

Appendix 2

Fauna and Black Cockatoo Survey 2017

Level 1 Fauna and Targeted Black Cockatoo Surveys

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Armadale Road to North Lake Road Bridge
Project

Document Approval

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ACRONYMS/ABBREVIATIONS

Acronym	Meaning
BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BoM	Bureau of Meteorology
CBG	Cleared – Predominantly Bare Ground
CD	Collector Distributor
DBCA	Department of Biodiversity, Conservation and Attractions
DBH	Diameter at Breast Height
DoEE	Department of the Environment and Energy
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
IBRA	Interim Biogeographical Regionalisation of Australia
IT	Isolated Trees
MNES	Matters of National Environmental Significance
MRWA	Main Roads Western Australia
PMG	Parkland and Maintained Gardens
PMST	Protected Matters Search Tool
RFA	Regional Forestry Agreement
SCP	Swan Coastal Plain
SL	Shrubland
SMG	Shrubland with Minimal Groundcover
WC Act	<i>Wildlife Conservation Act 1950</i>
WL	Woodland
WMU	Woodland with Minimal Understorey
WRVD	Wetlands, Riparian Vegetation and Drainage

1 EXECUTIVE SUMMARY

Main Roads Western Australia required an ecological investigation for the Armadale Road to North Lake Road Bridge Project (the Project). A Level 1 fauna survey and a targeted Black Cockatoo survey were undertaken over the Survey Area as part of this investigation. The Project is required to accommodate increasing traffic volumes in the area.

The Project extends from Armadale Road at Tapper Road to North Lake Road and includes the southbound collector distributor (CD) roads from Berrigan Drive to approximately 1.6 km south of Armadale Road and includes a patch of native vegetation northeast of Armadale Road and Kwinana Freeway Corner (near Cockburn Train Station). The area surveyed extends beyond this and is referred to in this report as the "Survey Area".

A detailed desktop assessment was undertaken incorporating results (where relevant) from the Department of Biodiversity, Conservation and Attractions (DBCA) database, NatureMap and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST). The desktop fauna assessment identified 45 conservation significant fauna species that could potentially occur within the Survey Area. Of these, six species are likely to occur, 19 species may occur and 20 species are unlikely to occur. The species likely to occur in the Survey Area include four bird, one reptile and one mammal species. The likelihood of occurrence of fauna species was determined by assessing the likely presence of suitable habitat in the Survey Area, and reviewing the recent records and distribution of the species.

The field surveys were undertaken by Ecologists Matt Cann and Jared Leigh between 24 and 28 July 2017. The Survey Area was largely traversed on foot. The Level 1 fauna survey primarily focused on mapping of fauna habitat and assessing the potential presence of conservation significant fauna, but also on recording observations of fauna within the Survey Area. Seven fauna habitat assessments were completed throughout the Survey and surrounding area. Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna. Seven microhabitat searches of areas of leaf litter, bark and fallen logs, rocks, rubbish and building materials were conducted when appropriate areas were located. For Black Cockatoos, foraging habitat assessments were conducted at nine sites across the Survey and surrounding area. Observations of Black Cockatoos and their foraging evidence, and breeding and roosting trees, were recorded opportunistically.

Thirty-seven fauna species were recorded directly or indirectly within the Survey and surrounding Area during the field survey. This comprised three reptile, one amphibian, six mammal and 27 bird species. Of the 37 fauna species observed, six species were of conservation significance. These comprised:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) - listed as Endangered under the EPBC Act and under the Wildlife Conservation Act 1950 [WC Act]
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) - listed as Endangered under the EPBC Act and under the WC Act)
- Quenda (*Isoodon obesulus fusciventer*) – listed on the DBCA Priority fauna list.
- Horsfield's Bronze Cuckoo (*Chrysococcyx basalus*), Magpie Lark (*Grallina cyanoleuca*) and the Australian White Ibis (*Threskiornis moluccus*) – all listed as Marine under the EPBC Act. Note that species listed as Marine under the EPBC Act are only considered of conservation significance when recorded within Commonwealth Land.

Eight fauna habitats have been defined and mapped within the Survey Area. The most common fauna habitat within the Survey Area, apart from Cleared Predominantly Bare Ground, is the Isolated Trees habitat at approximately 12%. This habitat generally comprises cleared, or partially cleared areas with scattered isolated mature trees (including Tuart and Flooded Gum). This habitat

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would support many of the common species of the area and may also be utilised by many of the conservation significant species such as the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Perth Lined Skink (*Lerista lineata*), Quenda (*Isoodon obesulus fusciventer*) and Rainbow Bee-eater (*Merops ornatus*).

The Survey Area contains 30 native trees defined as potential Black Cockatoo breeding habitat trees. Six of these trees contained nine potential hollows, but these were not suitable to be utilised by breeding Black Cockatoos.

The Survey Area contains 23.7 ha of foraging habitat for Carnaby's Cockatoo. Much of the Survey Area has been cleared and the best quality foraging habitat is the Banksia Woodlands to the east of the Survey Area. The Survey Area contains minimal (0.14 ha) of foraging habitat for the Forest Red-tailed Black Cockatoo.

INTRODUCTION

1.1 Background

Main Roads Western Australia is proposing to construct a flyover bridge over Kwinana Freeway connecting Armadale Road to North Lake Road. A four lane dual carriageway with grade separated duck 'n' dive intersections and elevated roundabouts will also be constructed at the intersections of: Armadale Road, Tapper Road, and Verde Drive; and Armadale Road and Solomon Road.

There will be modifications to the existing intersection at Midgegooroo Avenue and North Lake Road and at grade left in/left out intersections at Verde Drive east end, Public Transport Authority (PTA) parking, Knock Place and Lot 1 on Armadale Road. A two lane collector distributor (CD) road will be installed southbound from Berrigan Drive to Armadale Road. This upgrade will provide a direct link between Armadale and North Lake Road, improve access to the Kwinana Freeway and Cockburn Central Station, support residential and commercial expansion in the area and complement other significant road improvements.

The Project may require clearing of vegetation and fauna habitat. Ecological investigations are being undertaken to characterise and quantify the potential environmental impacts from the Project. This report details the fauna component of these investigations.

1.2 Location

The Project survey area is located in the City of Cockburn approximately 16-22 km south of Perth city centre in Western Australia. The Project extends from Armadale Road at Tapper Road to North Lake Road and includes the southbound collector distributor (CD) roads from Berrigan Drive to approximately 1.6 km south of Armadale Road and includes a patch of native vegetation northeast of Armadale Road and Kwinana Freeway Corner (near Cockburn Train Station). The survey area is shown in Figure 1.



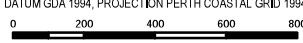
1.3 Objectives

The objective of this survey is to assess the faunal significance of the Survey Area. The specific objectives of the survey were to:

- conduct a Level 1 fauna survey
- map fauna habitats
- identify fauna species present
- assess the likelihood of conservation significant species utilising the Survey Area
- conducted a targeted Black Cockatoo survey
- assess the extent and quality of Black Cockatoo foraging habitat
- identify and assess Black Cockatoo roosting and breeding habitat.

This technical document describes the existing environment, methodology, desktop and field results and preliminary discussion.



<p>PROJECT ID 60539165 CREATED BY RNM APPROVED BY JLeigh LAST MODIFIED 14 DEC 2017</p>	<p>LEGEND  Survey Area</p>		<p>SURVEY AREA</p>
<p>DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994</p>  <p>1:20,000 when printed at A4</p>	<p>ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE - PROJECT LEVEL 1 FAUNA AND TARGETED BLACK COCKATOO MAIN ROADS WESTERN AUSTRALIA</p>		<p>FIGURE 1</p>

2 EXISTING ENVIRONMENT

2.1 Climate

The Project is located in the southwest of Western Australia which experiences a Mediterranean climate. A Mediterranean climate is characterised by warm to hot, dry summers and mild to cool, wet winters. The Mediterranean climate in Australia is a result of the Indian Ocean High, a high pressure cell that shifts towards the poles in summer and the equator in winter, playing a major role in the formation of the deserts of Western Australia, and the Mediterranean climate of southwest and south-central Australia. Precipitation occurs during winter months, with the possibility of some summer storms.

The nearest Bureau of Meteorology (BoM) weather station with comprehensive rainfall and temperature data is Jandakot Aero Station 009172. Jandakot Aero Station 009172 has recorded an average annual rainfall of 823.5 mm since 1973, with the majority of rainfall occurring between May and August (Figure 2 [BoM, 2017]). February experienced a significantly larger than average rainfall event, recording 121.2 mm of rainfall when the long term average is 18.4 mm. Average maximum temperatures peak between December and February and coincide with low rainfall averages (BoM, 2017). Temperatures at the time of the survey varied between 6.8-17.9°Celsius.

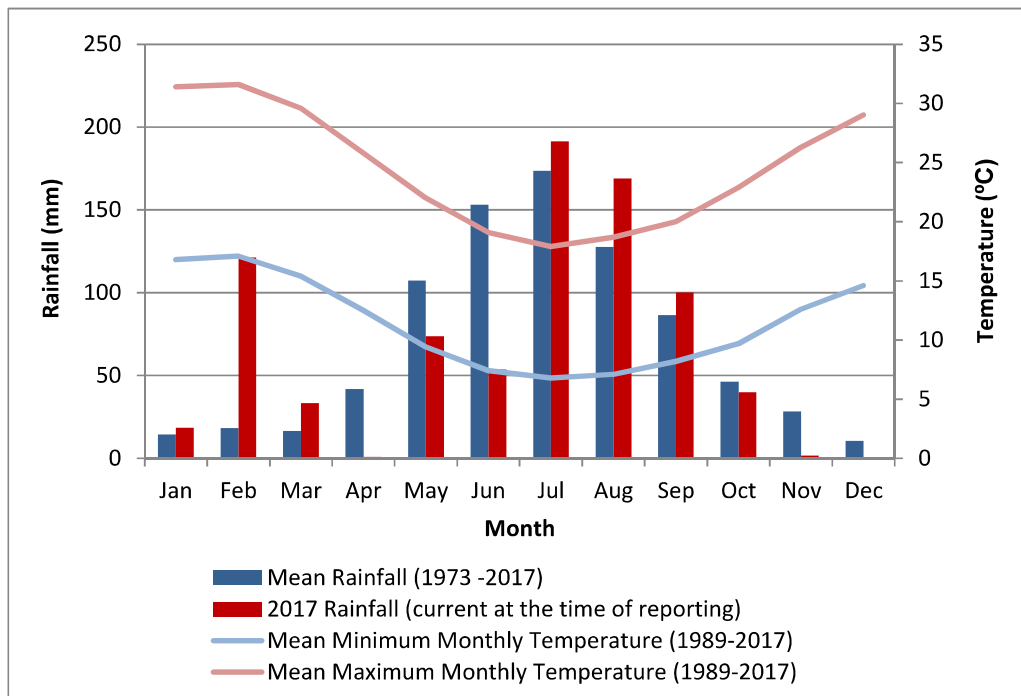


Figure 2 Climate Data from Jandakot Aero Station 009172

2.2 IBRA Regions

There are 89 recognised Interim Biogeographical Regionalisation of Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna. IBRA is the National Reserve System’s planning framework which assists in identifying reservation targets and setting priorities to meet these targets (Australian Government, 2013). Western Australia supports 53 IBRA subregions and the project area lies within the Swan Coastal Plain (SCP) IBRA region.

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The SCP is comprised of a narrow 30 km wide belt of aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age (Gibson *et al.*, 1994). The Plain is bound by the Indian Ocean and the Yilgarn block, uplifting of which has caused the Darling Scarp on the east side of the Plain. The Perth subregion is found on colluvial and aeolian sands, alluvial river flats and coastal limestone and includes a complex series of seasonal wetlands (Mitchell *et al.*, 2002). The subregion is 1,138,648 ha in size.

2.3 Vegetation

The SCP is a low-lying coastal plain dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas (Mitchell *et al.*, 2002). J.S. Beard completed the vegetation mapping of the Swan Coastal Plain in 1981 and classified the area as vegetation associations 1001, described as 'Medium very sparse woodland; jarrah, with low woodland; *Banksia* & *Casuarina*' (Beard, 1981). Approximately 22% of this vegetation association remains on the SCP (Government of Western Australia, 2016).

The Survey Area occurs in the Bassendean central and south vegetation complex under the Heddlé *et al.* (1980) classification system. This vegetation complex is comprised of predominantly open eucalyptus forest and woodlands of *E. marginata* and various *Banksia* species, with some areas of low woodland of *Melaleuca* spp. and sedgeland on the moister sites..

2.4 Soils

There is one dominant soil type within the Survey Area, as mapped by the Australian Soil Atlas. This is the Bassendean Sand formation which consists of basal conglomerate overlain by dune quartz sand with heavy mineral concentrations (Geological Survey of WA & Geoscience Australia, 2008). The soils are mapped as Cb39, described as subdued dune-swale terrain: chief soils are leached sands on the low dunes. Associated are small areas of other sand soils.

3 LEGISLATIVE FRAMEWORK

3.1 Overview

Table 1 summarises the key legislation governing the protection and management of Western Australia's conservation significant fauna species.

Table 1 Relevant Legislation, Regulations and Guidance

Legislation	Purpose
Commonwealth of Australia	
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity.
EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species (DSEWPaC, 2012)	These guidelines are intended to assist proponents in determining whether an action needs to be referred to the Australian Government. Definitions of habitat are provided as are criteria used to judge significant impact for these black Cockatoo species.
EPBC Act Draft Referral Guidelines (DoEE, 2017)	These draft guidelines are intended to assist proponents in determining whether an action needs to be referred to the Australian Government. Definitions of habitat are provided as are criteria used to judge significant impact for these black Cockatoo species.
Western Australia	
<i>Wildlife Conservation Act 1950</i> (WC Act)	Provides for the conservation and protection of Western Australia's wildlife.
<i>Environmental Protection Act 1986</i> (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
<i>Biosecurity and Agriculture Management Act 2007</i> (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally.
Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016a)	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia's terrestrial fauna.
Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, 2016b)	Provides advice on fauna sampling techniques and methodologies for different regions of the State and the analysis, interpretation and reporting requirements for EIA.

3.2 Commonwealth – EPBC Act

The EPBC Act is the main piece of Federal legislation protecting biodiversity in Australia. All matters of national environmental significance (MNES) are listed under the EPBC Act. These include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park

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- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 2.

Table 2 Categories of Species Listed under Schedule 179 of the EPBC Act

Conservation	Code Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time: <ol style="list-style-type: none"> a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered b) the following subparagraphs are satisfied: <ol style="list-style-type: none"> i. the species is a species of fish ii. the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised iii. the plan of management is in force under a law of the Commonwealth or of a State or Territory cessation of the plan of management would adversely affect the conservation status of the species.

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3.3 Western Australia

3.3.1 Wildlife Conservation Act 1950

Animals that are considered Threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the WC Act. These categories are defined in Table 3.

Table 3 Conservation Codes for Fauna Listed under the *Wildlife Conservation Act 1950*

Code	Category
CR	Critically Endangered Species Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	Endangered Species Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora
VU	Vulnerable Species Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	Presumed Extinct Species Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
IA	Migratory birds protected under an international agreement 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 the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.
CD	Special conservation
OS	Special protection for reasons other than those already mentioned

Species that have not yet been adequately surveyed to warrant being listed under the WA Act are added to a Priority List by the State Minister for Environment. Categories and definitions of Priority flora and fauna species are provided in Table 4.

Table 4 Conservation Codes for Fauna Endorsed by the Minister for Environment

Conservation Code	Category
P1	<p>Priority One – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.</p>
P2	<p>Priority Two – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc.</p> <p>Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three – Poorly Known Species</p> <p>Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four – Rare, Near Threatened and other species in need of monitoring</p> <p>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.</p> <p>b) Near Threatened. Species 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>c) (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>

3.3.2 Biosecurity and Agriculture Management Act 2007

Biosecurity is the management of the risk of animal and plant pests and diseases entering, emerging, establishing or spreading in WA to protect the economy, environment and community. Biosecurity is managed under the BAM Act which came into effect 1 May 2013. Exotic animals and plants can become an invasive species if they can establish in new areas where local conditions are favourable for their growth.

4 METHODOLOGY

4.1 Desktop Assessment

A detailed desktop assessment was completed. The desktop assessment focussed on defining the existing environment and determining the potential presence of Threatened and Priority fauna, and their habitats. Desktop database searches were requested for the Survey Area. Sources consulted included:

- Department of Biodiversity, Conservation and Attractions (DBCA) Threatened Species and Communities database
- NatureMap
- EPBC Act Protected Matters Search Tool (PMST).

The search results were reviewed to assess the potential presence of conservation significant fauna and a likelihood of occurrence was completed based on the categories outlined in Table 5.

Table 5 Categories of Likelihood of Occurrence for Fauna Species

Likelihood Category	Fauna
Likely to occur	Survey Area is within the known distribution of the species, habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area.
May occur	Survey Area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the Survey Area.
Unlikely to occur	Survey Area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the Survey Area.

4.2 Field Surveys

4.2.1 Level 1 Fauna

A Level 1 fauna survey was conducted by Ecologists Matt Cann and Jared Leigh from 24 – 28 July 2017. The survey was conducted in accordance with EPA Guidance Statement No. 56 (EPA, 2016a) and Fauna Survey Technical Guide (EPA, 2016b), EPA Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002). The Level 1 fauna survey primarily focused on mapping of fauna habitat and assessing the potential presence of conservation significant fauna, but also on recording observations of fauna within the Survey Area.

The fauna habitats of the Survey Area were mapped during the field survey by assessing changes in the various habitat features. The habitat assessments included:

- Location
- General habitat description
- Habitat condition and disturbance types
- Dominant / characteristic flora species and vegetation layers

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- Presence and abundance of:
 - large mature trees
 - small and large hollows
 - varying sizes of fallen logs
 - coarse and fine litter
 - decorticating bark
 - bare ground
 - grass
 - varying sizes of stones and boulders
 - rock crevices
 - soil cracks
 - cryptogamic crust
 - vines
 - mistletoe
 - dense shrubs
 - water bodies etc.
- Presence of fauna and secondary signs (e.g. scats, digging, tracks, burrows, egg shell, bones, feathers etc.)
- Connectivity of habitat.

Seven detailed and additional comparative fauna habitat assessments were completed throughout the Survey and surrounding area (Figure 3). Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna, in order to determine the potential for these habitats to support conservation significant species.

In addition to recording all observed fauna and birds identified from distinctive calls, details of indirect evidence such as scats, tracks and diggings were documented. In particular, attention was given to searching for conservation significant species identified in the desktop assessment as having the potential to occur in the area. All observations were made between daylight hours of 0700 and 1700.

Thorough microhabitat searches of areas of leaf litter, bark and fallen logs, rocks, rubbish and building materials were conducted when appropriate areas were located. These included thorough raking of the soil under those items listed (refer to Plate 1). Seven of these microhabitat searches were conducted across the Survey and surrounding area (refer to Figure 3). Pieces of metal, building rubble, rocks, and logs were also turned over opportunistically throughout the Survey Area and inspected for fauna.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians is consistent with the Western Australian Museum's Checklist of Vertebrates of Western Australia (2010) and for bird species the Bird's Australia Checklist of Australian Birds by Christidis and Boles (2008).



Plate 1 Example of Microhabitat Search Site (Site ID 110)

4.2.1.1 Targeted Black Cockatoo Survey

A targeted Black Cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat for the two threatened Black Cockatoo species that are likely to occur in the Survey Area. These are Carnaby's Cockatoo (*Calyptorhynchus latirostris* [Endangered under the EPBC Act and under the WC Act]) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso* [Vulnerable under the EPBC Act and under the WC Act]). Refer to Section 5.2.2 for further information on these species.

Surveys were conducted in accordance with DSEWPaC (2012) and also utilised the draft DoEE (2017) Referral Guidelines. The field survey was conducted by Matthew Cann, a fauna ecologist with six years' experience conducting Black Cockatoo assessments and Jared Leigh, 15 years' experience in fauna survey programs, including two years conducting Black Cockatoo surveys.

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4.2.2 Breeding Habitat

The Black Cockatoo breeding habitat assessment focussed on quantifying potential breeding trees within the Survey Area. Table 6 defines breeding habitat and identifies those trees that Black Cockatoos will utilise as breeding trees, according to DoEE (2017). The following information was collected for all potential breeding trees with a Diameter at Breast Height (DBH) >500 mm (*Eucalyptus wandoo* >300 mm):

- location
- fire scarring present
- tree species
- DBH
- height
- number of hollows
- number of potentially suitable hollows.

Photographs were also taken of each tree.

Table 6 Potential Breeding Habitat for Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo

Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Generally in woodland or forest, but also breeds in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (any tree species may provide suitable hollows), particularly Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, York Gum, Powderbark, Karri and Marri.	Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (any tree species may provide suitable hollows), particularly Marri, Karri, Wandoo, Bullich, Blackbutt, Tuart and Jarrah.

Source: DoEE (2017).

4.2.2.1 Roosting Habitat

Table 7 defines the suitable trees that the Black Cockatoo species may utilise as roosting trees. Carnaby's Cockatoo typically roosts in or near riparian environments or near other permanent water sources. The Forest Red-Tailed Black Cockatoo prefers the edges of forests for roosting (DoEE, 2017). Potential roosting trees were searched for and assessed during the field survey.

Table 7 Suitable Roosting Trees for Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo

Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Any tall trees may provide suitable roosting, but particularly Flat-topped Yate (<i>E. occidentalis</i>), Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts and introduced pines.	Any tall trees may provide suitable roosting, but particularly tall Jarrah, Marri, Blackbutt, Tuart and introduced eucalypt trees or large trees on the edges of forests.

Source: DoEE (2017).

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4.2.2.2 Foraging Habitat

The common food items that these two Black Cockatoo species forage upon are presented in Table 8. The quality of foraging habitat not only reflects the availability of food sources, but also the proximity to reliable water sources, connectivity to other suitable habitat, presence of potential breeding trees, and proximity to confirmed roost and breeding sites (amongst others). These parameters were utilised by the DoEE to produce a draft quality of foraging habitat scoring system (Table 10.) This scoring system was utilised to assess potential foraging habitat for each Black Cockatoo species. Eleven assessments were completed across the Survey and surrounding area (Figure 3).

Table 8 Foraging and Common Food Items

Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Native shrubland, kwongan heathland and woodland on seeds, flowers and nectar of native proteaceous plant species (<i>Banksia</i> sp., <i>Hakea</i> sp., <i>Dryandra</i> sp., and <i>Grevillea</i> sp.), as well as <i>Callistemon</i> sp. and Marri. Also seeds of introduced species including <i>Pinus</i> sp., <i>Erodium</i> sp., wild radish, canola, almonds and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.	Primarily seeds of Jarrah and Marri in woodlands and forest, and edges of Karri forests, including Wandoo and Blackbutt. Forages on <i>Eucalyptus caesia</i> , <i>E. erythrocorys</i> , <i>Allocasuarina</i> cones, fruits of snottygobble (<i>Persoonia longifolia</i>) and Mountain Marri (<i>Corymbia haematoxylon</i>). Also some introduced eucalypts such as River Red Gum (<i>E. camaldulensis</i>) and Flooded or Rose Gum (<i>E. grandis</i>). On the Swan Coastal Plain, often feeds on introduced Cape Lilac (<i>Melia azedarach</i>).

Source: DoEE (2017).

The scoring tool is used by initially defining the quality of the overall habitat present (i.e. Very High Quality, High Quality, Quality and Low Quality) and then adding or subtracting points from this depending on the ecological values of the habitat (i.e. proximity to water, proximity to a known roost site, evidence of foraging material etc.). This determines an overall quantitative rating. These scores were then used as representative scores for that unit. Table 10 defines the levels of foraging habitat quality used during the assessment.

Table 9 Black Cockatoo Foraging Assessment Scoring

Score	Foraging Quality
1 – 3	Low Quality
4 – 6	Quality
7 – 8	High Quality
>8	Very High Quality

Level 1 Fauna and Targeted Black Cockatoo Surveys

Table 10 Quality of Foraging Habitat Assessment Tool for two of the Western Australian Threatened Black Cockatoo Species

Starting Score	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
10 – Very High Quality	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing
7 – High Quality	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt (not mallee) woodland and forest that is dominated by foraging species. Does not include orchards, canola, or areas under a RFA	Jarrah and Marri woodlands and forest, and edges of Karri forests, including Wandoo and Blackbutt, within the range of the subspecies. Does not include areas under a RFA
5 – Quality	Pine plantation or introduced eucalypts	Introduced eucalypts as well as the introduced Cape lilac (<i>Melaleuca</i>)
1 – Low Quality	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)
Additions: Context adjustor – attributes improving habitat quality		
+3	Is within the Swan Coastal Plain	Jarrah and/or Marri shows good recruitment (i.e. evidence of young trees)
+3	Contains trees known to be used for breeding and / or with suitable nest hollows	Contains trees known to be used for breeding and / or with suitable nest hollows
+2	Primarily comprises Marri	Primarily contains Marri and / or Jarrah
+2	Contains trees with potential to be used for breeding (DBH ≥500 mm or ≥300 mm for Salmon Gum and Wandoo)	
+1	Known to be a large or key roosting site	
Subtractions: Context adjustor – attributes reducing habitat quality		
-2	Does not contain evidence of foraging by species	
-2	No other foraging habitat within 6 km	
-1	Is > 12km from known roosting site	
-1	Is >12 km from known breeding location	
-1	Is >2 km from watering point	
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or Marri canker)	

Source: DoEE (2017)



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LEGEND

- Black Cockatoo Foraging Assessments
- Microhabitat Search
- Fauna Habitat Assessment
- ▭ Survey Area



Fauna Assessment Locations

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE - PROJECT LEVEL 1 FAUNA AND TARGETED BLACK COCKATOO MAIN ROADS WESTERN AUSTRALIA

Figure 3

Level 1 Fauna and Targeted Black Cockatoo Surveys

4.3 Survey Limitations

Limitations of the Level 1 fauna and Black Cockatoo surveys are discussed in Table 11.

Table 11 Limitations of the Level 1 Fauna and Black Cockatoo Surveys

Limitation	Black Cockatoo Survey	Level 1 Fauna Survey
Competency/experience of consultant conducting survey	Nil Matt is an ecologist with over six years' experience conducting Black Cockatoo surveys and Jared is an ecologist with over 15 years' experience in the environmental industry who has conducted fauna surveys in a range of bioregions within Western Australia.	Nil Matt and Jared are Ecologists with over six and 15 years' experience respectively, in the environmental industry. Both have conducted fauna surveys in a range of bioregions within Western Australia.
Scope (i.e. what life forms were sampled)	Minor All areas of potential foraging habitat were inspected and every potential breeding tree within the Survey Area was assessed for suitability. Assessment of hollows is not always entirely possible from the ground. The Precautionary Principle is utilised when this is the case.	Minor The Level 1 fauna survey: <ul style="list-style-type: none"> Assessed all fauna habitats within the Survey Area Documented secondary evidence (scats, diggings, burrows etc.) and fauna sightings Conducted microhabitat searches at appropriate sites.
Proportion of fauna identified, recorded and/or collected (based on sampling, timing and intensity)	Nil Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo were recorded through either direct sighting and / or indirect evidence. Foraging evidence can be searched for at any time of year, as cones can remain on the ground for up to two years.	Minor Information gained for a Level 1 fauna survey was sufficient. Fauna were observed (through direct or indirect evidence) during daylight hours (0700 and 1700hrs). Therefore nocturnal species were only predominantly observed through indirect evidence.
Sources of information	Minor Data on roosting and breeding locations for the Forest Red-tailed Black Cockatoo is not readily available. Some of the resources utilised to inform the Black Cockatoo survey include the DBCA database, Naturemap, EPBC Act PMST, DoEE (2017) and DSEWPac (2012) were utilised to inform the Black Cockatoo survey.	Minor Some of the resources utilised to inform the level 1 fauna survey include the DBCA database, Naturemap, EPBC Act PMST, DoEE (2017) and DSEWPac (2012).
Completion (is further work needed)	Nil The objectives of the targeted Black Cockatoo survey were met and no further work is required.	Nil The objectives of the level 1 fauna survey were met and no further work is required.
Timing, weather, season, cycle	Nil No limitations were identified relating to timing, weather, season or cycle. Foraging evidence can be searched for at any time of year, as cones can remain on the ground for up to two years.	Minor The survey was conducted during the colder months when some fauna groups (reptiles in particular) are not as active. This assessment was also limited to one survey period during one year, and predominantly during daylight hours. However, this does not significantly impact a Level 1 fauna survey.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	Nil The Targeted Black Cockatoo survey was not disrupted or impacted.	Nil The Level 1 fauna survey was not disrupted or impacted.

Level 1 Fauna and Targeted Black Cockatoo Surveys

Limitation	Black Cockatoo Survey	Level 1 Fauna Survey
Intensity (was the intensity adequate)	<p>Nil</p> <p>The Survey Area was assessed over a four day period which enabled sufficient time to assess the areas of vegetation present, search for foraging evidence and assess each potential breeding habitat tree.</p>	<p>Minor</p> <p>The Survey Area was assessed over a four day period which enabled sufficient time to assess the fauna habitats present, search for and collect opportunistic records for conservation significant species. The fauna survey was conducted in accordance with Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016a) and Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, 2016b).</p> <p>This Survey Area was part of a larger study area and hence some of the field assessment locations are just outside of the Survey Area.</p>
Resources (degree of expertise available in animal identification)	<p>Nil</p> <p>The resources (time, equipment and expertise) were sufficient for a Black Cockatoo survey. Matt is an ecologist with over six years (over three years conducting Black Cockatoo surveys) and Jared is an ecologist with over 15 years' (two years conducting Black Cockatoo surveys) environmental industry experience.</p>	<p>Nil</p> <p>The resources (time, equipment and expertise) were sufficient for a Level 1 fauna survey. Matt is an ecologist with over six years and Jared is an ecologist with over 15 years' environmental industry experience.</p>
Remoteness and/or access problems	<p>Minor</p> <p>The majority of the Survey Area was traversed on-ground and was accessible.</p>	<p>Minor</p> <p>The majority of the Survey Area was traversed on-ground and was accessible.</p>
Availability of contextual information on the region	<p>Nil</p> <p>Sufficient contextual information is available on the Swan Coastal Plain.</p>	<p>Nil</p> <p>Sufficient contextual information is available on the Swan Coastal Plain.</p>

5 RESULTS AND DISCUSSION

5.1 Desktop Assessment

5.1.1 Conservation Significant Fauna

The desktop fauna assessment identified 45 conservation significant fauna species that could potentially occur within the Project area. Of these:

- six species are likely to occur
- 19 species may occur
- 20 species are unlikely to occur.

The species likely to occur in the Project area include four bird, one reptile and one mammal species. The likelihood of occurrence of fauna species was determined by assessing the likely presence of suitable habitat in the Project area, and reviewing the recent records and distribution of the species. Table 12 identifies the seven species likely to occur within the Project area. The conservation significant categories as defined by DBCA, the WC Act and the EPBC Act are defined in Section 3.

The full desktop assessment for all 45 fauna species and their likelihood of occurrence in the Project area are presented in Appendix A.

Level 1 Fauna and Targeted Black Cockatoo Surveys

Table 12 Conservation Significant Fauna Species Likely to Occur within the Survey Area Based on the Desktop Assessment

Species	Common Name	Conservation Code		Latest DBCA Record	No. of DBCA Records	PMST	Ecology
		Commonwealth	State				
<i>Ardea modesta</i>	Great Egret	Migratory	IA	2011	38		The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2003). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2007). This species may utilise the Wetlands, Riparian Vegetation and drainage fauna habitats of the Survey Area.
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	Vulnerable	VU	2016	8	+	The Forest Red-tailed Black Cockatoo requires tree hollows of Karri (<i>Eucalyptus diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>Corymbia calophylla</i>) forests to nest and breed. Flocks move out onto the Swan Coastal Plain in search of food from exotic trees such as the White Cedar (Johnstone <i>et al.</i> , 2010). The foraging habitat for the species consists of Jarrah and Marri woodlands and forest within its range. This species may utilise the Woodlands; Isolated Trees; Parklands and Maintained Gardens; and Wetlands, Riparian Vegetation and Drainage fauna habitats of the Survey Area.
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	Endangered	EN	2016	148	+	Carnaby's Cockatoo is a postnuptial nomad and typically moves west soon after breeding. The species nests in hollows of smooth-barked eucalypts, particularly Salmon Gum (<i>Eucalyptus salmophloia</i>) and Wandoo (<i>E. Wandoo</i>) but is not limited to these eucalypts. Diet consists of an array of Proteaceous and <i>Eucalyptus</i> species prevalent on the Swan Coastal Plain. Foraging habitat, including <i>Banksia</i> woodlands, is considered to be habitat critical to the survival of the species (Johnstone <i>et al.</i> , 2010). This species may utilise the Woodlands; Isolated Trees; Parklands and Maintained Gardens; Wetlands, Riparian Vegetation and Drainage; and Shrubland fauna habitats of the Survey Area.
<i>Isodon obesulus fusciventer</i>	Quenda	-	P4	2016	388		The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008). This species may utilise all of the fauna habitats of the Survey Area.

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Code		Latest DBCA Record	No. of DBCA Records	PMST	Ecology
		Commonwealth	State				
<i>Lerista lineata</i>	Perth Lined Skink	-	P3	2016	21		The Perth Lined Lerista is an underground dwelling skink, sheltering in leaf litter and upper layers of loose soil. It is typically found at the bases of shrubs, spoil heaps and stick ant nests (Bush <i>et al.</i> , 2010). The species inhabits sandy soils supporting Eucalypt/Banksia woodland, coastal heath and low shrubland (Bush <i>et al.</i> , 2010; Wilson and Swan, 2010). This species may utilise the Woodlands; Parklands and Maintained Gardens; Wetlands, Riparian Vegetation and Drainage; and Shrubland fauna habitats of the Survey Area.
<i>Merops ornatus</i>	Rainbow Bee-eater	Marine	IA	2010	34		The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. It is possible that this species will occupy open and disturbed areas within the Survey Area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2003), and may utilise the Woodlands; Isolated Trees; Parklands and Maintained Gardens; Wetlands, Riparian Vegetation and Drainage; Cleared Predominantly Bare Ground; and Shrubland fauna habitats of the Survey Area.

5.2 Field Surveys

5.2.1 Level 1 Fauna Survey

5.2.1.1 Fauna Species

Thirty-seven fauna species were recorded within the Survey and surrounding Area during the field survey. This comprised three reptile, one amphibian, six mammal and 27 bird species. The observed species list is presented in Table 13. Of the 37 fauna species observed, six species were of conservation significance. These comprised:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) - listed as Endangered under the EPBC Act and under the WC Act)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) - listed as Endangered under the EPBC Act and under the WC Act)
- Horsfield's Bronze Cuckoo (*Chrysococcyx basalis*), Magpie Lark (*Grallina cyanoleuca*) and the Australian White Ibis (*Threskiornis moluccus*) – all listed as Marine under the EPBC Act
- Quenda (*Isoodon obesulus fusciventer*) – listed on the DBCA Priority fauna list.

Refer to Section 5.2.1.1.2 for further detail on these species. Note that species listed as Marine under the EPBC Act are only considered of conservation significance when recorded within Commonwealth Land. Therefore, Horsfield's Bronze Cuckoo, Magpie Lark and the Australian White Ibis will not be discussed further as the Survey Area does not contain Commonwealth land.

5.2.1.1.1 Introduced Fauna

Seven introduced and naturalised fauna species were recorded in the Survey Area. These comprised:

- Cat (*Felis catus*)
- Dog (*Canis lupis familiaris*)
- European Wild Rabbit (*Oryctolagus cuniculus*) Declared Pest - s22(2) (C3 Prohibited)
- Rainbow Lorikeet (*Trichoglossus moluccanus*)
- Laughing Turtle-Dove (*Streptopelia senegalensis*)
- Laughing Kookaburra (*Dacelo novaeguineae*)
- Red Fox (*Vulpes vulpes*) Declared Pest - s22(2) (C3 Exempt).

The European Wild Rabbit and Red Fox are listed as a Declared Pests under the BAM Act. Generally these species were recorded intermittently throughout the Survey Area, and were identified by scats, dens, tracks and burrows.

Level 1 Fauna and Targeted Black Cockatoo Surveys

Table 13 Fauna Species Observed in the Survey and Surrounding Area

Name	Common Name	Status
Birds		
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	Native
<i>Anas superciliosa</i>	Pacific Black Duck	Native
<i>Anthochaera carunculata</i>	Red Wattlebird	Native
<i>Anthochaera lunulata</i>	Western Little Wattlebird	Native
<i>Barnardius zonarius semitorquatus</i>	Australian Ringneck	Native
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	Native
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	Native
<i>Chrysococcyx basalus</i>	Horsfield's Bronze Cuckoo	Native
<i>Corvus coronoides</i>	Australian Raven	Native
<i>Cracticus tibicen</i>	Australian Magpie	Native
<i>Cracticus torquatus</i>	Grey Butcherbird	Native
<i>Dacelo novaeguineae</i>	Laughing Kookaburra*	Naturalised
<i>Eolophus roseicapilla</i>	Pink and Grey Galah	Native
<i>Fulica atra</i>	Eurasian Coot	Native
<i>Gerygone fusca</i>	Western Gerygone	Native
<i>Grallina cyanoleuca</i>	Magpie Lark	Native
<i>Lichmera indistincta</i>	Brown Honeyeater	Native
<i>Lichenostomus virescens</i>	Singing Honeyeater	Native
<i>Ocyphaps lophotes</i>	Crested Pigeon	Native
<i>Pardalotus striatus</i>	Striated Pardalote	Native
<i>Phylidonyris niger</i>	White-cheeked Honeyeater	Native
<i>Phylidonyris novae-hollandiae</i>	New Holland Honeyeater	Native
<i>Rhipidura albiscapa</i>	Grey Fantail	Native
<i>Rhipidura leucophrys</i>	Willie Wagtail	Native
<i>Streptopelia senegalensis</i>	Laughing Turtle-Dove*	Naturalised
<i>Threskiornis moluccus</i>	Australian White Ibis	Native
<i>Trichoglossus moluccanus</i>	Rainbow Lorikeet*	Introduced
Amphibians		
<i>Limnodynastes dorsalis</i>	Western Banjo Frog	Native
Mammals		
<i>Canis lupis familiaris</i>	Dog*	Introduced
<i>Felis catus</i>	Cat*	Introduced
<i>Isoodon obesulus fusciventer</i>	Quenda	Native
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	Native
<i>Oryctolagus cuniculus</i>	European Wild Rabbit*	Introduced
<i>Vulpes vulpes</i>	Red Fox*	Introduced
Reptiles		
<i>Cryptoblepharus buchananii</i>	Buchanan's Snake-eyed Skink	Native
<i>Hemiergis quadrilineata</i>	Two-toed Earless Skink	Native
<i>Tiliqua rugosa rugosa</i>	Bobtail	Native

Level 1 Fauna and Targeted Black Cockatoo Surveys

5.2.1.1.2 Conservation Significant Fauna

Refer to Section 5.2.2.1 for detailed ecological information on Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo.

Quenda (*Isoodon obesulus fusciventer*)

The Quenda or Southern Brown Bandicoot is listed on the DBCA Priority fauna list as a Priority 4 species. Priority 4 fauna species are those that are considered Rare, Near Threatened or in need of monitoring.

The Quenda has coarse dark grey or yellow brown fur above and creamy-white below, with a short, tapered, dark brown tail. The ears are short and rounded, and the tail is lightly furred. The Quenda is omnivorous, feeding on invertebrates, underground fungi, subterranean plant material, and occasionally on small vertebrates. The Quenda inhabits scrubby, often swampy, vegetation with dense cover up to one metre high. The Quenda was directly sighted in the woodland habitat, and is also likely to utilise the heathland and wetland habitats present. The Quenda is widely distributed near the southwest coast from Guilderton north of Perth to east of Esperance. Quenda have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain, and inland as far as Hyden (DPaW, 2012).

5.2.1.2 Fauna Habitat

Eight fauna habitats have been defined and mapped within the Survey Area (refer to Table 14 and Figure 4). The most common fauna habitat within the Survey Area, apart from Cleared Predominantly Bare Ground, is the Isolated Trees habitat at approximately 12%. This habitat generally comprises cleared, or partially cleared areas, with scattered isolated mature trees (including Tuart and Flooded Gum). This habitat would support many of the common species of the area and may also be utilised by many of the conservation significant species such as the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Perth Lined Skink (*Lerista lineata*), Quenda (*Isoodon obesulus fusciventer*) and Rainbow Bee-eater (*Merops ornatus*).


5.2.1.2.1 Fauna Habitat Linkages

Habitat linkages are typically areas or corridors of vegetation that link (larger) areas of fauna habitat. Linkages are important as they enable fauna to move freely between remnant bushland patches, therefore increasing gene-flow between populations. A study conducted by Gilbert *et al.* (1998) found that corridors and/or linkages do maintain species richness in the fragmented landscapes.

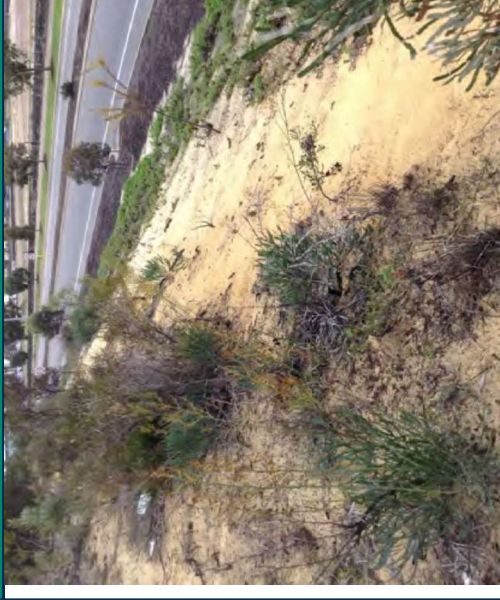

The Survey Area contains significant amounts of cleared and rehabilitated land adjacent roads and does not provide significant habitat linkages in terms of connecting isolated areas of significant fauna habitat. However, it does include part of a reasonable sized, good quality *Banksia* Woodland, which has been heavily cleared within a metropolitan setting.

Level 1 Fauna and Targeted Black Cockatoo Surveys


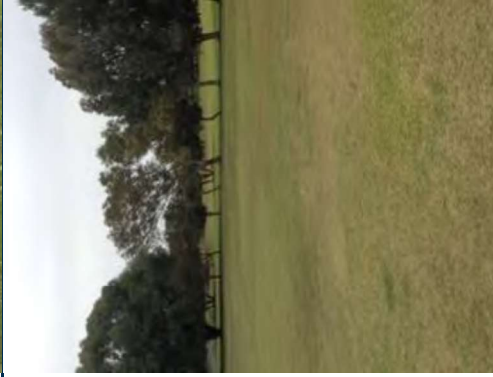
Table 14 Fauna Habitats of the Survey Area

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos
Woodland (WL)	<p>This habitat is predominantly Banksia woodland of varying condition, with occasional mallee eucalypts over a layer of varying cover native shrubs.</p> <p>Significant habitat characteristics include:</p> <ul style="list-style-type: none"> • Rare presence of large trees and large hollows • common abundance of small trees, small hollows and fallen logs <30 cm • moderate amounts of decorticating bark, coarse leaf litter layer and bare ground • minimal stones and boulders. 	<ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) • Quenda (<i>Isodon obesulus fusciventer</i>) • Perth Lined Skink (<i>Lerista lineata</i>) 	6.18	7.11	
Woodland with Minimal Understorey (WMU)	<p>This habitat contains woodland areas that are heavily degraded and have little understorey, potentially due to partial clearing.</p> <p>Significant habitat characteristics include:</p> <ul style="list-style-type: none"> • abundant bare ground • presence of small trees, small hollows and fallen logs <30 cm • moderate amounts of decorticating bark and coarse leaf litter layer • minimal stones and boulders. 	<ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) 	0.55	0.63	N/A

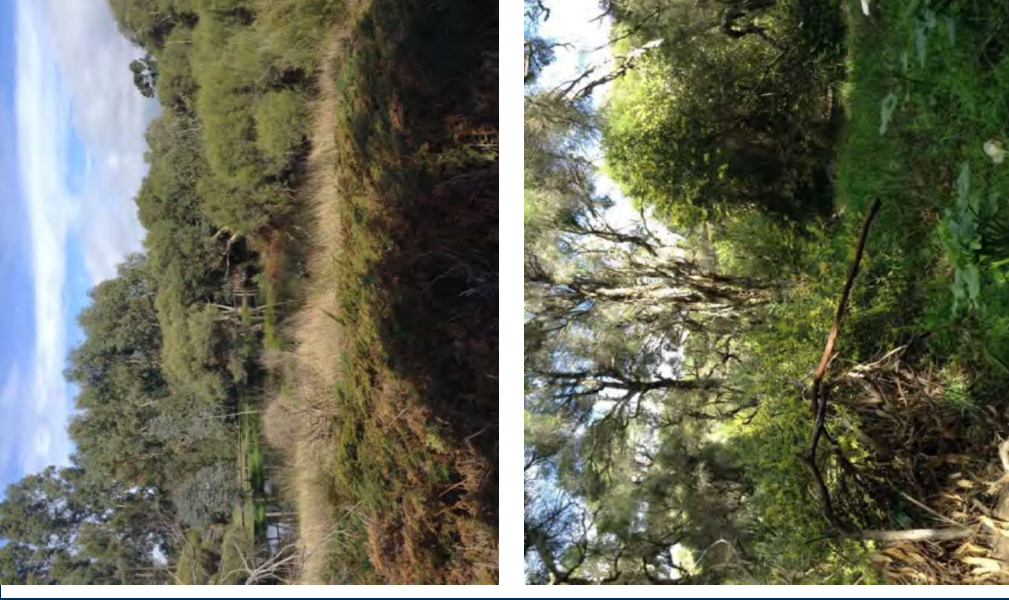
Level 1 Fauna and Targeted Black Cockatoo Surveys

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos
Shrubland with Minimal Groundcover (SMG)	<p>This habitat contains a varied density and height shrubland with minimal to no vegetative groundcover. It predominantly comprises cleared areas that have been rehabilitated.</p> <p>Significant habitat characteristics include:</p> <ul style="list-style-type: none"> • absence of large mature trees, large fallen logs and hollows • moderate to sparse cover shrub layer • absence of dense understorey • varied abundance of leaf litter • abundant bare ground and minimal stones and rocks. 	<ul style="list-style-type: none"> • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) • Perth Lined Skink (<i>Lerista lineata</i>) • Rainbow Bee-eater (<i>Merops ornatus</i>) 	5.15	5.93	
Shrubland (SL)	<p>This is predominantly moderate to high cover shrubland with no overstorey.</p> <p>Significant habitat characteristics include:</p> <ul style="list-style-type: none"> • absence of large and small mature trees, large fallen logs and hollows • varied abundance of leaf litter • minimal stones and rocks. 	<ul style="list-style-type: none"> • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) • Quenda (<i>Isodon obesulus fusciventer</i>) • Perth Lined Skink (<i>Lerista lineata</i>) 	0.94	1.08	

Level 1 Fauna and Targeted Black Cockatoo Surveys

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos
Isolated Trees (IT)	This habitat generally comprises disturbed areas that have minimal understorey and have occasionally to commonly abundant mature (mostly large) trees. There is often abundant bare ground and / or occasional shrubs.	<ul style="list-style-type: none"> Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) Perth Lined Skink (<i>Lerista lineata</i>) Rainbow Bee-eater (<i>Merops ornatus</i>) Quenda (<i>Isodon obesulus fusciventer</i>) 	10.72	12.34	
Parkland and Maintained Gardens (PLMG)	<p>This generally comprises maintained parks with large mature trees and lawns, garden beds and verges.</p> <p>Significant habitat features may include:</p> <ul style="list-style-type: none"> stones, rocks and boulders are generally absent, though landscaped items such as curbs, bricks and walls may be present general absence of fallen logs general absence of dense understorey abundant bare ground and maintained lawns. 	<ul style="list-style-type: none"> Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) Rainbow Bee-eater (<i>Merops ornatus</i>) 	4.18	4.81	

Level 1 Fauna and Targeted Black Cockatoo Surveys

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos
<p>Wetlands, Riparian Vegetation and Drainage (WRVD)</p>	<p>This habitat is varied and includes natural wetlands and riparian vegetation, and modified and manmade drainage ponds.</p> <p>Significant habitat features may include:</p> <ul style="list-style-type: none"> • presence of permanent or ephemeral water • presence of dense understorey • presence of large mature trees and hollows. 	<ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) • Perth Lined Skink (<i>Lerista lineata</i>) • Rainbow Bee-eater (<i>Merops ornatus</i>) • Quenda (<i>Isodon obesulus fusciventer</i>) 	4.36	5.01	


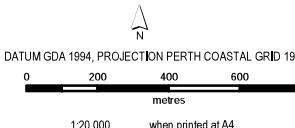
Level 1 Fauna and Targeted Black Cockatoo Surveys

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos
Cleared – predominantly bare ground (CBG)	Generally areas which have been cleared and now comprise bare soil and / or weeds, or have been recently rehabilitated and contain mulch and very small planted seedlings. Not areas that contain hardstand.	Rainbow Bee-eater (<i>Merops ornatus</i>)	19.57	22.51	

Note:

- 40% of the Survey Area consists of predominantly cleared hardstand areas.



<p>PROJECT ID 60539165 CREATED BY RNM APPROVED BY JLeigh LAST MODIFIED 14 DEC 2017</p>  <p>DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994</p> 	<p>LEGEND</p> <ul style="list-style-type: none"> ● Typical Quenda Digging Survey Area <p>Fauna Habitat</p> <ul style="list-style-type: none"> Cleared Predominantly Bare Ground Isolated Trees Parkland and Maintained Gardens Shrubland Shrubland Minimal Groundcover Woodland Woodland with Minimal Understorey Wetlands, Riparian Vegetation and Drainage 	<p>Fauna Habitats</p> <p>ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE - PROJECT LEVEL 1 FAUNA AND TARGETED BLACK COCKATOO MAIN ROADS WESTERN AUSTRALIA</p> <p style="text-align: right;">Figure 4</p>
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5.2.2 Black Cockatoo Surveys

5.2.2.1 Black Cockatoo Ecology

5.2.2.1.1 Carnaby's Cockatoo

Carnaby's Cockatoo is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin. This Black Cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill. Carnaby's Black Cockatoo feeds on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia*, *Grevillea* and *Hakea*), *Corymbia calophylla* (Marri), *Eucalyptus* (e.g. Jarrah [*Eucalyptus marginata*]), and seeds from the cones of Pine trees (*Pinus* sp.).

Carnaby's Cockatoo displays strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum (*E. loxophleba* subsp. *loxophleba*), Flooded Gum (*E. rudis*), Karri (*E. diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*E. wandoo*) and Tuart (*E. gomphocephala* [DSEWPaC, 2012]). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone and Storr, 1998).

Breeding habitat for this species occurs in the Wheatbelt, Jarrah Forest and South Coast regions, and the species is expanding its current breeding range with small patches of breeding habitat now being utilised across the Swan Coastal Plain (SCP). After breeding, Carnaby's Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July. Breeding has been recorded from early July to mid-December.

5.2.2.1.2 Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC, 2012). It has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding on Blackbutt (*E. patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*E. diversicolor*), Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone, 2016 pers. comm.).

Forest Red-tailed Black Cockatoo are monogamous and pairs nest in tree hollows from 6.5–33 m above ground. Most nests are in very large and very old, mature Marri (Johnstone, Kirkby & Sarti, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.). Breeding habitat for this species occurs in the eastern margins of the Jarrah forests of the Wheatbelt, and within the Jarrah Forest regions, and the Forest Red-tailed Black Cockatoo is expanding its current breeding range with small patches of breeding habitat now being utilised across the SCP.

A flock of eight Forest Red-tailed Black Cockatoos were observed within a small stand of introduced eucalypts to the east of the Survey Area (refer to Figure 5).

5.2.2.2 Foraging Habitat

5.2.2.2.1 Carnaby's Cockatoo

The Survey Area contains a total of 23.7 ha of foraging habitat for Carnaby's Cockatoo. Much of the Survey Area has been cleared, and the best quality foraging habitat is the Banksia Woodlands to the east of the Survey Area. These 5.95 ha of Banksia Woodlands are considered High Quality

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foraging habitat. Foraging habitat is presented spatially in Figure 5 and the total approximate foraging quality areas are presented in Table 15.

No clear Carnaby's Cockatoo foraging evidence was recorded within the Survey Area. Typical Carnaby's Cockatoo chewing on a Banksia infructescence (for grub removal) was recorded in habitat adjacent the Survey Area (refer to Figure 5 and Plate 4).

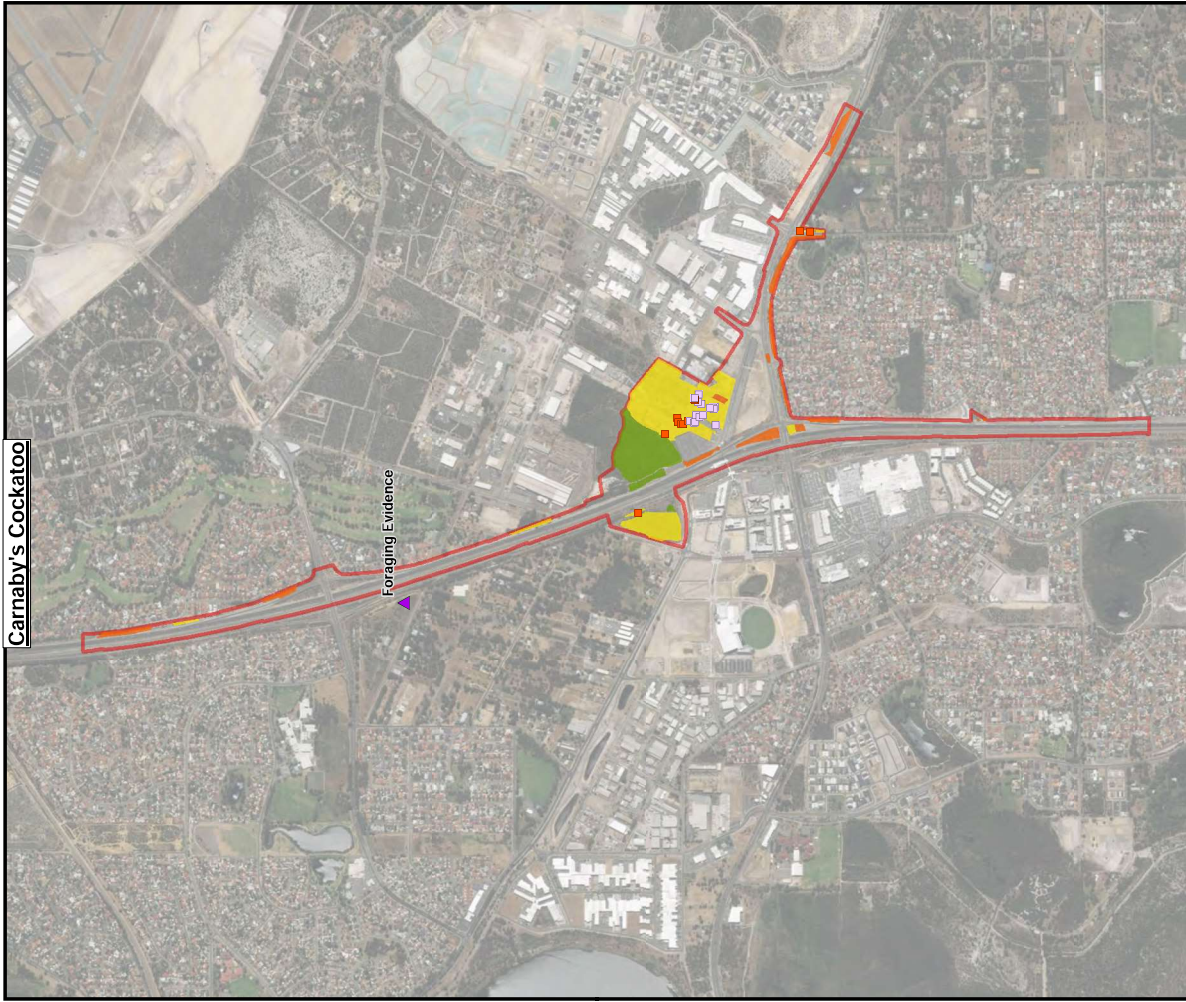
Table 15 Carnaby's Cockatoo Foraging Habitat Areas

Foraging Quality	Areas (ha)
Low Quality (1-3)	4.23
Quality (4-6)	13.51
High Quality (7-8)	5.95
Very High Quality (>8)	0
Total	23.70



Plate 2 Potential Carnaby's Cockatoo Foraging Evidence

Forest Red-tailed Black Cockatoo



Carnaby's Cockatoo

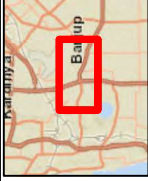


PROJECT ID: 8059/185
 CREATED BY: RIM
 APPROVED BY: J. Leigh
 LAST MODIFIED: 15 DEC 2017



DATUM: GDA 1984, PROJECTION: PERTH COASTAL GRID 1984
 0 200 400 600 800
 metres
 (when printed at A3)

- LEGEND**
- Carnaby's Cockatoo
 - Forest Red-tailed Black Cockatoo
 - Potential Breeding Trees
 - Eucalyptus gomphocephala (Tuart)
 - Eucalyptus rudis (Flooded Gum)
 - Foraging Habitat Quality
 - Very High Quality
 - High Quality
 - Low Quality
 - Survey Area



Data sources: Survey Data HERE, Data from LISRS, Bureau of Meteorology, Department of Transport and Infrastructure, DTI, Department of Environment and Heritage, Department of Planning, Urban and Infrastructure, and the GIS User Community

Black Cockatoo Potential Foraging and Breeding Habitat

ARMADALE ROAD TO NORTH LAKE ROAD
 BRIDGE -
 PROJECT LEVEL 1 FAUNA AND TARGETED
 BLACK COCKATOO SURVEYS
 MAINS ROADS WESTERN AUSTRALIA

Figure
5

A3 size

Level 1 Fauna and Targeted Black Cockatoo Surveys

5.2.2.2.1 Forest Red-tailed Black Cockatoo

The Survey Area contains minimal foraging habitat for the Forest Red-tailed Black Cockatoo, with only 0.14 of Low Quality foraging habitat available. This comprises a small patch of rehabilitated land that contains some small Marri and Sheoak. Foraging habitat is presented spatially in Figure 5 and total approximate areas are presented in Table 16.

Table 16 Black Cockatoo Foraging Habitat Areas

Foraging Quality	Areas (ha)
Low Quality (1-3)	0.14
Quality (4-6)	-
High Quality (7-8)	-
Very High Quality (>8)	-
Total	0.14

5.2.2.3 Breeding Habitat

The Survey Area contains 30 native trees defined as potential Black Cockatoo breeding habitat trees according to the DSEWPaC (2012) guidelines. These are presented spatially in Figure 5 and details are presented in Table 17. Six of these trees contained nine hollows, but these were not suitable to be utilised by breeding Black Cockatoos.

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Table 17 Potential Black Cockatoo Breeding Habitat Trees Recorded in the Survey Area

ID	Fire Scaring Present	Species	Tree Height (m)	DBH (cm)	No. of Potential Hollows	No. of Potentially Suitable Hollows	Comments
218	No	<i>Eucalyptus rudis</i> (Flooded Gum)	11	65	0		
215	No	<i>Eucalyptus rudis</i> (Flooded Gum)	13	150	3	0	Hollows unsuitable
212	No	<i>Eucalyptus rudis</i> (Flooded Gum)	11	64	0		
206	No	<i>Eucalyptus gomphocephala</i> (Tuart)	45	120	0		
203	No	<i>Eucalyptus gomphocephala</i> (Tuart)	45	130	1	0	Hollow unsuitable
200	No	<i>Eucalyptus gomphocephala</i> (Tuart)	25	145	0		
197	No	<i>Eucalyptus gomphocephala</i> (Tuart)	20	90	0		
194	No	<i>Eucalyptus gomphocephala</i> (Tuart)	14	87	2	0	Hollows unsuitable
191	No	<i>Eucalyptus gomphocephala</i> (Tuart)	25	150	1	0	Hollow unsuitable
188	No	<i>Eucalyptus gomphocephala</i> (Tuart)	17	90	0		
185	No	<i>Eucalyptus gomphocephala</i> (Tuart)	17	86	0		
182	No	<i>Eucalyptus rudis</i> (Flooded Gum)	14	80	0		
179	No	<i>Eucalyptus rudis</i> (Flooded Gum)	12	70	0		
176	-	<i>Eucalyptus gomphocephala</i> (Tuart)	13	75	0		
173	No	<i>Eucalyptus rudis</i> (Flooded Gum)	18	70	0		
170	No	<i>Eucalyptus rudis</i> (Flooded Gum)	12	57	0		
167	No	<i>Eucalyptus rudis</i> (Flooded Gum)	20	110	0		
164	No	<i>Eucalyptus rudis</i> (Flooded Gum)	21	100	0		
161	No	<i>Eucalyptus rudis</i> (Flooded Gum)	19	60	0		
158	No	<i>Eucalyptus rudis</i> (Flooded Gum)	14	50	0		
155	No	<i>Eucalyptus gomphocephala</i> (Tuart)	20	130	0		
152	-	<i>Eucalyptus gomphocephala</i> (Tuart)	22	130	1	0	Hollow unsuitable and currently being utilised by bees
149	No	<i>Eucalyptus gomphocephala</i> (Tuart)	18	63	0		
146	No	<i>Eucalyptus gomphocephala</i> (Tuart)	15	68	0		
143	No	<i>Eucalyptus gomphocephala</i> (Tuart)	20	120	0		
140	No	<i>Eucalyptus gomphocephala</i> (Tuart)	20	90	0		
137	No	<i>Eucalyptus gomphocephala</i> (Tuart)	18	60	0		
134	No	<i>Eucalyptus gomphocephala</i> (Tuart)	20	76	0		
113	No	<i>Eucalyptus rudis</i> (Flooded Gum)	13	60	0		
110	No	Stag	7	100	1	0	10cm diameter unsuitable branch hollow

6 CONCLUSION

In summary, the significant faunal values of the Survey Area include:

- Eight fauna habitats. The most common fauna habitat within the Survey Area, apart from Cleared Predominantly Bare Ground, is the Isolated Trees habitat at approximately 12%. This habitat generally comprises cleared, or partially cleared areas with scattered isolated mature trees (including Tuart and Flooded Gum). This habitat would support many of the common species of the area and may also be utilised by many of the conservation significant species such as the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Perth Lined Skink (*Lerista lineata*), Quenda (*Isoodon obesulus fusciventer*) and Rainbow Bee-eater (*Merops ornatus*).
- Seven introduced and naturalised fauna species were recorded in the Survey Area. Of these, the European Wild Rabbit and Red Fox were recorded and are listed as a Declared Pests under the *Biosecurity and Agricultural Management Act 2007*. Generally these species were recorded throughout the Survey Area and were identified by scats, burrows or tracks.
- Isolated areas of potentially suitable habitat for many of the conservation significant fauna species likely to be found in the area, including the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Perth Lined Skink (*Lerista lineata*), Quenda (*Isoodon obesulus fusciventer*) and Rainbow Bee-eater (*Merops ornatus*).
- The presence of 30 native trees defined as potential Black Cockatoo breeding habitat trees according to the DSEWPaC (2012) guidelines. Six of these trees contained nine potential hollows, but these were not suitable to be utilised by breeding Black Cockatoos. The SCP is used by Black Cockatoos primarily for foraging resources, however their breeding ranges are expanding due to heavy historic clearing, and small patches of breeding habitat are now being utilised across the SCP (DoEE, 2017).
- Minimal foraging habitat for the Forest Red-tailed Black Cockatoo – 0.14 ha of Low Quality foraging habitat.
- 23.7 ha of foraging habitat for Carnaby's Cockatoo. Much of the Survey Area has been cleared and the best quality foraging habitat is the Banksia Woodlands to the east of the Survey Area. Areas of foraging habitat for Carnaby's Cockatoo comprise:
 - Low Quality: 4.23 ha
 - Quality: 13.51 ha
 - High Quality: 5.95 ha
 - Very High Quality: 0 ha.

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Appendix A: Detailed Desktop Assessment

Level 1 Fauna and Targeted Black Cockatoo Surveys

Appendix A: Detailed Desktop Assessment

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Actitis hypoleucos</i>	Common Sandpiper	Migratory	IA	-	-	+	The Common Sandpiper is widespread throughout Australia, with few important sites on the continent. They visit Australia during the non-breeding season. Preferred habitat is coastal wetlands with muddy margins or rocky shores but has also been recorded in inland wetlands and dams (DotE, 2015).	May occur
<i>Anous stolidus</i>	Common Noddy	Migratory	IA	-	-	+	The Common Noddy occupies blue-water seas, usually far from the mainland and is distributed in Western Australia from northern seas south to Lancelin Island (Johnstone & Storr, 1998).	Unlikely
<i>Anous tenuirostris melanops</i>	Australian Lesser Noddy	Vulnerable	EN	-	-	+	The Australian Lesser Noddy is a small Noddy, standing at approximately 34 cm and a wingspan of 60 cm (Pizzey & Knight, 2007). This species breeds only in Houtman Abrolhos with colonies recorded on Pelsaert, Wooded, and Morley Islands (TSSC, 2015). Birds remain near the breeding islands all year. The oceanic range is unknown, with gales able to displace birds hundreds of kilometres away (TSSC, 2015). The main threat to the species is catastrophic destruction of habitat by cyclones (TSSC, 2015).	Unlikely
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory	IA			+	The Fork-tailed Swift is almost exclusively aerial, and a non-breeding visitor to Australia (DotE, 2015). They are rarely seen roosting on land.	May occur

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Ardea modesta</i>	Great Egret	Migratory	IA	2011	38		The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2003). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2007).	Likely to occur
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Endangered	EN	-	-	+	The Australasian Bittern is a large thick-necked bird, growing to a length of 66 to 76 cm. The Australasian Bittern occurs from south-east Queensland to south-east South Australia, Tasmania and the south-west of Western Australia. There are currently two known sub-populations including the south-eastern and the south-western sub-populations. It's preferred habitat is comprised of wetlands with tall dense vegetation where it forages in still, shallow water up to 0.3 m deep, edges of pools or waterways, or from platforms or mats of vegetation over deep water. Freshwater habitats dominated by sedges, rushes and reeds are preferred.	May occur
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Migratory	IA	1951	1	+	The Sharp-tailed Sandpiper is a small to medium sized wader with a length of 17 to 22 cm and weighing 65g. They are widespread in Western Australia from the Pilbara region to the south-west.	Unlikely

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Calidris canutus</i>	Red Knot	Endangered	VU	-	-	+	The Red Knot is a widely distributed marine and migratory species. It is common in the north-west of Western Australia with populations in the tens of thousands recorded at 80-mile Beach, not far from the study area (Bamford et al. 2008). The species mainly inhabits intertidal mudflats, sand flats, in estuaries, bays and lagoons. They are occasionally seen on inland salt lakes and wetlands but hardly every use freshwater swamps.	Unlikely
<i>Calidris ferruginea</i>	Curlew Sandpiper	Critically Endangered	VU & IA	2005	2	+	The Curlew Sandpiper is a small, slim weighing 57 g. In Australia, Curlew Sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. In Western Australia, they are widespread around coastal and sub coastal plains from Cape Arid to the south-west Kimberley. They occur in large numbers at Port Hedland Saltworks, Eighty-mile Beach, Roebuck Bay and Lake Macleid. They're rarely recorded in north-west Kimberley. This species does not breed in Australia	May occur
<i>Calidris melanotos</i>	Pectoral Sandpiper	Migratory	IA	-	-	+	The Pectoral Sandpiper occupies shallow, fresh waters often containing low grass or other small herbs. It is also observed in swamp margins, flooded pastures and saltmarshes. This species breeds in the northern hemisphere and is a regular though uncommon summer visitor to Australia (Pizzey & Knight, 2007). Rarely recorded in Western Australia (DotE, 2015).	Unlikely

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory	IA	2006	5	+	The Red-necked Stint is the smallest wader in Australia and is distributed along most of the Australian coastline, with the greatest densities in Victoria and Tasmania. The nearest internationally important site for the species is the Alfred Cove Nature Reserve on the Swan River (DotE, 2015).	May occur
<i>Calidris subminuta</i>	Long-toed Stint	Migratory	IA	-	-	+	The Long-toed Stint breeds in the northern hemisphere, before migrating to northern and coastal Australia where it occupies weedy margins of shallow wetlands, sewage ponds and tidal mudflats (Pizzey & Knight, 2007). In Western Australia records of this species are generally found along the coast (DotE, 2015).	Unlikely
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	Vulnerable	VU	2016	8	+	The Forest red-tailed black cockatoo requires tree hollows of Karri (<i>E. diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>Corymbia calophylla</i>) forests to nest and breed. Flocks move out onto the Swan Coastal Plain in search of food from exotic trees such as the White Cedar (Johnstone et al, 2010). The foraging habitat for the species consists of Jarrah and Marri woodlands and forest within its range.	Likely to occur

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	Vulnerable	EN	-	-	+	The Baudin's Cockatoo's habitat is critical to its survival; including forests of Karri (<i>E. diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>C. calophylla</i>), in areas of 600 mm average rainfall per year. Individuals typically move north through the Perth region from March to May and south through the Perth region from August to October. The species ranges from Gidgegannup and Hoddy Well in the north and west to the Eastern Strip of the Swan Coastal Plain. It includes West Midland in the north, heading south through Armadale, Byford and south and towards the coast until Lake Clifton where it continues to hug the coastline to east of Albany (Johnstone <i>et al.</i> , 2010).	Unlikely
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	Endangered	EN	2016	148	+	Carnaby's Cockatoo is a postnuptial nomad and typically moves west soon after breeding. The species nests in hollows of smooth-barked eucalypts, particularly Salmon Gum (<i>Eucalyptus salmonophloia</i>) and Wandoo (<i>E. Wandoo</i>) but is not limited to these eucalypts. Diet consists of an array of Proteaceous and Eucalypt species prevalent on the Swan Coastal Plain. Foraging habitat, including <i>banksia</i> woodlands, is considered to be habitat critical to the survival of the species (Johnstone <i>et al.</i> , 2010).	Likely to occur
<i>Charadrius dubius curonicus</i>	Little Ringed Plover	Migratory	IA	1999	2	+	The Little Ringed Plover can be found on muddy edges or mudflats of tidal or freshwater wetlands (Morcombe, 2007).	May occur

Level 1 Fauna and Targeted Black Cockatoo Surveys

Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Dasyurus geoffroii</i>	Chuditch	Vulnerable	VU	-	-	+	Following European settlement the range of this species contracted dramatically, from much of the continent to a small area in the south west. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008). The majority of records are found in the contiguous Jarrah forests of the south west of Western Australia (DotEE, 2017).	Unlikely
<i>Falco peregrinus</i>	Peregrine Falcon	-	OS	1998	1		A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009a)	May occur
<i>Gallinago megala</i>	Swinhoe's Snipe	Migratory	IA	-	-	+	This species is distributed in Western Australia in the far north (Johnstone & Storr, 1998).	Unlikely
<i>Gallinago stenura</i>	Pin-tailed Snipe	Migratory	IA	-	-	+	This species occupies shallow freshwaters and is distributed on the north-west coastal plains but is a casual visitor further south to Perth (Johnstone & Storr, 1998).	Unlikely
<i>Isoodon obesulus fusciventer</i>	Quenda	-	P4	2016	388		The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).	Likely to occur

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Leioproctus douglasii/lus</i>	a short-tongued bee	Critically Endangered	EN	-	-	+	This species of native bee is dependent on <i>Goodenia filiformis</i> and <i>Anthotium junceiforme</i> (South Metro Connect, 2011).	May occur
<i>Leipoa ocellata</i>	Malleefowl	Vulnerable	VU	-	-	+	Malleefowl is found in semi-arid to arid shrublands and low woodlands of Australia's interior, particularly areas dominated by mallee trees and/or <i>Acacia</i> shrubs. The species is highly sensitive to grazing by sheep and other herbivores, and altered fire regimes.	Unlikely
<i>Lerista lineata</i>	Perth Lined Skink	-	P3	2016	21		The Perth Lined Lerista is an underground dwelling skink, sheltering in leaf litter and upper layers of loose soil. It is typically found at the bases of shrubs, spoil heaps and stick ant nests (Bush <i>et al</i> , 2010). The species inhabits sandy soils supporting Eucalypt/ <i>Banksia</i> woodland, coastal heath and low shrubland (Bush <i>et al</i> , 2010; Wilson and Swan, 2010). There are no records of this species north of the Swan River on the Swan Coastal Plain (South Metro Connect, 2011).	Likely to occur

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Limosa limosa</i>	Black-tailed Godwit	Migratory	IA	2005	1	+	The Black-tailed Godwit is found in all states and territories of Australia however it typically inhabits coastal regions and is concentrated in the north of the country. It is found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit. It has also been found in shallow sparsely vegetated, near-coastal, wetlands such as saltmarsh, saltflats, river pools, swamps, lagoons and floodplains. They forage on wide intertidal mudflats or sandflats in soft mud or shallow water and occasionally in shallow estuaries.	May occur
<i>Macropus irma</i>	Western Brush Wallaby	-	P4	2014	8	-	The Western Brush-wallaby occurs in the south-west of Western Australia. Its preferred habitat consists of open sclerophyll forest or woodland and favours open flats over scrub thickets. It is also found in larger areas of mallee and heathland in the wheat belt and is uncommon in wet sclerophyll forest (Van Dyck & Strahan, 2008). Three most commonly consumed species are <i>Cynodon dactylo</i> , <i>Nuytsia floribunda</i> and <i>Carpobrotus edulis</i> (DEC, 2006).	May occur
<i>Merops ornatus</i>	Rainbow Bee-eater	-	IA	2010	34		The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. It is possible that this species will occupy open woodland areas within the Project area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2003).	Likely to occur

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Motacilla cinerea</i>	Grey Wagtail	Migratory	IA	-	-	+	The Grey Wagtail is a scarce but regular visitor to northern Australia, typically arriving in October and leaving in March. The species is most commonly associated with water and are found across a wide variety of wetlands, watercourses and on the banks of lakes and marshes (Referral guideline for 14 birds listed as migratory species under the EPBC Act, Australian Government, 2015).	May occur
<i>Myrmecobius fasciatus</i>	Numbat	Vulnerable	EN	1989	2		Originally widespread, the Numbat now only persists in two remnant populations at Dryandra and Perup in Western Australia with several reintroduced populations in the Western Australian wheatbelt (DotE, 2015).	Unlikely
<i>Neopasiphae simplicior</i>	A native bee	Critically Endangered	EN	-	-	+	<i>Neopasiphae simplicior</i> is restricted in range and has currently only been recorded in a small area of bushland within the Forrestdale Lake Nature Reserve adjacent to Forrestdale Lake and the Armadale Golf Course and an area of bushland near Cannington (DotEE, 2017).	May occur
<i>Ninox connivens connivens</i>	Barking Owl	-	P2	2010	4		The Barking Owl occurs in almost all mainland states and persists in the south-west of Western Australia, though uncommon. This species has been observed in varied habitats including open forests, woodlands, dense scrub, foothills and paperbark woodlands (Pizzey & Knight, 2007).	May occur
<i>Numenius madagascariensis</i>	Eastern Curlew	Critically Endangered	VU	-	-	+	Within Australia, this bird has a primarily coastal distribution. It is found in all states and has a continuous distribution from Barrow Island through the Kimberley region and into the Northern Territory with more scattered records along the coastlines south (DotE, 2015).	Unlikely

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Numenius minutus</i>	Little Curlew	Migratory	IA	-	-	+	The Little Curlew breeds in Arctic Siberia and migrates south to Australia in September, returning by April. When in Australia this species occupies dry grassplains, floodplains, margins of drying swamps, tidal mudflats, crops and sewage ponds (Pizzey & Knight, 2007).	May occur
<i>Oxyura australis</i>	Blue-billed Duck	-	P4	2013	31	-	The Blue-billed Duck is a shy and secretive bird that sometimes will dive into water instead of flying when disturbed. These ducks rarely come onto land and spend most of their time on the water when they aren't flying. They typically occupy deep, permanent denseley vegetated freshwater lakes, swamps and dams. They winter on more open waters however (Morcombe, 2003).	May occur
<i>Pandion haliaetus</i>	Osprey	Migratory	IA	-	-	+	The breeding range of the Eastern Osprey includes the northern coast of Australia from Albany in WA to Lake Macquarie in NSW (DotEE, 2017). This bird is moderately common in Australia, mostly in northern Australia. It is rare to uncommon in southern WA. The Eastern Osprey occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. Found mostly in coastal areas but can travel inland along major rivers. Areas of open fresh, brackish or saline water for foraging is essential for their habitat; visiting various wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps and broad rivers, reservoirs and large lakes. They can also occur over atypical habitats such as heath, woodland or forest when travelling between foraging sites.	Unlikely

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Philomachus pugnax</i>	Ruff (Reeve)	Migratory	IA			+	The Ruff, or Reeve for females, breeds in Eurasia and is a regular, uncommon migrant to coastal Australia where it frequents fresh, brackish and saline wetlands, tidal mudflats and saltfields (Pizzey & Knight, 2007).	Unlikely
<i>Plegadis falcinellus</i>	Glossy Ibis	Migratory	IA	2011	2	-	The Glossy Ibis occupies well vegetated wetlands, wet pastures, floodwaters, brackish wetlands and mudflats. This species is a non-breeding visitor to south-west Western Australia (Pizzey & Knight, 2007).	May occur
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	Vulnerable	CR	-	-	+	This species is restricted to the south-west corner of Western Australia. Closer to the coast it is closely associated with Peppermint (<i>Agonis flexuosa</i>) forest and woodland and Tuart (<i>Eucalyptus gomphocephala</i>) with a peppermint mid-story. Further from the coast the species is found in Jarrah (<i>Eucalyptus marginata</i>), Wandoo (<i>Eucalyptus wandoo</i>) and Marri (<i>Corymbia calophylla</i>) forest (Van Dyck & Strahan, 2008).	Unlikely
<i>Rostratula australis</i>	Australian Painted Snipe	Endangered	EN	-	-	+	The Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (DotE, 2015) This species is a very rare summer visitor to the south-west of Western Australia. Breeding habitat in Western Australia is not quite known however a nest located near Moora was located in a tussock beside a swamp (Johnstone & Storr, 1998).	Unlikely

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Setonix brachyurus</i>	Quokka	Vulnerable	VU	-	-	+	The Quokka is distributed from Jarrah forest south-east of Perth, extending south through southern Jarrah, Marri and Karri forests onward to the south coast. It is now thought to be absent from the Swan Coastal Plain. Habitat use varies and includes thickets of <i>Acacia</i> , <i>Melaleuca</i> and is sometimes found in conjunction with tea-tree (Van Dyck & Strahan, 2008).	Unlikely
<i>Throscodectes xiphos</i>	a cricket	-	P1	1999	4		Occurs in Banskia Woodland on the Swan Coastal Plain.	May occur
<i>Tringa glareola</i>	Wood Sandpiper	Migratory	IA	2002	1	+	The Wood Sandpiper is a summer migrant to Australia where it is more common in the north although a casual visitor to southern parts. It occupies wetland margins, saltmarshes and sewage ponds (Pizzey & Knight, 2007).	May occur
<i>Tringa nebularia</i>	Common Greenshank	Migratory	IA	2011	4	+	The Common Greenshank is known in WA from a few records including Great Sandy Desert and Nullabor Plain. It most often occurs around the coast from Cape Arid to Carnarvon. In the Kimberleys it has been recorded in the south-west and north-east. The typical habitat includes inland wetlands and sheltered coastal habitats of varying salinity.	May occur
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Migratory	IA	1950	1	+	This species breeds from Austria to Mongolia and moves to Australia for summer and is found in mostly coastal areas (Pizzey & Knight, 2007). Scattered records exist in Western Australia and are found mainly near the coast (DotE, 2015). This species occupies wetlands of varying salinity including fresh, sewage ponds and estuaries (Pizzey & Knight, 2007).	Unlikely

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Species	Common Name	Conservation Codes		DBCA		PMST	Ecology	Likelihood
		Federal	State	Latest Record	No. of Records			
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	-	VU	1973	1	-	This bivalve species is the only mussel species known to inhabit freshwater systems of south-west Western Australia (Klunzinger <i>et al</i> , 2012).	Unlikely

Appendix B: Black Cockatoo Foraging Habitat Assessments

Level 1 Fauna and Targeted Black Cockatoo Surveys

Appendix B1: Carnaby's Cockatoo Foraging Habitat Assessment

ID	Initial Score	Within the Swan Coastal Plain (+3)	Contains trees with suitable nest hollows (+3)	Primarily comprises Marri (+2)	Contains trees with potential to be used for breeding (+2)	Known to be a large or key roosting site (+1)	Does not contain evidence of foraging by species (+2)	No other foraging habitat within 6 km (-2)	Is >12 km from known breeding location (-1)	Is >12km from known roosting site (-1)	Is >2 km from a watering point (-1)	Disease present (-1)	Final Score	General Comments
S44	1	3	0	0	0	0	-2	0	0	0	0	0	2	Advanced rehab shrubland on SCP with occasional foraging species (e.g. <i>Banksia</i> and <i>Grevillea</i>). No breeding or potential breeding trees. Within 12 km of known roosting and potential breeding sites.
S35	0												0	Revegetated area with minimal to no foraging species.
FH101	7	3	0	0	0	0	-2	0	0	0	0	0	8	Predominantly good quality <i>Banksia</i> woodland on SCP that doesn't contain breeding or potential breeding trees. No foraging evidence recorded.
BC-176	1	3	0	0	2	0	-2	0	0	0	0	0	4	Area of large mature <i>E.gomphacephala</i> and <i>E.rudis</i> of breeding potential. On SCP. No foraging evidence.
VFJ FID30	1	3	0	0	0	0	0	0	0	0	0	0	4	Small patch on SCP containing mixed shrubs, and occasional foraging species (Marri and Sheoak). No breeding or potential breeding trees. Precautionary principle used for foraging evidence (could not access area).
BC212	1	3	0	0	2	0	-2	0	0	0	0	0	4	Maintained gardens on SCP with large <i>E.rudis</i> of breeding potential. No foraging evidence recorded. Within 12 km of known roosting and potential breeding sites.
VCF FID43	1	3	0	0	2	0	-2	0	0	0	0	0	4	Small area of Flooded Gums of breeding potential size on the SCP. No foraging evidence. Within 12 km of known roosting and potential breeding sites.
OF ID92	1	3	0	0	2	0	-2	0	0	0	0	0	4	Small area on the SCP with minimal foraging species but does contain a potential breeding tree. No foraging evidence and within 12 km of known roosting and potential breeding sites.
VCF FID 458	1	3	0	0	0	0	-2	0	0	0	0	0	2	Maintained gardens with occasional foraging species. No foraging evidence or breeding or potential breeding trees. Within 12 km of known roosting and potential breeding sites.
UID 160	1	3	0	0	0	0	-2	0	0	0	0	0	2	Small area on SCP containing scattered <i>Banksia</i> and Marri. No foraging evidence or breeding or potential breeding trees. Within 12 km of known roosting and potential breeding sites.

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ID	Initial Score	Within the Swan Coastal Plain (+3)	Contains trees with suitable nest hollows (+3)	Primarily comprises Marri (+2)	Contains trees with potential to be used for breeding (+2)	Known to be a large or key roosting site (+1)	Does not contain evidence of foraging by species (-2)	No other foraging habitat within 6 km (-2)	Is >12 km from known breeding location (-1)	Is >12km from known roosting site (-1)	Is >2 km from a watering point (-1)	Disease present (-1)	Final Score	General Comments
UID 48	1	3	0	0	0	0	-2	0	0	0	0	0	2	Small area on SCP containing scattered Banksia. No foraging evidence or breeding or potential breeding trees. Within 12 km of known roosting and potential breeding sites.

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Appendix B2: Forest Red-tailed Black Cockatoo Foraging Habitat Assessment

ID	Initial Quality	Jarrah and/or Marri shows good recruitment (+3)	Contains trees with suitable nest hollows (+3)	Primarily contains Marri and/or Jarrah (+2)	Contains trees with potential to be used for breeding (+2)	Known to be a large or key roosting site (+1)	No other foraging habitat within 6 km (+2)	Is >12km from known roosting site (-1)	Does not contain evidence of foraging by species (-2)	Is >12 km from known breeding location (-1)	Is >2 km from watering point (-1)	Disease present (-1)	Final Score	General Comments
S44	0												0	Area with minimal foraging species.
S35	0												0	Revegetated area with minimal foraging species.
FH101	1	0	0	0	0	0	0	0	-2	0	0	0	-1	Predominantly good quality Banksia woodland with occasional scattered foraging species. No foraging evidence and Precautionary Principle used for proximity of roosting and breeding sites.
BC-176	0												0	Area of large mature <i>E.gomphacephala</i> and <i>E.rudis</i> of breeding potential with minimal foraging species.
VFJ FID30	1	0	0	0	0	0	0	0	0	0	0	0	1	Small patch containing mixed shrubs, and occasional foraging species (Marri and Sheoak). No breeding or potential breeding trees. Precautionary Principle used for foraging evidence (could not access) and proximity of roosting and breeding sites.
VCF FID 43	0												0	Small area of Flooded Gums with no foraging species.
VCF FID 458	1	0	0	0	0	0	0	0	-2	0	0	0	-1	Maintained gardens with occasional foraging species (Sheoak). No foraging evidence or breeding or potential breeding trees. Precautionary Principle utilised for known roosting and potential breeding sites.
UID 160	1	0	0	0	0	0	0	0	-2	0	0	0	-1	Small area on SCP containing scattered Marri. No foraging evidence or breeding or potential breeding trees. Precautionary Principle utilised for known roosting and potential breeding sites.

