program (1998)*', a report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 1999, '*A fauna survey of planned mining areas at Alcoa's Orion Mining Region*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2004, '*A Vertebrate Survey of Rehabilitated Areas at Alcoa's Huntly Mine site – year 2000 results*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2001a, '*Alcoa World Alumina Australia Ltd. Long Term Fauna Monitoring Program - 2001 results*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2001b, '*A Vertebrate Fauna Survey of rehabilitated areas at Alcoa's Willowdale Mine site – Year 2000 results*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2003, '*McCoy Long Term Fauna Monitoring Program 2003*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2006, '*Long term fauna monitoring program 2006*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2007a, '*McCoy Long Term Fauna Monitoring Program –results of the 2007 survey*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2007b, '*A Vertebrate Fauna Survey of Rehabilitated Area's at Alcoa's Huntly Minesite -year 2007 results Final Report*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2007, '*A Vertebrate Survey of Rehabilitated areas at Alcoa's Willowdale Minesite – Year 2007 results*', report prepared for Alcoa of Australia.

Environmental Management and Research Consultants (EMRC) 2015, '*Long Term Fauna Monitoring Program Summary of Results at Alcoa's Orion Mining Region*', report prepared for Alcoa of Australia.

Environmental Protection Authority (EPA) 2016a, '*EPA Technical Guidance –Terrestrial Fauna Surveys*', Perth.

Environmental Protection Authority (EPA) 2016b, '*EPA Technical Guidance – Sampling methods for terrestrial vertebrate fauna*', Perth.

Environmental Protection Authority (EPA) 2020, '*EPA Technical Guidance – Sampling methods for terrestrial vertebrate fauna*', Perth.

Freegard C (2007). Nomination of a Western Australian species for listing as threatened change of Status or delisting: Woylie. Report. Department of Environment and Conservation, Kensington, WA.

Garnett, ST & Crowley, GM 2000, '*The Action Plan for Australian Birds*', Environment Australia, Canberra.

GHD 2021a, Terrestrial Fauna Survey and Black Cockatoo Habitat Assessment for Huntly Mine – Myara North Pinjarra Alumina Refinery Revised Proposal. For Alcoa of Australia Limited. Unpublished Report

GHD 2021b, Terrestrial Fauna Survey and Black Cockatoo Habitat Assessment for Huntly Mine – Holyoake Pinjarra Alumina Refinery Revised Proposal. For Alcoa of Australia Limited. Unpublished Report

GHD 2024a, Terrestrial Fauna Survey Assessment, Holyoake Mine Development – O'Neil East. For Alcoa of Australia Limited. Unpublished Report.

GHD 2024b, O'Neil East Targeted Woylie Assessment. For Alcoa of Australia Limited. Unpublished report.

Government of Western Australia (GoWA) 2023, Data WA, retrieved 05 2023, from <https://data.wa.gov.au/>.

Higgins, PJ (ed.) 1999, '*Handbook of Australian, New Zealand & Antarctic Birds, Volume 4: Parrots to Dollarbird*', South Melbourne, Australia, Oxford University Press.

- Hohnen, R, Ashby, J, Tuft, K, & McGregor, H 2012, '*Individual identification of northern quolls (Dasyurus hallucatus) using remote cameras*', Australian Mammalogy, CSIRO Publishing.
<http://dx.doi.org/10.1071/AM12015>.
- Johnstone, RE & Kirkby, T 1999, '*Food of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south-west Western Australia*', *Western Australian Naturalist*, vol 22, pp 167-177.
- Johnstone, RE & Kirkby, T 2008, 'Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia', *Records of the Western Australian Museum*, vol 25, pp 107-118.
- Johnstone, RE & Storr, GM 1998, *Handbook of Western Australian Birds. Volume 1: Nonpasserines (Emu to Dollarbird)*, Western Australian Museum, Perth.
- Johnstone, RE and Storr, GM 2004, *Handbook of Western Australian Birds, Volume 2: Passerines (Blue-winged Pitta to Goldfinch)*, Perth, Australia, Western Australian Museum.
- Johnstone, RE 1997, 'Current studies on three endemic Western Australian cockatoos', *Eclectus*, vol 3, pp 34--35.
- Johnstone, RE, Kirkby, T & Sarti, K 2017, 'The distribution, status movements and diet of the Forest Red-tailed Black Cockatoo in the south-west with emphasis on the greater Perth regions', *Western Australian Naturalist*, vol 30 (4), pp 1-193.
- Jones, D & Goth, A (2008). *Mound-builders*. CSIRO Publishing. Victoria.
- Kavanagh, RP & Murray, M 1996, '*Home Range, Habitat and Behaviour of the Masked Owl Tyto novaehollandiae Near Newcastle, New South Wales*', *Emu Austral Ornithology, Journal of Birdlife Australia*, vol 96, pp 250-257, CSIRO publishing.
- Kitchener, DJ 1995, '*Quokka*', In R. Strahan (Ed.) *The Mammals of Australia*, Australian
- Kitchener, DJ, Caputi, N, Jones, B 1986, '*Revision of Australo-Papuan Pipistrellus and Falsistrellus (Microchiroptera: Vespertilionidae)*', *Records of the Western Australian Museum*, vol 12, pp 435–495, ISSN 0312-3162.
- Klunzinger MW 2012, 'Ecology, life history and conservation status of *Westralunio carteri* Iredale 1934, an endemic freshwater mussel of south-western Australia', PHD Thesis, Murdoch University, Perth Western Australia.
- Klunzinger, MK, Beatty, SJ, Morgan, DL, & Lymbery, AJ 2012, '*Distribution of Westralunio carteri Iredale, 1934 (Bivalvia: Unionoida: Hyriidae) on the south coast of south-western Australia, including new records of the species*', *Journal of the Royal Society of Western Australia*, vol 95, pp 77-81.
- Marchant, S & Higgins, PJ, (eds.) 1993, *Handbook of Australian, New Zealand and Antarctic Birds, Volume 2 - Raptors to Lapwings*, Melbourne, Victoria: Oxford University Press.
- Mastrantonis, S, Craig, MD, Renton, M, Kirkby, T & Hobbs, RJ 2019, '*Climate change indirectly reduces breeding frequency of a mobile species through changes in food availability*', *Ecosphere*, vol 10 (4), e02656.
 10.1002/ecs2.2656.
- Mattiske Consulting 2023, 'Holyoake east Flora and Vegetation Survey Report', in prep.
- Mattiske, EM & Havel JJ 1998, *Vegetation Mapping in the South West of Western Australia and Regional Forest Agreement vegetation complexes. Map sheets for Pemberton, Collie, Pinjarra, Busselton- Margaret River, Mt Barker, and Perth, Western Australia. Scale 1:250,000. Department of Conservation and Land Management, Perth.*
- Mawson, PR & Johnstone, RE 1997, 'Conservation status of parrots and cockatoos in Western Australia', *Eclectus*, vol 2, pp 4-9.
- McGregor, RA, Stokes, VL & Craig, MD 2014, '*Does forest restoration in fragmented landscapes provide habitat for a wide-ranging carnivore?*', *Animal Conservation*, vol 17, pp 467–475.
- McKenzie, N & Start, T (1999). *The Action Plan for Australian Bats 2000*. Environment Australia, Canberra, Australia.

- Menkhorst, P & Knight, F 2011, *A Field Guide to Mammals of Australia*, third edition, South Melbourne, Australia, Oxford University Press.
- Morcombe, M 2014, *Field Guide to Australian Birds*, Steve Parish Publishing, Archerfield, Queensland.
- Nevill, SJ 2013, *Birds of Western Australia*, Simon Nevill Publications, Perth, Western Australia.
- Pizzey, G & Knight, F 2012, *The Field Guide to the Birds of Australia*, Harper Collins Publishers, Sydney, Australia.
- Saunders, DA 1974, 'Subspeciation in the White-tailed Black Cockatoo, *Calyptorhynchus baudinii*, in Western Australia', Australian Wildlife Research, vol 1, pp 55-69.
- Saunders, DA 1979, 'Distribution and Taxonomy of the White-tailed and Yellow-tailed Black-Cockatoos *Calyptorhynchus spp*', Emu, vol 79, pp 215--227.
- Saunders, DA 1982, 'The breeding behaviour of the short-billed form of the White-tailed Black Cockatoo *Calyptorhynchus funereus*', Ibis, vol 124, pp 422--455.
- Saunders, DA and Ingram, JA 1987, 'Factors affecting survival of breeding populations of Carnaby's Cockatoo, *Calyptorhynchus latirostris* in remnants of native vegetation', IN: Saunders, DA, Arnold, GW, Burbidge, AA and Hopkins, AJM, Nature Conservation: the Role of Remnants of Native Vegetation, Surrey Beatty and Sons, Chipping Norton, pp 249-58.
- Shepherd, DP, Beeston, GR, and Hopkins, AJM 2002, Native Vegetation in Western Australia – Extent, Type and Status, Resource Management Technical Report 249, Department of Agriculture, Western Australia.
- Scida, M and Gratton, R 2017, 'Monitoring the threatened brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*) at Sugarloaf Reservoir, Victoria', Australian Mammalogy, vol 40(2), pp 307-311.
- Stokes, V 2011, 'Orion Long Term Fauna Monitoring Program 2010', Internal report for Alcoa of Australia.
- Stokes, V 2012, 'Vertebrate Fauna Survey of Planned Mining Areas at Alcoa's Keats Mining Region 2011/12', Internal report for Alcoa of Australia.
- Storr, GM 1991, *Birds of the South-west Division of Western Australia*. Records of the Western Australian Museum, Suppl. 35.
- Storr, GM, Smith, LA & Johnstone, RE 1999, *Lizards of Western Australia, Volume 1: Skinks*, revised edition, Perth, Western Australian Museum.
- Storr, GM, Smith, LA & Johnstone, RE 2002, *Snakes of Western Australia*, Western Australian Museum, Perth, W.A.
- Threatened Species Scientific Committee (TSSC) 2016a, 'Commonwealth Listing Advice on *Cacatua pastinator pastinator* (Muir's corella)', Department of the Environment, Canberra.
- Threatened Species Scientific Committee (TSSC) 2016b, 'Commonwealth Listing Advice on *Limosa lapponica* (Bar-tailed Godwit)', Department of the Environment, Canberra.
- Tyler, MJ & Doughty, P 2009, *Field Guide to Frogs of Western Australia*, Fourth Edition, Western Australian Museum.
- Van Dyck, S & Strahan, R 2008, *The Mammals of Australia*, fourth edition, Sydney, Australia, New Holland Publishers.
- Van Dyck, S., Gynther., I & Baker, A 2013. Field companion to the mammals of Australia. New Holland Publishers, Australia.
- Way, S, Stokes, V & Majer, J 2013, 'McCoy Long Term Fauna Monitoring Program Report of the 2013 Field Survey', report prepared for Alcoa of Australia by Environmental Research Department.
- Williams, K & Mitchell, D 2001, Jarrah Forest (JF1 – Northern Jarrah Forest subregion), A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002.
- Wilson, S & Swan, G 2021, *A Complete Guide to Reptiles of Australia*, Sixth edition, Sydney, Australia, New Holland Press.

Appendices

Appendix A

Figures

Figure 1 Location of Survey Area

Figure 2 Environmental constraints

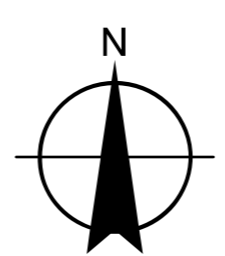
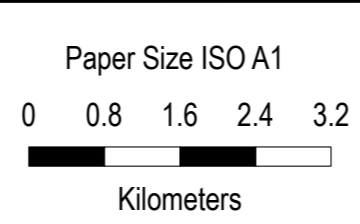
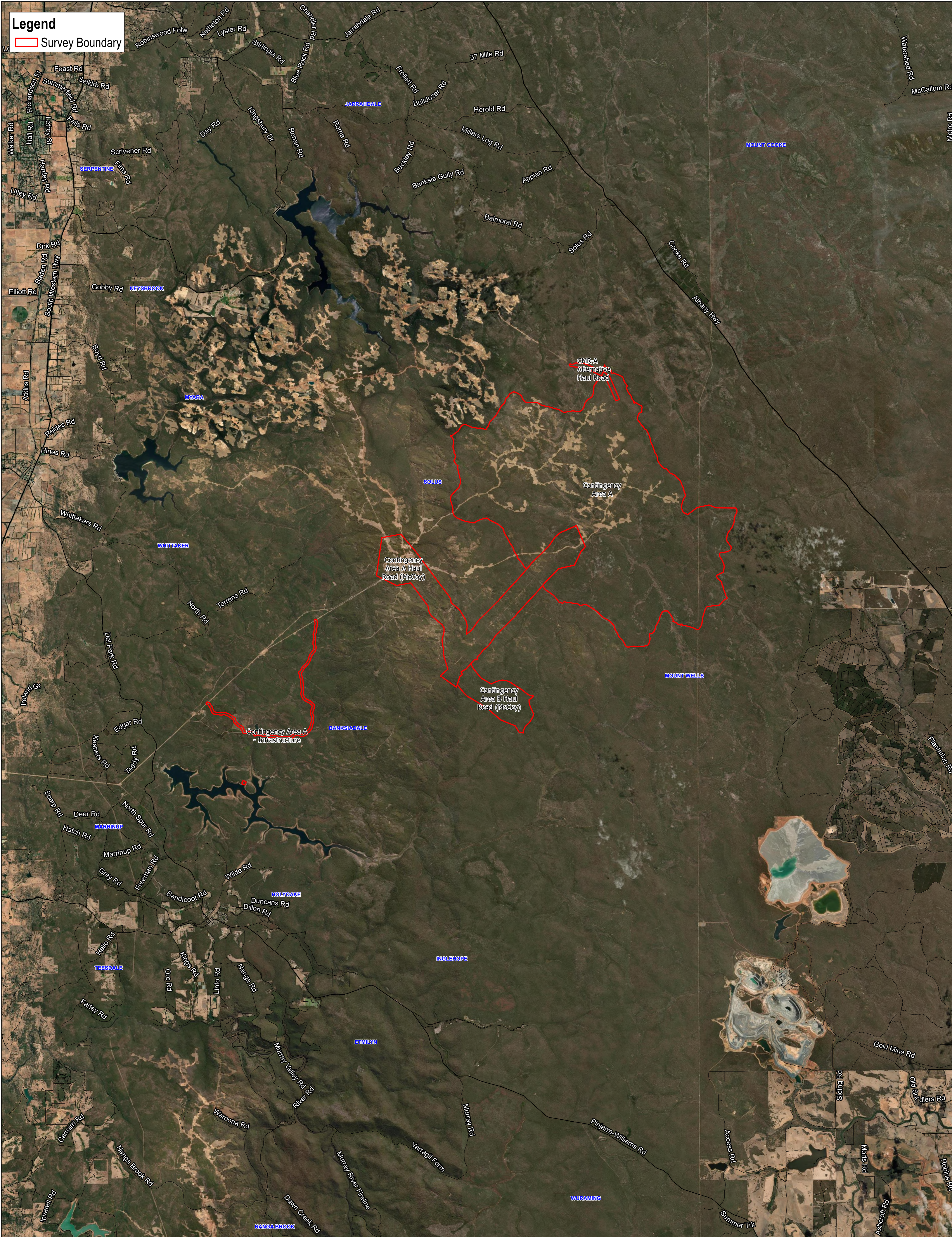
Figure 3 Fauna survey methods

Figure 4 Threatened fauna (other than Black Cockatoo)

Figure 5 Black Cockatoo

Figure 6 Fauna Habitat

Legend
 Survey Boundary



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50

Alcoa of Australia Ltd
 Terrestrial Fauna Assessment O'Neil

Project No. 12565572
 Revision No. 0
 Date 10/05/2024

Project Location

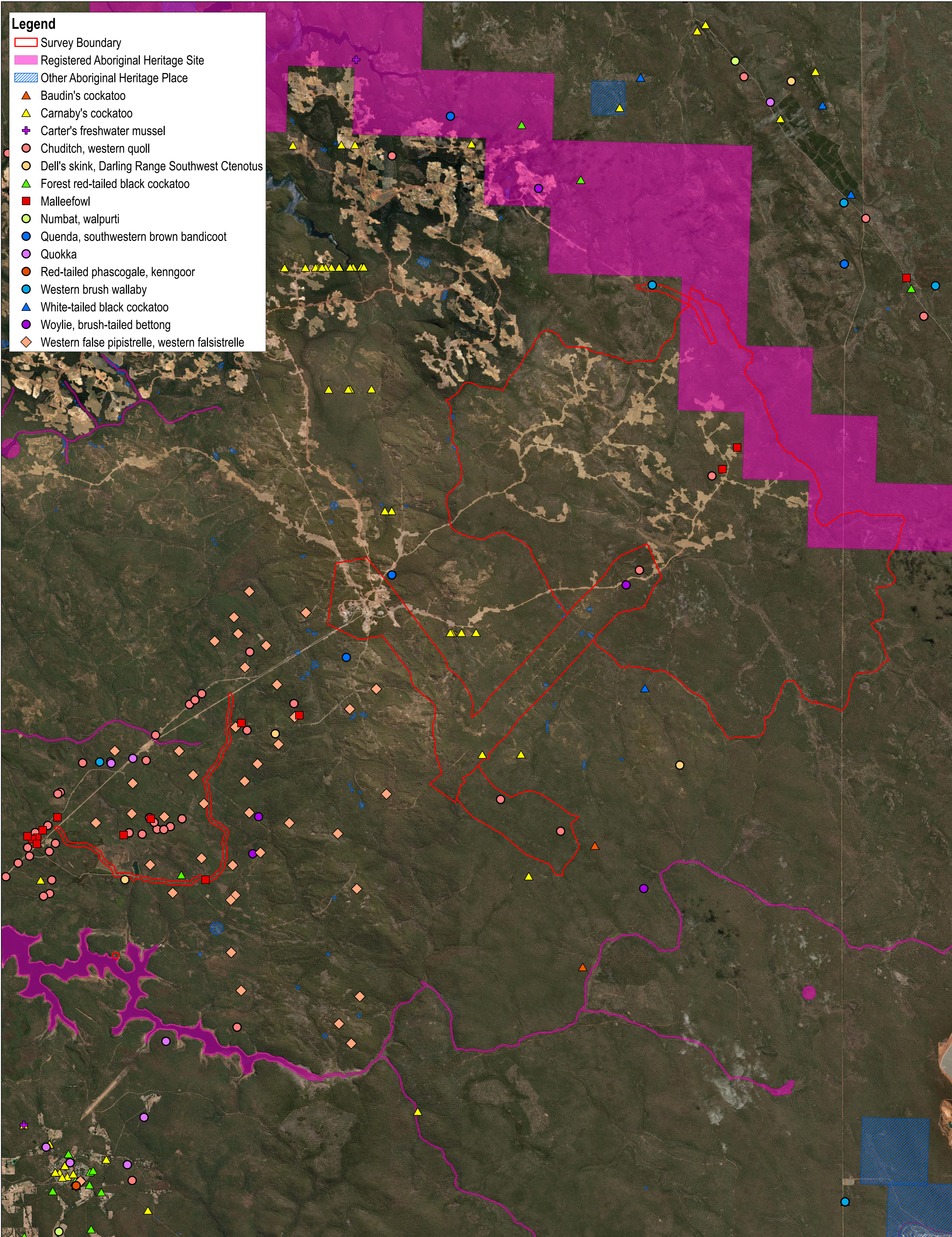
FIGURE 1

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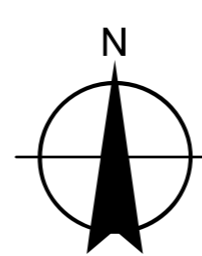
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Legend

- Survey Boundary
- Registered Aboriginal Heritage Site
- Other Aboriginal Heritage Place
- ▲ Baudin's cockatoo
- ▲ Carnaby's cockatoo
- + Carter's freshwater mussel
- Chuditch, western quoll
- Dell's skink, Darling Range Southwest Ctenotus
- ▲ Forest red-tailed black cockatoo
- Malleefowl
- Numbat, walpurti
- Quenda, southwestern brown bandicoot
- Quokka
- Red-tailed phascogale, kenngoor
- Western brush wallaby
- ▲ White-tailed black cockatoo
- Woylie, brush-tailed bettong
- ◆ Western false pipistrelle, western falsistrelle



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Map Projection: Transverse Mercator
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Alcoa of Australia Ltd
 Terrestrial Fauna Assessment O'Neil

Project No. 12565572
 Revision No. 1
 Date 10/05/2024

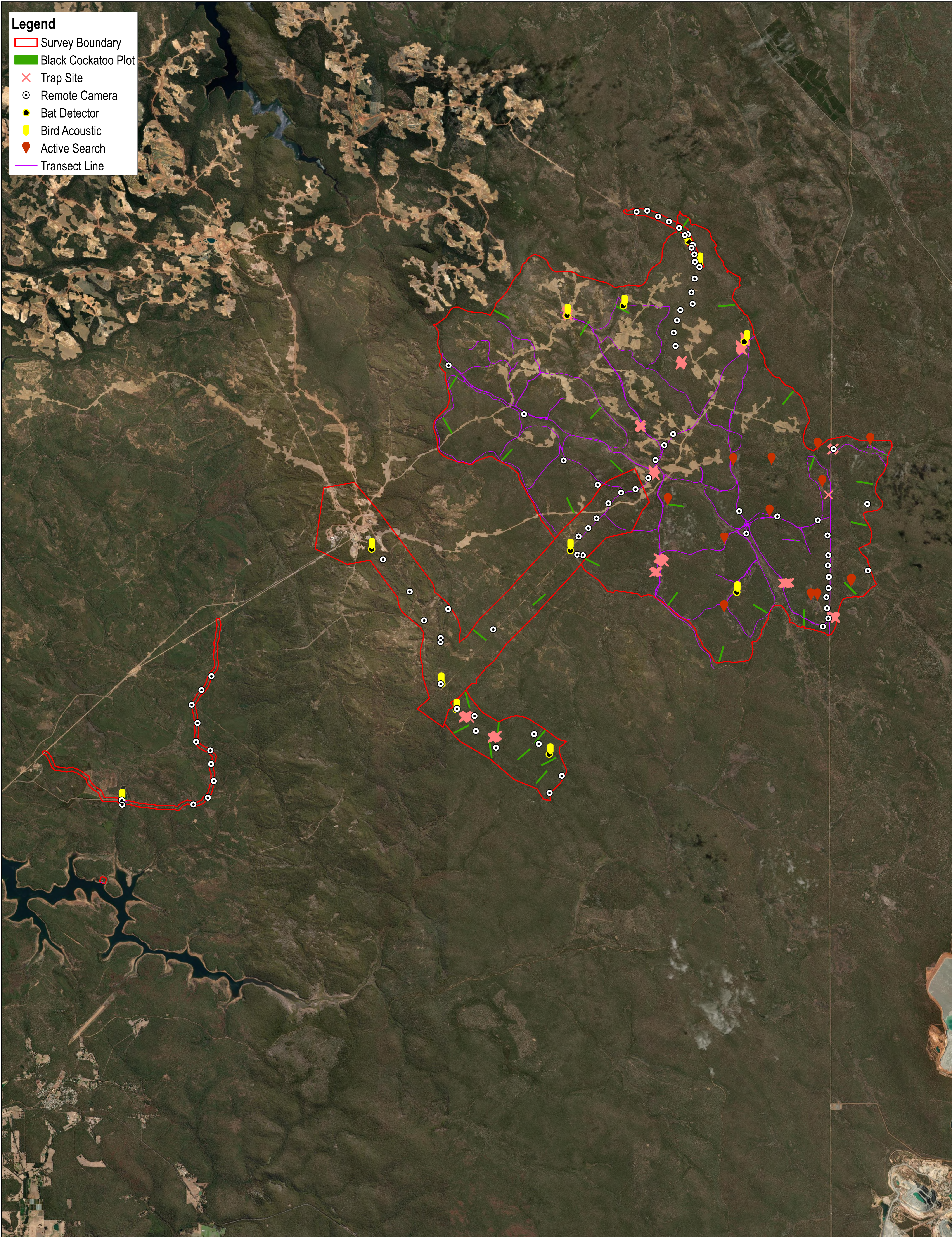
Ecological Constraints

FIGURE 2

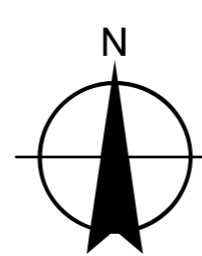
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Data source: World Imagery: Maxar. Created by: Mabez

- Legend**
- ▭ Survey Boundary
 - ▭ Black Cockatoo Plot
 - ✕ Trap Site
 - Remote Camera
 - Bat Detector
 - Bird Acoustic
 - Active Search
 - Transect Line



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Map Projection: Transverse Mercator
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Fauna Survey Methods

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FIGURE 3

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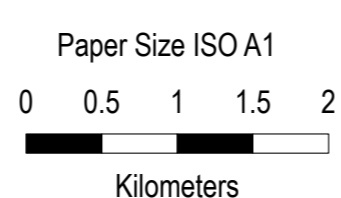
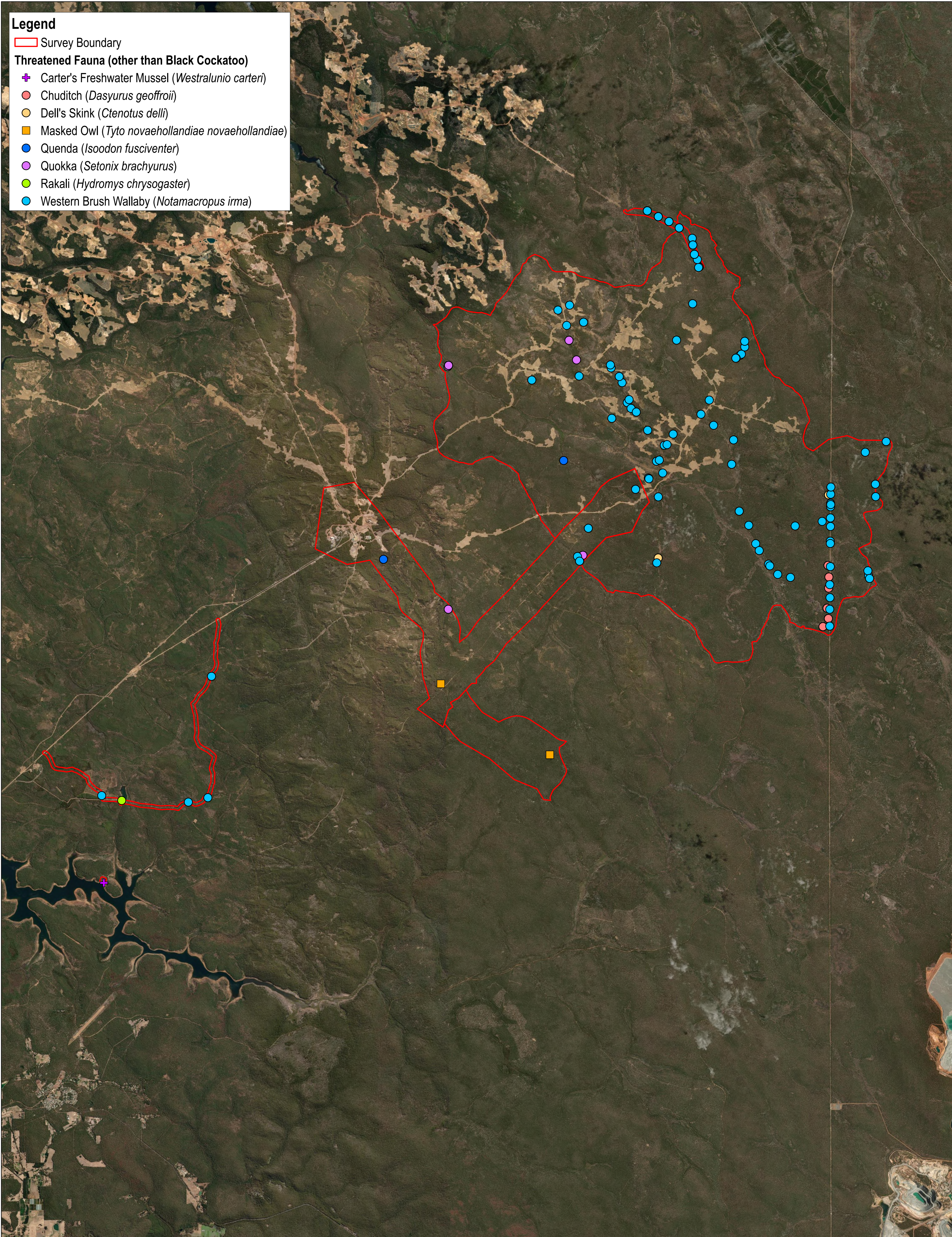
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Legend

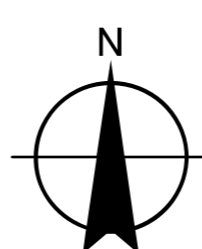
Survey Boundary

Threatened Fauna (other than Black Cockatoo)

- + Carter's Freshwater Mussel (*Westralunio carteri*)
- Chuditch (*Dasyurus geoffroii*)
- Dell's Skink (*Ctenotus delli*)
- Masked Owl (*Tyto novaehollandiae novaehollandiae*)
- Quenda (*Isoodon fusciventer*)
- Quokka (*Setonix brachyurus*)
- Rakali (*Hydromys chrysogaster*)
- Western Brush Wallaby (*Notamacropus irma*)



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



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**Threatened Fauna
(other than Black Cockatoos)**

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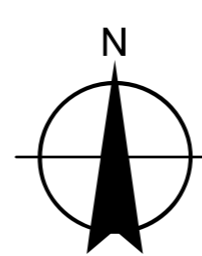
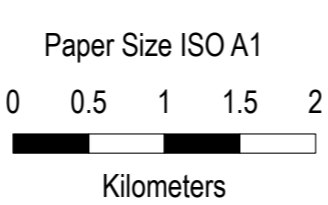
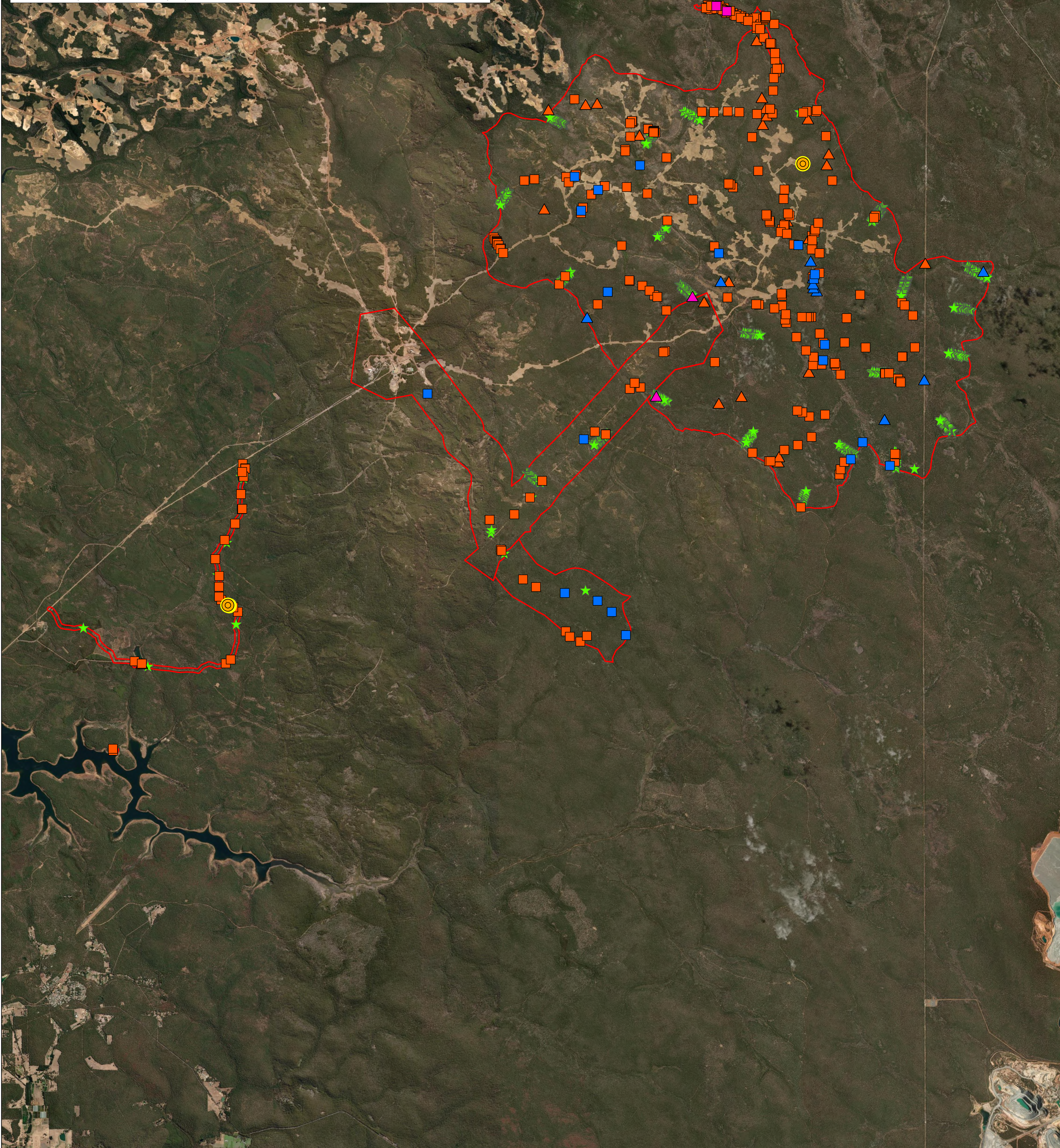
FIGURE 4

Legend

- Survey Boundary
- ▲ Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) Sighting
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) Foraging Evidence
- ▲ Baudin's Cockatoo (*Zanda baudinii*) Sighting
- Baudin's Cockatoo (*Zanda baudinii*) Foraging Evidence
- ▲ Carnaby's Black Cockatoo (*Zanda latirostris*) Sighting
- Carnaby's Black Cockatoo (*Zanda latirostris*) Foraging Evidence
- ★ Black Cockatoo Tree

Black Cockatoo Hollows

- ◎ Marri (*Corymbia calophylla*) 1 Hollow



Map Projection: Transverse Mercator
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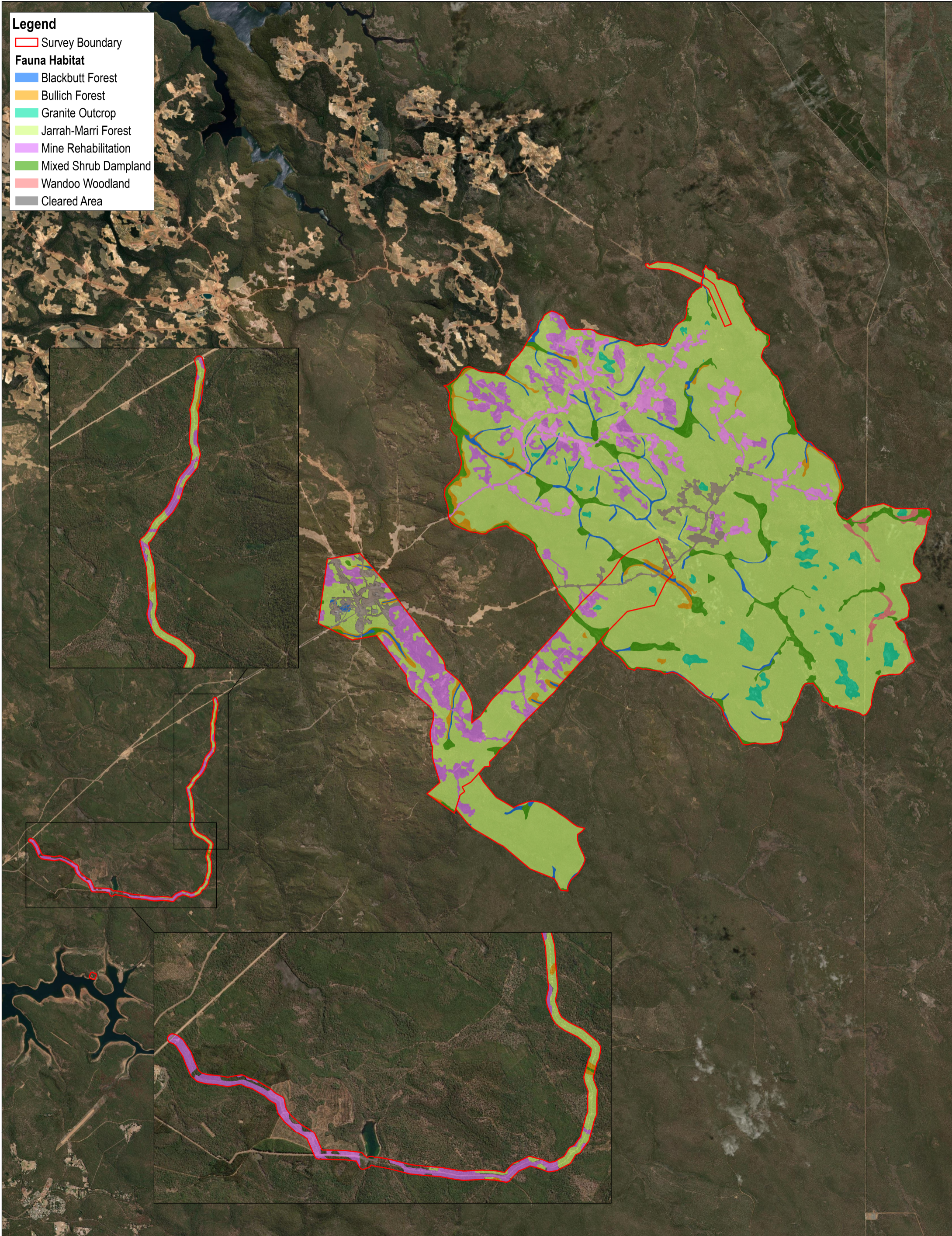
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Black Cockatoo Results

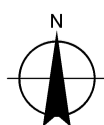
FIGURE 5

- Legend**
- ▬ Survey Boundary
 - Fauna Habitat**
 - ▬ Blackbutt Forest
 - ▬ Bullich Forest
 - ▬ Granite Outcrop
 - ▬ Jarrah-Marri Forest
 - ▬ Mine Rehabilitation
 - ▬ Mixed Shrub Dampland
 - ▬ Wandoo Woodland
 - ▬ Cleared Area



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Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



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Fauna Habitat

Project No. 12565572
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FIGURE 6

Appendix B

**Relevant legislation, background
information and conservation codes**

Relevant legislation

Federal *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The biological aspects listed as MNES include:

- Nationally threatened flora and fauna species and ecological communities
- Migratory species

A person must not undertake an action that has, will have, or is likely to have a significant impact (direct or indirect) on MNES, without approval from the Federal Minister for the Environment.

The EPBC Act is administered by the Department of the Environment and Energy (DEE).

State *Environment Protection Act 1986*

The *Environmental Protection Act 1986* (EP Act) is the primary legislative Act dealing with the protection of the environment in Western Australia. The Act allows the Environmental Protection Authority (EPA), to prevent, control and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing. Part IV of the EP Act is administered by the EPA and makes provisions for the EPA to undertake environmental impact assessment of significant proposals, strategic proposals and land use planning schemes.

The Department of Water and Environment Regulation (DWER) is responsible for administering the clearing provisions of the EP Act (Part V). Clearing of native vegetation in Western Australia requires a permit from the DWER, unless exemptions apply. Applications for clearing permits are assessed by the Department and decisions are made to grant or refuse the application in accordance with the Act. When making a decision the assessment considers clearing against the ten clearing principles as specified in Schedule 5 of the EP Act:

1. Native vegetation should not be cleared if it comprises a high level of biodiversity.
2. Native vegetation should not be cleared if it comprises the whole or a part of or is necessary for the maintenance of a significance habitat for fauna indigenous to Western Australia.
3. Native vegetation should not be cleared if it includes, or is necessary, for the continued existence of rare flora.
4. Native vegetation should not be cleared if it comprises the whole or part of native vegetation in an area that has been extensively cleared.
5. Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.
6. Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.
7. Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.
8. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.
9. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.
10. Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Exemptions for clearing include clearing that is a requirement of a written law or authorised under certain statutory processes (listed in Schedule 6 of the EP Act) and exemptions for prescribed low impact day-to-day activities (prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004); these exemptions do not apply in environmentally sensitive areas (ESAs).

State *Biodiversity and Conservation Act 2016*

The *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation and protection of biodiversity and biodiversity components, as well as the promotion of the ecologically sustainable use of biodiversity components in Western Australia. The BC Act replaces both the repealed *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929* (Sandalwood Act), as well as their associated regulations. To attain the objectives of the BC Act, principles of ecological sustainable development have been established:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision-making.
- Improved valuation, pricing and incentive mechanisms should be promoted.

The BC Act is administered by the Department of Biodiversity Conservation and Attractions (DBCA).

State *Biosecurity and Agriculture Management Act 2007*

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) and associated regulations are administered by the Department of Primary Industries and Regional Development (DPIRD) and replace the repealed *Agriculture and Related Resources Protection Act 1976*. The main purposes of the BAM Act and its regulations are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering WA.
- Manage the impact and spread of those pests already present in the state.
- Safely manage the use of agricultural and veterinary chemicals
- Increased control over the sale of agricultural products that contain violative chemical residues.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act. A Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) of the Act is in force. Declared Pests may be assigned a control category including: C1 (exclusion), C2 (eradication) and C3 (management). The category may apply to the whole of the State, LGAs, districts, individual properties or even paddocks, and all landholders are obliged to comply with the specific category of control. Categories of control are defined below.

Control class code	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which is currently is free of that pest.

Fauna Conservation codes

The Federal conservation level of fauna species and their significance status is assessed under the EPBC Act. The significance levels for fauna used in the EPBC Act align with the International Union for Conservation of Nature (IUCN) Red List criteria, which are internationally recognised as providing best practice for assigning the conservation status of species. The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

The State conservation level of fauna species and their significance status also follows the IUCN Red List criteria. Under the BC Act fauna can be listed as Threatened, Extinct and as Specially Protected species.

Threatened species are those are species which have been adequately searched for and are deemed to be, in the wild, either rare, under identifiable threat of extinction, or otherwise in need of special protection, and have been gazetted as such. The assessment of the conservation status of Threatened species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria. Specially protected species meet one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as Threatened or Extinct species under the BC Act cannot also be listed as Specially Protected species.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna List under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

For the purposes of this assessment, all species listed under the EPBC Act, BC Act and DBCA Priority species are considered significant.

Conservation categories and definitions for EPBC Act and BC Act listed fauna species

Conservation category	Definition
Threatened species	
Critically Endangered (CR)	Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”. Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with criteria set out in section 20 and the ministerial guidelines.
Endangered (EN)	Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”. Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.
Vulnerable (VU)	Threatened species considered to be “facing a high risk of extinction in the wild in the medium term future as determined in accordance with criteria set out in the ministerial guidelines”. Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.
Extinct species	
Extinct (EX)	Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
Extinct in the Wild (EW)	Species that “is known only to survive in cultivation, in captivity or as a naturalized population well outside its past range, and it has not been recorded in its known habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its lifecycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).
Specially protected species	
Migratory (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
Species of special conservation interest (conservation dependent fauna) (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Other specially protected fauna (OS)	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Conservation codes for DBCA listed Priority fauna

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

Other significant fauna

Fauna species may be significant for a range of reasons other than those protected by international agreement or treaty, Specially Protected or Priority Fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed (EPA 2010).

References

ANZECC 2000, Core Environmental Indicators for Reporting on the State of Environment, ANZECC State of the Environment Reporting Task Force.

Commonwealth of Australia 2001, National Targets and Objectives for Biodiversity Conservation 2001–2005, Canberra, AGPS.

EPA 2010, Technical Guide – Terrestrial Fauna Surveys, EPA, Perth, WA

Appendix C

Desktop Searches

NatureMap Species Report

EPBC Act Protected Matters Search Tool Report

NatureMap Species Report

TAXON	CLASS	CONS
<i>Crinia georgiana</i>	AMPHI	
<i>Crinia glauerti</i>	AMPHI	
<i>Crinia pseudinsignifera</i>	AMPHI	
<i>Geocrinia leai</i>	AMPHI	
<i>Heleioporus barycragus</i>	AMPHI	
<i>Heleioporus eyrei</i>	AMPHI	
<i>Heleioporus inornatus</i>	AMPHI	
<i>Heleioporus psammophilus</i>	AMPHI	
<i>Heleioporus sp.</i>	AMPHI	
<i>Litoria adelaidensis</i>	AMPHI	
<i>Litoria moorei</i>	AMPHI	
<i>Pseudophryne guentheri</i>	AMPHI	
<i>Acanthiza apicalis</i>	BIRD	
<i>Acanthiza chrysorrhoa</i>	BIRD	
<i>Acanthiza inornata</i>	BIRD	
<i>Acanthorhynchus superciliosus</i>	BIRD	
<i>Accipiter cirrocephalus</i>	BIRD	
<i>Aegotheles cristatus</i>	BIRD	
<i>Anthochaera carunculata</i>	BIRD	
<i>Anthochaera lunulata</i>	BIRD	
<i>Aquila audax</i>	BIRD	
<i>Artamus cyanopterus</i>	BIRD	
<i>Barnardius zonarius</i>	BIRD	
<i>Cacatua roseicapilla</i>	BIRD	
<i>Cacomantis flabelliformis</i>	BIRD	
<i>Cacomantis pallidus</i>	BIRD	
<i>Calyptorhynchus banksii</i>	BIRD	
<i>Calyptorhynchus banksii</i> subsp. <i>naso</i>	BIRD	VU
<i>Calyptorhynchus baudinii</i>	BIRD	EN
<i>Calyptorhynchus latirostris</i>	BIRD	EN
<i>Calyptorhynchus sp.</i>	BIRD	
<i>Chenonetta jubata</i>	BIRD	
<i>Chrysococcyx basalis</i>	BIRD	
<i>Climacteris rufa</i>	BIRD	
<i>Colluricincla harmonica</i>	BIRD	
<i>Coracina novaehollandiae</i>	BIRD	
<i>Corvus coronoides</i>	BIRD	
<i>Cracticus tibicen</i>	BIRD	
<i>Dacelo novaeguineae</i>	BIRD	

TAXON	CLASS	CONS
<i>Daphoenositta chrysoptera</i>	BIRD	
<i>Dromaius novaehollandiae</i>	BIRD	
<i>Eopsaltria australis</i> subsp. <i>griseogularis</i>	BIRD	
<i>Eopsaltria georgiana</i>	BIRD	
<i>Eopsaltria griseogularis</i>	BIRD	
<i>Falco berigora</i>	BIRD	
<i>Falco cenchroides</i>	BIRD	
<i>Falco peregrinus</i>	BIRD	OS
<i>Falcunculus frontatus</i> subsp. <i>leucogaster</i>	BIRD	
<i>Gerygone fusca</i>	BIRD	
<i>Glyciphila melanops</i>	BIRD	
<i>Hamirostra isura</i>	BIRD	
<i>Hirundo neoxena</i>	BIRD	
<i>Hirundo nigricans</i>	BIRD	
<i>Leipoa ocellata</i>	BIRD	VU
<i>Lichenostomus leucotis</i>	BIRD	
<i>Lichenostomus ornatus</i>	BIRD	
<i>Lichenostomus virescens</i>	BIRD	
<i>Lichmera indistincta</i>	BIRD	
<i>Malurus elegans</i>	BIRD	
<i>Malurus splendens</i>	BIRD	
<i>Malurus splendens</i> subsp. <i>splendens</i>	BIRD	
<i>Melithreptus brevirostris</i>	BIRD	
<i>Melithreptus chloropsis</i>	BIRD	
<i>Melithreptus lunatus</i>	BIRD	
<i>Merops ornatus</i>	BIRD	
<i>Neophema elegans</i>	BIRD	
<i>Ninox novaeseelandiae</i>	BIRD	
<i>Nycticorax caledonicus</i>	BIRD	
<i>Ocyphaps lophotes</i>	BIRD	
<i>Pachycephala pectoralis</i>	BIRD	
<i>Pachycephala pectoralis</i> subsp. <i>fuliginosa</i>	BIRD	
<i>Pachycephala rufiventris</i>	BIRD	
<i>Pardalotus punctatus</i>	BIRD	
<i>Pardalotus striatus</i>	BIRD	
<i>Pardalotus striatus</i> subsp. <i>westraliensis</i>	BIRD	
<i>Petrochelidon nigricans</i>	BIRD	
<i>Petroica boodang</i>	BIRD	
<i>Petroica multicolor</i>	BIRD	
<i>Petroica multicolor</i> subsp. <i>campbelli</i>	BIRD	
<i>Phaps chalcoptera</i>	BIRD	

TAXON	CLASS	CONS
<i>Phylidonyris novaehollandiae</i>	BIRD	
<i>Platycercus icterotis</i>	BIRD	
<i>Platycercus spurius</i>	BIRD	
<i>Platycercus zonarius</i>	BIRD	
<i>Polytelis anthopeplus</i>	BIRD	
<i>Purpureicephalus spurius</i>	BIRD	
<i>Rhipidura albiscapa</i>	BIRD	
<i>Rhipidura fuliginosa</i>	BIRD	
<i>Rhipidura leucophrys</i>	BIRD	
<i>Sericornis frontalis</i>	BIRD	
<i>Smicrornis brevirostris</i>	BIRD	
<i>Stagonopleura oculata</i>	BIRD	
<i>Strepera versicolor</i>	BIRD	
<i>Tadorna tadornoides</i>	BIRD	
<i>Todiramphus sanctus</i>	BIRD	
<i>Turnix varius</i>	BIRD	
<i>Zosterops lateralis</i>	BIRD	
Mammals		
<i>Antechinus flavipes</i> subsp. <i>leucogaster</i>	MAMMAL	
<i>Bettongia penicillata</i> subsp. <i>ogilbyi</i>	MAMMAL	CR
<i>Canis lupus</i> subsp. <i>dingo</i>	MAMMAL	
<i>Cercartetus concinnus</i>	MAMMAL	
<i>Chalinolobus gouldii</i>	MAMMAL	
<i>Chalinolobus morio</i>	MAMMAL	
<i>Dasyurus geoffroii</i>	MAMMAL	VU
<i>Falsistrellus mackenziei</i>	MAMMAL	P4
<i>Isoodon fusciventer</i>	MAMMAL	P4
<i>Isoodon obesulus</i>	MAMMAL	
<i>Isoodon obesulus</i> subsp. <i>fusciventer</i>	MAMMAL	
<i>Macropus fuliginosus</i>	MAMMAL	
<i>Macropus irma</i>	MAMMAL	
<i>Mormopterus planiceps</i>	MAMMAL	
<i>Mus musculus</i>	MAMMAL	
<i>Myrmecobius fasciatus</i>	MAMMAL	EN
<i>Notamacropus irma</i>	MAMMAL	P4
<i>Nyctophilus geoffroyi</i>	MAMMAL	
<i>Nyctophilus gouldi</i>	MAMMAL	
<i>Nyctophilus major</i>	MAMMAL	
<i>Nyctophilus</i> sp.	MAMMAL	
<i>Nyctophilus timoriensis</i> subsp. <i>timoriensis</i>	MAMMAL	
<i>Ozimops australis</i>	MAMMAL	

TAXON	CLASS	CONS
<i>Rattus rattus</i>	MAMMAL	
<i>Setonix brachyurus</i>	MAMMAL	VU
<i>Sminthopsis gilberti</i>	MAMMAL	
<i>Sminthopsis griseoventer</i>	MAMMAL	
<i>Sminthopsis griseoventer</i> subsp. <i>griseoventer</i>	MAMMAL	
<i>Tachyglossus aculeatus</i>	MAMMAL	
<i>Tadarida australis</i>	MAMMAL	
<i>Trichosurus vulpecula</i>	MAMMAL	
<i>Trichosurus vulpecula</i> subsp. <i>vulpecula</i>	MAMMAL	
<i>Vespadelus regulus</i>	MAMMAL	
<i>Reptiles</i>		
<i>Acritoscincus trilineatum</i>	REPTILE	
<i>Acritoscincus trilineatus</i>	REPTILE	
<i>Aprasia pulchella</i>	REPTILE	
<i>Aprasia repens</i>	REPTILE	
<i>Christinus marmoratus</i>	REPTILE	
<i>Cryptoblepharus buchananii</i>	REPTILE	
<i>Cryptoblepharus plagiocephalus</i>	REPTILE	
<i>Ctenophorus ornatus</i>	REPTILE	
<i>Ctenotus delli</i>	REPTILE	P4
<i>Ctenotus impar</i>	REPTILE	
<i>Ctenotus labillardieri</i>	REPTILE	
<i>Diplodactylus granariensis</i> subsp. <i>granariensis</i>	REPTILE	
<i>Diplodactylus polyophthalmus</i>	REPTILE	
<i>Diporiphora pindan</i>	REPTILE	
<i>Egernia kingii</i>	REPTILE	
<i>Egernia napoleonis</i>	REPTILE	
<i>Hemiergus initialis</i>	REPTILE	
<i>Hemiergus initialis</i> subsp. <i>initialis</i>	REPTILE	
<i>Lerista distinguenda</i>	REPTILE	
<i>Lerista microtis</i> subsp. <i>microtis</i>	REPTILE	
<i>Lialis burtonis</i>	REPTILE	
<i>Menetia greyii</i>	REPTILE	
<i>Morethia obscura</i>	REPTILE	
<i>Nephrurus milii</i>	REPTILE	
<i>Notechis scutatus</i>	REPTILE	
<i>Oedura reticulata</i>	REPTILE	
<i>Parasuta gouldii</i>	REPTILE	
<i>Parasuta nigriceps</i>	REPTILE	
<i>Pogona minor</i>	REPTILE	
<i>Pogona minor</i> subsp. <i>minor</i>	REPTILE	

TAXON	CLASS	CONS
<i>Pseudechis australis</i>	REPTILE	
<i>Pseudonaja affinis</i> subsp. <i>affinis</i>	REPTILE	
<i>Ramphotyphlops australis</i>	REPTILE	
<i>Ramphotyphlops pinguis</i>	REPTILE	
<i>Simoselaps bertholdi</i>	REPTILE	
<i>Tiliqua rugosa</i>	REPTILE	
<i>Tiliqua rugosa</i> subsp. <i>pararra</i>	REPTILE	
<i>Tiliqua rugosa</i> subsp. <i>rugosa</i>	REPTILE	
<i>Underwoodisaurus milii</i>	REPTILE	
<i>Varanus gouldii</i>	REPTILE	
<i>Varanus rosenbergi</i>	REPTILE	

Please note that *NatureMap* data contains some inaccuracies.



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 14-Jan-2022

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar)	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	15
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	1
Nationally Important Wetlands:	None
EPBC Act Referrals:	8
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands)

[\[Resource Information \]](#)

Ramsar Site Name

[Peel-yalgorup system](#)

Proximity

30 - 40km upstream
from Ramsar site

Listed Threatened Species

[\[Resource Information \]](#)

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name

Threatened Category

Presence Text

BIRD

[Calidris ferruginea](#)

Curlew Sandpiper [856]

Critically Endangered

Species or species
habitat may occur
within area

[Calyptorhynchus banksii naso](#)

Forest Red-tailed Black-Cockatoo,
Karrak [67034]

Vulnerable

Species or species
habitat known to
occur within area

[Leipoa ocellata](#)

Malleefowl [934]

Vulnerable

Species or species
habitat known to
occur within area

[Numenius madagascariensis](#)

Eastern Curlew, Far Eastern Curlew
[847]

Critically Endangered

Species or species
habitat may occur
within area

[Rostratula australis](#)

Australian Painted Snipe [77037]

Endangered

Species or species
habitat may occur
within area

[Zanda baudinii listed as Calyptorhynchus baudinii](#)

Baudin's Black-Cockatoo, Long-billed
Black-cockatoo [87736]

Endangered

Roosting likely to
occur within area

[Zanda latirostris listed as Calyptorhynchus latirostris](#)

Carnaby's Black Cockatoo, Short-billed
Black-cockatoo [87737]

Endangered

Species or species
habitat known to
occur within area

MAMMAL

Scientific Name	Threatened Category	Presence Text
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
OTHER		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Verticordia fimbrialepis subsp. fimbrialepis Shy Featherflower [24631]	Endangered	Species or species habitat likely to occur within area
Listed Migratory Species [Resource Information]		
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Extra Information

State and Territory Reserves [\[Resource Information \]](#)

Protected Area Name	Reserve Type	State
Monadnocks	5(1)(g) Reserve	WA

Regional Forest Agreements [\[Resource Information \]](#)

Note that all areas with completed RFAs have been included.

RFA Name	State
South West WA RFA	Western Australia

EPBC Act Referrals [\[Resource Information \]](#)

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Alcoa Pinjarra Refinery Production Increase and Bauxite Export	2020/8743	Controlled Action	Assessment Approach
Efficiency and Growth Increase of Alumina Production	2004/1566	Controlled Action	Post-Approval
Newmont Boddington Gold Mine Extension Project	2012/6370	Controlled Action	Post-Approval
Not controlled action			
Albany Highway extension of existing passing lanes	2013/6727	Not Controlled Action	Completed
Construction and operation of a putrescible landfill	2011/5998	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Not controlled action (particular manner)			
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Appendix D

Fauna Field Data

Fauna likelihood of occurrence assessment guideline and definitions

Fauna Likelihood of occurrence assessment

Combined Species List

Phase 2 targeted survey data

Phase 3 targeted survey data

Phase 1 camera data

Phase 2 camera data

Single target camera data

Chuditch remote capture spot assessment

Black Cockatoo foraging assessment

Species recorded from studies and database searches

The table presents all vertebrate fauna species recorded in previous studies within or in proximity to the Survey Area, and database searches within a 20 kilometre radius of the Survey Area.

Fauna likelihood of occurrence assessment guidelines

Assessment outcome	Description
Known	Species recorded during the field survey or from recent, reliable records from within or close proximity to the Survey Area.
Likely	Species are likely to occur in the Survey Area where there is suitable habitat within the Survey Area and there are recent records of occurrence of the species in close proximity to the Survey Area. OR Species known distribution overlaps with the Survey Area and there is suitable habitat within the Survey Area.
Unlikely	Species assessed as unlikely include those species previously recorded within 40 km of the Survey Area however: There is limited (i.e. the type, quality and quantity of the habitat is generally poor or restricted) habitat in the Survey Area. The suitable habitat within the Survey Area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the Survey Area. OR Those species that have a known distribution overlapping with the Survey Area however: There is limited habitat in the Survey Area (i.e. the type, quality and quantity of the habitat is generally poor or restricted). The suitable habitat within the Survey Area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the Survey Area.
Highly unlikely	Species that are considered highly unlikely to occur in the Survey Area include: Those species that have no suitable habitat within the Survey Area. Those species that have become locally extinct, or are not known to have ever been present in the region of the Survey Area.

Source information - desktop searches

NM – *DBCA NatureMap* (accessed May 2022)

PMST – DAWE Protected Matters Search Tool (PMST) to identify fauna listed under the EPBC Act potentially occurring within the Survey Area (accessed June 2020)

Definitions

Term	Description
Database search area	a 10 km buffer around the Survey Area
Survey Area	the area subject to the current survey
CR	Critically endangered under the EPBC Act or BC Act
EN	Endangered under the EPBC Act or BC Act
VU	Vulnerable under the EPBC Act or BC Act
IA	Migratory birds protected under an international agreement
MI, MA	Migratory, Marine
CD	Conservation dependent fauna
OS	Other specially protected fauna under the BC Act
P1	Priority 1: Poorly known fauna. Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	Priority 2: Poorly known species. Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	Priority 3: Poorly known species. Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	Priority 4: Rare, Near Threatened and other species in need of monitoring. (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Fauna Likelihood of occurrence assessment of significant species relevant to the Survey Area

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	CR	Curlew Sandpipers mainly occur in areas with soft mud conditions, including intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are found inland less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. In WA, they are widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division but are more sparsely distributed between Carnarvon and Dampier Archipelago (DAWE 2021e). They are common on the Swan Coastal Plain, particularly near large drying lakes like Thompson and Forrestdale, and Peel Inlet. They are less common along the southern coast to Esperance (Nevill 2013).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	PMST
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	The Forest Red-tailed Black Cockatoo inhabits the dense Jarrah, karri, and Marri forests receiving more than 600 mm annual average rainfall but also occurs in a range of other forest and woodland types, including Blackbutt (<i>E. patens</i>), Wandoo (<i>E. wandoo</i>), Tuart (<i>E. gomphocephala</i>), Albany Blackbutt (<i>E. staeri</i>), Yate (<i>E. cornuta</i>), and Flooded Gum (<i>E. rudis</i>) (DAWE 2021b). Habitats tend to have an understorey of balga (<i>Xanthorrhoea</i> spp.), kingia (<i>Kingia australis</i>), snottygobble (<i>Persoonia</i> spp.), parrot bush (<i>Banksia sessillis</i>), holly-leaved mirbelia (<i>Mirbelia dilatata</i>), bull banksia (<i>B. grandis</i>), bullich (<i>Taxandria</i> spp.) and sheoak (<i>Allocasuraina fraseriana</i>). They are most common in the Jarrah forest region of the northern Darling Range from Collie north to Mundaring and are very local throughout the lower south-west. They can be found on the Swan Coastal Plain, mainly in search of food the exotic white cedar (<i>Melia azedarach</i>). There are also several small isolated populations in the eastern parts of its range (DAWE 2021b).	Known This species is known from the region.	Known Known to occur within Survey Area. Recorded sightings and foraging within the Survey Area.	NatureMap, PMST, DBCA & GHD
<i>Zanda baudinii</i>	Baudin's Black Cockatoo	EN	EN	Baudin's Black Cockatoo mainly occurs in eucalypt forests, especially Jarrah, Marri and karri forest that receives 750 mm of annual rainfall. The species is less frequently in woodlands of wandoo (<i>Eucalyptus wandoo</i>), blackbutt (<i>E. patens</i>), flooded gum (<i>E. rudis</i>), yate (<i>E. cornuta</i>), partly cleared farmlands and urban areas. The range of the species extends from Albany northward to Gidgegannup and Mundaring (east of Perth), and inland to the Stirling Ranges and near Kojonup. Preferred roosts are in areas with a dense canopy close to permanent sources of water (DAWE 2021c).	Known This species is known from the region.	Known Known to occur within Survey Area. Recorded sighting and foraging within the Survey Area.	NatureMap, PMST, DBCA & GHD

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
<i>Zanda latirostris</i>	Carnaby's Black Cockatoo	EN	EN	Carnaby's Cockatoo occurs in uncleared or remnant native eucalypt woodlands, especially those that contain Salmon gum, Wandoo, Marri, Jarrah and Karri, and in shrubland or kwongan heathland dominated by Hakea, Dryandra, Banksia and Grevillea species. Breeding activity is restricted to eucalypt woodlands mainly in the semiarid and subhumid interior, from Kalbarri in the north, Three Springs District south to the Stirling Range, west to Cockleshell Gully and east to Manmanning. The species has expanded its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the tuart forests of the Swan Coastal Plain, including the Yanchep area, Lake Clifton and near Bunbury. It nests in trees older than 120-150 years (DAWE 2021d).	Known This species is known from the region.	Known Known to occur within Survey Area. Foraging evidence was recorded within Survey Area.	NatureMap, PMST, DBCA & GHD
<i>Falco peregrinus macropus</i>	Peregrine Falcon	OS		The Peregrine Falcon is found on and near cliffs, gorges, timbered watercourses, riverine environments, wetlands, plains, open woodlands, and pylons and spires of buildings, though less frequently in desert regions (Morcombe 2004; Pizzey & Knight 2012). They are not common but can be found almost anywhere throughout WA and in the southwest, including particularly at Fitzgerald River, Stirling Range, Porongurup National Parks, Kondinin, and Peak Charles, with many more locations north of Perth (Nevill 2013).	Likely Specimen have been recorded in the region the closest in Holyoake block	Likely The species wasn't recorded during the surveys however the species is known to persist in the region. Suitable habitat and prey items are found within the survey area.	NatureMap & DBCA
<i>Leipoa ocellata</i>	Malleefowl	VU	VU & MI	The Malleefowl generally occurs in semi-arid areas of WA, in shrublands and low woodlands that are dominated by mallee vegetation, as well as native pine Callitris woodlands, Acacia shrublands, paperbark, sheoak, Broombush <i>Melaleuca uncinata</i> vegetation, eucalypt woodlands, or coastal heathlands. Mostly they are found where there are sandy or gravel soils. The nest is a large mound of sand or soil and organic matter (Jones & Goth 2008; Morcombe 2014; Nevill 2013). In WA they are found from the southwest Nullarbor to Albany, north, and then west from Moore River up to Shark Bay, past Cue, across to Wiluna and east to the northern Victoria Desert south of the Blackstone Ranges (Nevill 2013; Pizzey & Knight 2012).	Unlikely The Survey Area does not contain suitable undisturbed habitat to support this species.	Unlikely Regional records are historical. The Survey Area does not contain suitable undisturbed habitat to support this species. The area is to readily logged and burnt to persist in the area. Over 35 transects were undertaken across the Survey	NatureMap, PMST & DBCA

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
						Area with no evidence of use recorded.	
<i>Numenius madagascariensis</i>	Eastern Curlew	CR	CR & MI	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, sometimes within the mangroves, and in coastal saltworks and sewage farms. In the south west, Eastern Curlews are recorded from Eyre, and there are scattered records from Stokes Inlet to Peel Inlet (Marchant & Higgins 1993). They are uncommon further south of Geraldton, but can be spotted in Alfred Cove, Peel Inlet and the Albany region (Nevill 2013).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	NatureMap & PMST
<i>Tringa brevipes</i>	Grey-tailed Tattler	Mi & P4	IA	Within Australia, the Grey-tailed Tattler has a primarily northern coastal distribution and is found in most coastal regions. It is found in the south-west between Augusta and Cervantes (DAWE 2021d).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	NatureMap
<i>Tyto novaehollandiae</i> subsp. <i>novaehollandiae</i>	Masked Owl (southern subsp)	P3		The Masked Owl is found in forests (wet and dry sclerophyll, non-eucalypt dominated), open woodlands, farmlands or scrub with large trees (12-20 m) and adjacent cleared country, timbered watercourses, paperbark woodlands, and caves (Pizzey & Knight 2012). It requires large hollows in old growth eucalypts or bare sand or the earth of a cave for nesting, and often favours areas with dense understorey or ecotones comprising dense and sparse ground cover. It is often recorded foraging within 100-300 m of the boundary of two vegetation types (Bell & Mooney 2002). The bird is restricted to the thicker humid forests of the southwest region, particularly in the Pemberton and Manjimup area and along the Murray River in the Lane Poole area (Kavanagh & Murray 1996). It nests in hollows in large Karri (<i>Eucalyptus diversicolor</i>), Marri (<i>Corymbia calophylla</i>) and Jarrah (<i>E. marginata</i>) trees (Nevill 2013).	Likely The Survey area contains suitable habitat. Masked owls have been previously recorded near the survey area.	Known A hand fall of Masked Owl calls were record via SM4 Song Meters. The survey area contains suitable habitat.	NatureMap, DBCA & GHD
<i>Apus pacificus</i>	Fork-tailed Swift	Mi	Mi	The Fork-tailed Swift is common in coastal and sub coastal areas between Carnarvon and Augusta including near and offshore islands. There are scattered records along south coast from Denmark east to Cocklebiddy on the Great Australian Bight, and sparsely scattered records inland. They are found across a range of habitats, from inland open plains to wooded areas. They are most often observed over inland plains in Australia, but sometimes recorded over coastal cliffs and	Unlikely The species is rarely observed inland use is rare and opportunistic	Unlikely The species is occasionally observed in the south-west of WA but roosting	PMST

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
				beaches as well as urban areas. They have been recorded well out to sea as well as from offshore islands especially when on passage from Indonesia. This species is almost exclusively aerial (DotE 2015).		infrequently. May occasionally fly over Survey Area.	
<i>Rostratula australis</i>	Australian Painted Snipe	En	En	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire. It sometimes use areas that are lined with trees, or that have some scattered fallen or washed-up timber (DAWE 2021e). In the south west it can be found around Carnarvon and wetlands north of Perth, particularly those west of Moora and Gin Gin (Nevill 2013).	Highly Unlikely The Survey Area lacks suitable wetlands, and the species is not typically known from this region.	Highly Unlikely The Survey Area lacks suitable wetlands, and the species is not typically known from this region.	PMST
<i>Motacilla cinerea</i>	Grey Wagtail	Mi	Mi	The Grey Wagtail is an opportunistic migrant to Australia. The species typically migrates to Indonesia occasionally landing in Australia. Most records for the species are from Northern Australia and South Australia (Morcombe 2004). The non-breeding habitat only of the Grey Wagtail has a strong association with water, particularly rocky substrates along water courses but also lakes and marshes (DAWE 2021e). It can be found mainly in banks and rocks in fast-running freshwater habitats: rivers, creeks, streams, and around waterfalls, both in forest and open country; but occurs almost anywhere during migration (Johnstone & Storr 2004).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely Survey Area is beyond the range of this species	PMST
<i>Actitis hypoleucos</i>	Common Sandpiper	Mi	Mi	The Common Sandpiper is found along all coastlines of Australia and uses a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around often narrow and steep muddy margins or rocky shores. The species has been recorded in estuaries and deltas of streams, as well as on banks further upstream; around lakes, pools, mangroves, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. It is often found near mangroves, and sometimes in areas of mud littered with rocks or snags (DAWE 2021e). They are somewhat uncommon in the south west, but can be found on Rottneest and Penguin Islands, and along the south coast all the way to the Esperance region, including the inland lakes like Lake Warden (Nevill 2013).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	PMST
<i>Calidris auminata</i>	Sharp-tailed Sandpiper	Mi	Mi	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh, or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans, and hypersaline salt lakes	Highly Unlikely The Survey Area lacks suitable	Highly Unlikely The Survey Area lacks suitable	PMST

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
				inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries, or seashores, and also swamps and creeks lined with mangroves. Sometimes they occur on rocky shores (DAWE 2021e). They are found throughout many wetlands on the Swan Coastal Plain, in Perth lakes with wet grassed margins and receding waters, Vasse and Harvey Estuaries, and the Busselton wetlands, but are less common on the south coast until the Esperance region (Nevill 2013).	wetland or shoreline habitat.	wetland or shoreline habitat.	
<i>Calidris melanotos</i>	Pectoral Sandpiper	Mi	Mi	In Australia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The bird can be seen on the Swan Coastal Plain but is rare to scarce on Lake Thompson, and as well on any freshwater wetland in the southwest with shallow, well-grassed margins. They are seen at Lake Warden, Esperance, and at Lake McLarty (Nevill 2013).	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	Highly Unlikely The Survey Area lacks suitable wetland or shoreline habitat.	PMST
Mammals							
<i>Bettongia penicillata ogilbyi</i>	Woylie	CR	EN	Preferred habitat for the Woylie includes dense undergrowth, logs and rock-cavities and occasionally in burrows (Burbidge 2004). Scattered Woylie populations may be found throughout the Jarrah forest in the south-west corner of WA. Extant naturally occurring populations of the species are restricted to three small wheatbelt reserves – Dryandra Woodland, Tutanning Nature Reserve and Perup Forest. All are characterised by the presence of thickets of the plant <i>Gastrolobium</i> (Van Dyck and Strahan 2008). The species is now restricted to forests and areas where predation has been controlled (or excluded). It rests during the day in a well-concealed nest, built over a shallow depression. The nest is most commonly built using long strands, of grasses, but other material such as strips of bark are also used (in the forest) or dried seagrass and/or <i>triodia</i> (in arid coastal areas) (Freegard 2007).	Unlikely Suitable habitat is present within the Survey Area. The Woylie is known to be previously recorded in Dwellingup area (many years ago) but there are no current local records in Holyoake and Jarrahdale forests. Due to fire frequency and presence of feral predators (such	Likely There is suitable habitat within the Survey Area Woylies were recorded in the adjacent O’Neil East Survey Area.	NatureMap, PMST, DBCA & GHD

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
					as foxes and cats) they are unlikely to be currently present. There is a possibility of vagrant occurrence but unlikely a current population in the Survey Area.		
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	The Chuditch inhabits eucalypt forest (especially Jarrah, <i>Eucalyptus marginata</i>), dry woodland, mallee shrublands, heaths, and desert, particularly in the south coast of WA. They also occur at lower densities in drier woodland and mallee shrubland in the goldfields and wheatbelt, as well as in Kalbarri National Park (translocated). Chuditch require adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) to survive (DEC 2012b). In Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest (Van Dyck & Strahan 2008). The species can travel large distances, and for this reason requires habitats that are of a suitable size and not excessively fragmented.	Known This species is known from the region. The Survey Area provides suitable denning and foraging/hunting habitat to support this species.	Known This species was recorded during the survey via remote cameras and several locations. The Survey Area provides suitable denning and foraging/hunting habitat to support this species.	NatureMap, PMST, DBCA & GHD
<i>Hydromys chrysogaster</i>	Rakali, Water-rat	P4		The Water Rat lives in the vicinity of permanent bodies of fresh, brackish, or marine water, lakes, and farm dams, and on sheltered coastal beaches, mangroves and offshore islands. In the south-west of WA, they have been shown to prefer areas with riparian vegetation, better water quality and a degree of habitat complexity. Woody debris, rock ledges and wetland islands are likely to be important areas for feeding and refuge (DEC 2012a). It is an occasional vagrant to temporary waters. Water Rat's dens are made at the end of tunnels in banks and occasionally in logs (Van Dyck & Strahan 2008).	Likely This species is known from the region in creeks, brooks and rivers that provide suitable aquatic and riparian habitats.	Known One individual was recorded via remote camera in the southwestern portion of the Survey Area.	NatureMap, DBCA & GHD
<i>Falsistrellus mackenziei</i>	Western False Pipistrelle	P4		The Western False Pipistrelle occurs in wet sclerophyll forest dominated by Karri, and in the high rainfall zones of the Jarrah and Tuart dry sclerophyll forests. The species is restricted to areas in or adjacent to stands of old growth forest. Marri, Sheoak and Peppermint are often codominant at its collection localities (Churchill 2008; McKenzie and Start 1999).	Likely This species is known from the region and was recorded in	Known This species had a singular recording via a SM4 Bat Acoustic	NatureMap, DBCA & GHD

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
					Holyoake area in 2021	during Phase 1 of the survey.	
<i>Isoodon fusciventer</i>	Quenda (Southern Brown Bandicoot)	P4		The Quenda prefers dense scrubby, often swampy, vegetation with dense cover up to one metre high. However, it also occurs in woodlands, and may use less ideal habitat where this habitat occurs adjacent to the thicker, more desirable vegetation. The species often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover (Van Dyck & Strahan 2008).	Known This species is known from the region	Known This species was recorded during the survey via both remote cameras and diggings. The Survey Area provides suitable breeding and foraging habitat to support this species.	NatureMap, DBCA & GHD
<i>Myrmecobius fasciatus</i>	Numbat	EN	EN	Current Numbat populations occupy several different habitat types: upland Jarrah forest, open eucalypt woodland, banksia woodland and tall closed shrubland. The only remaining original subpopulations are at Dryandra Woodland and the Upper Warren area (including Tone Perup Nature Reserve, Greater Kingston National Park, and adjoining State Forest). In WA there are nine translocation sites, including Boyagin Nature Reserve, Tutanning Nature Reserve, Batalling block and Karroun Hill Nature Reserve (see DPaW 2015 for complete list and details). At Dryandra, numbats inhabit brown mallet (<i>Eucalyptus astringens</i>) plantations. Habitats usually have an abundance of termites in the soil, and hollow logs, tree hollows, burrows and branches for shelter (DAWE 2021e; Van Dyck & Strahan 2008).	Likely Historical records include the Jarrah forest and wandoo areas in the southwest. A resident population occurs in the Narrogin area and re-introduced population at Boyagin rock. Anedotal recocords exist in the Boddington area however this is unconfirmed.	Likely Historical records include the region. A resident population occurs in the Narrogin area and re-introduced population at Boyagin rock. Eastern portions of the O'Neil Survey Area have excellent open wandoo woodland representing suitable Numbat habitat within the species' former range. This species potentially occurs within this suitable habitat, but at	NatureMap &, DBCA

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
						very low population density, and potentially below the level of detectability based on current survey effort.	
<i>Notamacropus irma</i>	Western Brush Wallaby	P4		The Western Brush Wallaby is found primarily in open forest or woodland, particularly favouring open, seasonally- wet flats with low grasses and open scrubby thickets. It is also found in some areas of mallee and heathland and is uncommon in karri forest (DEC 2011; Van Dyck & Strahan 2008).	Known This species is known from the region.	Known This species was recorded numerously during the survey. The Survey Area provides suitable breeding and foraging habitat to support this species.	NatureMap, DBCA & GHD
<i>Phascogale tapoatafa wambenger</i>	South-west Brush Tailed Phascogale	CD		The Brush-tailed Phascogale is sparsely distributed outside the semi-arid zone in dry sclerophyll forest and monsoonal forest and woodland. The species is generally rare and threatened by habitat fragmentation in the south west of WA. (Scida et al 2017). Habitat varies but forest or woodlands is required with large trees to provide hollows and cover. Canopy connection provides excellent cover and connectivity for the species to mover through their environment (Scida et al 2017).	Known This species is known from the region	Likely This species is known from this area. Suitable habitat is found within the Survey Area.	NatureMap, DBCA, GHD
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	CR	CR	The Western Ringtail Possum occurs in coastal and near coastal and Peppermint Tree (<i>Agonis flexuosa</i>) forest and Tuart (<i>Eucalyptus gomphocephala</i>) dominated forest with a Peppermint Tree understorey from Bunbury to Albany. Also occurs in Jarrah (<i>E. marginata</i>) forest and Jarrah-Marri (<i>Corymbia calophylla</i>) forest associated with Peppermint Tree (Van Dyck & Strahan 2008).	Unlikely Suitable habitat (Tuart over peppermint understorey) is not present to support this species and the Study Area is beyond the current local range of the species.	Unlikely Suitable habitat (Tuart over peppermint understorey) is not present to support this species and the Study Area is beyond the current range of the species.	NatureMap & DBCA

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
<i>Setonix brachyurus</i>	Quokka	Vu	Vu	The current distribution of the Quokka includes Rottnest and Bald Islands, and at least 25 sites on the mainland, including Two Peoples Bay Nature Reserve and Torndirrup, Mt Manypeaks and Walpole-Nornalup National Parks, and swamp areas through the south-west forests from Jarrahdale to Walpole. The last known population on the Swan Coastal Plain occurs in Muddy Lakes near Bunbury. Quokkas have also been reintroduced to Karakamia Sanctuary (DEC 2013). They occupy dense forests and thickets, streamside vegetation, heaths, shrublands, <i>Agonis linearifolia</i> -dominated swamps in the Jarrah (<i>Eucalyptus marginata</i>) forest, and sometimes tea-tree thickets on sandy soils along creek systems. The northern extent on the mainland is in the Jarrah forest immediately south-east of the Perth metropolitan area, from where it extends southward through the southern Jarrah, Marri and Karri forests to the south coast, but largely confined throughout to areas receiving an annual rainfall of 1,000 mm or more (DEC 2013; Van Dyck & Strahan 2008).	Likely This species was recorded during the Holyoake main survey on remote cameras. The Survey Area looks to provide suitable breeding and foraging habitat to support this species within the low lying and riparian areas.	Known This species was recorded via remote cameras during the Survey period.	NatureMap, PMST, DBCA & GHD
Reptiles							
<i>Acanthophis antarcticus</i>	Southern Death Adder	P3		The Southern Death Adder habitat ranges from rainforest to shrublands and heaths. This species is declining in many areas, probably due to habitat destruction and altered fire regimes (Wilson & Swan 2021).	Likely. Habitat is present for this species	Likely. Known to occur locally albeit patchily within northern Jarrah forests. Habitat is present for this species, even though was not recorded during the surveys.	GHD
<i>Ctenotus delli</i>	Dell's Skink	P4		Dell's Skink is associated with Jarrah-Marri woodland that has a shrub-dominated understorey, on laterite, sandy or clay soils. It is found in the north Darling Range and inhabits dry sclerophyll forest on granite outcrops, stony hills and ranges. It is absent from the Swan Coastal Plain (Cogger 2014; Wilson & Swan 2021).	Likely The Survey Area contains suitable habitat such as granite and lateritic clay to support this species and historical records surround the	Known This species was recorded at two different Quadrats via pit traps and funnel traps.	NatureMap, DBCA & GHD

Species name	Common name	Status		Habitat requirements	Likelihood of occurrence pre field assessment	Likelihood of occurrence post field assessment	Source
		BC Act	EPBC Act				
Birds							
					Holyoake east location.		
Fish							
<i>Geotria australis</i>	Pouched Lamprey	P3		This species utilises freshwater streams in the south west (Perth to Albany) to breed and grow before migrating to the ocean to mature (Allen <i>et al.</i> 2002). Dams and weirs are the main obstacles for the species. Sporadic records exist throughout the South West Coast Drainage Division between Perth and Albany including the Swan, Canning, Serpentine, Margaret, Donnelly, Warren and Goodga rivers.	Highly Unlikely The Survey Area lacks suitable water ways and presumed locally extinct upstream of South Dandalup Dam.	Highly Unlikely The Survey Area lacks suitable water ways and presumed locally extinct upstream of South Dandalup Dam.	NatureMap & DBCA
Invertebrates							
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	Vu	Vu	Carter's Freshwater Mussel is usually found in freshwater river pools. They are most common in areas with muddy, silty and sandy bottoms and flowing permanent water. Environmental tolerances of <i>W. carteri</i> are not precisely known but they can be found where water temperatures range from 4° C to over 30° C. Formerly this species occurred widely through the southwest including interior rivers of southwest such as Avon, Murray and Blackwood, however Salination of many waterways has severely reduced this species distribution (Klunzinger 2012; Klunzinger, et al. 2012).	Likely The Survey Area has some suitable habitat.	Known Remnants shells were found at Lake Banksiadale.	PMST
<i>Glacidorbis occidentalis</i>	Jarrah Forest Freshwater snail	P3		The Jarrah Forest Freshwater snail inhabits freshwater streams in the Darling Range, Western Australia. The minute shell reaches a maximum diameter of 1.2mm varying from a cream colour to light grey. The streams they inhabit are found within the Jarrah forest.	Unlikely. The survey Area doesn't contain suitable habitat.	Unlikely. The survey Area doesn't contain suitable habitat.	NatureMap

Combined species list

Family	Scientific Name	Species	EPBC listing	DBCA listing	Recc.	Camera Rotation	Phase 1	Phase 2	Phase 3	Single Target
Mammals										
Dasyuridae	<i>Antechinus flavipes</i>	Mardo					X	X	X	X
Dasyuridae	<i>Dasyurus geoffroii</i>	Chuditch	Vu	Vu	X		X			X
Leporidae	<i>Oryctolagus cuniculus</i>	European Rabbit	Int	Int				X		
Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo			X		X	X	X	X
Macropodidae	<i>Notamacropus irma</i>	Western Brush Wallaby		P4	X	X	X	X	X	X
Macropodidae	<i>Setonix brachyurus</i>	Quokka	Vu	Vu	X	X			X	
Molossidae	<i>Ozimops kitcheneri</i>	South-western Free-tailed Bat				X	X			
Muridae	<i>Hydromys chrysogaster</i>	Rakali		P4				X		
Muridae	<i>Mus musculus</i>	House Mouse	Int	Int				X		
Muridae	<i>Rattus fuscipes</i>	Bush Rat			X		X			
Muridae	<i>Rattus rattus</i>	Black Rat	Int	Int	X		X	X		
Peramelidae	<i>Isoodon fusciventer</i>	Quenda		P4		X				
Suidae	<i>Sus scrofa</i>	Feral Pig	Int	Int	X		X	X		X
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna			X		X			X
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				X	X			
Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat				X	X			
Vespertilionidae	<i>Falsistrellus mackenziei</i>	Western false pipistrelle		P4			X			
Vespertilionidae	<i>Nyctophilus species</i>	Australian long-ear bats				X	X			
Vespertilionidae	<i>Vespadelus regulus</i>	Southern Forest Bat				X	X			
Birds										
Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill			X		X		X	
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			X					
Acanthizidae	<i>Acanthiza inornata</i>	Western Thornbill						X		
Acanthizidae	<i>Gergoyne fusca</i>	Western Gerygone			X		X	X	X	
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren			X		X	X	X	

Family	Scientific Name	Species	EPBC listing	DBCA listing	Recc.	Camera Rotation	Phase 1	Phase 2	Phase 3	Single Target
Acanthizidae	<i>Smicrornis brevirostris</i>	Weebill			X		X	X	X	
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk						X		
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle			X		X	X		
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite							X	
Accipitridae	<i>Lophoictinia isura</i>	Square-tailed Kite						X	X	
Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar					X			
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra		Int	X	X	X		X	
Anatidae	<i>Anas gracilis</i>	Grey Teal						X		
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck			X					
Anatidae	<i>Biziura lobata</i>	Musk Duck					X	X		
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck						X		
Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow							X	
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow							X	
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird			X		X			
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie			X					
Artamidae	<i>Strepera versicolor</i>	Grey Currawong			X			X	X	X
Cacatuidae	<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	Vu	Vu	X	X	X	X	X	
Cacatuidae	<i>Eolophus roseicapillus</i>	Galah			X					
Cacatuidae	<i>Zanda baudinii</i>	Baudin's Cockatoo	En	En	X	X		X	X	
Cacatuidae	<i>Zanda latirostris</i>	Carnaby's Black Cockatoo	EN	EN						X
Campephagidae	<i>Chalcites lucidus</i>	Shining Bronze Cuckoo			X		X			
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			X			X	X	
Campephagidae	<i>Lalage tricolor</i>	White-winged Triller							X	
Casuariidae	<i>Dromaius novaehollandiae</i>	Emu			X		X	X		
Climacteridae	<i>Climacteris rufus</i>	Rufous Tree Creeper						X		
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing			X				X	
Columbidae	<i>Phaps elegans</i>	Brush Bronzewing			X			X	X	

Family	Scientific Name	Species	EPBC listing	DBCA listing	Recc.	Camera Rotation	Phase 1	Phase 2	Phase 3	Single Target
Corvidae	<i>Corvus coronoides</i>	Australian Raven			X		X	X	X	X
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo			X	X			X	
Cuculidae	<i>Cacomantis pallidus</i>	Pallid Cuckoo			X	X			X	
Cuculidae	<i>Chrysococcyx basalus</i>	Horsfield's Bronze Cuckoo							X	
Falconidae	<i>Falco berigora</i>	Brown Falcon						X		
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin					X		X	
Maluridae	<i>Malurus elegans</i>	Red-winged Fairywren			X		X	X		
Maluridae	<i>Malurus splendens</i>	Splendid Fairywren			X		X	X	X	X
Meliphagidae	<i>Acanthorhynchus superciliosus</i>	Western Spinebill					X		X	
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird			X				X	
Meliphagidae	<i>Anthochaera lunulata</i>	Western Wattlebird							X	
Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater			X		X		X	
Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater							X	
Meliphagidae	<i>Melithreptus lunatus</i>	White-napped Honeyeater			X			X		
Meliphagidae	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater			X		X		X	
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater							X	
Monarchidae	<i>Myiagra inquieta</i>	Restless Flycatcher							X	
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sitella							X	
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Strike Thrush			X		X	X	X	
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler			X			X	X	
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler			X		X			
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote			X		X		X	
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote			X		X		X	
Petroicidae	<i>Eopsaltria georgiana</i>	White-breasted Robin			X					
Petroicidae	<i>Eopsaltria griseogularis</i>	Western Yellow Robin			X		X		X	X
Petroicidae	<i>Melanodryas cucullata</i>	Hooded Robin						X		

Family	Scientific Name	Species	EPBC listing	DBCA listing	Recc.	Camera Rotation	Phase 1	Phase 2	Phase 3	Single Target
Petroicidae	<i>Petroica boodang</i>	Scarlet Robin			X		X		X	
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant						X		
Psittaculidae	<i>Barnardius zonarius</i>	Australian Ringneck Parrot			X		X	X	X	
Psittaculidae	<i>Neophema elegans</i>	Elegant Parrot			X		X			
Psittaculidae	<i>Platycercus icterotis</i>	Western Rosella			X		X	X	X	
Psittaculidae	<i>Purpureicephalus spurius</i>	Red-capped Parrot			X				X	
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail			X		X		X	
Strigidae	<i>Ninox boobook</i>	Southern Boobook			X		X			
Turnicidae	<i>Turnix varius</i>	Painted Button Quail								X
Tytonidae	<i>Tyto novaehollandiae novaehollandiae</i>	Masked Owl		P3			X			
Zosteropidae	<i>Zosterops lateralis</i>	Silvereeye			X		X			
Reptiles										
Agamidae	<i>Ctenophorus ornatus</i>	Ornate Crevice-dragon					X			
Agamidae	<i>Pogona minor</i>	Western Bearded Dragon			X					
Carphodactylidae	<i>Underwoodisaurus milii</i>	Barking Gecko			X		X			
Elapidae	<i>Suta gouldii</i>	Gould's Hooded Snake					X		X	
Elapidae	<i>Suta nigriceps</i>	Mallee Black-backed Snake					X			
Gekkonidae	<i>Christinus marmoratus</i>	Marbled Gecko						X		
Gekkonidae	<i>Diplodactylus lateroides</i>	Speckled stone gecko			X		X	X	X	
Pygopodidae	<i>Aprasia pulchella</i>	Pretty Worm-lizard					X			
Pygopodidae	<i>Delma fraseri</i>	Fraser's Delma						X		
Pygopodidae	<i>Lialis burtonis</i>	Burton's legless lizard							X	
Pygopodidae	<i>Pygopus lepidopodus</i>	Common Scaly-foot						X		
Scincidae	<i>Acritoscincus trilineatus</i>	South-western cool-skink						X		
Scincidae	<i>Cryptoblepharus buchananii</i>	Buchanan's Snake-eyed Skink						X		
Scincidae	<i>Ctenotus delli</i>	Dell's Skink		P4				X	X	

Family	Scientific Name	Species	EPBC listing	DBCA listing	Recc.	Camera Rotation	Phase 1	Phase 2	Phase 3	Single Target
Scincidae	<i>Ctenotus impar</i>	South-western Odd-striped Ctenotus						X		
Scincidae	<i>Ctenotus labillardieri</i>	Common south-west Ctenotus			X		X	X	X	
Scincidae	<i>Egernia kingii</i>	King Skink						X		
Scincidae	<i>Egernia napoleonis</i>	Napoleon Skink						X		X
Scincidae	<i>Hemiergis initialis</i>	South-western earless skink					X	X	X	
Scincidae	<i>Hemiergis quadrilineata</i>	Two-toed Earless Skink						X		
Scincidae	<i>Lerista distinguenda</i>	South-western Orange-tailed Slider							X	
Scincidae	<i>Menetia greyii</i>	Common Dwarf Skink						X	X	
Scincidae	<i>Morethia obscura</i>	Shrubland Skink					X	X	X	X
Scincidae	<i>Tiliqua rugosa rugosa</i>	Shingleback					X	X		
Typhlopidae	<i>Anilius australis</i>	Southern Blind Snake							X	
Varanidae	<i>Varanus gouldii</i>	Gould's Monitor								X
Varanidae	<i>Varanus rosenbergi</i>	Rosenberg's Monitor						X	X	X
Amphibians										
Hylidae	<i>Litoria adelaidensis</i>	Slender Tree Frog			X			X	X	
Limnodynastidae	<i>Heleioporus eyrei</i>	Moaning Frog						X	X	
Limnodynastidae	<i>Heleioporus psammophilus</i>	Sand Frog						X	X	
Myobatrachidae	<i>Crinia georgiana</i>	Quacking Frog					X	X		
Myobatrachidae	<i>Crinia glauerti</i>	Rattling Froglet					X			
Myobatrachidae	<i>Crinia pseudinsignifera</i>	Bleating Froglet			X		X	X	X	
Myobatrachidae	<i>Pseudophryne guentheri</i>	Gunther's toadlet/Crawling toadlet						X	X	
Other										
Hyriidae	<i>Westralunio carteri</i>	Carter's freshwater mussel	Vu		X					

Phase 2 Trapping data

Family	Taxa	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Total
Mammals									
Muridae	<i>Mus musculus</i>	House Mouse				1			1
Birds									
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren			1				1
Acanthizidae	<i>Smicronis brevirostris</i>	Weebill						1	1
Cacatuidae	<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo						2	2
Falconidae	<i>Falco berigora</i>	Brown Falcon			1				1
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Strike Thrush						1	1
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler						1	1
Psittaculidae	<i>Platycercus zonarius</i>	Australian Ringneck parrot						1	1
Reptiles									
Gekkonidae	<i>Diplodactylus lateroides</i>	Laterite stone gecko						2	2
Pygopodidae	<i>Delma fraseri</i>	Fraser's Delma	1						1
Pygopodidae	<i>Pygopus lepidopodus</i>	Common Scaly foot					2		2
Scincidae	<i>Cryptoblepharus buechananii</i>	Buchanan's Snake-eyed Skink						1	1
Scincidae	<i>Ctenotus dell</i>	Dell's Skink			2				2
Scincidae	<i>Ctenotus impar</i>	South-western striped Ctenotus				2			2
Scincidae	<i>Ctenotus labillardieri</i>	Common south-west Ctenotus						1	1
Scincidae	<i>Hemiergis initialis</i>	Southwestern earless skink	1	4	3			3	11
Scincidae	<i>Menetia greyii</i>	Common Dwarf skink	1			1	5		7
Scincidae	<i>Morethia obscura</i>	Shrubland Skink				2	6	6	14
Frogs									
Limnodynastidae	<i>Heleioporus eyrei</i>	Moaning Frog	1						1
Limnodynastidae	<i>Heleioporus inornatus</i>	Plain Frog			2				2
Limnodynastidae	<i>Heleioporus psammophilus</i>	Sand Frog			6	1	1		8
Myobatrachidae	<i>Crinia georgiana</i>	Quacking Frog	1						1
Myobatrachidae	<i>Pseudophryne guentheri</i>	Gunther's toadlet			7	1	2		10

Phase 3 Trapping data

Family	Taxa	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Total
Mammals									
Dasyuridae	<i>Antechinus flavipes</i>	Mardo			2	1		2	5
Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	2					2	4
Macropodidae	<i>Notamacropus Irma</i>	Western Bush Wallaby		1				1	2
Birds									
Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill	1						1
Acanthizidae	<i>Gergoyne fusca</i>	Western Gerygone		2		1		3	6
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren	1		2	2		3	8
Acanthizidae	<i>Smicromnis brevirostris</i>	Weebill	2	7	4			4	17
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite				1			1
Accipitridae	<i>Lophoictinia isura</i>	Square-tailed Kite			2				2
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra		1		1			2
Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow				4			4
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow					4		4
Artamidae	<i>Strepera versicolor</i>	Grey Currawong		2	3	1			6
Cacatuidae	<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	2		2			2	6
Cacatuidae	<i>Zanda baudinii</i>	Baudin's Cockatoo			1	2		2	5
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				1			1
Campephagidae	<i>Lalage tricolor</i>	White-winged Triller	1						1
Casuariidae	<i>Dromaius novaehollandiae</i>	Emu					2		2
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing					1		1
Columbidae	<i>Phaps elegans</i>	Brush Bronzewing				1			1
Corvidae	<i>Corvus coronoides</i>	Australian Raven				1	1		2
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo					1		1
Cuculidae	<i>Cacomantis pallidus</i>	Pallid Cuckoo	1						1
Cuculidae	<i>Chrysococcyx basalis</i>	Horsfield's Bronze Cuckoo	1			4		1	6
Cuculidae	<i>Chrysococcyx lucidus</i>	Shining Bronze-cuckoo		1					1
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin	16			5	1		22

Family	Taxa	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Total
Maluridae	<i>Malurus splendens</i>	Splendid Fairywren	2		4		1		7
Meliphagidae	<i>Acanthorhynchus superciliosus</i>	Western Spinebill		1	1	6	1		9
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird	2	2	1				5
Meliphagidae	<i>Anthochaera lunulata</i>	Western Wattlebird		5					5
Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater	22	3			2		27
Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater		1				1	2
Meliphagidae	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	1			4			5
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	1						1
Monarchidae	<i>Myiagra inquieta</i>	Restless Flycatcher	1						1
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sitella		8				4	12
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Strike Thrush		1		3			4
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	2	1	2	1	1	2	9
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote		4				4	8
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote	2	2	6	4	1	15	30
Petroicidae	<i>Eopsaltria griseogularis</i>	Western Yellow Robin		2					2
Petroicidae	<i>Petroica boodang</i>	Scarlet Robin			1				1
Psittaculidae	<i>Platycercus icterotis</i>	Western Rosella					1		1
Psittaculidae	<i>Platycercus zonarius</i>	Australian Ringneck parrot	2						2
Psittaculidae	<i>Purpureicephalus spurius</i>	Red Capped Parrot	1			2			3
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail		1	1		1	1	4
Reptiles									
Elapidae	<i>Suta gouldii</i>	Gould's Hooded Snake	1						1
Gekkonidae	<i>Diplodactylus lateroides</i>	Laterite stone gecko				1		4	5
Pygopodidae	<i>Lialis burtonis</i>	Burton's legless lizard	2				1	1	4
Scincidae	<i>Ctenotus dell</i>	Dell's Skink					1		1
Scincidae	<i>Ctenotus impar</i>	South-western striped Ctenotus				17			17
Scincidae	<i>Ctenotus labillardieri</i>	Common south-west Ctenotus			1			1	2
Scincidae	<i>Hemiergis initialis</i>	Southwestern earless skink		1				2	3

Family	Taxa	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Total
Scincidae	<i>Lerista distinguenda</i>	South-western Orange-tailed Slider		7	1		3	3	14
Scincidae	<i>Menetia greyii</i>	Common Dwarf skink	3	2	2	1	4	4	16
Scincidae	<i>Morethia obscura</i>	Shrubland Skink	1		3	3	2	6	15
Typhlopidae	<i>Anilius australis</i>	Southern Blind Snake	2				1	1	4
Varanidae	<i>Varanus rosenbergi</i>	Rosenberg's Monitor	1						1
Frogs									
Limnodynastidae	<i>Heleioporus eyrei</i>	Moaning Frog				1			1
Limnodynastidae	<i>Heleioporus psammophilus</i>	Sand Frog			3	2			5
Myobatrachidae	<i>Crinia georgiana</i>	Quacking Frog	1	2					3
Myobatrachidae	<i>Crinia pseudinsignifera</i>	Bleating Froglet			1				1
Myobatrachidae	<i>Pseudophryne guentheri</i>	Gunther's toadlet			1	1			2
Pelodyadidae	<i>Litoria adelaidensis</i>	Slender Tree Frog		1					1

Reconnaissance camera data

Species	Cam 1	Cam 7	Cam HP3	CAM 77	CAM 4	CAM Yalgoo	CAM P1	CAM HF12	Cam 8
Black Rat (Int)	6		12					21	7
Bush Rat								5	
Chuditch (VU)				4		1			
Echidna									
Mardo	18		19	6	4	13	1	9	4
Quokka (VU)	22								
Western Brush Wallaby (P4)		1							
Western Grey Kangaroo		1							
Red-winged Fairy Wren	3	1	13					6	
Tree Creeper						11			
White-breasted Robin								1	
White-browed Scrubwren								3	
Western Bearded Dragon	1								

Camera rotation camera data

Species	CAM NO NAME	CAM 12	CAM 14	CAM 20	CAM 21	CAM 31	CAM 55	CAM R59
Chuditch (VU)								3
Echidna	1	1			1			
Mardo		1	5		2	5	1	1
Western Brush Wallaby (P4)					2			
Grey Fantail						1		
Inland Thornbill							1	
Red-winged Fairy Wren	1					1		
White-breasted Robin								
White-browed Scrubwren							1	

Phase 1 Camera data

Species	CAM NO NAME	CAM 12	CAM 14	CAM 21	CAM 31	CAM 55	CAM R59	CAM 5	CAM 16	CAM 17F	CAM 19	CAM 28	CAM 53	CAM C42	CAM HP4	CAM P6	CAM P1	CAM 77	CAM P5	CAM P4	CAM P2	CAM 1	CAM HF12
Black Rat (Int)																						2	
Bush Rat																						6	
Chuditch (VU)							3				2	2	2	1									
Echidna	1	1		1								1					1	2					1
Mardo		1	5	2	5	1	1	1	6	4	2		6	1			8	31		20	2	11	
Western Brush Wallaby (P4)				2											1	1					1		
Western Grey Kangaroo										1		1			2			1					
Grey Currowong																							1
Grey Fantail					1																		
Inland Thornbill						1							1										
Owlet Nightjar								1															
Red-winged Fairy Wren	1				1								1		1								
Spotted Pardalote													1										
Weebill																							1
Western Yellow Robin																							1
White-browed Scrubwren						1							1										

Phase 2 Camera data




Species	CAM14	CAM21	CAM31	CAM55	CAM Forgot	CAM HF12	CAM HP4	CAM P2	CAM P6	CAM No Name	Cam 12	Cam 57
Black Rat (Int)											6	
Echidna	1					1	1				1	
Mardo		2		6	2	6	7	2	9	1	9	
Rakali (P4)												1
Western Brush Wallaby (P4)			1				1	1		1		
Western Grey Kangaroo		2								1		
Australian Raven												4
Grey Currawong									1			
Grey Teal												1
Red-winged Fairy Wren											2	2
Splendid Fairywren												8
White-browed Scrubwren										1		10
King Skink											1	2
Napoleon Skink				1								
Rosenberg's Monitor												4
Shingleback				1							1	




Single Target camera data






Common Name	Cam W5	Cam HF10	Cam P5	Cam Yalgoo	Cam W2	Cam W8	Cam 53	CAM P4	Cam W12
Mardo		1	2	2			2	16	3
Chuditch (Vu)					1				
Western Grey Kangaroo		3	1		5	2			2
Western Brush Wallaby (P4)	7		12	6		17			14
Feral Pig (int)								1	2
Short-beaked Echidna		3	2	6		1			
Australian Raven	1								
Western Yellow Robin					1			1	
Splendid Fairy Wren				1	1				
Grey Currawong		2		1		1			1
Southwest Crevice Skink			1	4				5	
Shrubland Skink						2			2
Painted Button Quail			1	3		2			
Rosenberg's Monitor		1		3					
Gould's Monitor			4						


Chuditch camera capture (*Dasyurus geoffroi*) physical assessment data

Spot patterns of Chuditch were examined in detail and used to identify individuals from camera trap photographs. In order to use these patterns to identify individuals, accurate and proportionate sketches were made of the top of the head, back, left and right sides of individual Chuditch from the photographs taken by the remote cameras. Each sketch aimed to provide a useful summary that strongly aided subsequent recognition of individuals (Hohnen *et al* 2015). The spot patterns were examined to determine whether the Chuditch in question was new or a previously viewed individual. Often two or more key spot patterns were visible in a photograph of a single side (e.g. one group on the shoulder and one on the haunch). When these key collections of spots could be matched and no area of the coat had con-complementary patterns, it was deemed to be the same individual. Therefore a clear view of a single side was sufficient to confirm the identify of the individual, if that individual had been previously identified. Only good quality images showing two or more clear spot patterns were used for identification and photographs with obscured or blurred patterns were not used (Hohnen *et al* 2015).

Chuditch ID	Camera ID	Easting	Northing	Date	ID marks	Spot pattern diagram	Remote camera Image
Chuditch 1	CAM 77			Phase Reccy deployment: 02/07/2023	Distinct row of three spots directly behind left ear.		Chuditch Left Side:
				Phase Reccy Deployment: 06/07/2023	Distinct row of three spots in semi-circle pattern directly behind right ear.		
				Phase Reccy Deployment: 10/07/2023			Chuditch Right Side:
				Phase Reccy Deployment: 16/07/2023			

Chuditch ID	Camera ID	Easting	Northing	Date	ID marks	Spot pattern diagram	Remote camera Image
Chuditch 2	CAM Yalgoo			Phase Reccy deployment:03/07/2023	Visible notch on left ear, mating scar across neck.		Chuditch Left Side: 
	CAM R59			Phase North East Powerlines: 19/08/2023	Circle of five spots along middle of right hand side flank.		Chuditch Right Side: 
	CAM53			Phase North East Powerlines: 20/08/2023 Phase Powerlines: 25/08/2023	Square formation of four spots along front left shoulder.		

Chuditch ID	Camera ID	Easting	Northing	Date	ID marks	Spot pattern diagram	Remote camera Image
Chuditch 3	Cam 19			Phase Powerlines: 24/08/2023	Two distinct, large spots directly underneath right ear.		Chuditch Left Side: 
				Phase Powerlines: 25/08/2023	Star-shaped pattern of six spots along back left flank.		Chuditch Right Side: 
Chuditch 4	CAM 28 CAM C42			Phase Powerlines: 17/08/2023	Circular pattern of eight spots in middle of left hand flank.		Chuditch Left Side: 
				Phase Powerlines: 18/08/2023	Straight horizontal band of four spots along right hand flank.		
				Phase Powerlines:			

Chuditch ID	Camera ID	Easting	Northing	Date	ID marks	Spot pattern diagram	Remote camera Image
				17/08/2023			Chuditch Right Side: 

Reference

Hohnen, R, Ashby, J, Tuft, K, & McGregor, H 2012, '*Individual identification of northern quolls (Dasyurus hallucatus) using remote cameras*', Australian Mammalogy, CSIRO Publishing. <http://dx.doi.org/10.1071/AM12015>.

Black Cockatoo foraging assessment

	Starting score	Carnaby's Cockatoo	Baudin's Cockatoo	Forest Red-tailed Black Cockatoo
Foraging tool template	10	Start at a score of 10 if your site is native shrubland, Kwongan heathland or woodland, dominated by proteaceous plant species such as Banksia spp. (including Dryandra spp.), Hakea spp. and Grevillea spp., as well as native eucalypt woodland and forest that contains foraging species, within the range of the species, including along roadsides and parkland cleared areas. Also includes planted native vegetation. This tool only applies to sites equal to or larger than 1 hectare in size.	Start at a score of 10 if your site is native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly Marri, within the range of the species, including along roadsides and parkland cleared areas. Can include planted vegetation. This tool only applies to sites equal to or larger than 1 hectare in size.	Start at a score of 10 if your site is Jarrah or Marri woodland and/or forest, or if it is on the edge of Karri forest, or if Wandoo and Blackbutt occur on the site, within the range of the subspecies, including along roadsides and parkland cleared areas. This tool only applies to sites equal to or larger than 1 hectare in size.
	Attribute/score subtraction	Context adjustor (attributes reducing functionality of foraging habitat)		
	Foraging potential (-2)	Subtract 2 from your score if there is no evidence of feeding debris on your site.	Subtract 2 from your score if there is no evidence of feeding debris on your site.	Subtract 2 from your score if there is no evidence of feeding debris on your site.
	Connectivity (-2)	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	Subtract 2 from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.
	Proximity to breeding (-2)	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat.	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat.	Subtract 2 if you have evidence to conclude that your site is more than 12 km from breeding habitat.
	Proximity to roosting (-1)	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	Subtract 1 if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.
	Impact from significant plant disease (-1)	Subtract 1 if your site has disease present (e.g., Phytophthora spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	Subtract 1 if your site has disease present (e.g., Phytophthora spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	Subtract 1 if your site has disease present (e.g., Phytophthora spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.
	Attribute/score subtraction	Carnaby's Cockatoo	Baudin's Cockatoo	Forest Red-tailed Black Cockatoo

Jarrah-Marri forest	Starting score	10	10	10
	Foraging potential (-2)	0	0	0
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	10	10	10
Appraisal and adjusted score	The Jarrah-marri forest contains suitable foraging habitat. The habitat has good connectivity with foraging habitat within 12kms of the Survey Area. Previously recorded breeding trees are recorded within the Survey Area. Roosting sites were recorded with 20kms from Survey Area. Some signs of Phytophthora or Marri canker was observed and frequent fires and logging have the potential to affect habitat usage (-1). Score: 9	The Jarrah-marri forest contains suitable foraging habitat with many signs of foraging evidence scattered throughout the Survey Area. The habitat has good connectivity with foraging habitat within 12kms of the Survey Area. Previously recorded breeding trees are recorded within the Survey Area. Roosting sites were recorded with 20kms from Survey Area. Some signs of Phytophthora or Marri canker was observed and frequent fires and logging have the potential to affect habitat usage (-1). Score 9	The Jarrah-marri forest contains suitable foraging habitat with many signs of foraging evidence scattered throughout the Survey Area. The habitat has good connectivity with foraging habitat within 12kms of the Survey Area. Previously recorded breeding trees are recorded within the Survey Area. Roosting sites were recorded with 20kms from Survey Area. Some signs of Phytophthora or Marri canker was observed and frequent fires and logging have the potential to affect Forest Red-tail Black Cockatoo (-1). Score 9	
Wandoo Woodland	Starting score	10	10	10
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	8	8	8

	Appraisal and adjusted score	Foraging evidence was not observed within the Wandoo woodlands, Wandoo doesn't provide much foraging potential for Black Cockatoos. Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score 7	Foraging evidence was not observed within the Wandoo woodlands, Wandoo doesn't provide much foraging potential for Black Cockatoos. Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score 7	Foraging evidence was not observed within the Wandoo woodlands, Wandoo doesn't provide much foraging potential for Black Cockatoos. Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score 7
Blackbutt	Starting score	10	10	10
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	8	8	8
	Appraisal and adjusted score	No foraging evidenced recorded within Blackbutt Forest or a favoured foraging item for Black Cockatoos. However, Blackbutt has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 5	No foraging evidenced recorded within Blackbutt Forest or a favoured foraging item for Black Cockatoos. However, Blackbutt has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 5	No foraging evidenced recorded within Blackbutt Forest or a favoured foraging item for Black Cockatoos. However, Blackbutt has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 5
Bullich Forest	Starting score	10	10	10
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	8	8	8

	Appraisal and adjusted score	No foraging evidenced recorded within Bullich Forest or a favoured foraging item for Black Cockatoos. However, Bullich has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 6	No foraging evidenced recorded within Bullich Forest or a favoured foraging item for Black Cockatoos. However, Bullich has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 6	No foraging evidenced recorded within Bullich Forest or a favoured foraging item for Black Cockatoos. However, Bullich has the potential to provide suitable hollows. Great connectivity to the larger forested area, within 12km of known breeding trees and within 20kms of roosting sites. No signs of diseases affecting vegetation. Score 6
Granite Outcrop	Starting score	10	0	0
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	8	-2	-2
	Appraisal and adjusted score	No foraging evidence recorded within granite outcrop habitat however proteaceous species are present. Great connection to larger forested area. Within 12km to confirmed breeding trees and within 20kms from roosting trees. No diseases affecting vegetation present in area. Rain could cause seasonal pools providing drinking sources for Black Cockatoos. Frequent fires and logging can also affect the habitat usage (-1). Score 7	No foraging evidence recorded within granite outcrop habitat. Great connection to larger forested area. Within 12km to confirmed breeding trees and within 20kms from roosting trees. No diseases affecting vegetation present in area. Rain could cause seasonal pools providing drinking sources for Black Cockatoos. Frequent fires and logging can also affect the habitat usage (-1). Score 7	No foraging evidence recorded within granite outcrop habitat. Great connection to larger forested area. Within 12km to confirmed breeding trees and within 20kms from roosting trees. No diseases affecting vegetation present in area. Rain could cause seasonal pools providing drinking sources for Black Cockatoos. Frequent fires and logging can also affect the habitat usage (-1). Score 5
Damplands	Starting score	10	10	10
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0

	Total score	-2	-2	-2
	Appraisal and adjusted score	Foraging evidence was not observed within the melaleuca woodlands. Potential Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score: 7	Foraging evidence was not observed within the melaleuca woodlands. Potential Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score: 7	Foraging evidence was not observed within the melaleuca woodlands. Potential Breeding hollows within 12kms and roosting trees within 20kms. No signs of disease within the woodland. Good connectivity with the greater forested area. Frequent fires and logging can also affect the habitat usage (-1). Score: 7
Rehab Areas	Starting score	0	0	0
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	-2	-2	-2
	Appraisal and adjusted score	No foraging evidence was recorded within rehab areas. More established rehab areas can provide foraging potential or foraging potential from established Jarrah or Marri trees. Rehab areas have good connectivity to the great forest area and are located with 20kms from roosting sites and 12kms from Known breeding trees. However, Seasonal bodies of water providing drinking sources for Black Cockatoos. Score: 4	No foraging evidence was recorded within rehab areas. More established rehab areas can provide foraging potential or foraging potential from established Jarrah or Marri trees. Rehab areas have good connectivity to the great forest area and are located with 20kms from roosting sites and 12kms from Known breeding trees. However, Seasonal bodies of water providing drinking sources for Black Cockatoos. Score: 4	No foraging evidence was recorded within rehab areas. More established rehab areas can provide foraging potential or foraging potential from established Jarrah or Marri trees. Rehab areas have good connectivity to the great forest area and are located with 20kms from roosting sites and 12kms from Known breeding trees. However, Seasonal bodies of water providing drinking sources for Black Cockatoos. Score: 4
Cleared Land	Starting score	0	0	0
	Foraging potential (-2)	-2	0	0
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0

	Total score	-2	0	0
	Appraisal and adjusted score	Potential for foraging on Parrot Bush and Marri trees fringing roads and powerlines. Good connectivity to greater forested area. Previously confirmed breeding trees within 12kms of area and roosting sites with 20kms of cleared areas. Score:2	Baudin's Cockatoo were observed foraging on Parrot Bush fringing roads and powerlines and Marri nuts were often found on tracks. Good connectivity to greater forested area. Previously confirmed breeding trees within 12kms of area and roosting sites with 20kms of cleared areas. Score: 2	Foraging evidence of Jarrah and Marri nuts were often observed on roads and tracks. However, Previously confirmed breeding trees within 12kms of area and within 20kms of roosting sites. Score: 2
Water Body	Starting score	10	10	10
	Foraging potential (-2)	-2	-2	-2
	Connectivity (-2)	0	0	0
	Proximity to breeding (-2)	0	0	0
	Proximity to roosting (-1)	0	0	0
	Impact from significant plant disease (-1)	0	0	0
	Total score	-2	-2	-2
	Appraisal and adjusted score	No foraging evidence recorded on the banks of water bodies, potential foraging habitat in woodlands surrounding water body. Great connectivity with greater forested area. Within 12kms from known breeding trees. Within 20kms from known roosting trees. No signs of disease affecting vegetation. Water body provides a consistent drinking source year-round for Black Cockatoos. Score: 2	No foraging evidence recorded on the banks of water bodies, potential foraging habitat in woodlands surrounding water body. Great connectivity with greater forested area. Within 12kms from known breeding trees. Within 20kms from known roosting trees. No signs of disease affecting vegetation. Water body provides a consistent drinking source year-round for Black Cockatoos. Score: 2	Foraging evidence recorded 20 meters away from water's edge. Great connectivity with greater forested area. Within 12kms from known breeding trees. Within 20kms from known roosting trees. No signs of disease affecting vegetation. Water body provides a consistent drinking source year-round for Black Cockatoos. Score: 3

Appendix E

External data assessments

Results from Bird acoustic analysis

Results from Bat acoustic analysis

Results of acoustic surveys
conducted for

Masked Owl (*Tyto
novaehollandiae*)

Alcoa Project – Contingency
Area A

Jun – Sep 2023

Report to:

GHD

Prepared by:

Nick Leseberg

Adaptive NRM

10th February 2024



1. Summary

During the period June – September 2023, autonomous recording units (ARUs) were deployed at nine sites within the Alcoa Contingency Area A project area in southwest Western Australia to survey for Masked Owls (*Tyto novaehollandiae*). Resulting acoustic data was analysed using signal parameters optimised for detecting Masked Owl screech calls. Masked Owl calls were detected at three sites.

2. Survey effort

Research has demonstrated Masked Owls occupy long-term home ranges for periods of up to several years (Kavanagh and Murray 1996). The owls have predictable year-round calling periods at dusk and dawn (N. Jackett unpubl. data), with calling detected at these times usually indicating proximity to a roost site (Todd et al. 2018; Young et al. 2021). Therefore, ARUs have the potential to localise roost sites through strategic deployment. It is likely that multiple recordings nights, during calm weather with minimal background noise, are required for greatest confidence pertaining to Masked Owl presence, but further research is warranted.

Masked Owls are also known to call during the night when away from their roost or breeding sites and can similarly be detected using ARUs (N. Jackett unpubl. data). However, it is likely that the probability of detecting a Masked Owl away from its roost site diminishes with distance, and therefore additional nights may be required to detect a Masked Owl in foraging only areas.

The likelihood of detection may also be influenced by the type of ARU being used. In calm conditions, Song Meter 4s may be capable of reliably detecting Masked Owl screech calls at distances greater than 200m (N. Jackett unpubl. data).

GHD conducted sampling for the Masked Owl between June and September 2023. Four Song Meter 4 (Wildlife Acoustics, MA, USA) autonomous recording units were deployed across nine sites. At eight sites the ARUs recorded 3-5 nights of data, while at one site only one night of data was recorded. The units were programmed to record approximately from sunset to sunrise. A combined total of 30 nights of data were recorded (Table 1).

Table 1. Bioacoustic recordings analysed from the Jun – Sep surveys.

Machine	Recording start date (PM)	Recording end date (AM)	Total recording nights
SM4-AC1	27-Jun-23	30-Jun-23	3
SM4-AC3	27-Jun-23	30-Jun-23	3
SM4-AC4	24-Jul-23	27-Jul-23	3
SM4-AC3	16-Aug-23	21-Aug-23	5
SM4-AC1	21-Aug-23	25-Aug-23	4
SM4-AC3	21-Aug-23	25-Aug-23	4
SM4-AC2	24-Aug-23	25-Aug-23	1
SM4-AC3	5-Sep-23	8-Sep-23	3
SM4-AC3	8-Sep-23	12-Sep-23	4
Total			30

3. Data analysis

ANRM received the raw acoustic data in '.wav' format, as 60-minute files. These were scanned using the acoustic analysis software Kaleidoscope (Wildlife Acoustics, MA, USA), targeting the frequency range of 1600 – 2400 Hz, within which Masked Owl screech calls are distributed. Based on data from previous surveys in this region, this method will detect approximately 87% of screech calls within a dataset. Calls not detected are typically faint (i.e. likely distant from the acoustic recorder), or occurred during light rain, or wind gusts. Within the test dataset, the probability of non-detection of a true-positive screech call was 13.3%; two consecutive true-positive screech calls was 1.8%; etc. Of the data tested, the median number of consecutive (spaced at <10 minutes apart) calls in a screech sequence when Masked Owls were recorded was 5 (1–21, $n = 18$). Based on previous analyses of datasets containing Masked Owl vocalisations, the probability of at least one screech call being detected within a sequence of median length is >99.9%.

4. Survey results

A total of 3136 Kaleidoscope detections were manually assessed for Masked Owl screech calls. 15 Masked Owl screech calls were detected from four calling sequences across three sites (Table 2). Except for the call sequence detected on SM4-AC3, call sequences were outside the period when owls are departing or arriving at their roost sites (i.e. < 1 hour post-sunset or < 1 hour pre-sunrise). The calls detected on SM4-AC3 were approximately 50 minutes after sunset,

and while possibly a bird near its roost site, are more likely a bird in transit given no calls were detected in this period on other nights.

19 non-target species were detected during the analysis. A list of these species is provided at Appendix 1.

Table 2. Masked Owl calls detected during Jun – Aug surveys. Shading indicates call sequences.

Machine	Lat	Long	Date	Time
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:46:55
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:46:30
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:46:38
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:47:11
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:47:27
SM4-AC1	-32.6011	116.1895	28-Jun-23	19:47:37
SM4-AC1	-32.6011	116.1895	29-Jun-23	01:41:46
SM4-AC3	-32.5082	116.2888	16-Aug-23	18:32:45
SM4-AC3	-32.5082	116.2888	16-Aug-23	18:33:08
SM4-AC3	-32.5082	116.2888	16-Aug-23	18:40:36
SM4-AC3	-32.5082	116.2888	16-Aug-23	18:41:44
SM4-AC3	-32.5082	116.2888	16-Aug-23	18:42:07
SM4-AC4	-32.6207	116.2245	24-Jul-24	18:45:14
SM4-AC4	-32.6207	116.2245	24-Jul-24	18:53:37
SM4-AC4	-32.6207	116.2245	24-Jul-24	18:55:55

5. Conclusion

Based on these results, it is considered unlikely Masked Owls roosted in proximity to the ARU sites during the survey. However, based on a home range size of ~1000 – 2000 ha, a roost and/or nest site may have been present within several kilometres of those sites where calls were detected. A denser acoustic sampling array within several kilometres of these sites may provide further indication of roost presence.

It is important to note that these results pertain specifically to that area immediately surrounding the survey points, and do not necessarily support conclusions about the presence or absence of Masked Owls in the wider landscape.

6. References

- Kavanagh, R. P., & Murray, M. (1996). Home range, habitat and behaviour of the Masked Owl *Tyto novaehollandiae* near Newcastle, New South Wales. *Emu - Austral Ornithology*, 96(4), 250–257.
- Todd, M. K., Kavanagh, R. P., Bell, P., & Munks, S. A. (2018). Calling behaviour of the Tasmanian Masked Owl *Tyto novaehollandiae castanops*. *Australian Zoologist*, 39(3), 449–463.
- Young, D., Bell, P., & Mooney, N. (2021). Roosting behaviour of radio-tracked Tasmanian Masked Owls *Tyto novaehollandiae castanops*. *Australian Field Ornithology*, 38, 13–18.

Appendix 1 – Non-target species detected during analysis

Appendix 1. Non-target species detected during analysis. Note that this list is not exhaustive, and includes only species that were incidentally detected across all survey sites while manually checking detections made by the signal scanning algorithm. Taxonomy follows the Checklist of the Terrestrial Vertebrate Fauna of Western Australia (November 2022).

Australian Owlet-Nightjar	<i>Aegotheles cristatus</i>
Pallid Cuckoo	<i>Heteroscenes pallidus</i>
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>
Shining Bronze Cuckoo	<i>Chalcites lucidus</i>
Southern Boobook	<i>Ninox boobook</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Twenty-eight Parrot	<i>Barnardius zonarius semitorquatus</i>
Forest Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksii naso</i>
Brown Honeyeater	<i>Lichmera indistincta</i>
Striated Pardalote	<i>Pardalotus striatus</i>
Spotted Pardalote	<i>Pardalotus punctatus</i>
Grey Butcherbird	<i>Cracticus torquatus</i>
Pied Butcherbird	<i>Craccticus nigrogularis</i>
Grey Currawong	<i>Strepera versicolor</i>
Grey Shrikethrush	<i>Colluricincla harmonica</i>
Grey Fantail	<i>Rhipidura albiscapa</i> <i>Corvus</i>
Australian Raven	<i>coronoides</i> <i>Eopsaltria</i>
Western Yellow Robin	<i>griseogularis</i> <i>Petroica</i>
Scarlet Robin	<i>boodang</i>

Technical Memorandum

January 24, 2023

Bat call analysis for Project 12565572

Dr Erin Westerhuis, Senior Terrestrial Ecologist, GHD

1. Summary

Bat identifications from acoustic recordings are provided from the Holyoake East area in southwest Western Australia. Five detectors were deployed in June, August and September 2023. There was a total effort of 58 detector nights (the sum of all nights from all detectors). Recorded data was analysed using a combination of manual and automated identification with specific analysis to identify bat fauna recorded. Overall, 19084 bat calls were recorded. Of these, 33547 calls could be identified to a species or species group. A single file with calls matching the characteristics of the priority 4 species *Falsistrellus mackenziei* was observed on the 20th August 2023 at 20:11 hrs. A large number of calls recorded were fragments or social calls and could not be positively identified to a species or group. Of the species recorded, *Nyctophilus* species and *Vespadelus regulus* was recorded on most detector nights. *Chalinolobus gouldii*, *Ozimops kitcheneri* and *Chalinolobus morio* were recorded less commonly. All species are bats which roost and breed in tree hollows. Activity was highest at dusk and dawn which suggests tree roosts may be in the study area.

2. Methods

2.1 Bat call analysis method

Data was processed and analysed using a combination of manual review and automated techniques using Kaleidoscope Pro (Wildlife Acoustic, version 5.4.6) and Anabat Insight (Titely Scientific, version 2.0.1). The following process was used:

1. Calls were initially processed in Kaleidoscope Pro using a 4 – 150 kHz frequency range, 1 – 5000 ms minimum and maximum length of detected pulses, a maximum inter-syllable gap of 500 ms and with a minimum of 3 pulses detected. Files were split to standard 1 second intervals and noise files were moved to a subfolder.
2. For each night, the first hour of data passing the Kaleidoscope pro filter was manually reviewed for bat calls using Anabat Insight by visually comparing the time-frequency graph (spectrogram) and call characteristics (e.g. peak frequency, characteristic frequency and call shape) with species call descriptions from published guidelines (Armstrong and Cole 2007; McKenzie and Bullen 2009; Guppy et al. 1985; Hanrahan et al. 2021; Hourigan 2011). Species were manually labelled according to species
3. Manually labelled species identifications were used to build a custom species-specific filter and a decision tree in Anabat Insight. This was achieved by extracting the call metadata for all identified calls,

then calculating the interquartile ranges of values per pulse. These values then informed the ranges used to build filters for automatic species identification using a decision tree.

4. To identify *Falsistrellus mackenziei* calls, a separate filter was built using parameters reported for the species in Strahans Mammals of Australia; that is a peak frequency between 32- 34 kHz and a call duration of 12 milliseconds. Every file identified as positive for *F. mackenziei* was manually vetted.
5. Call identification was assisted by consulting distribution information for potential species (Armstrong 2011 and McKenzie et al various dates; Churchill 2008; Van Dyck et al. 2013) and records from Australasian Bat Society BatMap (November 2022). No reference calls were collected during the survey.

3. Summary of results

During all nights of recording 54541 bat calls were recorded. Of these, 33547 could be identified to species or species group level. Unidentified calls consisted of irregular vocalisations rather than search phase echolocation. These are likely a form of social calls or fragments of calls that were not “search phase”.

3.1 Species recorded in study area

Desktop assessments of bat species distributions overlapping the study area indicated that 9 species had the potential to occur (BatMap ausbats.org.au accessed online 30th November 2023). Eight are least concern under state and federal legislation and the Western false pipistrelle is currently listed as Priority 4 under Western Australian legislation.

The species identified as having the potential to occur were:

- *Austronomus australis* – White-striped free-tailed bat
- *Chalinolobus gouldii* – Gould’s wattled bat
- *Chalinolobus morio* – Chocolate wattled bat
- *Falsistrellus mackenziei* – Western false pipistrelle
- *Nyctophilus geoffroyi* – Lesser long-eared bat
- *Nyctophilus holtorum* - Holt’s long-eared bat
- *Nyctophilus major* – Western long-eared bat
- *Ozimops kitcheneri* – Southwestern free tailed bat
- *Vespadelus regulus* – Southern forest bat

3.2 Bat species identified and activity patterns

Overall, bat activity detected at the detector sites during the survey varied greatly with between 1 and 7432 bat passes recorded each night (Table 1). A single file with calls matching the characteristics of *F. mackenziei* was identified on the 20th August 2023 on detector S4U14898 at 20:11 hrs. Previously the range of the species was thought to have contracted south of Collie (Armstrong et al. 2021b) however it has more recently been reported North of Collie but only along the Hotham River and south of the Harvey River estuary (Bullen et al. 2023). The species is readily identified in flight by its large size and flight behaviour and spotlighting in suitable habitat may assist with a more defined identification.

Vespadelus regulus and *Nyctophilus* sp. was recorded at most sites and was the most frequently recorded. For *Nyctophilus* species, it is not possible to reliably differentiate between calls of the three species and so any bat calls matching the characteristics of *Nyctophilus* like calls (low amplitude and steep, near vertical pulses) were grouped. *Chalinolobus gouldii*, *C. morio* and *Ozimops kitcheneri* were recorded less commonly.

All species identified are tree roosting microbat species and bat activity was highest around dusk and dawn when bats are emerging and re-entering roosts, which suggests that suitable tree roosts may be within the survey area.

Table 1 Number of calls recorded per species per detector night. FAMA = *Falsistrellus mackenziei*, CHGO = *Chalinolobus gouldii*, CHMO = *Chalinolobus morio*, OZKI = *Ozimops kitcheneri*, NYCT= *Nyctophilus* species, VERE= *Vespadelus regulus*.

FOLDER	DATE	FAMA	CHGO	CHGO/ OZKI	CHMO	NYCT	OZKI	VERE	Grand Total
S4U04382	8/16/2023					12		6	18
S4U04382	8/17/2023				3	103		112	218
S4U04382	8/18/2023					185		265	450
S4U04382	8/19/2023				1	156		272	429
S4U04382	8/20/2023				1	281		435	717
S4U04382	8/21/2023					33		55	88
S4U04382	8/22/2023					34		52	86
S4U04382	8/23/2023					17		31	48
S4U04382	8/24/2023			4	4	96		439	543
S4U04382	8/25/2023		1	2	1	75		175	254
S4U04382	9/5/2023					1			1
S4U04382	9/6/2023					17		8	25
S4U04382	9/7/2023					18		2	20
S4U04382	9/8/2023				4	773		890	1667
S4U04382	9/9/2023		3	1	55	1964		5025	7048
S4U04382	9/10/2023		7		11	1607		3286	4911
S4U04382	9/11/2023		5	2	40	2131		5254	7432
S4U04382	9/12/2023		3		55	1559		4558	6175
S4U14895	8/17/2023				3	71		52	126
S4U14895	8/18/2023		3			130		98	231
S4U14895	8/19/2023		5	5	2	128		107	247
S4U14895	8/20/2023		89	13	4	179		155	440
S4U14895	8/21/2023		1			37		38	76
S4U14895	8/22/2023					10		34	44
S4U14895	8/23/2023					5		13	18
S4U14895	8/24/2023		5			12		11	28
S4U14895	8/25/2023				1	4		4	9
S4U14895	9/5/2023					2		6	8
S4U14895	9/6/2023				8	6		14	28
S4U14895	9/7/2023		1	1	8	17		59	86
S4U14895	9/8/2023				3	25		15	43
S4U14895	9/9/2023		1	1		5		12	19
S4U14895	9/10/2023					5		4	9
S4U14895	9/11/2023					4		7	11
S4U14895	9/12/2023		1			9		6	16
S4U14898	8/17/2023					1		17	18
S4U14898	8/18/2023				1	28		18	47
S4U14898	8/19/2023		1	1	1	30		42	75
S4U14898	8/20/2023	1	17		4	147		217	385
S4U14898	8/21/2023					5		23	28
S4U14898	8/22/2023					4		2	6
S4U14898	8/23/2023					19		8	27
S4U14898	8/24/2023					12	1	45	58
SM2-A	6/28/2023							7	7
SM4-6	6/27/2023				1	3		10	14
SM4-6	6/28/2023				14	115		180	309

SM4-6	6/29/2023					14		31	45	
SM4-6	7/24/2023					2		14	16	
SM4-6	7/25/2023					18		75	93	
SM4-6	8/17/2023					23		4	27	
SM4-6	8/18/2023		1		15	236		35	287	
SM4-6	8/19/2023				8	17		5	30	
SM4-6	8/20/2023				9	155		68	232	
SM4-6	8/21/2023				8	11		54	73	
SM4-6	8/22/2023					17		61	78	
SM4-6	8/23/2023					7		24	31	
SM4-6	8/24/2023					25		66	91	
SM4-6	8/25/2023							1	1	
Grand Total			1	144	30	265	10600	1	22507	33547

4. References

- Armstrong K. N., Broken-Brow J., Hoyer G., Ford G., Thomas M., Corben C. (2021a) Effective detection and identification of sheath-tailed bats of Australian forests and woodlands. *Australian Journal of Zoology* 68, 346-363.
- Armstrong, K.N., Woinarski, J.C.Z. & Burbidge, A.A. (2021b). *Falsistrellus mackenziei* (amended version of 2017 assessment). The IUCN Red List of Threatened Species 2021: e.T17348A209540109. <https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T17348A209540109.en>
- Armstrong, K. N., and Coles, R. B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonictis aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88, 94-104.
- Armstrong, K. N. (2011). The current status of bats in Western Australia. In: 'The biology and conservation of Australasian bats.' (Eds B. Law, P. Eby, D. Lunney and L. Lumsden.) pp. 257–269. (Royal Zoological Society of New South Wales: Mosman.)
- Bullen, R. D. and McKenzie, N. L. (2011). Recent developments in studies of the community structure, foraging ecology and conservation of Western Australian bats. In 'The biology and conservation of Australasian bats.' (Eds B. Law, P. Eby, D. Lunney and L. Lumsden.) pp. 31-43. (Royal Zoological Society of New South Wales: Mosman.)
- Bullen, R., Mackenzie, N. & Start, A., (2023) *Falsistrellus mackenziei*, Western Falsistrelle, In Baker, Andrew & Gynther, Ian (Eds.) (2023) *Strahan's Mammals of Australia*. [4th ed.]. New Holland Publishers, Sydney, NSW.
- Churchill, S (2008). *Australian Bats*, Allen and Unwin, Australia.
- Denzinger, A. and Schnitzler, H.U., 2013. Bat guilds, a concept to classify the highly diverse foraging and echolocation behaviors of microchiropteran bats. *Frontiers in physiology*, 4, p.164.
- Duffy, AM, Lumsden, LF, Caddle, CR, Chick, RR & Newell, GR (2000). The efficacy of Anabat ultrasonic detectors and harp traps for surveying microchiropterans in southeastern Australia, *Acta Chiropterologica* 2: 127-144.
- Guppy, A., Coles, R.B and Pettigrew, J.D (1985) Echolocation and acoustic communication in the Australian Ghost Bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). *Australian Mammology* 8, 299-308.
- Hanrahan Nicola, Turbill Christopher, Armstrong Kyle N., Dalziell Anastasia H., Welbergen Justin A. (2021) Ghost bats exhibit informative daily and seasonal temporal patterns in the production of social vocalisations. *Australian Journal of Zoology* 67, 305-315.
- Hourigan, C. (2011). Ghost Bat, *Macroderma gigas*. Targeted species survey guidelines. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.
- McKenzie, N. L., and Bullen, R. D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum Supplement* 78: 123–155.
- McKenzie, N. L., and Bullen, R. D. (2012). An acoustic survey of zoophagic bats on islands in the Kimberley, Western Australia, including data on the echolocation ecology, organisation and habitat relationships of regional communities. *Records of the Western Australian Museum Supplement* 81: 67–108.
- Mills, DJ, Norton, TW, Parnaby, HE, Cunningham, RB & Nix, HA (1996), Designing surveys for microchiropteran bats in complex forest landscapes – a pilot study from south-east Australia. *Forest Ecology and management* 85 (1-3):149-161.
- Parnaby, H.E., King, A.G. and Eldridge, M.D.B. 2021. A new bat species from Western Australia, previously assigned to Gould's Long-eared Bat *Nyctophilus gouldi* Tomes, 1858. *Records of the Australian Museum* 73(1): 53-66.

Richardson, S.M. Lintott, S.R. Hosken, D.J. Economou, T. and Mathews, F. Peaks in bat activity at turbines and the implications for mitigating the impact of wind energy developments on bats. Scientific Reports, 2021; 11 (1) DOI: 10.1038/s41598-021-82014-9

Reardon, T. B., McKenzie, N. L., Cooper, S. J. B., Appleton., B., Carthew, S. and Adams, M (2014) A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats Mormopterus (Chiroptera : Molossidae). Australian Journal of Zoology 62: 109-136.

Van Dyke. S, Gynther. I, and Baker. A. (2013). Field Companion To The Mammals of Australia. New Holland Publishers.

5. Example spectrograms for each species or species group identified

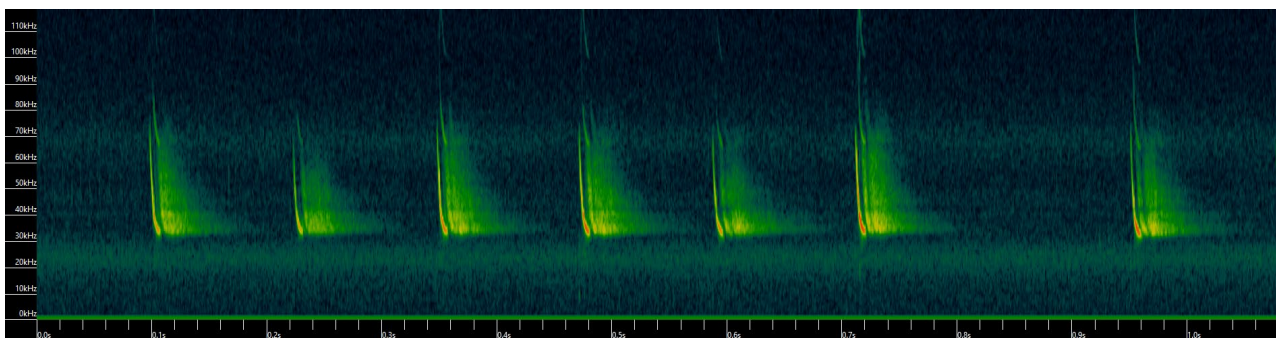


Figure 1 *Falsistrellus mackenziei*, Western Falsistrelle

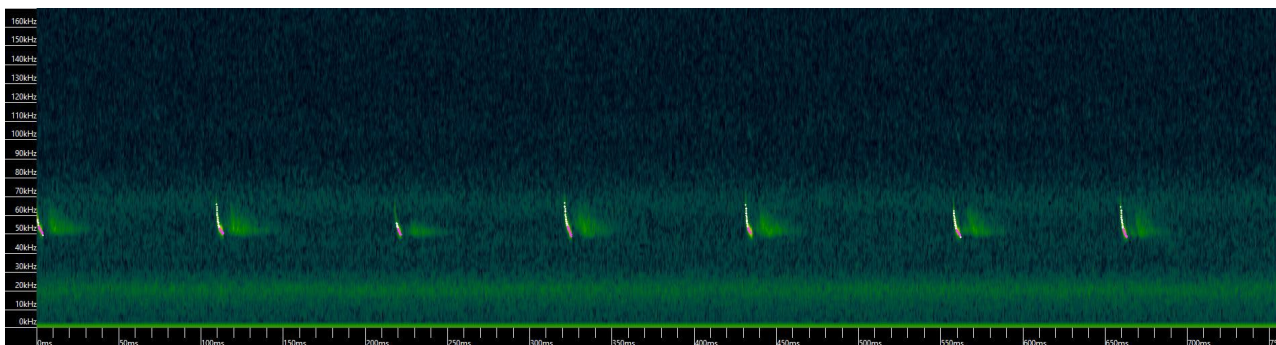


Figure 2 *Chalinolobus morio* Chocolate wattled bat

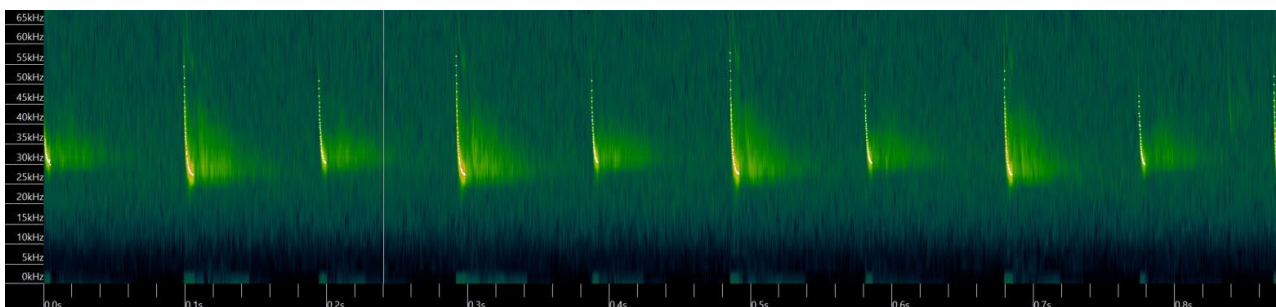


Figure 3 *Chalinolobus gouldii* Gould's wattled bat

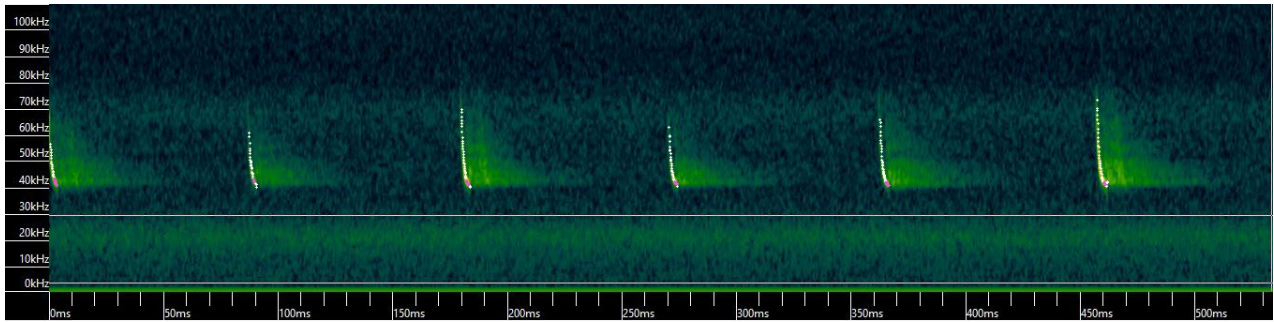


Figure 4 *Vespadelus regulus* Southern forest bat

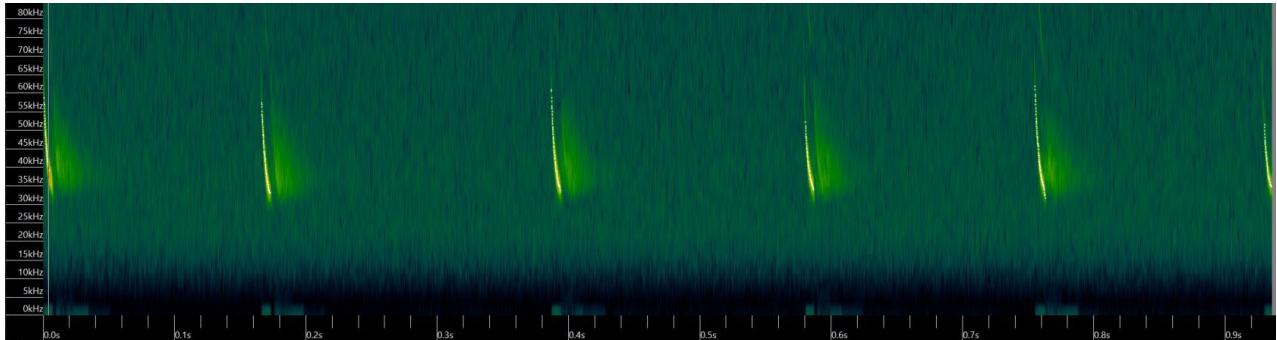


Figure 5 *Nyctophilus* sp.

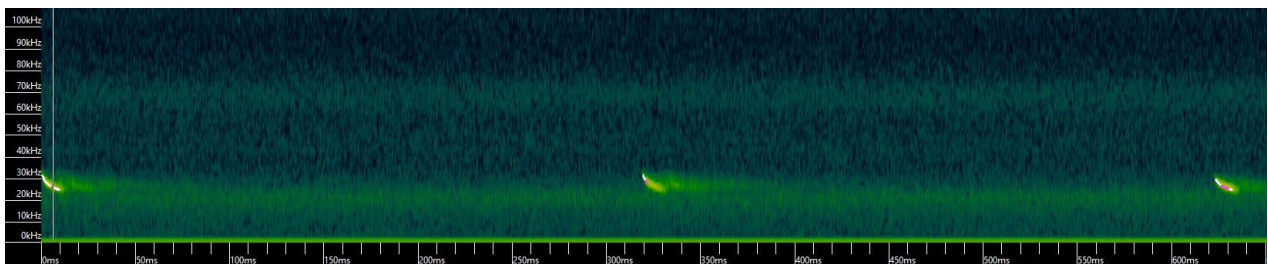


Figure 6 *Ozimops kitcheneri* Southwestern freetail bat

