Mandogalup Terrestrial Vertebrate Fauna Survey and Environmental Impact Assessment

Biologic Environmental Survey

Report to Strategen-JBS&G

November 2020

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1 Introduction

1.1 Background

Strategen-JBS&G commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a Level 1 Vertebrate Fauna Survey and a black cockatoo hollow and roosting assessment, including an Environmental Impact Assessment, at Lots 2 and 10 Rowley Road in Mandogalup, Perth. The assessment will support the environmental approvals required by the proponent (Questdale Holdings Pty Ltd), who are proposing to clear vegetation to extend an existing sand quarry extraction and for bushfire fuel reduction.

The objectives for the assessment were as follows;

- Undertake a Level 1 Vertebrate Fauna survey, to
    - Describe and map the fauna habitat values of the Development Envelope, with particular reference to habitat for 'threatened' or 'priority' fauna species with potential to occur within the Development Envelope;
    - Compile an inventory of fauna taxa present within the Development Envelope;
    - Map the preferred habitat of significant terrestrial fauna species and illustrate any recorded locations of conservation significant terrestrial species;
- Undertake a targeted black cockatoo tree hollow and night roosting assessment, to determine their suitability for nesting, to confirm if any suitable hollows are currently in use or have been used by black cockatoos, and to assess the habitats present for night roosting suitability.
- Undertake an impact assessment, discussing:
    - the values and significance of fauna habitat and habitat connectivity within the Development Envelope and other areas likely to be indirectly impacted by the proposal, and describe these values in a local, regional and state context;
    - the significance of the potential direct, indirect and cumulative impacts as a result of both construction and operational elements of the proposal on fauna and conservation significant fauna (including those protected under the *Biodiversity Conservation Act 2016* [BC Act] and *Environmental Protection and Biodiversity Conservation Act 1999* [EPBC Act]), at a local and regional scale.

1.2 Mandogalup Development Envelope

The area to be surveyed, hereafter referred to as the Development Envelope (Figure 1-1) is located approximately 33 km south of Perth and is enclosed within an area bounded by the Kwinana Freeway to the east, Anketell Rd to the south, Mandogalup Rd to the west, and Rowley Rd to the north. It covers an area of 43.67 hectares (ha).

The Development Envelope itself is comprised of remnant *Banksia* and eucalypt woodland and is adjacent (to the east) to an existing sand quarry. The Development Envelope is in the immediate vicinity of important resources for conservation significant fauna, including black

cockatoo, such as the Harry Waring Marsupial Reserve (including Banganup Lake (~ 800 m north-west), Thomson's Lake Nature Reserve (~ 2.7 km north), and the Spectacles Wetlands at Beeliar Regional Park (~ 2.5 km south). Thomson's Lake is also considered a Ramsar Wetland of international importance.

1.3 Swan Coastal Plain

The Swan Coastal Plain, the region encompassing the Development Envelope, is recognised as a Global Biodiversity Hotspot (Hopper & Gioia, 2004). A key management focus for the region is the ongoing viability of foraging resources, particularly in *Banksia* woodlands, for black cockatoo particularly Carnaby's cockatoo (EPA, 2019). Banksia Woodland Threatened Ecological Communities (TEC), Endangered under the EPBC Act (TSSC, 2016), are therefore crucial for the persistence of these species, providing important foraging resources and some small patches of breeding habitat (EPA, 2019). Connecting corridors of vegetation between foraging resources, breeding habitat and night roosting sites are also essential to enable black cockatoos access resources across their range (DSEWPaC, 2012). These communities are fragmented across the region, and more than 60% of this ecological community has been cleared (DoE, 2016).

In light of this, some activities or developments, such as large new developments, works or infrastructure that permanently clear significant areas of intact or high-quality native vegetation potentially affecting TECs and threatened species may require referral under the EPBC Act (TSSC, 2016). The proposed activities within the Development Envelope have been submitted for referral both under the EPBC Act and *Environmental Protection Act 1986* (EP Act).

1.4 Assessment of species conservation significance

Current listings for conservation significant fauna for this report were checked against the EPBC Act list of threatened species (available online at http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl). Any planned disturbance to federally listed species and their habitat could require a referral. The table below (Table 1.1) details the applicable legislation and provides a comparative context.

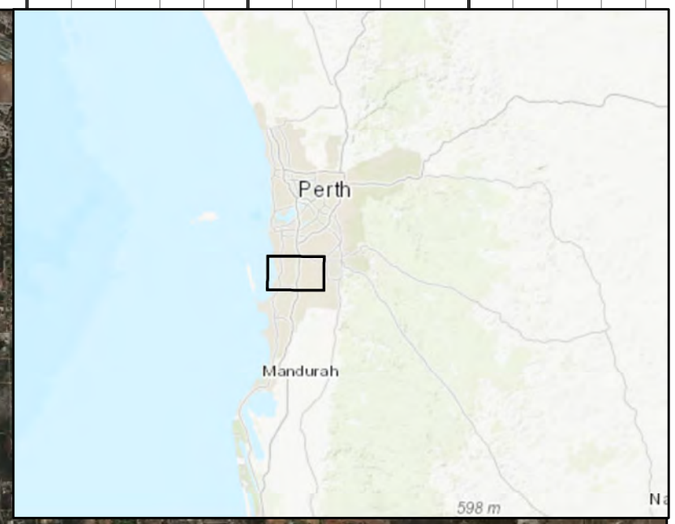
Table 1.1: Conservation significance assessment guidelines

Agreement, Act or List	Status Codes
Federal	
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)** The Department of the Environment and Energy (DoEE) lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) per criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	• Extinct (Ex) • Extinct in the Wild (EW) • Critically Endangered (Cr) • Endangered (En) • Vulnerable (Vu) • Conservation Dependent (CD) • Migratory (Mi) • Marine (Ma)
State	
Biodiversity Conservation Act 2016 (BC Act) At a state level, native fauna is protected under the *Biodiversity Conservation Act 2016*. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	• Extinct (Ex) • Extinct in the Wild (EW) • Critically Endangered (Cr) • Endangered (En) • Vulnerable (Vu)
DBCA Priority List DBCA produces a list of Priority species that have not been assigned statutory protection under the *Wildlife Conservation Act 1950*. This system gives a ranking from Priority 1 to Priority 4.	• Priority 1 (Poorly-known species) (P1) • Priority 2 (Poorly-known species) (P2) • Priority 3 (Poorly-known species) (P3) • Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4)

381600 383400 385200 387000 388800 390600 392400 394200 396000 397800 399600

6443200
6441600
6440000
6438400
6436800
6435200
6433600

THOMSONS LAKE
BANGANUP LAKE
Wattleup Rd
Mandogalup Rd
Kwinana Fwy
THE SPECTACLES



Legend

Study Area

N

1:50,000

0 0.275 0.55 1.1 1.65 2.2 km

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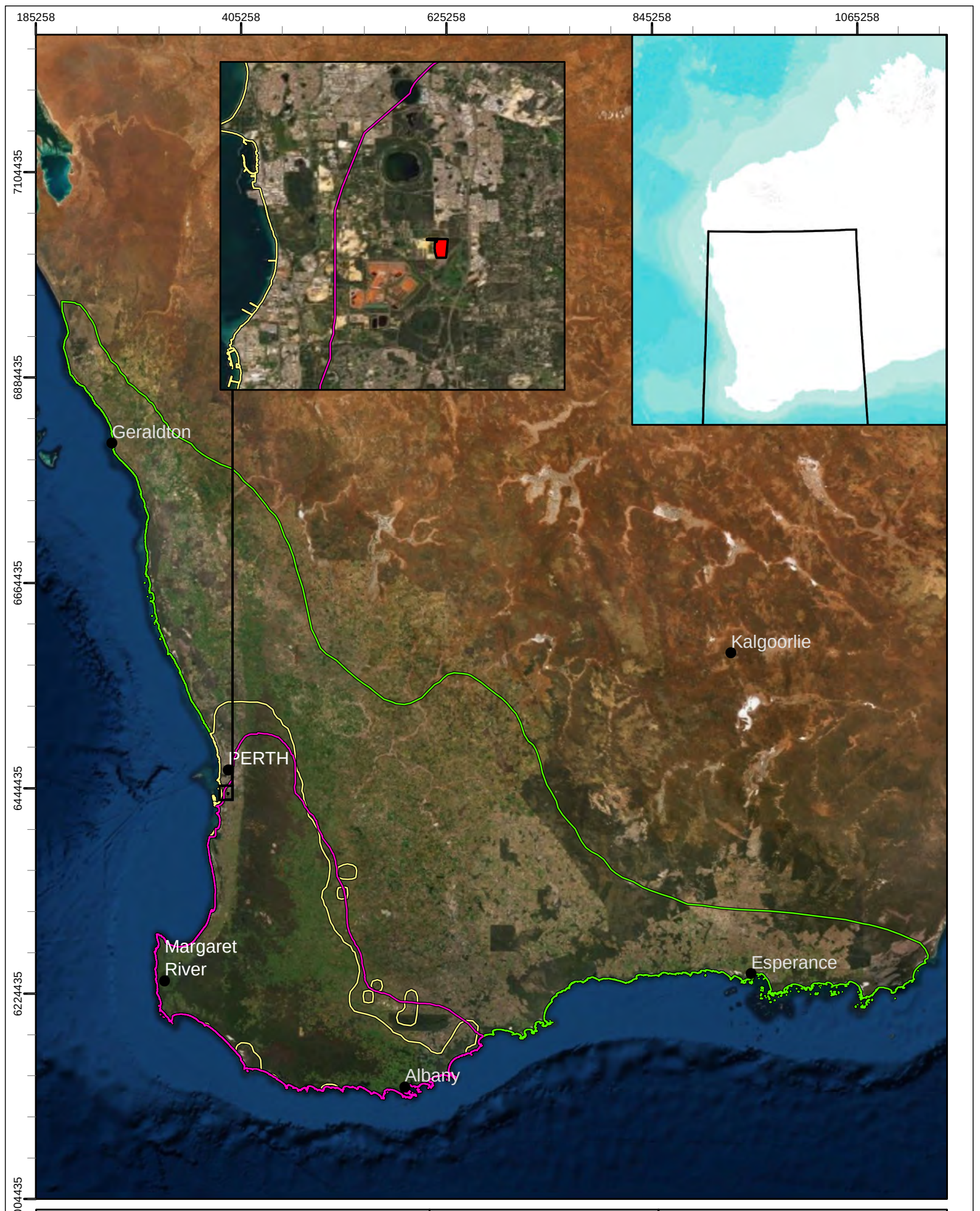
Mandogalup Level 1 Vertebrate Fauna EIA

Figure 1.1: Location of Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019



Legend

Study Area

Distribution

- Baudin's Black Cockatoo
- Carnaby's Black Cockatoo
- Forest Red-tailed Black Cockatoo

biologic Environmental Survey

N

1:5,000,000

0 37.5 75 150 km

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Fig. 1.2: Distribution of Black Cockatoo species relative to the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 12/12/2019

2 Methods

2.1 Compliance

The survey was carried out in a manner consistent with following guidance documents of the Western Australian Environmental Protection Authority (EPA), and the Department of the Environment and Energy (DoEE – formerly DEWHA);

- Environmental Protection Authority (EPA, 2016b) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA (2016c) Technical Guidance: Terrestrial Fauna Surveys;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Birds; and
- DSEWPaC (2012) EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Redt-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso.*

2.2 Desktop Assessment

Although a black cockatoo habitat assessment was completed in 2017 during a Flora and Vegetation survey (Strategen, 2017), the current survey represents the first Level 1 fauna study conducted in the Development Envelope. PGV (2015) provided environmental advice for the site, which discussed the main fauna values likely to be associated with the Development Envelope. These were decided as most likely to be;

- fauna assemblage: depauperate, limited medium and small mammals and some bird species reptiles and vertebrates;
- species of significance include southern brown bandicoot and black cockatoos; and
- ecological processes affecting fauna assemblage includes limited connectivity, influences in hydrology, fire and degradation processes.

Four databases were searched to obtain information on species and communities previously recorded within the vicinity of the Development Envelope (Birdata, NatureMap and Threatened and Priority Fauna Search), and conservation significant species and communities likely to occur within the Development Envelope (Protected Matters Database) (Table 2.1);

- BirdLife Australia's Birdata Custom Search (Birdlife Australia, 2019) – to determine black cockatoo roosting sites recorded from the region;
- Department of Biodiversity Conservation and Attractions' (DBCA) NatureMap database (DBCA, 2019a) to determine fauna recorded from the region;
- DBCA's Threatened and Priority Fauna Search (DBCA, 2019b) - to determine threatened fauna recorded from the region and;
- DoEE's Protected Matters Database (DoEE, 2019b) – to determine matters of national environmental significance recorded from the area.

The search radius of the database searches was selected based on relevant guidelines (DSEWPaC, 2012).

Table 2.1: Databases used for the vertebrate fauna review

Provider	Database	Date received	Point of reference	Distance
BirdLife Australia	Birdata Custom Bird List (Black Cockatoo Roost locations)	Nov 2019	Circle centred on the point -32.185 ° 115.845 °	12km
DBCA	NatureMap	Oct 2019		12 km
DBCA	Threatened and Priority Fauna Search	Nov 2019		5 km
DoEE	Protected Matters Database Search Tool	Oct 2019		12 km

2.3 Field Survey

The field survey was completed over two days; a Level 1 vertebrate fauna assessment on 31st October 2019 by experienced senior zoologists Claire Brooks and Ryan Ellis, and a targeted Black Cockatoo hollow assessment on 3rd November 2019 by recognised expert Tony Kirkby. The temperatures experienced (maximum of 17.1 °C respectively, Station 009172) were below long term averages for the area (22.9 °C) (22.9 °C; BoM, 2019). In addition, 10.5 mm of rain fell during the date of the Level 1 survey, was uncharacteristic for the time of year and represented 28 % of the monthly rainfall for October 2019 (37.1 mm, Station 009258; BoM, 2019).

2.3.1 Habitat Assessments and Mapping

Fauna habitat mapping was completed through adaptation of the vegetation mapping completed by Strategen (2017) in conjunction with six habitat assessments conducted across all habitat types during the field survey, and high-resolution aerial imagery. Habitats were delineated and mapped across the Development Envelope at a scale of approximately 1:10,000. Fauna habitats were assessed for the likelihood that they may support conservation significant fauna. Any disturbances present (e.g. weeds, clearing, tracks, feral animals) were also documented. Summarised habitat information is given in Appendix A for each site assessed during the survey.

2.3.2 Targeted and Opportunistic Vertebrate Fauna Records

Targeted searches were undertaken to identify the occurrence of fauna of conservation significance and to search for important habitat features, such as water bodies. Targeted searches were conducted within the most prospective areas in terms of habitat features and habitats suitable for species of conservation significance. During the targeted searches, and while traversing the Development Envelope, the team recorded all vertebrate fauna species of conservation significance encountered, either from primary (*i.e.* direct observation) or secondary (*e.g.* burrows, scratching's, diggings, scats, feathers and nests) evidence. The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM, 2019) was used as a guide to the current taxonomy and nomenclature of these groups. For birds, the current checklist of Australian birds maintained by Birdlife Australia

(based on Christidis & Boles, 2008) was used in conjunction with the WAM species list (WAM, 2019).

2.3.3 Black cockatoo hollow and roosting assessment

A black cockatoo hollow assessment was conducted targeting 23 hollows identified by Strategen (2017) within the Development Envelope. Suitable nest hollows are considered any hollow that appeared to be deep enough with an opening large enough to be used by black cockatoos, of both natural and artificial origin (DSEWPaC, 2012). Favourable attributes were looked for, with inspections identifying the presence/absence of any known breeding signs*, i.e*. hollows showing evidence of wear and chew marks around the hollow entrance, or the presence of down feathers, that may be attributed to black cockatoos (Johnstone *et al.*, 2013b), through the use of a pole-mounted camera. Where possible, hollow usage by fauna was also recorded, including use by introduced honeybees or other species.

Roosting habitat is defined as a suitable tree (generally the tallest) or group of tall trees, native or introduced, usually close to an important water source, and within an area of quality foraging habitat within the range of the black cockatoo species (DSEWPaC, 2012). The potential for night roosting to occur within the Development Envelope was interpreted and extrapolated from the 23 hollows identified by Strategen (2017), mapping of potential breeding habitat, proximity to suitable watering spots, and knowledge of any known roosting sites within the vicinity of the Development Envelope. A Birdlife Australia black cockatoo search was conducted within the 12 km of the Development Envelope to identify the presence of any known roosting locations both within the Development Envelope and in the near vicinity (refer to Section 2.2).

Any evidence of possible roosting events (i.e. clipped leaves and branches or droppings under suitable trees) recorded during the field survey was documented.

2.4 Assessment on Occurrence

The likelihood of occurrence within the Development Envelope for species of conservation significance identified in the desktop assessment was assessed using the decision matrix shown in Table 2.2. The occurrence assessment was based on known information relating to species' distribution, habitat preferences (landforms, substrates and vegetation associations), locality records from database searches and previous studies within and/or in the vicinity of the Development Envelope, and results of the current survey pertaining to species records and/or habitats occurring within the Development Envelope.

The fauna assessments assigned each species to one of seven ratings, ranging from Confirmed to Highly Unlikely (Table 2.2). Due to several factors influencing species occurrence (i.e. known distribution, habitat preferences, ecology and/or dispersal capabilities), interpretation of occurrence assessment criteria may vary between species (i.e. a small species with limited dispersal capabilities previously recorded close to the Development Envelope may not necessarily occur within the Development Envelope, whereas larger species with greater dispersal and/or foraging capabilities may have an increased likelihood of occurring).

Where a species determined likelihood of occurrence differs from the assessment criteria in Table 2.2 Table 2.2, detailed justification for the determined assessment will be provided in the discussion of that species. For example, historic or presumed erroneous records which may not be representative of species' current known distribution (i.e. locally/regionally extinct species) or limited sampling within or in the vicinity of the Development Envelope resulting in lack of contextual records which may influence a higher or lower determined likelihood of occurrence to criteria.

Table 2.2: Species likelihood of occurrence decision matrix

Range/occurrence categories (Records only considered when < 50 years old)	Habitat Categories (within Development Envelope)			
	Core/critical habitat present	Foraging/ dispersal habitat present	Marginal/ intermittent habitat present	No suitable habitat present
Recorded in Development Envelope	Confirmed	Confirmed	Confirmed	Confirmed
Recorded within < 2 km	Highly Likely	Likely	Possible	Possible
Recorded within 2-5 km	Likely	Possible	Possible	Unlikely
Recorded within 5 -20 km	Possible	Possible	Unlikely	Unlikely
Recorded > 20 km	Possible	Unlikely	Unlikely	Highly Unlikely
Species considered locally/regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

2.5 Assessment on Potential Environmental Impacts

The terms "significant impact" and "significant effect" are not defined in the EP Act 1986. Therefore, the prediction of significance for each potential impact identified in the Development Envelope is assessed using criteria considered by the EPA in their referral process (EPA, 2018). These criteria were considered and defined by Biologic in Table 2.3 below and are considered in detail for each conservation significant species in Section 3.2.4.

Table 2.3: Impact criteria used for each impact source assessed in the Development Envelope

Criteria	Assessment value	Definition
Duration	Short-term	>1 year
	Long-term	Years – decades
	Permanent	Indefinitely
Magnitude	Negligible	Displacement or loss of condition in individual animals
	Low	Loss of individuals but no measurable change in population size
	Moderate	Demonstrable change in population
	High	Population persistence threatened
Certainty	Data deficient	Insufficient data exist to quantify the impact pathway or the species' ecological response
	Low	The impact has not been documented during similar mining developments, but anecdotal accounts, literature reviews of other data suggest it could arise

Criteria	Assessment value	Definition
	Moderate	A reasonable body of data exist to support the assessment, or the impact has occurred during similar mining developments and would reasonably be expected to arise from the current proposal
	High	The impact is quantifiable and can be predicted with confidence from a reasoned evidence base

2.6 Potential limitations and constraints

The EPA (2016c) outlines several potential limitations to fauna surveys. These aspects are assessed and discussed in Table 2.4 below. The sampling techniques used during the survey were not constrained by any significant limitations. The survey was conducted by qualified personnel with experience in terrestrial vertebrate assessments and targeted black cockatoo assessments, as per the criteria outlined in DoEE (2017).

Table 2.4: Survey limitations and constraints

Potential limitation or constraint	Constraint (Y/N)	Applicability to this survey
Experience of personnel	No	DoEE (2017) requires that black cockatoo surveys should be done by a suitably qualified person with experience in such surveys. The senior field personnel involved in the survey, Claire Brooks and Ryan Ellis, both have extensive experience with black cockatoo and ecological surveys. Tony Kirkby, who undertook the hollow assessment, is considered an expert in this field.
Scope (faunal groups sampled and whether any constraints affect this)	No	The scope was a Level 1 and targeted black cockatoo hollow and roosting assessment and was conducted within that framework. Limited targeted searching was undertaken by the field personal; this reduced the ability to detect all species present, particularly species of conservation significance. Additionally, the Level 1 survey was undertaken over a short period of time (one day), reducing the ability to detect some fauna. However the survey was completed in line with the scope of a Level 1 survey (EPA, 2016b, 2016c), and thus it was not necessary to record all species present. Potential presence was determined using a systematic process utilising previous results and habitat present.
Proportion of fauna identified	No	All observed fauna was identified at the point of observation. Evidence of black cockatoo hollow use was identified by expert personnel with > 3 years' experience surveying for the species.
Sources of information (recent or historic) and availability of contextual information	No	A significant amount of black cockatoo survey work has been undertaken in the wider local area and the surrounding region, including annual black cockatoo monitoring for the past decade. These survey results were available for review. The Birdlife, DBCA, and DoEE database searches provided additional sources of recent information.
Proportion of the task achieved	No	A Level 1 and targeted black cockatoo hollow assessment of the Development Envelope was completed and related to the results of surveys in the broader area.
Disturbances (e.g. fire or flood)	No	Significant rainfall (10.7 mm) fell over the two days of the survey, in addition to hail and high winds. Although this may have contributed to a reduced level of opportunistic fauna activity, this was not the primary objective of a Level 1 survey.
Intensity of survey	Partial	A Level 1 and targeted black cockatoo survey was undertaken across the Development Envelope to assist with potential future environmental approvals. This level of survey is the required intensity given the size of the Development Envelope and the significance which a potential development may have. Follow-up targeted work may be required to clarify the occurrence for a number of Priority species.
Completeness of survey	No	The survey was adequately completed to meet the requirements of a Level 1 and targeted black cockatoo hollow assessment.
Resources (e.g. degree of expertise available)	No	All resources required to complete the survey were available.
Remoteness or access issues	No	The Development Envelope was accessible either by vehicle or on foot, thus the sampling techniques used during this survey were unconstrained by accessibility or remoteness.

3 Results

3.1 Desktop Results

3.1.1 Fauna

Based on species records and habitat present within the vicinity, database searches identified 206 vertebrate fauna species as potentially occurring within the Development Envelope. These results are comprised of 22 mammal species (including four non-native species), 145 birds (including five non-native species), 32 reptile species, and seven amphibians (listed in Appendix B, Appendix C, Appendix D). Fifty-five species of conservation significance have been previously recorded within 12 km of the Development Envelope, including migratory birds, or have habitat present to support them (Table 3.1). Of these, one species (Carter's freshwater mussel) was disregarded due to its aquatic nature, as well as an invertebrate species (graceful sunmoth). Species records outside of their currently known distribution, such as the numbat and western ringtail possum, were also excluded. The remaining fifty-one species were considered to have the potential to occur in the Development Envelope.

As the first Level 1 survey conducted on site there were no previous records of conservation significant species within the Development Envelope boundary. However, southern brown bandicoot *Isoodon fusciventer* (DBCA Priority 4) was recorded ~250 m north-east of the Development Envelope in 2015 (DBCA, 2019b). An additional 250 records of this species fall within 5 km of the Development Envelope, with 91 of these observations recorded at The Spectacles wetlands 2.5 km south of the Development Envelope.

Numerous migratory water-birds records within 5 km of the Development Envelope were noted from the database searches, including the sharp-tailed sandpiper, eastern curlew, red-necked stint, black-tailed godwit, common greenshank, curlew sandpiper, long-toed stint, and pectoral sandpiper. These records are concentrated at Thomsons Lake, ~ 3 km north-west of the Development Envelope. This lake is recognised as a Ramsar Wetland of international importance. There is no water present in the Development Envelope, and none of the migratory bird records fell within the boundary.

DBCA's Threatened and Priority Fauna database returned numerous Carnaby's cockatoo records (52) in the near vicinity (12 km radius) of the Development Envelope, as well as two records of forest red-tailed black-cockatoo (Figure 3-1). In addition, thirty-two black cockatoo roosts are recorded within 12 km of the Development Envelope, consisting of 18 white-tailed cockatoo roosts, six forest red-tailed black cockatoo roosts, six joint roosts, and two cleared roosts (Birdlife Australia, 2019).

Table 3.1: Species of conservation significance recorded from database searches

Species		Conservation Status			Database		
		EPBC Act	BC Act	DBCA	Nature-map DBCA (2019a)	Priority Fauna DBCA (2019b)	Protected Matters DoEE (2019b)
Mammals							
Chuditch, Western Quoll	*Dasyurus geoffroii*	VU	VU		x	x	x
South-Western Brush-Tailed Phascogale, Wambenger	*Phascogale tapoatafa wambenger*		CD		x		
Western False Pipistrelle	*Falsistrellus mackenziei*			P4	x	x	
Water-rat	*Hydromys chrysogaster*			P4	x	x	
Quenda, Southern Brown Bandicoot	*Isoodon fusciventer*			P4	x	x	
Tammar Wallaby	*Notamacropus eugenii subsp. derbianus*			P4	x	x	
Western Brush Wallaby	*Notamacropus irma*			P4	x		
BIRDS							
Eastern Curlew	*Numenius madagascariensis*	CR/ MI	CR/ MI				x
Curlew Sandpiper	*Calidris ferruginea*	CR/ MI	MI		x	x	x
Australian Painted Snipe	*Rostratula australis*	EN	EN				x
Painted Snipe	*Rostratula benghalensis*	EN	EN				x
Australian Bittern	*Botaurus poiciloptilus*	EN	EN				x
Red Knot	*Calidris canutus*	EN	EN				x
Baudin's cockatoo	*Calyptorhynchus baudinii*	EN	EN			x	x
Carnaby's cockatoo	*Calyptorhynchus latirostris*	EN	EN		x	x	x
Forest Red-Tailed Black Cockatoo	*Calyptorhynchus banksii naso*	VU	VU		x	x	x
Little Ringed Plover	*Charadrius dubius*	MI	MI				x
Red-capped Plover	*Charadrius ruficapillus*	MA					x
Red-necked Avocet	*Recurvirostra novaehollandiae*	MA					x
Hooded Plover	*Thinornis rubricollis*	MA		P4		x	x
Malleefowl	*Leipoa ocellata*	VU	VU				x
Australian Fairy Tern	*Sternula nereis nereis*	VU	VU				x
Common Sandpiper	*Actitis hypoleucos*	MI	MI		x	x	x
Fork-tailed Swift	*Apus pacificus*	MI	MI				x
Great Egret	*Ardea alba*	MA					x
Cattle Egret	*Ardea ibis*	MA					x
Flesh-footed Shearwater	*Ardenna carneipes*	MI	MI				x
Sharp-tailed Sandpiper	*Calidris acuminata*	MI	MI		x	x	x
Pectoral Sandpiper	*Calidris melanotos*	MI	MI		x	x	x
Red-Necked Stint	*Calidris ruficollis*	MI	MI		x	x	x
Long-toed Stint	*Calidris subminuta*	MI	MI		x	x	x

Species		Conservation Status			Database		
		EPBC Act	BC Act	DBCA	Nature-map DBCA (2019a)	Priority Fauna DBCA (2019b)	Protected Matters DoEE (2019b)
White-winged black tern	*Chlidonias leucopterus*	MI	MI		x	x	
Black-tailed Godwit	*Limosa limosa*	MI	MI		x	x	x
Grey Wagtail	*Motacilla cinerea*	MI	MI				x
Glossy Ibis	*Plegadis falcinellus*	MI	MI		x	x	
Wood Sandpiper	*Tringa glareola*	MI	MI		x	x	x
Common Greenshank	*Tringa nebularia*	MI	MI		x	x	x
Marsh Sandpiper	*Tringa stagnatilis*	MI	MI			x	x
Terek Sandpiper	*Xenus cinereus*	MI	MI			x	
Eastern Osprey	*Pandion cristatus*	MI	MI			x	x
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	MA					x
Pied Stilt	*Himantopus himantopus*	MA					x
Grey Plover	*Pluvialis squatarola*	MI	MI			x	
Ruff	*Philomachus pugnax*	MI	MI				x
Roseate Tern	*Sterna dougallii*	MI	MI				x
Crested Tern	*Thalasseus bergii*	MI	MI				
Peregrine Falcon	*Falco peregrinus*		OS		x	x	
Blue-Billed Duck	*Oxyura australis*			P4	x	x	
Red-tailed Tropicbird	*Phaethon rubricauda*			P4	x	x	
REPTILES							
Perth Slider	*Lerista lineata*			P3	x	x	
Black-Striped Snake	*Neelaps calonotos*			P3	x	x	

**Invertebrate and aquatic species are not shown.*

384000 386000 388000 390000 392000 394000 396000 398000 400000

6442000
6440000
6438000
6436000
6434000

Bird
- Carnaby's Cockatoo
- Common Sandpiper
- Long-toed Stint
- Sharp-tailed Sandpiper
- Black-tailed Godwit
- Blue-billed Duck
- Common Greenshank
- Curlew Sandpiper
- Forest Red-tailed Black Cockatoo
- Glossy Ibis
- Pectoral Sandpiper
- Peregrine Falcon
- Red-necked Stint
- Red-tailed Tropicbird
- White-winged Black Tern
- Wood Sandpiper

Mammal
- Chuditch
- Quenda
- South-western Brush-tailed Phascogale
- Tammar Wallaby
- Water-rat
- Western Brush Wallaby
- Western False Pipistrelle

Reptile
- Perth Slider
- Black-striped Snake

Legend
- Study Area

biologic Environmental Survey

N

1:42,589

0 0.25 0.5 1 1.5 2 km

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Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.1: Conservation significant fauna database results

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

3.1.2 Threatened and Priority Ecological Communities

The vegetation survey undertaken by Strategen (2017) found that the majority of the Survey Area comprised vegetation listed as a Threatened Ecological Community (TEC) under the EPBC Act; "Banksia Woodlands of the Swan Coastal Plain". This community is classified as an "Endangered" TEC under both the EPBC Act (TSSC, 2016). The community also relates to the Priority 3 Priority Ecological Community (Swan Coastal Plain *Banksia attenuata – Banksia menziesii* woodlands) (TSSC, 2016). This community is identified as part of the Swan Coastal Plain foraging resources for these three black cockatoos species, and as core habitat for *Lerista lineata* (TSSC, 2016).

3.1.2 Black cockatoo breeding and roosting records

Modelled distributions show that the Development Envelope is within breeding distribution for Carnaby's cockatoo and forest red-tailed black cockatoo (DSEWPaC, 2012). The Development Envelope is immediately within the boundary of the modelled distribution for Baudin's cockatoo, and therefore there is a lower risk of significant impact to this species (DSEWPaC, 2012). Black cockatoo breeding habitat is defined in the referral guidelines as species of trees known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow (DSEWPaC, 2012).

Database searches recorded no confirmed breeding sites within a 12 km radius of the Development Envelope, of either natural or artificial character (Birdlife Australia, 2019). However, significant roost sites exist for Carnaby's cockatoo in the Greater Perth-Peel region (Peck *et al.*, 2019), while forest red-tailed black cockatoos have been recorded breeding in the Perth region over recent years. Thirty roost sites have been recorded within 12 km of the Development Envelope (Birdlife Australia, 2019):

- 18 white-tailed black cockatoo roosts;
- 6 forest red-tailed black cockatoo; and
- 6 joint sites (Figure 3-4).

The nearest roosts to the Development Envelope are confirmed white-tailed black cockatoo roosts KWIWANR002 and KWIWANR001, which are located 2.4 km and 3.8 km to the west of the Development Envelope, respectively (Birdlife Australia, 2019). KWIWANR002 was utilized by five birds as a night roost in 2017 (Peck *et al.*, 2019), but was not used for the next two years. KWIWANR001 was last utilized as a roost site in 2013 and was not surveyed in 2019 (Peck *et al.*, 2019). Additionally, KWIWANR004 (located 4.5 km east of the Development Envelope) was first surveyed in 2017 at which time it supported 73 roosting white-tailed black cockatoos (Peck *et al.*, 2019). This site has not been used for roosting in the last two years. however, these sites may become in use in subsequent years as most roosts are not occupied consistently each year (Peck *et al.*, 2019).

3.2 Field Survey Results

3.2.1 Fauna Habitats

As per Section 2.3.1, fauna habitat mapping was completed through adaptation of the vegetation mapping completed by Strategen (2017). The Development Envelope is considered to comprise of two broad fauna habitat types as well as an area considered 'Cleared' and completely degraded. The habitats types are:

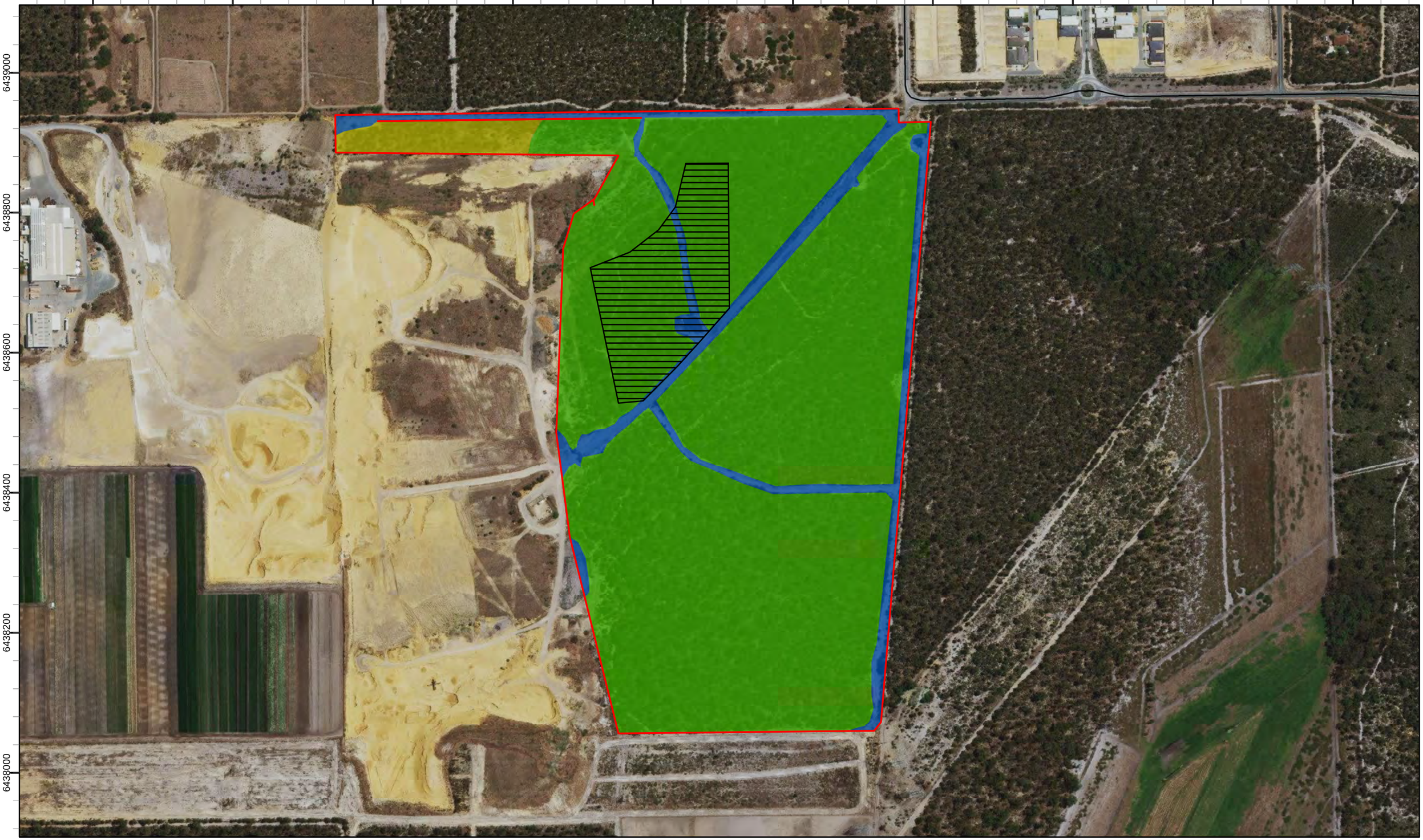
- Low Banksia Woodland (Plate 3.1): Open *Banksia menzesii* and *Banksia attenuata* woodland with emergent jarrah *Eucalyptus marginata,* over an open understorey including *Xanthorrhoea, Hibbertia hypericoides* and mixed *Acacia* species. This habitat type comprises 38.09 ha (87 %) of the Development Envelope, and condition was considered Very Good-Excellent. This habitat aligns with the *Banksia Woodland of the Swan Coastal Plain* TEC overlapping the Development Envelope. In consideration of its high foraging value for black cockatoo, potential to support other conservation significant species, and highly fragmented distribution on the Swan Coastal Plain, the habitat type is considered of High Significance on both a local and regional scale.
- *Acacia* Scrubland (Plate 3.2): Scrubland of *Acacia saligna* with emergent Jarrah *Eucalyptus marginata* and *Allocasuarina fraseriana*. This habitat type comprises 1.27ha (3 %) of the Development Envelope, and condition was considered Good. The habitat has been re-assessed following Strategen (2017) and is not considered "closed" here. In consideration of its foraging value for black cockatoo and potential to support some conservation significant species, the habitat type is considered of Moderate Significance.
- Cleared: Infrastructure including radio towers, cleared areas, roads and tracks, and verge. This habitat type comprises 4.29 ha (10 %) of the Development Envelope, and condition was considered Poor. This habitat is considered of Low Significance in relation to its potential to support conservation significant species.

Plate 3.1: Example of Low Banksia Woodland in the Development Envelope

Plate 3.2: Example of Acacia Scrubland in the Development Envelope

390200 390400 390600 390800 391000 391200 391400 391600 391800 392000

6439000 6438800 6438600 6438400 6438200 6438000



Legend

- Study Area
- Area to be conserved

Habitat Type

- Cleared
- Acacia Scrubland
- Low Banksia Woodland

N

1:5,000

0 0.0275 0.055 0.11 0.165 0.22 km

biologic Environmental Survey

Strategen JB&G

Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.2: Fauna habitats identified in the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

3.2.2 Fauna Recorded

During the field survey, targeted and opportunistic encounters with vertebrate fauna species were recorded. A total of 25 species were recorded during the field survey, comprising 14 avian species, four mammalian species (including two non-native species), and seven reptile species (Table 3.2).

Table 3.2: Vertebrate species recorded during the current survey

Scientific Name	Common Name	EPBC Act listing	State listing
Mammals			
Isoodon fusciventer	Southern Brown Bandicoot		P4
Macropus fuliginosus	Western Grey Kangaroo		
*Oryctolagus cuniculus**	Rabbit*		
*Vulpes vulpes**	Fox*		
Birds			
Anthochaera carunculata	Red Wattlebird		
Artamus personatus	Masked Woodlswallow		
Calyptorhynchus banksii naso	Forest Red-tailed Cockatoo	Vu	Vu
Coracina novaehollandiae	Black-faced Cuckoo-shrike		
Corvus coronoides	Australian Raven		
Cracticus tibicen	Australian Magpie		
Gavicalis virescens	Singing Honeyeater		
Merops ornatus	Rainbow Bee-eater		
Petroica boodang	Scarlet Robin		
Phylidonyris novaehollandiae	New Holland Honeyeater		
Platycercus zonarius	Australian Ringneck		
Podargus strigoides	Tawny Frogmouth		
Rhipidura leucophrys	Willie Wagtail		
Trichoglossus moluccanus	Rainbow Lorikeet		
Reptiles			
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink		
Delma australis	Marble-faced Delma		
Egernia napoleonis	South-western crevice-skink		
Hemiergis quadrilineata	Two-toed earless skink		
Pseudonaja affinis	Dugite		
Tiliqua rugosa	Shingleback Lizard		
Varanid sp.	Monitor species		

*denotes introduced species.

3.2.3 Fauna of Conservation Significance

Two species of conservation significance were recorded during the current survey; forest red-tailed black cockatoo (*Calyptorhynchus banksii naso,* EPBC and BC Act Vulnerable), and southern brown bandicoot (*Isoodon obesulus fusciventer,* DBCA Priority 4). These are the first conservation significant species to have been recorded within the Development Envelope; however, this is likely due to a lack of survey effort. In total, 51 species of conservation significance were identified through the desktop assessment as having the potential to occur within the Development Envelope (Section 3.1; Table 3.1) comprising seven mammals, 42 birds and two reptiles.

Aside from these species records from the current survey, based on distribution, previous records in the vicinity and the habitats present within the Development Envelope, one species of conservation significance was deemed highly likely to occur (Carnaby's cockatoo *Calyptorhynchus latirostris*) and three were deemed likely to occur (Baudin's cockatoo *Calyptorhynchus baudinii,* western brush wallaby *Notamacropus irma,* and the Perth slider *Lerista lineata*) (Table 3.3). The remaining species are considered only Possible (four species), Unlikely (39 species) and Highly Unlikely (three species) to occur. These species, and the justification for their likelihood of occurrence, are detailed below, and summarised in Table 3.3.

Species confirmed in the Development Envelope

Forest Red-tailed Black Cockatoo

The forest red-tailed black-cockatoo (*Calyptorhynchus banksii naso*, EPBC and BC Act Vulnerable) is distributed through the humid and sub-humid southwest of Western Australia from Gingin through the Darling Ranges to the southwest, from approximately Bunbury to Albany (Johnstone & Storr, 1998). They inhabit dense jarrah, karri and marri forests that receive more than 600 mm average annual rainfall (Johnstone *et al.*, 2017), and breeds in the southwest of Western Australia between October and November, producing one or two eggs. Population size has been estimated recently at approximately 15,000 birds (Peck *et al.*, 2019).

The forest red-tailed black cockatoo occurs in pairs or small flocks, or occasionally large flocks of up to 200 (Johnstone & Storr, 1998). Although not nomadic like Carnaby's and Baudin's cockatoos, the forest red-tailed black-cockatoo has been known to exhibit extreme population fluctuations in response to food availability and fires (Johnstone & Storr, 1998). There has been a change in foraging ecology of many individuals of the species from the Darling Range west onto the Swan Coastal Plain noted since 1995 (Johnstone *et al.*, 2011; Johnstone *et al.*, 2017). This change for some flocks from being largely sedentary to regularly moving onto the Swan Coastal Plain, including the establishment of new roost and breeding sites, has led to a public perception that the species is more common in Perth than is actually the case (Johnstone *et al.*, 2017; Johnstone *et al.*, 2013a).

The forest red-tailed black cockatoo was recorded from the current survey from a dropped feather (Plate 3.3). This sighting was made within the banksia woodland habitat (Figure 3-3). Some black cockatoo feeding activity was recorded, with a small number of jarrah nuts (*n* = 4) showing seed extraction characteristic of black cockatoo; however, the species was unable to be determined. Forest red-tailed black-cockatoos can obtain energy faster when feeding on marri and jarrah than other food sources (Cooper *et al.*, 2002), and these two plant species make up 90% of their diet (Johnstone & Kirkby, 1999).

Plate 3.3: Forest red-tailed black cockatoo feather observed during the current field survey (left), jarrah nuts potentially eaten by a forest red-tailed black cockatoo (right)

Southern brown bandicoot

The Southern brown bandicoot (*Isoodon obesulus fusciventer,* DBCA Priority 4) was recorded via secondary observations (evidence of digging) in the banksia woodland habitat in the center of the Development Envelope (Figure 3-3). This is the first observation of this species from within the Development Envelope; however there is a contemporary record ~250 m north-east of the Development Envelope from 2015 (DBCA, 2019b). An additional 250 records of this species fall within 5 km of the Development Envelope, with 91 of these observations recorded at The Spectacles wetlands 2.5 km south of the Development Envelope. Although southern brown bandicoot have a patchy distribution through the Swan Coastal Plain (DEC, 2012), the species can survive in the metropolitan area, as long as there is adequate vegetation for shelter (Lohr *et al.*, 2018). The preferred habitat for the species is described as jarrah forest and swamp habitats, preferring dense vegetation around wetland fringes and heathland (Cooper, 1998; Woinarski *et al.*, 2014). Therefore, the species is most likely to utilise all habitats of the Development Envelope apart from the Developed areas.

Species potentially occurring in the Development Envelope

Carnaby's cockatoo

Carnaby's cockatoo (*Calyptorhynchus latirostris,* EPBC and BC Act Endangered) is endemic to south west Western Australia, and is distributed from the Murchison River to Esperance and inland to Coorow, Kellerberrin and Lake Cronin (Cale, 2003). The species was once common,

but the population has declined significantly in the last half century (Johnstone & Storr, 1998) and is now locally extinct in some areas (Shah, 2006). The total population of Carnaby's cockatoo is currently estimated at 40,000 (Peck *et al.*, 2019). Several significant roost sites exist for Carnaby's cockatoo in the Greater Perth-Peel region. Data from the Birdlife Australia Great Cocky Count 2019 (Peck *et al.*, 2019) shows 80 % of roost sites for the species occur within the Greater Perth-Peel region, although 73% of the Carnaby's cockatoos recorded were associated with the Gnangara-Pinjar pine plantation, north of Perth.

Carnaby's cockatoos feed on seeds, nuts and flowers of a variety of native and exotic plants, including *Banksia* (including those previously included in the genus *Dryandra*), Pine trees (*Pinus* sp.), marri, jarrah, *Grevillea*, *Allocasuarina,* and *Hakea* (Shah, 2006). For Carnaby's cockatoo, the seeds from *Banksia* seed pods and the cones of pine trees provide the highest energetic yield as Carnaby's cockatoo are less efficient at extracting marri seeds than Baudin's cockatoo (Cooper *et al.*, 2002). Carnaby's cockatoo are highly associated with the Banksia Woodlands of the Swan Coastal Plain TEC (EPA, 2019; TSSC, 2016).

Trees used as nest sites by Carnaby's cockatoo are mature, hollow bearing trees, usually with a crown containing dead limbs and a sparse canopy (Cale, 2003; Johnstone & Storr, 1998). They generally nest in hollows of smooth barked eucalypts, especially salmon gum and wandoo, and on the Swan Coastal Plain most nests are in tuart (Johnstone & Storr, 1998); however, there is evidence that they nest in any species of eucalypt with a suitable hollow (Cale, 2003; Saunders, 1979). Breeding has been recorded from early July to mid-December and primarily occurs in the Wheatbelt (Johnstone & Storr, 1998). On the Swan Coastal Plain, Carnaby's cockatoo are known to breed in small numbers at Regans Ford, Yanchep, Gingin, Mandurah and Bunbury (Johnstone & Storr, 1998).

There are 52 records of Carnaby's cockatoo within 5 km of the Development Envelope (DBCA, 2019b), in addition to 18 white-tailed black cockatoo roosts recorded within 12 km (Birdlife Australia, 2019). Based on the abundance of records in the vicinity and the amount of Very High-Quality foraging habitat present within the Development Envelope (38.09 ha of Banksia Woodland), the species is considered Highly Likely to occur. The jarrah nut chewed by black cockatoo recorded during the current survey (Figure 3-3) is most likely attributed to either Carnaby's cockatoo or forest red-tailed black cockatoo, but the species is unable to be definitively determined.

Baudin's cockatoo

Baudin's cockatoo (*Calyptorhynchus baudinii,* EPBC and BC Act Endangered) is distributed through the south western humid and sub-humid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and east to Albany (Johnstone & Storr, 1998). They usually occur in small flocks of up to 30, or occasionally up to 50, or rarely in aggregations of up to 1200 (Johnstone & Kirkby, 2008). The total population of Baudin's cockatoo is estimated to be about 12,000 birds (Peck *et al.*, 2019).

This species forages primarily in eucalypt forest, where it feeds on marri seeds, flowers, nectar and buds (Johnstone & Kirkby, 2008). They also feed on a wide range of seeds of *Eucalyptus*,

Banksia and *Hakea*, as well as the fruits of apples, pears, persimmons, pines, and beetle larvae from under the bark of trees (Johnstone & Kirkby, 2008; Johnstone & Storr, 1998). For Baudin's cockatoo, the seeds from marri provide a high energetic yield because marri seeds are a high energy food and Baudin's cockatoo are able to quickly extract the seeds from the nut using their long bill (Cooper *et al.*, 2002).

Baudin's cockatoos nest in tree hollows in the deep southwest of Western Australia, with primary nesting trees being karri, marri, and wandoo (*Eucalyptus wandoo*). Baudin's cockatoo is mostly a postnuptial nomad (Johnstone & Kirkby, 2008) and breed from around October to December. After breeding, Baudin's cockatoos leave nesting areas and amalgamate to form large foraging flocks. These flocks generally migrate north to the main non-breeding wintering area in the northern Darling Range between Collie and Mundaring (Johnstone & Kirkby, 1999).

The DoEE "Species of National Environmental Significance" database places the Development Envelope immediately within the boundary for Baudin's cockatoo (Figure 1-2) (DoEE, 2019a). There are limited records of the species in the immediate vicinity, although the nearest observation is 4 km north of the Development Envelope from 2016 (DBCA, 2019a). However, Baudin's cockatoo has very similar morphological characteristics to Carnaby's cockatoo, and many early accounts of white-tailed black cockatoos did not distinguish between the two species (Chapman, 2007). In addition, the two species commonly occur together in mixed flocks (Peck *et al.*, 2019), and therefore correct identification of white-tailed black cockatoos is difficult. Based on the presence of Very High-quality foraging resources for the species, a recent record within 5 km of the Development Envelope, and location of the Development Envelope within the boundary of its distribution, Baudin's cockatoo is considered Likely to occur.

Perth Slider

The Perth slider *Lerista lineata* (DBCA Priority 3) is a fossorial skink largely restricted to the Swan Coastal Plain (Maryan *et al.*, 2015). However, Australian squamate fauna has not been re-assessed for more than 25 years (Tingley *et al.*, 2019), and the species listing as Endangered by the IUCN (Gaikhorst *et al.*, 2017) suggests that it's listing may be upgraded. The species distribution follows a narrow strip located approximately 20–25 km inland from the coast, with the majority of *L. lineata* records from the southern suburbs of the Perth metropolitan area on the Bassendean and Spearwood Dune Systems. It is estimated that suitable habitat for the species has declined by 86 % since European settlement (Maryan *et al.*, 2015). This habitat includes the TEC Banksia Woodlands of the Swan Coastal Plain (TSSC, 2016), found across the Development Envelope.

There are 142 records of the species within 5 km of the Development Envelope (DBCA, 2019b), with the closest record ~1 km south (1978), and the nearest contemporary record ~2 km south (2014) (DBCA, 2019a). Based on the availability of suitable habitat, the proximity and number of nearby records, and the distribution of the species, the Perth slider is considered Likely to occur in the Development Envelope.

Western brush wallaby

The Western brush wallaby *Notamacropus irma* (DBCA Priority 4) inhabits a wide-range of habitats including low *Banksia* woodlands, jarrah/marri woodlands and moist *Melaleuca* lowlands, favouring open, grassy areas (Wann & Bell, 1997; Woinarski *et al.*, 2014). There are two contemporary records of the species from 2015 in the Harry Waring Marsupial Reserve, ~2 km north-west of the Development Envelope (DBCA, 2019b).

Based on the presence of suitable habitat (Banksia Woodland) and a contemporary record in the immediate vicinity of the Development Envelope, the western brush wallaby is considered Likely to occur.

Western quoll, Chuditch

The chuditch *Dasyurus geoffroii* (EPBC Act and BC Act Vulnerable) has experienced a severe contraction of range since European settlement (Woinarski *et al.*, 2014). Orell and Morris (1994) report that the species were recorded on the Swan Coastal Plain until the 1930s, but a contemporary record from 2013 has been recorded ~3 km south of the Development Envelope at The Spectacles wetlands (DBCA, 2019b). Habitat is described as moist, densely vegetated, steeply sloping Jarrah forest and drier, open, gently sloping forest particularly in riparian vegetation (Orell & Morris, 1994), and the Banksia Woodland in the Development Envelope may provide some marginal habitat.

Based on the presence of potentially suitable habitat present within the Development Envelope (Banksia Woodland), and the distribution and temporal aspect of nearby records, this species is considered Possible to occur.

South-western brush-tailed phascogale

Phascogale tapoatafa wambenger (BC Act Conservation Dependent) populations in Western Australia fluctuate markedly in response to climatic conditions (Rhind, 2002); however, the species is thought to have declined significantly, most likely due to habitat degradation, clearance, and fragmentation (Woinarski *et al.*, 2014). The species is an obligate arborealist, highly dependent on trees for nest hollows and bark invertebrates, especially jarrah and marri below 400 mm DBH (Rhind, 1996). The Banksia Woodland habitat, with emergent jarrah present, may provide suitable habitat in the Development Envelope. The nearest record is a historical observation from 1961 approximately 3 km south-west of the Development Envelope (DBCA, 2019b); however, there is a contemporary record of the species from 2013 approximately 10 km south-east of the Development Envelope (DBCA, 2019a).

Based on the presence of potentially suitable habitat present within the Development Envelope (Banksia Woodland) with some habitat connectivity in a regional context, and the distribution and temporal aspect of nearby records this species is considered Possible to occur.

Western false pipistrelle

The western false pipistrelle, *Falsistrellus mackenziei* (DBCA P4) is a small insectivorous bat that inhabits tall forests and woodlands in the south-west of Western Australia (Woinarski *et al.*, 2014). Although there have been records within jarrah and tuart forest, most records are from

karri forest. The nearest record to the Development Envelope is a historical record from 1973 at Jandakot in the Harry Waring Marsupial reserve (DBCA, 2019a; Woinarski *et al.*, 2014). However, there have been no contemporary records north of Collie in Jarrah forest since this time despite targeted searching (Woinarski *et al.*, 2014).

Based on the lack of contemporary records, and marginally suitable habitat present within the Development Envelope (jarrah trees within the Banksia Woodland habitat), this species is considered Unlikely to occur.

Tammar wallaby

The tammar wallaby *Notamacropus eugenii derbianus* (DBCA Priority 4) was once widespread throughout the south west of Western Australia but has suffered a large range restriction (Woinarski *et al.*, 2014). They are considered locally abundant where fox control is in place (Woinarski *et al.*, 2014). The species is herbivorous, mostly eating grasses and shrubs, and use dense vegetation for shelter and open grassy areas for feeding. The Banksia Woodland in the Development Envelope is considered to provide potentially suitable habitat (Woinarski *et al.*, 2014). The nearest record is a historical observation from 1971 approximately 2 km north of the Development Envelope in the Harry Waring Marsupial reserve (DBCA, 2019b); however, there is a contemporary record of the species from 2015 approximately 14 km from the Development Envelope (DBCA, 2019a).

Based on the presence of potentially suitable habitat present within the Development Envelope (Banksia Woodland), and the distribution and temporal aspect of nearby records, this species is considered Possible to occur.

Black-Striped Snake

The black-striped snake, *Neelaps calonotos* (DBCA Priority 3) is restricted to coastal areas in the south west of Western Australia around Perth between Port Kennedy and the Dongarah region (Gaikhorst *et al.*, 2018). The species inhabits sand dunes and sand plains vegetated with heaths, *Banksia* and eucalypt woodlands (ALA, 2019). The nearest contemporary records of the species is ~12 km north-east of the Development Envelope in 2011, although a historical record approximately three kilometres north from 1978 also exists (DBCA, 2019a).

Based on the presence of potentially suitable habitat present within the Development Envelope (Banksia Woodland), and the distribution and temporal aspect of nearby records, this species is considered Possible to occur.

Table 3.3: Conservation significant species likelihood assessment

Species	Conservation Status			Preferred Broad Habitats	Within Current Known Distribution	Distance to Nearest Record - Year	Potential Habitat Within Development Envelope	Recorded Within Development Envelope	Likelihood of Occurrence
	EPBC Act	BC Act	DBCA						
MAMMALS									
Southern Brown Bandicoot *Isoodon fusciventer*			P4	Jarrah Forest and swamp habitats, preferring dense vegetation around wetland fringes and heathland (Cooper, 1998; Woinarski *et al.*, 2014).	Yes	<1km NW (2016) (DBCA, 2019a)	Yes (all habitats except Developed)	Yes	Confirmed
Western Quoll, Chuditch *Dasyurus geoffroii*	VU	VU		In the Jarrah forest, Chuditch occur in moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest particularly in Riparian vegetation (Orell & Morris, 1994).	Yes	~3 km S (2013) (DBCA, 2019a)	Marginal	No	Possible
South-western Brush-tailed Phascogale *Phascogale tapoatafa wambenger*		CD		Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Woinarski *et al.*, 2014).	Yes	~ 3 km SE (1961) (DBCA, 2019b) ~10 km SE (2013) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Possible
Western False Pipistrelle *Falsistrellus mackenziei*			P4	Jarrah, Marri, Tuart and Karri forests with high rainfall. Has also found in Banksia woodlands on the Swan Coastal Plain (Armstrong *et al.*, 2017).	Yes	~2 km NW (1993) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Unlikely
Western Brush Wallaby *Notamacropus irma*			P4	The species inhabits a wide-range of habitats including low Banksia woodlands, Jarrah/Marri woodlands and moist *Melaleuca* lowlands, favours open, grassy areas (Wann & Bell, 1997; Woinarski *et al.*, 2014).	Yes	~2 km S (2015) (DBCA, 2019b)	Yes (Banksia Woodland)	No	Likely
Tammar Wallaby *Notamacropus eugenii subsp. derbianus*			P4	Dense, low vegetation for daytime shelter and open grassy areas for feeding. Inhabits coastal scrub, heath and dry sclerophyll forest (Woinarski *et al.*, 2014).	Yes	~2 km N (1971) ~14 km (2015) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Possible
Water Rat, Rakali *Hydromys chrysogaster*			P4	Permanent bodies of fresh or brackish water, subalpine streams to lakes and farm dams and on sheltered coastal beaches, mangroves and offshore islands (van Dyck & Strahan, 2008).	Yes	~3 km NW (1973), ~8 km NW (1998) (DBCA, 2019a)	No	No	Unlikely
BIRDS									
Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*	VU	VU		Inhabits humid and subhumid eucalypts forests with an average of 600mm rainfall. They mainly inhabit dense Jarrah, Karri and Marri forests with high rainfall. Attracted to seeding Albany Blackbutt, Blackbutt, Karri, Snottygobble and Sheok (Johnstone & Storr, 1998).	Yes	~2 km SE (2008) (DBCA, 2019a)	Yes (Banksia Woodland)	Yes	Confirmed
Carnaby's cockatoo *Calyptorhynchus latirostris*	EN	EN		Occurs in semiarid eucalypt woodlands, preferring Wandoo and Salmon Gum. Will also inhabit proteaceous scrubland and heaths dominated by dryandra, grevillea and banksia species. Prefer coastal areas and banksia woodlands during the non-breeding season . (Johnstone & Storr, 1998).	Yes	<1 km N (2013) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Highly Likely
Baudin's cockatoo *Calyptorhynchus baudinii*	EN	EN		Species forages primarily in humid and sub-humid Eucalypt forests, feeding on Marri nuts, flowers, nectar and seeds, as well as, *Banksia* and *Hakea* species (Johnstone & Storr, 1998). Nesting trees are Karri, Marri, and Wandoo. Species is less frequently found in Wandoo, Blackbutt, Flooded Gum and farming or urban areas(Johnstone & Kirkby, 2008).	Yes	~4 km N (2016) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Likely
Fork-tailed Swift *Apus pacificus*	MI	MI		Inhabits dry/open habitats, inclusive of riparian woodlands and tea-tree swamps, low scrub, heathland or saltmarsh, as well as treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. Aerial species, which forages high above the tree canopy and rarely lower. (Johnstone & Storr, 1998).	Yes	~9 km E (2000) (DBCA, 2019a)	No (Potential aerial route)	No	Unlikely
Glossy Ibis *Plegadis falcinellus*	MI	MI		Freshwater wetlands, irrigated areas, margins of dams, floodplains, brackish and saline wetlands, tidal mudflats, pastures, lawns and public gardens (Johnstone *et al.*, 2013a).	Yes	~3 km N (2019) (DBCA, 2019a)	No	No	Unlikely
Peregrine Falcon *Falco peregrinus*		OS		In arid areas, it is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone & Storr, 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces between 25 m and 50 m high (Olsen *et al.*, 2004; Olsen & Olsen, 1989). The species occurs along coastal cliffs, rivers and ranges as well as wooded watercourses and lakes nesting on cliffs, granite outcrops, quarries and in the wheatbelt, old Raven and Whistling Kite nests (Johnstone & Storr, 1998).	Yes	~3 km N (2017) (DBCA, 2019a)	No	No	Unlikely

Species	Conservation Status			Preferred Broad Habitats	Within Current Known Distribution	Distance to Nearest Record - Year	Potential Habitat Within Development Envelope	Recorded Within Development Envelope	Likelihood of Occurrence
	EPBC Act	BC Act	DBCA						
Blue-billed Duck *Oxyura australis*			P4	Mainly deep freshwater swamps and lakes; occasionally salt lakes and estuaries freshened by flood waters (Johnstone & Storr, 1998).	Yes	~3 km N (2017) (DBCA, 2019a)	No	No	Unlikely
Australian Painted Snipe *Rostratula australis*	EN	EN		Generally, occupies shallow terrestrial freshwater wetlands (i.e. temporary and permanent lakes, swamps and claypans) with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire (Johnstone & Storr, 1998).	Yes	~5 km N (2010) (DBCA, 2019a)	No	No	Unlikely
Painted Snipe *Rostratula benghalensis*	EN	EN		Favours recently flooded areas in shallow lowland freshwater temporary or permanent wetlands. This includes swamps, marshes, reedbeds, overgrown ricefields, inundated grassland and saltmarsh, margins of pools, freshwater lakes, sewage pools, reservoirs and mudflats (Birdlife International, 2016b).	No	~550 km NE (2013) (DBCA, 2019a)	No	No	Highly Unlikely
Flesh-footed Shearwater *Ardenna carneipes*	Mi	Mi		Continental shelves, slopes and occasionally inshore waters in the subtropics. Breed and roost in burrows on sloping ground and friable substrate, in coastal forest, scrubland, shrubland and grassland (DoEE, 2019c).	No	~10 km NW (2016) (DBCA, 2019a)	No	No	Unlikely
Red-necked Avocet *Recurvirostra novaehollandiae*	Ma			Shallow, open fresh, brackish or salt waters (swamps, lagoons, claypans, estuaries, saltwork and sewage ponds, ephemeral waters and dams) (Johnstone & Storr, 1998).	Yes	~3km N (2019) (DBCA, 2019a)	No	No	Unlikely
Australian Fairy Tern *Sternula nereis nereis*	VU	VU		Coastlines, estuaries, and wetlands, nesting on sheltered sandy beaches and banks (DoEE, 2019c).	No	~17 km N (2011) (DBCA, 2019a)	No	No	Unlikely
Terek Sandpiper *Xenus cinereus*	Mi	Mi		Mainly forages in open, soft wet intertidal mudflats, sheltered estuaries, embayments, harbours and lagoons, but also islets, mudbanks, sandbanks, spits, near mangroves and samphire. Generally, roosts in mangroves but also found on flat shores, muddy spits, islets, banks and occasionally sandy or pebbly beaches (DoEE, 2019c).	No	~4 km N (2012) (DBCA, 2019a)	No	No	Unlikely
Common Sandpiper *Actitis hypoleucos*	MI	MI		Estuaries and deltas of streams, as well as banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans (Johnstone & Storr, 1998).	No	~4 km N (2010) (DBCA, 2019a)	No	No	Unlikely
Sharp-tailed Sandpiper *Calidris acuminata*	MI	MI		Favours flooded samphire flats and grasslands, mangrove creeks mudflats, beaches, river pools, saltwork ponds, sewage ponds and freshwater soaks (Johnstone *et al.*, 2013a). Coastal and inland areas saline and freshwater but prefers non-tidal fresh or brackish wetlands (Geering *et al.*, 2007).	Yes	~2 km N (1984), ~3 km N (2016) (DBCA, 2019a)	No	No	Unlikely
Pectoral Sandpiper *Calidris melanotos*	MI	MI		Coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (Johnstone & Storr, 1998; Johnstone *et al.*, 2013a). It prefers wetlands with open fringing mudflats and low, emergent or fringing vegetation (Geering *et al.*, 2007).	Yes	~4 km N (2012) (DBCA, 2019a)	No	No	Unlikely
Red-necked Stint *Calidris ruficollis*	MI	MI		Lives in permanent or ephemeral wetlands of varying salinity, and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In Western Australia they prefer freshwater to marine environments. The species usually forages in shallow water at the edge of wetlands and roost or loaf on tidal mudflats, near low saltmarsh, and around inland swamps (Johnstone & Storr, 1998).	No	~3 km N (2010) (DBCA, 2019a)	No	No	Unlikely
Long-toed Stint *Calidris subminuta*	MI	MI		They prefer shallow freshwater or brackish wetlands but are also fond of muddy shorelines, growths of short grasses, weeds, sedges, low or floating aquatic vegetation, reeds, rushes and occasionally stunted samphire. The Long-toed Stint also frequents permanent wetlands and forages on wet mud or in shallow water, often among short grass, weeds and other vegetation on islets or around the edges of wetlands. They roost or loaf in sparse vegetation at the edges of wetlands and on damp mud near shallow water. It also roosts in small depressions in the mud (Johnstone & Storr, 1998).	No	~3 km N (2016) (DBCA, 2019a)	No	No	Unlikely
Black-tailed Godwit *Limosa limosa*	MI	MI		Utilises coastal habitats including estuaries, lagoons, sheltered bays, intertidal sand and mud flats. Can inhabit near-coastal wetlands, with minimal inland fresh and saltwater records (DoEE, 2019c).	No	~3 km N (2016) (DBCA, 2019a)	No	No	Unlikely
Wood Sandpiper *Tringa glareola*	MI	MI		Species occurs as a non-breeding summer migrant which occurs throughout the region. Occurs mainly in river pools, sewage ponds, flooded claypans, freshwater lagoons and bore overflows (Johnstone *et al.*, 2013a). Freshwater wetlands and occasional brackish intertidal mudflats (Geering *et al.*, 2007).	No	~3 km N (2016) (DBCA, 2019a)	No	No	Unlikely

Species	Conservation Status			Preferred Broad Habitats	Within Current Known Distribution	Distance to Nearest Record - Year	Potential Habitat Within Development Envelope	Recorded Within Development Envelope	Likelihood of Occurrence
	EPBC Act	BC Act	DBCA						
Common Greenshank *Tringa nebularia*	MI	MI		Species occurs as a non-breeding summer Migrant which occurs throughout the region. Occurs mainly in Tidal mudflats, mangrove creeks, flooded samphire flats, beaches, river pools, and saltwork and sewage ponds (Johnstone *et al.*, 2013a).	Yes	~1 km N (2000) (DBCA, 2019a)	No	No	Unlikely
Eastern Curlew *Numenius madagascariensis*	CR/ MI	CR/ MI		Mainly tidal mudflats, also reef flats, sandy beaches and rarely near-coastal lakes including saltwork ponds (Johnstone & Storr, 1998).	No	~10 km NE (2002) (DBCA, 2019a)	No	No	Unlikely
Curlew Sandpiper *Calidris ferruginea*	CR /MI	MI		Inhabits intertidal mudflats in sheltered coastal areas (i.e. estuaries, bays, inlets and lagoons) (Geering *et al.*, 2007). This rare species generally roosts on bare dry shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands (Geering *et al.*, 2007).	Yes	~3 km N (2001) (DBCA, 2019a)	No	No	Unlikely
Australasian Bittern *Botaurus poiciloptilus*	EN	EN		Beds of tall dense *Typha baumea* and sedges in freshwater swamps (Johnstone & Storr, 1998).	No	~5 km N (2017) (DBCA, 2019a)	No	No	Unlikely
Malleefowl *Leipoa ocellata*	VU	VU		Inhabits semi-arid shrublands and low woodlands dominated by mallee eucalypts and/or *Acacia*s with sandy loam soils (Benshemesh, 2007).	Yes	~20 km E (2004) (DBCA, 2019a)	No	No	Unlikely
Great Egret *Ardea alba*	Ma			Inhabits natural, artificial, permanent and ephemeral wetlands with shallow waters. This includes margins of rivers and lakes, swamps, marshes, salt lakes, mudflats, coastal lagoons, offshore reefs, flooded agricultural land, sewage ponds and drainage channels (DoEE, 2019c)	Yes	~3 km N (2011) (DBCA, 2019a)	No	No	Unlikely
Cattle Egret *Ardea ibis*	Ma			Commonly found in animal agricultural land, but also occurs in tropical and temperature grasslands, wooded lands and terrestrial wetlands. Prefers high grass pastures with poor drainage over low grass pastures. Known to forage away from water, and roosts in trees and ground vegetation near lakes and swamps (DoEE, 2019c).	Yes	~7 km N (2014) (DBCA, 2019a)	No	No	Unlikely
Grey Wagtail *Motacilla cinerea*	MI	MI		A rare vagrant to Western Australia where it has been recorded within various habitats with open waterbodies (Johnstone & Storr, 2004).	Yes	~290 km S (2013) (DBCA, 2019a)	No	No	Highly Unlikely
Marsh Sandpiper *Tringa stagnatilis*	MI	MI		Lives in permanent or ephemeral wetlands of varying salinity, and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In Western Australia they prefer freshwater to marine environments. The species usually forages in shallow water at the edge of wetlands and roost or loaf on tidal mudflats, near low saltmarsh, and around inland swamps (Johnstone & Storr, 1998).	No	~5 km N (2010) (DBCA, 2019a)	No	No	Unlikely
Eastern Osprey *Pandion cristatus*	MI	MI		Inhabits coastal areas and wetlands. Require large bodies of fresh, brackish or saline water including reefs, bays. Beaches, mangroves, estuaries, rivers and lakes (DoEE, 2019c).	No	~4 km N (2014) (DBCA, 2019a)	No	No	Unlikely
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Ma			Mainly found in coastal areas or in terrestrial wetlands where there are large, open water bodies. Can occur near fresh, brackish and saltwater, and near grassland, woodland and forest (DoEE, 2019c)	Yes	~4 km N (2012) (DBCA, 2019a)	No	No	Unlikely
Grey Plover *Pluvialis squatarola*	Mi	Mi		Inhabit coastal areas including estuaries, lagoons, mudflats and salt flats. Can occur in inland wetlands, lakes and salt-lakes (DoEE, 2019c).	No	~4 km N (2014) (DBCA, 2019a)	No	No	Unlikely
Hooded Plover *Thinornis rubricollis*	Ma		P4	Margins and shallows of salt lakes, sandy and sea-weedy beaches and estuaries and also damns (Johnstone & Storr, 1998).	No	~4 km N (2007) (DBCA, 2019a)	No	No	Unlikely
Little Ringed Plover *Charadrius dubius*	Mi	Mi		Bare or sparsely vegetated sandy and pebbly shores of shallow standing freshwater pools, lakes or slow-flowing rivers. Also found in artificial habitats including gravel pits, sewage wqorks, industrial wastelands and rubbish tips (Birdlife International, 2016a).	No	~6 km N (1999) (DBCA, 2019a)	No	No	Unlikely
Red-capped Plover *Charadrius ruficapillus*	Ma			Found on sandy beaches and adjacent dunes, estuarine flats, saltlake and saltpan shores, and freshwater shores (claypans, river pools, drying swamps, dams and sewage ponds) (Johnstone & Storr, 1998).	Yes	~2 km N (2001) (DBCA, 2019a)	No	No	Unlikely
Red Knot *Calidris canutus*	EN	EN		Mainly found on sandy beaches, sandflats, mudflats, estuaries, lagoons, bays and inlets. Can also inhabit sandy ocean beaches, rock platforms and coral reefs (Higgins & Davies, 1996).	Yes	~9 km NW (2014) (DBCA, 2019a)	No	No	Unlikely

Species	Conservation Status			Preferred Broad Habitats	Within Current Known Distribution	Distance to Nearest Record - Year	Potential Habitat Within Development Envelope	Recorded Within Development Envelope	Likelihood of Occurrence
	EPBC Act	BC Act	DBCA						
Ruff *Philomachus pugnax*	Mi	Mi		Mainly fresh, brackish and saline wetlands with exposed mudflats. Found near lakes, swamps, pools, lagoons, tidal rivers and floodlands. Sometimes observed in sheltered coastal areas, including harbours and estuaries (DoEE, 2019c).	No	~5 km N (2016) (DBCA, 2019a)	No	No	Unlikely
Pied Stilt *Himantopus himantopus*	Ma			Shallow open fresh or brackish waters (swamps, lagoons, claypans, rain-freshened samphire flats and saltlakes, floodwaters, river pools, dams and sewage and mining ponds. Also saltlakes, including saltwork ponds, and estuaries (Johnstone & Storr, 1998).	Yes	~2 km N (2000) (DBCA, 2019a)	No	No	Unlikely
White-winged black tern *Chlidonias leucopterus*	Mi	Mi		Mainly estuaries and sheltered seas in north, mainly freshwater swamps and lakes in the south; also samphire and short-grass flats, saltlakes, saltwork and sewage ponds (Johnstone & Storr, 1998).	Yes	~4 km N (2009) (DBCA, 2019a)	No	No	Unlikely
Roseate Tern *Sterna dougallii*	Mi	Mi		Occurs in tropical and sub-tropical oceans in coastal and marine areas. Inhabits coral reefs, offshore islands, rocky and sandy beaches (Higgins & Davies, 1996).	No	~10 km NW (2018) (DBCA, 2019a)	No	No	Unlikely
Crested Tern *Thalasseus bergii*	Mi	Mi		Favours sheltered seas, also estuaries and saltwork ponds. Rarely crosses the coastline and inland records generally involve birds driven by a storm or cyclone (Johnstone & Storr, 1998).	No	~9 km NW (2014) (DBCA, 2019a)	No	No	Unlikely
Red-tailed Tropicbird *Phaethon rubricauda*			P4	Found on cliff faces and sandy beaches (ALA, 2019).	No	~4 km N (2009) (DBCA, 2019a)	No	No	Unlikely
REPTILES									
Perth Slider *Lerista lineata*			P3	Found in loose soil or sand, particularly in coastal heaths and low shrublands (Cogger, 2014).	Yes	~1 km S (1978), ~2 km S (2014) (DBCA, 2019a)	Yes (Banksia Woodland)	No	Likely
Black-Striped Snake *Neelaps calonotos*			P3	The species inhabits sandy areas, Banksia and Eucalypt woodlands (ALA, 2019).	Yes	~6 km W (no date), ~12 km NE (2011) ~3 km N (1978) (DBCA, 2019a)	Yes (all habitats except Developed)	No	Possible

390000 390200 390400 390600 390800 391000 391200 391400 391600 391800

6439000
6438800
6438600
6438400
6438200
6438000

Legend

Study Area

Species

Southern Black Bandicoot

Forest Red-tailed Black Cockatoo

Habitat Type

Cleared

Closed Acacia Scrubland

Low Banksia Woodland

biologic Environmental Survey

N

1:5,000

0 0.0275 0.055 0.11 0.165 0.22 km

Strategen JB&G

Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.3: Conservation significant fauna locations from the current survey

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

3.2.4 Black Cockatoo hollow and roosting assessment

Hollow assessment

The current survey inspected 23 hollows previously identified by Strategen (2017) for any evidence of usage by black cockatoo (Figure 3-5). None of the hollows present were considered suitable for usage as breeding sites for black cockatoo in relation to depth or size, and no evidence of usage (e.g. chew marks, feathers, droppings) were observed (Table 3.4).

Most of these hollows were observed in jarrah (*E. marginata*) trees of small DBH. It is recognized that this species in general provides only around ten percent of black cockatoo hollows (Johnstone, 2010; Kirkby, 2018), as although jarrah produce more hollows, they are of significantly smaller size than in marri (Whitford, 2002).

Although the hollows present in the Development Envelope were not considered suitable for black cockatoo nesting, the importance of veteran and stag trees are recognized in their potential to develop hollows in the future, as it can take more than 200 years for a tree to develop suitable hollows (DSEWPaC, 2012; Johnstone *et al.*, 2011).

The planned development within the Development Envelope proposes the removal of 54 potential breeding trees of suitable DBH (> 500 mm) for nesting and roosting black cockatoo, including the removal of 17 hollows (Figure 3-5). Ten trees of suitable DBH, including five hollows, are proposed to be retained within a conservation area. This represents a loss of 84 % of significant trees in the Development Envelope with the potential to support black cockatoo and develop suitable hollows in the future.

Table 3.4: Location and notes on usage for hollows recorded in the Development Envelope

Species	Latitude	Longitude	Comments on Black Cockatoo usage
Eucalyptus marginata	-32.183°	115.845°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.183°	115.846°	No hollows suitable for black cockatoos
Eucalyptus sp.	-32.181°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.185°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.183°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.183°	115.843°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.183°	115.844°	Very shallow hollow (floor can be seen from ground level). Duck down at entrance
Eucalyptus marginata	-32.184°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.182°	115.846°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.846°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.846°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.846°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.845°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.845°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.845°	No hollows suitable for black cockatoos
Eucalyptus sp.	-32.188°	115.845°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.188°	115.846°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.186°	115.845°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.186°	115.844°	No hollows suitable for black cockatoos
Eucalyptus marginata	-32.186°	115.844°	No hollows suitable for black cockatoos
Eucalyptus sp.	-32.182°	115.845°	No hollows suitable for black cockatoos

Potential Roosting Habitat

Potential roosting habitat was identified in the Development Envelope across the "Low Banksia Woodland" habitat (based on the habitat mapping conducted and the presence of recognized roosting species (i.e jarrah, introduced eucalypt trees; Johnstone *et al.*, 2011). This habitat type dominates the Development Envelope (comprising 38.09 ha or 87 % of the area) and was considered to be Very Good-Excellent condition. Black cockatoos favour roost sites that are within close range of a water source (DSEWPaC, 2012). Although, there are no water sources within the Development Envelope, there are numerous waterbodies within 5 km of the Study Area including Mandogalup Swamp South (~1 km south), The Spectacles North (~3 km south) and Thomsons Lake (~3.5 km north) (Figure 3.6). Although not every suitable roosting tree was visited, due to an lack of observed feather piles, piles of droppings, the absence of large quantities of defoliated leaves or large quantities of foraging evidence, there was no current evidence of black cockatoo roosting activity observed within the Development Envelope. The Development Envelope may however still be suitable for supporting roosting habitat in the future based on the:

- presence of ideal habitat for foraging and roosting (Low Banksia Woodland, including jarrah);
- proximity to water sources (Thomsons Lake, Mandogalup Lake, The Spectacles); and

- the reduction in the availability of suitable roosting habitat for black cockatoos on the Swan Coastal Plain.

374400 378600 382800 387000 391200 395400 399600 403800 408000

6448800
6444600
6440400
6436200
6432000

Legend

Study Area

Species Record

Carnaby's cockatoo

forest red-tailed black cockatoo

Roost Type

Cleared

Forest Red-tailed Roost

Joint roost

White-tailed Confirmed Roost

biologic Environmental Survey

N

1:90,000

0 0.5 1 2 3 4 km

Strategen JB&G

Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.4: Records of Black Cockatoos and roosts in the vicinity

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

390000 390200 390400 390600 390800 391000 391200 391400 391600 391800

6439000 6438800 6438600 6438400 6438200 6438000

Legend

- Study Area
- Area to be conserved

Tree Species

- *Eucalyptus marginata*
- *Eucalyptus* sp.

biologic Environmental Survey

N

1:5,000

0 0.0275 0.055 0.11 0.165 0.22 km

Strategen JB&G

Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.5: Hollows identified within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

382000 384000 386000 388000 390000 392000 394000 396000 398000 400000

6444000 6442000 6440000 6438000 6436000 6434000

Thomson Lake

Banganup Lake

KWIWANR002

KWIWANR001

KWIWANR004

Mandogalup Swamp

The Spectacles

Legend

- Study Area
- Area to be conserved
- Roost
- Potential Roosting Habitat

N

1:50,000

0 0.275 0.55 1.1 1.65 2.2 km

Strategen JB&G

Mandogalup Level 1 Vertebrate Fauna EIA

Figure 3.6: Potential black cockatoo roosting habitat in the Development Envelope

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 25/11/2019

4 Environmental Impact Assessment

4.1 Potential Impacts to Fauna Habitat

The Development Envelope and its vicinity contains habitat of extremely high significance, with one TEC listed under the BC Act, three PECs listed by DBCA and one TEC listed under the EPBC Act as potentially occurring within 5 km (Strategen, 2017). All vegetation within the Development Envelope mapped as Low Banksia Woodland met the diagnostic characteristics of the "Banksia woodlands of the Swan Coastal Plain" TEC (Endangered under the EPBC Act) (Strategen, 2017). An estimated 70 % of this Banksia woodland has been lost, with over 90 % lost within a 20 km radius of central Perth (Groom *et al.*, 2014). The majority (82 %) of remnant patches are now under 10 ha in size (DoE, 2016). This TEC is considered crucial for the persistence of the threatened black cockatoo species, providing important foraging resources and some small patches of breeding habitat (TSSC, 2016). The community also provides core habitat for the skink species *Lerista lineata* (TSSC, 2016).

The proposed development within the Development Envelope plans to retain a 4.09 ha patch of habitat of Low Banksia Woodland, fragmented by a large cleared track (Figure 3-2). This is a proposed removal of 91 % of the current total area of Development Envelope, and removal of 35.14 ha of Low Banksia Woodland (92 % of that present in the Development Envelope). Therefore, the indicative proposed clearance size of this habitat types meets the definition of "Areas considered critical to the survival of the Banksia Woodlands TEC", which covers all patches that meet the key diagnostic characteristics and condition thresholds for the ecological community (TSSC, 2016). In addition, the clearing of Very High to High quality foraging habitat for black cockatoos is considered likely to result in a significant impact for these species, and likely requires referral under Part IV of the EPBC Act (DSEWPaC, 2012). Black cockatoo flocks show site fidelity to particular areas (DSEWPaC, 2012; EPA, 2019; Groom, 2015; Johnstone *et al.*, 2017), and so the loss of known areas of foraging, roosting, or breeding habitat is significant. Therefore, any impacts to this remnant habitat type are considered significant not only on a local level for conservation fauna both present and potentially occurring, but also in a regional and state context due to the low level of retained habitat from the proposed development.

The viability of any habitat is dependent on its proximity to other natural areas and the quality of linkages between them (Del Marco, 2004; EPA, 2009; Molloy, 2009). It is recognised that a high number of fauna species are at risk on the Swan Coastal Plain due to habitat fragmentation and barriers to dispersal (Davis & Brooker, 2008). For example, connecting corridors of vegetation between foraging resources, breeding habitat and night roosting sites are essential to enable black cockatoos to access resources across their range (DSEWPaC, 2012). The Development Envelope and its habitats are classified as a Regional Ecological Linkage, "K6" (WALGA, 2014), defined as a series of continuous and non-continuous patches of native vegetation which, by virtue of their proximity to each other, act as stepping stones of habitat

which facilitate the maintenance of ecological processes and the movement of organisms within, and across, a landscape (Del Marco, 2004; Molloy, 2009).

4.2 Potential Impacts to Vertebrate Species of Conservation Significance

The direct and indirect sources of impact that may affect key fauna species can be difficult to quantify and predict in advance of developments occurring. Habitat loss and fragmentation is considered to be the primary impact to conservation significant fauna within the Development Envelope, and although land clearing or degradation may be estimated, the final impact to the species regional and local population (i.e. loss or displacement of individuals), is difficult to quantify and not well demonstrated. The extent and magnitude of other impact sources, such as noise, light, disease or changed fire regimes, are also limited in their accuracy. For example, the EPA technical report for Carnaby's cockatoo in Environmental Impact Assessment (EPA, 2019) states that although there is considerable knowledge on the foraging and breeding ecology for the species, there are still significant gaps in relation to the likely impacts of threatening processes, including the carrying capacity of remaining foraging habitat.

Table 4.1 below summarizes the potential impacts to fauna of conservation significance confirmed or likely to occur in the Development Envelope as a result of any proposed development. As discussed in Section 3.2.3, the Development Envelope has the potential to support 51 conservation significant species, of which two have been confirmed during the current survey. Other vertebrate fauna within the assessment area, including common and widespread species, would also be subject to a similar range of impacts. Aside from habitat loss and fragmentation, the main sources of impact to species of conservation significance from the proposed development within the Development Envelope are vehicle strike, inappropriate fire regimes, and impacts from introduced species. These impact sources are generally known to increase in occurrence or severity in proximity to urban development, either directly from construction or operational phases, or indirectly through increasing habitat fragmentation or reducing patch size (EPA, 2016d).

The proposed development within the Development Envelope proposes the clearing of 54 trees of suitable DBH to support black cockatoo roosting, including the loss of 17 hollows. Although these hollows are not considered of suitable size to currently support black cockatoo (Section 3.2.4), breeding habitat is defined as "species of trees known to support breeding within the range of the species which either have a suitable nest hollow OR are of a suitable diameter at breast height (DBH) to develop a nest hollow" (DSEWPaC, 2012). This takes into consideration the potential for trees to develop suitable hollows in the future. Although evidence was not found that the Development Envelope is currently being used for night roosting, the trees present are still considered potential roosting habitat for black cockatoos, defined as "suitable tree (generally the tallest) or group of tall trees, native or introduced, usually close to an important water source, and within an area of quality foraging habitat within the range of the species" (DSEWPaC, 2012).

Note that the assessment on the magnitude of impact to black cockatoos has been adopted from the referral guidelines, being that “Clearing or degradation of any part of a vegetation community known to contain breeding habitat” is considered a high risk of significant impacts and referral is recommended (DSEWPaC, 2012). Furthermore, a ‘significant impact’ is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DoE, 2013a). The DoE (2013a) state that for an impact to be ‘likely’, it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.

Table 4.1: Potential impacts to vertebrate species of conservation significance Confirmed, Highly Likely, or Likely to occur in the Development Envelope

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species recorded within the Development Envelope								
<u>Forest Red-tailed Black Cockatoo</u> *Calyptorhynchus banksii naso* **EPBC Act** Vulnerable **BC Act** Vulnerable	Confirmed (current survey)	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (feeding/ roosting/ breeding)	Permanent	**High** – Habitat loss is the principal cause of decline for the Forest Red-tailed black cockatoo (Chapman, 2007). Based on the species record from the current survey, and as an "area of natural vegetation in which cockatoos feed", the Development Envelope is considered "habitat critical to survival and important populations of forest black cockatoos" (Chapman, 2007). Ninety percent of the species diet is made up of the seeds from Marri and Jarrah fruits, and often return to the same individual trees to feed on a daily basis until the supply of fruit is depleted (Chapman, 2007; Johnstone & Kirkby, 1999). The development in the Development Envelope proposes to remove 29 ha of foraging resources, retaining only a 4 ha patch. Proximity of foraging habitat and water has been demonstrated to be critical to support breeding and roosting sites and within the Perth-Peel region, roosts require these resources within 12 km (DSEWPaC, 2012). The Development Envelope is within 4 km of confirmed roost sites (Birdlife Australia, 2019), and within 2 km of potential water resources such as Thomson's Lake and Banganup Lake. The Development Envelope also contains mature trees of an appropriate DBH with the potential to form breeding hollows in the future. Although no black cockatoo breeding or suitable hollows are currently recorded within the Development Envelope, fifty-four (85 %) trees of appropriate DBH to support the species are proposed to be cleared, representing 74 % of current hollows present.	**Moderate** – On a regional basis, the Swan Coastal Plain has undergone severe clearing of native vegetation to 29 % of pre-European extent (TSSC, 2016), and as such all areas of high quality foraging are considered critical to the survival of the species. The removal of these native vegetation patches and corridors contributes to habitat fragmentation and restricts the species ability to migrate across the region (DSEWPaC, 2012). It is well recognized that there is a paucity in many areas of the south-west for suitable nest hollows for black cockatoos, particularly in recognition that mature trees can take up to 200 years to develop suitable nesting hollows (Chapman, 2007; DSEWPaC, 2012; Johnstone *et al.*, 2011). In the region, the loss of hollow-bearing trees has outpaced the recruitment of replacement hollows (Johnstone *et al.*, 2013c). The loss of trees with hollows (23) and trees with the potential to develop hollows is (54 total) therefore considered of moderate regional magnitude based on this criterion.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High - Actions are deemed as likely to be significant if they adversely affect black cockatoo habitat quality (DSEWPaC, 2012).
		Vehicle Strike	Extent of expansion of existing road network	Long-term	**Moderate/High** – One of the most severe mortality risks for the species is vehicle strike (Johnstone & Kirkby, 2017). Death or injury is most common where road construction concentrates birds to roadside vegetation or to drink from rainwater puddles on roadsides (DSEWPaC, 2012). Vehicular movements are expected to significantly increase during construction and operation of the proposed development, and as such is considered to have a High local impact based on this criterion.	**Moderate** – road construction and network expansions are increasing across the region, and the movement of birds onto the Swan Coastal Plain, especially around Perth, has greatly increased the risk of birds being killed or injured from vehicle strikes (Johnstone *et al.*, 2017). However, vehicle strike specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Loss of individuals • Temporary reduction in population size	High - Actions are deemed as likely to have a significant effect if they result in mortality of an individual black cockatoo
		Increased light or noise	Extent of disturbance during construction and operation	Long-term	**Low** - Disturbance from noise, light, vibrations and fumes is a listed threat to black cockatoo (DSEWPaC, 2012). These disturbances are likely to occur throughout construction and operation of development in the Development Envelope. However, these impacts are not as well researched for the species and are considered low in magnitude for this criterion.	**Low** – There has been a change in foraging ecology of many individuals of the species from the Darling Range west onto the Swan Coastal Plain noted since 1995 (Johnstone *et al.*, 2011; Johnstone *et al.*, 2017). Therefore, on a regional scale, impacts from light or noise are likely to be minimal due to some acclimatization to human habitation and activities.	• Dispersal from greatly enhanced levels of light and noise disturbance	Moderate – Disturbance in areas surrounding black cockatoo habitat (e.g. increased human visitation) is listed as an uncertain risk level (DSEWPaC, 2012), and there is limited research into the impact of this criterion

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species	Extent of distribution of introduced predators and competitors	Permanent	**Low** – Introduced species such as Honeybees and Rainbow Lorikeets are listed threats to the species through competition for existing hollows (Chapman, 2007; DSEWPaC, 2012; Johnstone *et al.*, 2013c). However, development within the Development Envelope is not expected to increase the presence of these species, and the current hollows within the Development Envelope are not suitable for black cockatoo.	**Low** - On a regional scale, impacts from introduced nest competitors are unlikely to be significant from development within the Development Envelope.	• Loss of individuals from nest competitors (mortality from honeybees) • Displacement of individuals from nest competitors (*e.g.* Rainbow Lorikeets)	Moderate - Actions are deemed as with the potential to be significant if they adversely affect black cockatoo habitat quality through increases in nest competitors (DSEWPaC, 2012). However, development activities within the Development Envelope are unlikely to increase these competitor species.
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Low/Moderate** - Fire is acknowledged as a significant factor in the fall of hollow trees (Parnaby *et al.*, 2010), and many mature and stag Although no suitable black cockatoo hollows were recorded in the Development Envelope, fire is a threat to trees that have the potential to form hollows, which are also significant foraging species. There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and therefore the local impact is deemed Low/Moderate based on this criterion.	**Low/Moderate** - Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. The region experiences many hundreds of unplanned bushfires ignited by human activities and lightning (Whitford K. R. *et al.*, 2015). Inappropriate fire regimes can reduce the availability of both existing hollows and potential future hollow-bearing trees (Johnstone *et al.*, 2013b) and can impact the survival of local populations (Johnstone *et al.*, 2011).. There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and due to an overall decline in available and potential hollows, the regional impact is deemed Low/Moderate based on this criterion.	• Loss of foraging/ roosting/ nesting habitat • Loss of individuals from fire	Moderate - Actions are deemed as with the potential to have a significant effect if they result in impacts through inappropriate fire regimes (DSEWPaC, 2012)
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low** - Loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) are a listed threat to black cockatoo species (DSEWPaC, 2012; EPA, 2019). No evidence of this disease was recorded during the current survey. The impact from this criterion resulting from development in the Development Envelope is expected to be low.	**Low** - On a regional scale, impacts from disease are unlikely to be significant from development within the Development Envelope.	• Loss and degradation of habitat	Moderate – Actions are deemed as with the potential to have a significant effect if they result in impacts through introducing known plant diseases such as *Phytophthora* spp. (DSEWPaC, 2012). Phytopathogens are known to affect key tree species used by black cockatoo (TSSC, 2018).
Southern Brown Bandicoot *Isoodon fusciventer* **DBCA** Priority 4	Confirmed (current survey)	Removal, fragmentation or modification of habitat	Extent of clearing or barrier to movement in core habitat	Permanent	**High** – The species persistence in the region is dependent on remnant habitat (Lohr *et al.*, 2018) and disappears from cleared land (Woinarski *et al.*, 2014). Recovery plans observe that relatively small areas of habitat may be important in providing connectivity between larger habitat patches for bandicoots (Brown & Main, 2010). The development in the Development Envelope proposes to remove 29 ha of foraging resources, retaining only a 4 ha patch. However, although the current survey is the first record of the species within the Development Envelope; there are 250 records of southern brown bandicoot within 5 km of the Development Envelope (DBCA, 2019b). On a local scale, the loss or displacement of individuals from this criterion may have a High effect.	**High** - southern brown bandicoot have been recorded as disappearing from urban bushland or reserves where suitable habitat exists, and strong habitat connectivity is appears to be a key feature of landscapes where the species persists (Howard K.H., 2014). The Development Envelope is located within a Regional Ecological Linkage (WALGA, 2014), and therefore removal of core habitat for the species may fragment local populations of the species.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation	Moderate – It is likely that the full effects of recent habitat loss on southern brown bandicoot populations may take some time to be fully realized (Howard K.H., 2014)

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term	**High** - Howard K.H. (2014) reported that 44 % of reported mortality events (168 of 378 records) of southern brown bandicoot in Perth and Peel regions in 2012 were caused by vehicle strike, and was the most common cause of death. Vehicular movements are expected to significantly increase during construction and operation of the proposed development, and as such is considered to have a High local impact based on this criterion.	**Moderate –** road construction and network expansions are increasing across the region (EPA, 2016a), and increased habitat fragmentation from urban and road development is likely to increase fauna exposure to vehicle strike (Howard K.H., 2014). However, vehicle strike specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Loss of individuals • Reduction in population size	Moderate/High – although vehicle strike is a known severe threat for the species, the impact of this criterion at a population level requires further assessment (Brown & Main, 2010)
		Introduced species	Extent of distribution of introduced predators and invasive weeds	Permanent	**Moderate** - Predation by feral cats and foxes is listed as a severe threat to the species (Dickman, 1996; Woinarski *et al.*, 2014). Howard K.H. (2014) reported that 29 % of reported mortality events (168 of 378 records) of southern brown bandicoot in Perth and Peel regions in 2012 were caused by predation by cats, dogs, or foxes, and was the second most common cause of death. Native fauna in fragmented or disturbed environments are likely to be exposed to higher levels of fox predation from the predators preferences for human-modified environments including roads (Hradsky *et al.*, 2017). Therefore, construction and operation of any proposed development in the Development Envelope is considered to have a Moderate local impact based on this criterion. Weed invasion can degrade southern brown bandicoot habitat complexity (Brown & Main, 2010), with opportunities for weed invasion increasing with disturbances and edge effects from development.	**Low/Moderate** - Habitat fragmentation from urban developments is likely to increase fauna exposure to introduced predators (Howard K.H., 2014). Cats have the ability move easily throughout the urban landscape (Howard K.H., 2014), and habitat reduced to narrow strips or small areas may also facilitate the movement of foxes (Howard K.H., 2014). Development of the Development Envelope, resulting in a loss of habitat and increase in fragmentation of native vegetation, therefore increase the risk of predation to southern brown bandicoots, but on a regional scale the impact is likely to be Low/Moderate compared to on a localized level.	• Direct loss of individuals • Reduction in population size • Degradation of habitat	Moderate/High – predation risks and impacts are well documented from survey work for the species, and the proposed development within the Development Envelope will increase the impact of this criterion.
		Increased light or noise	Extent of ground disturbance	Long-term	**Low** – where suitable refuge habitats remain, the species is able to persist in residential and partially developed industrial areas, including gardens, workplaces, or roadsides, and artificial shelters such as buildings (Howard K.H., 2014). As such, the impacts of light or noise are not likely to have a significant impact on the species.	**Low** - On a regional scale, impacts from increased light and noise are unlikely to be significant from development within the Development Envelope.	• Dispersal from greatly enhanced levels of light and noise disturbance	Moderate/High – the potential impacts of this criterion have some research-based justification and merit; however, more research is required into the specific impacts of increased light or noise
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Moderate/Low** – Inappropriate fire regimes are listed as a moderate threat for the species (Woinarski *et al.*, 2014). Fire impacts resulting from potential development in the Development Envelope may render Bandicoot habitat unsuitable through the loss of key elements such as loss or modification of the understory (Brown & Main, 2010). As with other small Australian mammals, southern brown bandicoot numbers have been recorded as increasing in the years proceeding fire events, attributed to the gradual increase in vegetation density preferred by the species (Brown & Main, 2010). In New South Wales, recently burned habitats (0-20 years) appear to be less favoured by the species (Claridge & Barry, 2000) Predation by foxes also increases where habitat becomes more open (Woinarski *et al.*, 2014).	**Low/Moderate** – Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. Fire events have been known to cause the local extinction of a population of southern brown bandicoots in the eastern states (Brown & Main, 2010). As a species surviving in a highly fragmented landscape, the risk of fire as a threat of local extinctions may impact on the regional population sizes and dispersal capabilities. However, due the number of records in the vicinity surrounding the Development Envelope, the regional risk from fire resulting from development in the Development Envelope is considered low.	• Loss of foraging/ dispersal habitat • Loss/displacement of individuals	Moderate – the potential impacts of this criterion have some research-based justification and merit; however, more research is required into the specific impacts of inappropriate fire regimes

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low** - *Phytophthora cinnamomic* can alter the structural and floristic composition of southern brown bandicoot habitat and food resources (Brown & Main, 2010; Environment Australia, 2001). No evidence of this disease was recorded during the current survey. The impact from this criterion resulting from development in the Development Envelope is expected to be low.	**Low** – *P. cinnamomi* has been recorded in Metropolitan Perth bushland, and known vectors include disturbance activities and vehicle use. However, on a regional scale, impacts from disease are unlikely to be significant from development within the Development Envelope.	• Loss of foraging/ dispersal habitat	Low - The impact of disease such as *P. cinnamomi* on the species habitat is relatively unknown and requires further assessment.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species likely or possible to occur in the Development Envelope								
<u>Carnaby's cockatoo</u> *Calyptorhynchus latirostris* **EPBC Act** Endangered **BC Act** Endangered	Highly Likely	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (feeding/ roosting/ breeding)	Permanent	**High** – The species is most threatened by a loss and fragmentation of breeding and foraging habitat (EPA, 2019). On the Swan Coastal Plain, the most important food resource for Carnaby's cockatoo are Banksia species, in particular *B. attenuata, B. menziesii* and *B. sessilis*, as well as the fruit of Marri (EPA, 2019; Groom *et al.*, 2014). For Carnaby's cockatoo, "critical habitat" is classified as • remaining woodland breeding sites in the south west of Western Australia, and feeding and watering areas used during the breeding period; • woodland sites known to have supported breeding in the past and which could be used in the future if new food resources are established; and • coastal kwongan (heath) and other areas where the cockatoos feed when not breeding (Cale, 2003) Over 38 ha (87 %) of the Development Envelope is classified as Low Banksia Woodland, and flocks show site fidelity to a particular area (Groom, 2015). Although there is a presence of other local foraging resources, large areas of foraging habitat are required to support black cockatoo populations due to potential for reduced seed set and flowering due to drought, and the irregular or infrequent flowering and fruiting patterns of many of their food sources (DSEWPaC, 2012). The loss of these foraging resources (up to 29 ha cleared) are considered of High significance for the species. The Development Envelope also contains mature trees of an appropriate DBH with the potential to form breeding hollows in the future. This is particularly significant as the nearest White-tailed black cockatoo roost is within 2 km of the Development Envelope (Birdlife Australia, 2019). Although no black cockatoo breeding or suitable hollows are currently recorded within the Development Envelope, fifty-four (85 %) trees of appropriate DBH to support the species are proposed to be cleared, representing 74 % of current hollows present.	**High** – Foraging studies have confirmed the significance of Banksia Woodland habitat for Carnaby's cockatoo, with the species likely to exploit all areas of available Banksia foraging resources on the Swan Coastal Plain (EPA, 2019; Johnston *et al.*, 2016). The loss of up to 70 % of this habitat type in the Perth and Peel region means that the impact from this criterion is considered of high regional magnitude. In addition, the remaining portions are fragmented into smaller patches, with the majority (82%) of remnant patches under 10 ha size (DoE, 2016). This high level of fragmentation increases the distance that birds are required to travel to find resources, and Carnaby's cockatoo actively avoid cleared and open areas, including dense urban areas (EPA, 2019). It is well recognized that there is a paucity in many areas of the south-west for suitable nest hollows for black cockatoos, particularly in recognition that mature trees can take up to 200 years to develop suitable nesting hollows (Chapman, 2007; DSEWPaC, 2012; Johnstone *et al.*, 2011). In the region, the loss of hollow-bearing trees has outpaced the recruitment of replacement hollows (Johnstone *et al.*, 2013c). The loss of trees with hollows (23) and trees with the potential (54 total) to develop hollows is therefore considered of high regional magnitude based on this criterion.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High - Actions are deemed as likely to be significant if they adversely affect black cockatoo habitat quality (DSEWPaC, 2012).

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Vehicle Strike	Extent of expansion of existing road network	Long-term	**Moderate** - One of the most severe mortality risks for the species is vehicle strike (Johnstone & Kirkby, 2017). Of the 85 Carnaby's cockatoo admitted for veterinary aid in 2017-18, 21.2 % were due to vehicle collision, and this number is noted as likely to be an under-representation due to unreported deaths (EPA, 2019). Death or injury is most common where road construction concentrates birds to roadside vegetation or to drink from rainwater puddles on roadsides (DSEWPaC, 2012). Vehicular movements are expected to significantly increase during construction and operation of the proposed development, and as such is considered to have a High local impact based on this criterion.	**Moderate** – road construction and network expansions are increasing across the region, and the movement of birds onto the Swan Coastal Plain, especially around Perth, has greatly increased the risk of birds being killed or injured from vehicle strikes (Johnstone *et al.*, 2017). However, vehicle strike specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Loss of individuals • Temporary reduction in population size	High - Actions are deemed as likely to have a significant effect if they result in mortality of an individual black cockatoo
		Increased light or noise	Extent of disturbance during construction and operation	Long-term	**Low** - Disturbance from noise, light, vibrations and fumes is a listed threat to black cockatoo (DSEWPaC, 2012). These disturbances are likely to occur throughout construction and operation of development in the Development Envelope. However, these impacts are not as well researched for the species and are considered low in magnitude for this criterion.	**Low** - In the Perth-Peel region, Carnaby's cockatoo have adapted to the urban environment, utilising non-native species in plantations and residential trees for foraging and roosting (EPA, 2019). Therefore, impacts from light and noise specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Dispersal from greatly enhanced levels of light and noise disturbance	Moderate – Disturbance in areas surrounding black cockatoo habitat (e.g. increased human visitation) is listed as an uncertain risk level (DSEWPaC, 2012), and there is limited research into the impact of this criterion
		Introduced Species	Extent of distribution of introduced predators and competitors	Permanent	**Low** – Introduced species such as Honeybees and Rainbow Lorikeets are listed threats to the species through competition for existing hollows (Johnstone *et al.*, 2013c). However, development within the Development Envelope is not expected to increase the presence of these species, and the current hollows within the Development Envelope are not suitable for black cockatoo.	**Low** - On a regional scale, impacts from introduced nest competitors are unlikely to be significant from development within the Development Envelope.	• Loss of individuals from nest competitors (mortality from honeybees) • Displacement of individuals from nest competitors (*e.g.* Rainbow Lorikeets)	Moderate - Actions are deemed as with the potential to be significant if they adversely affect black cockatoo habitat quality through increases in nest competitors (DSEWPaC, 2012). However, development activities within the Development Envelope are unlikely to increase these competitor species.
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Low/Moderate** - Fire is acknowledged as a significant factor in the fall of hollow trees (Parnaby *et al.*, 2010), and many mature and stag Although no suitable black cockatoo hollows were recorded in the Development Envelope, fire is a threat to trees that have the potential to form hollows, which are also significant foraging species. There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and therefore the local impact is deemed Low/Moderate based on this criterion.	**Low/Moderate** - Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. The region experiences many hundreds of unplanned bushfires ignited by human activities and lightning (Whitford K. R. *et al.*, 2015). Inappropriate fire regimes can reduce the availability of both existing hollows and potential future hollow-bearing trees (Johnstone *et al.*, 2013b) and can impact the survival of local populations (Johnstone *et al.*, 2011). There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and due to an overall decline in available and potential hollows, the regional impact is deemed Low/Moderate based on this criterion.	• Loss of foraging/ roosting/ nesting habitat • Loss of individuals from fire	Moderate - Actions are deemed as with the potential to have a significant effect if they result in impacts through inappropriate fire regimes (DSEWPaC, 2012)

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low -** Loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) are a listed threat to black cockatoo species (DSEWPaC, 2012; EPA, 2019). No evidence of this disease was recorded during the current survey. The impact from this criterion resulting from development in the Development Envelope is expected to be low.	**Low** - On a regional scale, impacts from disease are unlikely to be significant from development within the Development Envelope.	• Loss and degradation of habitat	Moderate – Actions are deemed as with the potential to have a significant effect if they result in impacts through introducing known plant diseases such as *Phytophthora* spp. (DSEWPaC, 2012). Phytopathogens are known to affect key tree species used by Carnaby's cockatoo (TSSC, 2018).
<u>Baudin's cockatoo</u> *Calyptorhynchus baudinii* **EPBC Act** Vulnerable **BC Act** Vulnerable	Likely to occur	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (feeding/ roosting/ breeding)	Permanent	**Moderate**– Habitat loss is the principal cause of decline for Baudin's cockatoo (Chapman, 2007). The Development Envelope is within the northern limits of the foraging distribution for the species. With proteaceous trees and shrubs such as *Banksia grandis, B. littoralis,* and *B. ilicifolia* (Chapman, 2007) present, the 38 ha (87 %) of Development Envelope classified as Low Banksia Woodland is considered of high foraging significance. Although there is a presence of other local foraging resources, large areas of foraging habitat are required to support black cockatoo populations. The loss of these foraging resources (up to 29 ha cleared) are considered of Moderate significance for the species.	**Moderate** - The breeding distribution of the species is recorded as within the deep south-west within eucalypt forests (DSEWPaC, 2012; Johnstone *et al.*, 2011). The species is unlikely to breed within the region of the Development Envelope, and therefore the loss of potential hollows and breeding trees is not as severe an impact as for the other two black cockatoo species. However, the loss of foraging resources within the Development Envelope is considered significant, as large areas of foraging habitat are required to support black cockatoo populations (DSEWPaC, 2012). The loss of up to 70 % of this habitat type in the Perth and Peel region (TSSC, 2016) means that the impact from this criterion is considered of high regional magnitude. In addition, the remaining portions are fragmented into smaller patches, with the majority (82%) of remnant patches under 10 ha size (DoE, 2016). This high level of fragmentation increases the distance that birds are required to travel to find resources.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High - Actions are deemed as likely to be significant if they adversely affect black cockatoo habitat quality (DSEWPaC, 2012).
		Vehicle Strike	Extent of expansion of existing road network	Long-term	**Moderate/Low** – One of the most severe mortality risks for the species is vehicle strike (Johnstone & Kirkby, 2017). Death or injury is most common where road construction concentrates birds to roadside vegetation or to drink from rainwater puddles on roadsides (DSEWPaC, 2012). High numbers of birds can be killed by a single vehicle; for example five Baudin's cockatoos were killed by a vehicle while drinking on the road 10 km east of Manjimup on 22 April 2010 (Johnstone *et al.*, 2011). Vehicular movements are expected to significantly increase during construction and operation of the proposed development, and is considered to have a Moderate/Low local impact based on this criterion.	**Low** – road construction and network expansions are increasing across the region, and the movement of birds onto the Swan Coastal Plain, especially around Perth, has greatly increased the risk of birds being killed or injured from vehicle strikes (Johnstone *et al.*, 2017). However, vehicle strike specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Loss of individuals • Temporary reduction in population size	High - Actions are deemed as likely to have a significant effect if they result in mortality of an individual black cockatoo
		Increased light or noise	Extent of disturbance during construction and operation	Long-term	**Low** - Disturbance from noise, light, vibrations and fumes is a listed threat to black cockatoo (DSEWPaC, 2012). These disturbances are likely to occur throughout construction and operation of development in the Development Envelope. However, these impacts are not as well researched for the species and are considered low in magnitude for this criterion.	**Low** - In the Perth-Peel region, Baudin's cockatoo have adapted to the urban environment for foraging and roosting, to the extent that they are often shot by orchardists or farmers for crop destruction (Chapman, 2007; TSSC, 2018). Therefore, impacts from light and noise specifically resulting from development in the Development Envelope is unlikely to contribute on a regional scale to this impact criterion.	• Dispersal from greatly enhanced levels of light and noise disturbance	Moderate – Disturbance in areas surrounding black cockatoo habitat (e.g. increased human visitation) is listed as an uncertain risk level (DSEWPaC, 2012), and there is limited research into the impact of this criterion

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species	Extent of distribution of introduced predators and competitors	Permanent	**Low** – Introduced species such as Honeybees and Rainbow Lorikeets are listed threats to the species through competition for existing hollows (Chapman, 2007; Johnstone *et al.*, 2013c). However, development within the Development Envelope is not expected to increase the presence of these species, and the current hollows within the Development Envelope are not suitable for black cockatoo.	**Low** - On a regional scale, impacts from introduced nest competitors are unlikely to be significant from development within the Development Envelope.	• Loss of individuals from nest competitors (mortality from honeybees) • Displacement of individuals from nest competitors (*e.g.* Rainbow Lorikeets)	Moderate - Actions are deemed as with the potential to be significant if they adversely affect black cockatoo habitat quality through increases in nest competitors (DSEWPaC, 2012). However, development activities within the Development Envelope are unlikely to increase these competitor species.
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Low/Moderate** - Baudin's cockatoo nesting and foraging trees species, including Jarrah, Marri and Wandoo, are threatened by fire (TSSC, 2018) and mismanagement of fire. For example, wildfire in Jan 2016 in Waroona elimated 80-90 % of foraging habitat for the species and half of known nesting trees (TSSC, 2018). There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and therefore the local impact is deemed Low/Moderate based on this criterion.	**Low/Moderate** - Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. The region experiences many hundreds of unplanned bushfires ignited by human activities and lightning (Whitford K. R. *et al.*, 2015). Although Baudin's cockatoo is unlikely to breed within the vicinity of the Development Envelope, the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope to reduce regional foraging resources is deemed Low/Moderate based on this criterion.	• Loss of foraging/ roosting/ nesting habitat • Loss of individuals from fire	Moderate - Actions are deemed as with the potential to have a significant effect if they result in impacts through inappropriate fire regimes (DSEWPaC, 2012)
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low** - Loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) are a listed threat to black cockatoo species (DSEWPaC, 2012; EPA, 2019). No evidence of this disease was recorded during the current survey. The impact from this criterion resulting from development in the Development Envelope is expected to be low.	**Low** - On a regional scale, impacts from disease are unlikely to be significant from development within the Development Envelope.	• Loss and degradation of habitat	Moderate – Actions are deemed as with the potential to have a significant effect if they result in impacts through introducing known plant diseases such as *Phytophthora* spp. (DSEWPaC, 2012). Phytopathogens are known to affect key tree species used by Baudin's cockatoo (TSSC, 2018).
<u>Perth Slider</u> *Lerista lineata* **DBCA** Priority 3	Highly Likely to occur	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat	Permanent	**High** – it is estimated that suitable habitat for the species has declined by 86 % since European settlement (Maryan *et al.*, 2015). This habitat includes the TEC Banksia Woodlands of the Swan Coastal Plain (TSSC, 2016). The species is also likely to have poor dispersal capabilities (Maryan & Gaikhorst, 2016). The impact for the species from this criterion is expected to be High from the proposed development.	**High** - The species distribution follows a narrow strip approximately 20–25 km inland from the coast, with the majority of *L. lineata* records from the southern suburbs of the Perth metropolitan area on the Bassendean and Spearwood Dune systems (Maryan *et al.*, 2015). Historically, the species has been recorded in 32 suburbs in which nearly 50% have no designated areas set aside for the conservation of flora and fauna (Maryan *et al.*, 2015). This distribution and the resulting increase in fragmentation is likely to render remnant subpopulations susceptible to stochastic events (R. Ellis pers. comm. 2017). Therefore, removal of 29 ha of suitable habitat has the potential to have a Moderate/High impact to the species for this criterion.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – Biological information on the species is lacking (Maryan *et al.*, 2015), Impacts from this criterion are well-researched by multiple sources

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Vehicle Strike	Extent of expansion of existing road network	Long-term	**Low/Moderate** – *L. lineata* may be impacted on a local scale by increased vehicle traffic during construction and ongoing aspects of the proposed development; however, the impact from this criterion is expected to be Low/Moderate	**Low** - On a regional scale, impacts from vehicle strike are unlikely to be significant from development within the Development Envelope.	• Loss of individuals • Temporary reduction in population size	Low/Moderate - Biological information on the species is lacking (Maryan *et al.*, 2015), research is unclear regarding the overall impact of vehicle strike on the species and requires further assessment.
		Increased light or noise	Extent of disturbance during construction and operation	Long-term	**Low/Moderate** – *L. lineata* may be impacted on a local scale by increased light or noise during construction and ongoing aspects of the proposed development; however, the impact from this criterion is expected to be Low	**Low** - On a regional scale, impacts from increased light and noise are unlikely to be significant from development within the Development Envelope.	• Dispersal from greatly enhanced levels of light and noise disturbance	Low/Moderate - Biological information on the species is lacking (Maryan *et al.*, 2015), research is unclear regarding the overall impact of increased light or noise on the species and requires further assessment..
		Introduced Species	Extent of distribution of introduced predators and invasive weeds	Permanent	**Moderate** – Introduced species such as feral cats have been known to predate on fossorial reptiles, including other species of *Lerista* (Doherty *et al.*, 2015). Therefore, the species is likely to experience a Moderate local impact from this criterion. Weed infestation has been listed as a potential threat to the habitat of the species, potentially degrading the level of litter ground cover and debris required for shelter (Maryan & Gaikhorst, 2016). The species is likely to experience a Low/Moderate local impact from this criterion.	**Low/Moderate** - Habitat fragmentation from urban developments is likely to increase fauna exposure to introduced predators (Howard K.H., 2014). Cats have the ability move easily throughout the urban landscape (Howard K.H., 2014), and habitat reduced to narrow strips or small areas may also facilitate the movement of foxes (Howard K.H., 2014). Development of the Development Envelope, resulting in a loss of habitat and increase in fragmentation of native vegetation, therefore increase the risk of predation to *L. lineata*, but on a regional scale the impact is likely to be Low/Moderate.	• Direct loss of individuals • Reduction in population size • Degradation of habitat	Moderate – the potential impacts of this criterion have some research-based justification and merit; however, more research is required into the specific impacts of introduced species
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Low/Moderate** – The species relies on dense litter ground cover and other debris for shelter (Maryan & Gaikhorst, 2016), putting it at risk from inappropriate fire events. Although there is some evidence that the species is able to survive and disperse into recently burned areas (Carati, Unpublished), the long-term viability of populations in fire-affected areas is unclear, as fire may increase exposure to predation (Gaikhorst *et al.*, 2017). There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and therefore the local impact is deemed Low/Moderate based on this criterion.	**Moderate** - Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. The region experiences many hundreds of unplanned bushfires ignited by human activities and lightning (Whitford K. R. *et al.*, 2015). As the species persists in highly fragmented and remnant habitat patches (Maryan & Gaikhorst, 2016), with a highly reduced Perth-based distribution (Maryan *et al.*, 2015), the impact from inappropriate fire regimes within the Development Envelope may have a Moderate regional impact, particularly in consideration that the species is associated with the Banksia Woodlands TEC (TSSC, 2016).	• Loss of dispersal and foraging habitat • Loss of individuals from fire	Low/Moderate – Biological information on the species is lacking (Maryan *et al.*, 2015), research is unclear regarding the overall impact of fire on the species and requires further assessment..
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low** – The local impact of loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) is considered Low based on this criterion.	**Low** – The regional impact of loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) is considered Low based on this criterion.	• Loss and degradation of habitat	Low/Moderate – Biological information on the species is lacking (Maryan *et al.*, 2015), research is unclear regarding the overall impact of disease on the species and requires further assessment..

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Western Brush Wallaby *Notamacropus irma* **DBCA** Priority 4	Likely to occur	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat	Permanent	**Moderate/High** – Habitat loss and fragmentation is considered a severe threat for the species (Woinarski *et al.*, 2014). The species does not feed on agricultural land uses and are absent from urban and semi-urban land areas (Woinarski *et al.*, 2014), and therefore the potential loss of suitable habitat in proximity to contemporary species records is considered to have a Moderate/High local impact for the species.	**Moderate** - The Development Envelope is located within a Regional Ecological Linkage (WALGA, 2014), and therefore removal of core habitat for the species may fragment local populations of the species. The regional impact is considered Moderate from the proposed development.	• Loss/displacement of individuals during vegetation clearing • Loss of foraging/ dispersal habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – habitat loss and fragmentation is a recorded severe threat for the species
		Vehicle Strike	Extent of expansion of existing road network	Long-term	**Moderate** – the species are listed as often killed by vehicles (Woinarski & Burbidge, 2016; Woinarski *et al.*, 2014). Vehicular movements are expected to significantly increase during construction and operation of the proposed development, and as such is considered to have a Moderate local impact based on this criterion.	**Low** - On a regional scale, impacts from vehicle strike are unlikely to be significant from development within the Development Envelope.	• Loss of individuals • Temporary reduction in population size	Low/Moderate - research is unclear regarding the overall impact of vehicle strike on the species and requires further assessment.
		Increased light or noise	Extent of disturbance during construction and operation	Long-term	**Low/Moderate** – The species may be impacted on a local scale by increased light or noise during construction and ongoing aspects of the proposed development; however, the impact from this criterion is expected to be Low	**Low** - On a regional scale, impacts from increased light and noise are unlikely to be significant from development within the Development Envelope.	• Dispersal from greatly enhanced levels of light and noise disturbance	Low/Moderate - research is unclear regarding the overall impact of increased light or noise on the species and requires further assessment..
		Introduced Species	Extent of distribution of introduced predators	Permanent	**Low/Moderate** – Predation by foxes is a significant factor in the decline in abundance of this species (Woinarski *et al.*, 2014), and the species has increased in abundance where foxes have been controlled. Native fauna in fragmented or disturbed environments are likely to be exposed to higher levels of fox predation from the predators preferences for human-modified environments including roads (Hradsky *et al.*, 2017). Construction and operation of any proposed development in the Development Envelope is considered to have a Low/Moderate local impact based on this criterion.	**Low** - Habitat fragmentation from urban developments is likely to increase fauna exposure to introduced predators, and habitat reduced to narrow strips or small areas may also facilitate the movement of foxes (Howard K.H., 2014). Development of the Development Envelope, resulting in a loss of habitat and increase in fragmentation of native vegetation, therefore increase the risk of predation to western brush wallaby, but on a regional scale the impact is likely to be Low compared to on a localized level.	• Direct loss of individuals • Reduction in population size • Degradation of habitat	Moderate/High – Fox predation is a well recorded threat for the species
		Inappropriate fire regimes	Extent of fire increases from operation or construction	Long-term	**Low/Moderate** – western brush wallaby are observed as feeding in recently burnt areas; however, large scale fires are likely to lead to mortality and local population reduction (Woinarski *et al.*, 2014). There is the potential for planned and unplanned fire outbreaks to result from development within the Development Envelope, and therefore the local impact is deemed Low/Moderate based on this criterion.	**Low/Moderate** - Ramalho *et al.* (2014) found that Banksia Woodland remnants in the Perth metropolitan region are burnt more frequently in areas with a higher incidence of human activities. With limited urban and semi-urban distribution, the removal of suitable habitat on a regional scale is deemed Low/Moderate in consideration that the species prefers open habitat and feed in recently burnt areas (Woinarski *et al.*, 2014)	• Loss of dispersal and foraging habitat • Loss of individuals from fire	Low/Moderate – research is unclear regarding the overall impact of fire on the species and requires further assessment.
		Disease	Extent of spread of diseases such as *Phytophthora* spp.	Long-term	**Low** – The local impact of loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) is considered Low based on this criterion.	**Low** – The regional impact of loss and degradation of habitat by secondary impacts such as introduction of dieback caused by *Phytophtora cinnamomi* (and other plant diseases) is considered Low based on this criterion.	• Loss and degradation of habitat	Low/Moderate – research is unclear regarding the overall impact of disease on the species and requires further assessment.

4.3 Cumulative Impacts

4.3.1 Fauna Habitat

Of concern on the Swan Coastal Plain is the cumulative impact of clearing, where increasing urban expansion has resulted in only 29 per cent of natural vegetation remaining (EPA, 2016a). The Development Envelope contains 38.09 ha of the *Banksia Woodlands of the Swan Coastal Plain* TEC, representing 1 % of the total quantity of Banksia Woodland within the City of Kwinana, and 0.32 % of that present in the Bassendean System. Table 4.2 shows the degree of loss of this ecological community at different spatial and temporal scales in the vicinity of the Development Envelope.

The proposed development plans to leave a patch of 4.09 ha of Banksia Woodland habitat within the Development Envelope. Around 82 % of remaining Banksia Woodland patches are under 10 ha, with the median patch size 1.6 ha (TSSC, 2016). Fragments under 5 ha are considered to be under the level of critical functionality and are likely to show local extinction, with vegetation richness halving 50 years after fragmentation (Ramalho *et al.*, 2014). The cumulative impact of the loss of these small patches results in a significant degree of fragmentation. The number of *Banksia* woodland patches on the Swan Coastal Plain has increased from 132 to over 12,000, with the number of patches under 5 ha increasing by several orders of magnitude from 39 to over 9000 (Ramalho *et al.*, 2014). Therefore, although this fauna habitat within the Development Envelope represents a small percentage of that remaining in the region, the current size of the patch is significant, and the level of proposed removal contributes to a cumulative trend of habitat fragmentation on the Swan Coastal Plain.

Table 4.2: Extent of Banksia Woodland remaining at different spatial and temporal scales in the vicinity of the Development Envelope (TSSC, 2016)

Area	Pre-European extent (ha)	2015 Extent (ha)	Decline of total vegetation (%)
Perth Metropolitan	172,410.5	48,828.8	53.55
Bassendean System	53,283.5	11,586.0	78.26
City of Kwinana	10,472.9	3,804.8	65.51

4.3.2 Black Cockatoos

There is a recognized cumulative risk to black cockatoo arising from a combination of population decline and ongoing threats from further habitat clearing, disease, mortality and climate change (EPA, 2019). Black cockatoos have adapted to urban living, for example by using introduced tree species for night roosting and food resources, and using artificial water sources, and studies tracking cockatoos via satellite demonstrate that the birds use a large portion of the developed landscape of Perth (Groom *et al.*, 2014). However, the long-term sustainability of novel ecosystems such as this are unknown, and it is likely that these systems will continue to change rapidly through urban development and planning processes (Groom *et al.*, 2014). Groom *et al.* (2014) suggests that if the elements in the landscape that assist the

survival of black cockatoos can be identified, those elements can be protected and enhanced whilst allowing development to continue. The surrounding land uses of the Development Envelope (*e.g*. housing, conservation areas such as Harry Waring Marsupial Reserve), in conjunction with the high-quality foraging habitat present in the Development Envelope, may together support the species at present. But the removal of significant habitat present in the Development Envelope is likely to have a cumulative effect from the unknown long-term sustainability of novel and fragmented landscapes. Mitigation and management decisions are complicated by black cockatoo migration across breeding seasons between the Swan Coastal Plain, and areas such as the Wheatbelt and Jarrah Forest, requiring assessment of cumulative impacts on both a temporal and spatial scale.

Environmental impacts to black cockatoo species are currently assessed individually at a local project scale, and there is limited knowledge of the cumulative impacts from multiple proposals in the Perth region (EPA, 2019). It has been recommended to implement a broad suite of conservation actions to complement traditional habitat and species conservation measures for black cockatoos in Perth (Groom *et al.*, 2014) to mitigate the impact of cumulative impacts. A holistic conservation approach for the Perth region (as recommended for BC by Groom) is currently in development (EPA, 2015). However, until such time of release, priority should be given to linkages (such as that provided by the Development Envelope) and large patches of remnant vegetation.

4.3.3 Southern Brown Bandicoot

The persistence of southern brown bandicoot populations in the region is highly dependent on remnant patches of suitable habitat (Lohr *et al.*, 2018). The disappearance of previously existing populations of southern brown bandicoot from numerous urban bushland reserves, including large areas such as Bold Park and Herdsman Lake, suggests that there is a cumulative effect of multiple threat sources, including predation, fire, vehicle strike, and loss of habitat quality (Howard K.H., 2014). Strong habitat connectivity appears to be a key feature of landscapes where the species persists (Howard K.H., 2014). The Development Envelope is located within a Regional Ecological Linkage (WALGA, 2014) linking a large population at The Spectacles wetlands (DBCA, 2019b) with potential other local permanent populations. Removal of the species core habitat for the species may fragment local populations of the species and contribute to overall cumulative impacts associated with fragmentation.

5 Conclusion

Three broad habitat types were identified and mapped within the Development Envelope during the current survey; Low Banksia Woodland, Closed Acacia Scrubland, and Cleared. The Banksia Woodland present is consistent with the *Banksia Woodlands of the Swan Coastal Plain* TEC, classified as Endangered under the EPBC Act. This habitat type has the potential to support species of conservation significance or contain core habitats (i.e. foraging, roosting, or breeding sites) for these species, including black cockatoos, southern brown bandicoot and *Lerista lineata*. The Development Envelope and its habitats are also classified as part of a Regional Ecological Linkage ("K6"), identified as a crucial biological corridor in a highly fragmented landscape. In consideration of these factors, the Banksia Woodland habitat present within the Development Envelope is considered of high conservation significance, and approval under Part IV of the EPBC Act may be required prior to disturbance (DoE, 2013b).

The current survey opportunistically recorded a total of 25 species, comprising 14 native avian species, four mammalian species (including two non-native species), and seven reptile species. Two of these species are considered to be of conservation significance – the forest red-tailed black cockatoo and southern brown bandicoot. Based on database searches within the area, 51 species of conservation significance (excluding aquatic and invertebrate species) have the potential to occur within the Development Envelope. Forest red-tailed black cockatoo were recorded via secondary evidence (a dropped feather) and likely foraging evidence of chewed jarrah nuts in the Low Banksia Woodland habitat. Southern brown bandicoot was also recorded via secondary evidence (i.e. diggings). Excluding these two species, none of the other conservation significant species identified in the desktop assessment have been recorded within the Development Envelope to date. The other conservation significant species deemed most likely to occur in the Development Envelope are those classified as "Highly Likely" (Carnaby's cockatoo), and "Likely to occur" (Baudin's cockatoo *Calyptorhynchus baudinii,* Perth slider *Lerista lineata,* and western brush wallaby *Notamacropus irma)*.

The EPBC referral guidelines (DSEWPaC, 2012) for the three black-cockatoo species states that it is recommended that an action that has a high risk significant impact is referred to the Australian Government. The clearing of nesting trees or breeding habitat, complete clearance of roost sites close to high quality foraging habitat and water resources in non-breeding areas, or the clearing of Very High to High quality foraging habitat, is likely to result in a significant impact on these conservation significant species.

Strategen (2017) identified a total of 64 trees with a DBH greater than 500 mm and as such are assessed as potential breeding trees for black cockatoo. Of these trees 23 had natural hollows that were assessed during the current survey; however, none showed signs of breeding activity or are considered suitable for black cockatoo. Most of these hollows were observed in jarrah trees of small DBH. Although the hollows present in trees within the Development Envelope were not considered suitable for black cockatoo nesting, the importance of veteran and stag trees are recognized in their potential to develop hollows in the future, as it can take more than 200 years for a tree to develop suitable hollows (DSEWPaC, 2012; Johnstone *et al.*, 2011).

The planned clearing within the Development Envelope proposes the removal of 54 trees (84 %) of suitable DBH for nesting and roosting of black cockatoo, including the removal of 17 hollows (74 % of present hollows). Although there was no conclusive evidence of breeding and no known roosts occurring, the trees and habitat types identified within the Development Envelope meet the definition of breeding and roosting habitat for Carnaby's and forest red-tailed black cockatoos by the DoEE. Therefore, should clearing of this habitat be planned, referral to DoEE is likely to be required based on this criterion.

The proposed development within the Development Envelope plans to remove 39.58 ha of habitat, including removal of 35.14 ha of Low Banksia Woodland (92 % of which is present in the Development Envelope), and retain a 4.09 ha patch of habitat, fragmented by a large cleared track. This will significantly impact the quality of this Low Banksia Woodland habitat. Habitat loss and fragmentation pose the most significant threat to the conservation significant fauna present (and potentially present) within the Development Envelope, on both a local and regional scale. It should also be noted that an estimated 70 % of this Banksia woodland habitat has been lost within the Swan Coastal Plain (Groom *et al.*, 2014), and the majority (82 %) of remnant patches are now under 10 ha in size (DoE, 2016). This potential loss of habitat is greater than what is considered acceptable for black cockatoo habitat loss for quality (> 1 ha) habitat, as defined by the DSEWPaC (2012), and thus referral is also recommended based on this criterion. Other potential significant impacts include the increased effects of introduced predators, vehicle strike, inappropriate fire regimes, and disease such as Phytophthora dieback.

The potential cumulative impacts of the proposed development are difficult to quantify and are poorly understood. For example, environmental impacts to black cockatoo species are currently assessed individually at a local project scale, and there is limited knowledge of the cumulative impacts from multiple proposals in the Perth region (EPA, 2019). The cumulative effects of habitat loss, whereby the proposed clearing in the Development Envelope contributes to the creation of a smaller patch size (> 5 ha) and higher levels of habitat fragmentation, are currently of great concern (EPA, 2016a). As an area of remnant vegetation substantially larger in size than the average patch in the Perth region (43.67 ha compared to 1.6 ha across Perth), and as part of a Regional Ecological Linkage, the Development Envelope is likely to serve an important local and semi regional function. This function could include both fauna habitat suitable to support conservation significant species, and as a corridor to important conservation areas such as Harry Waring Marsupial Reserve, the Spectacles Wetlands, Banganup Lake, and Thomson's Lake. However, as the first Level 1 terrestrial fauna survey completed in the Development Envelope, its true function as an opportunistic refuge, wildlife corridor, or permanent fauna habitat is difficult to ascertain and may require further survey work to understand.

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Appendix A Habitat assessments conducted during the current survey

Site	Habitat type	Vegetation types	Landform	Soil type and availability	Vegetation litter	Woody debris	Last fire	Disturbances	Habitat condition	Burrowing suitability	Hollows <10cm	Hollows >10cm	Water presence
VMAN-03	Eucalyptus and Banksia woodland	Main species are Jarrah, *Banksia menziesii* and *Xanthorrhoea*. Open Banksia mid-story, with Hibbertia and Xanthorrhoea understory.	Sand Plain	Sandy Loam Scarce	Evenly Spread	Many Large Patches	Old (6+ yr)	Non-Discernible	1	Very High	None	None	None
VMAN-07	Banksia woodland	Main species are *Banksia menziesii* and *B. attenuata*, with scattered Jarrah. Moderately dense understory of Xanthorrhoea and scattered Allocasuarina. Limited mid-story	Sand Plain	Sandy Loam Few Small Patches	Evenly Spread	Many Small Patches	Old (6+ yr)	Rubbish/Litter	1	Very High	None	None	None
VMAN-06	Banksia and acacia shrubland	Open, limited understory (Hibbertia). Low upper story of Allocasuarina, Fabaceae, *Banksia attenuata* and *B. menziesii*. No eucalypts or tall trees. No Xanthorrhoea.	Undulating Low Hills	Sandy Loam Many Large Patches	Few Large Patches	Many Small Patches	Old (6+ yr)	Road/ Access Track,Rubbish/ Litter	0.6	Very High	None	None	None
VMAN-04	Banksia woodland	*Banksia menziesii* and *B. attenuata* and Allocasuarina upper story. Understory of young Allocasuarina, Xanthorrhoea and grasses. Not really any Jarrah present.	Sand Plain	Sandy Loam Few Small Patches	Many Large Patches	Many Large Patches	Old (6+ yr)	Road/ Access Track, Rubbish/Litter, development (large sand piles)	0.8	Very High	None	None	None
VMAN-02	Banksia and Eucalyptd woodland	Main species are *Banksia attenuata* and *B. menziesii*, Xanthorrhoea. Limited mid-story. Understory of Hibbertia. Some Jarrah trees and scattered Eucalypts	Sand Plain	Sandy Loam Many Small Patches	Many Large Patches	Few Large Patches	Old (6+ yr)	Road/ Access Track	0.8	Very High	Scarce	Scarce	None
VMAN-01	Banksia Woodland	Main species are *Banksia attenuata* and *B. menziesii*, Xanthorrhoea, and *Allocasuarina fraseri*. No eucalypts	Sand Plain	Sandy Loam Few Small Patches	Evenly Spread	Few Large Patches	Old (6+ yr)	Road/ Access Track, Rubbish/Litter	1	Very High	None	None	None

Appendix B Summarized results of the fauna database searches (including vertebrate species records excluded from discussion)

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
AMPHIBIANS								
PELODRYADIDAE								
Litoria adelaidensis	Slender Tree Frog					●		
Litoria moorei	Motorbike Frog					●		
LIMNODYNASTIDAE								
Heleioporus eyrei	Moaning Frog					●		
Limnodynastes dorsalis	Western Banjo Frog					●		
MYOBATRACHIDAE								
Crinia glauerti	Clicking Frog					●		
Crinia insignifera	Squelching Froglet					●		
Myobatrachus gouldii	Turtle Frog					●		
REPTILES								
AGAMIDAE								
Ctenophorus adelaidensis	Western Heath Dragon					●		
Pogona minor						●		
CHELUIDAE								
Chelodina colliei	Oblong Turtle					●		
DIPLODACTYLIDAE								
Christinus marmoratus	Marbled Gecko					●		
ELAPIDAE								
Brachyurophis semifasciatus						●		
Neelaps bimaculatus	Black-naped Snake					●		
Neelaps calonotos	Black-striped Snake			P3		●		●
Notechis scutatus	Tiger Snake					●		
Parasuta gouldii						●		
Pseudonaja affinis	Dugite					●		
Simoselaps bertholdi	Jan's Banded Snake					●		
GEKKONIDAE								
Gehyra variegata						●		
PYGOPODIDAE								
Aprasia repens						●		
Delma fraseri						●		
Lialis burtonis						●		
Pletholax gracilis	Keeled Legless Lizard					●		
Pygopus lepidopodus	Common Scaly Foot					●		
SCINCIDAE								
Acritoscincus trilineatus						●		
Cryptoblepharus buchananii						●		
Cryptoblepharus plagiocephalus						●		
Ctenotus australis						●		
Ctenotus fallens						●		
Egernia napoleonis						●		
Hemiergis quadrilineata						●		
Lerista elegans						●		
Lerista lineata	Lined Skink			P3	EN	●		●
Menetia greyii						●		
Morethia lineoocellata						●		
Morethia obscura						●		
Tiliqua occipitalis	Western Bluetongue					●		
Tiliqua rugosa						●		
VARANIDAE								
Varanus gouldii	Sand Monitor					●		
BIRDS								

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
ACANTHIZIDAE								
Acanthiza apicalis	Inland Thornbill					●		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill					●		
Acanthiza inornata	Western Thornbill					●		
Gerygone fusca	Western Gerygone					●		
Sericornis frontalis	White-browed Scrubwren					●		
Smicrornis brevirostris	Weebill					●		
ACCIPITRIDAE								
Accipiter cirrocephalus	Collared Sparrowhawk					●		
Accipiter fasciatus	Brown Goshawk					●		
Aquila audax	Wedge-tailed Eagle					●		
Circus approximans	Swamp Harrier					●		
Elanus axillaris	Black-shouldered Kite					●		
Haliaeetus leucogaster	White-bellied Sea-Eagle					●		
Haliastur sphenurus	Whistling Kite					●		
Hieraaetus morphnoides	Little Eagle					●		
Pandion haliaetus	Osprey, Eastern Osprey	MI	MI				●	
ACROCEPHALIDAE								
Acrocephalus australis	Australian Reed Warbler					●		
ALCEDINIDAE								
Dacelo novaeguineae	Laughing Kookaburra					●		
Todiramphus sanctus	Sacred Kingfisher					●		
ANATIDAE								
Anas castanea	Chestnut Teal					●		
Anas gracilis	Grey Teal					●		
Anas platyrhynchos	*Mallard					●		
Anas rhynchotis	Australasian Shoveler					●		
Anas superciliosa	Pacific Black Duck					●		
Aythya australis	Hardhead					●		
Biziura lobata	Musk Duck					●		
Chenonetta jubata	Australian Wood Duck					●		
Cygnus atratus	Black Swan					●		
Malacorhynchus membranaceus	Pink-eared Duck					●		
Oxyura australis	Blue-billed Duck			P4	NT	●		●
Stictonetta naevosa	Freckled Duck					●		
Tadorna tadornoides	Australian Shelduck					●		
ANHINGIDAE								
Anhinga novaehollandiae	Australiasian Darter					●		
APODIDAE								
Apus pacificus	Fork-tailed Swift	MI	MI				●	
ARDEIDAE								
Ardea ibis	Cattle Egret						●	
Ardea modesta	Eastern Great Egret					●	●	
Ardea novaehollandiae	White-faced Heron					●		
Ardea pacifica	White-necked Heron					●		
Botaurus poiciloptilus	Australasian Bittern	EN	EN				●	
Nycticorax caledonicus	Rufous Night Heron					●		
ARTAMIDAE								
Artamus cinereus	Black-faced Woodswallow					●		
Artamus cyanopterus	Dusky Woodswallow					●		
Cracticus nigrogularis	Pied Butcherbird					●		
Cracticus torquatus	Grey Butcherbird					●		
CACATUIDAE								
Cacatua sanguinea	Little Corella					●		

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
Cacatua tenuirostris	Eastern Long-billed Corella					●		
Calyptorhynchus banksii	Red-tailed Black Cockatoo					●		
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	VU				●	●
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	EN			●	●	
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	EN			●	●	●
CAMPEPHAGIDAE								
Coracina novaehollandiae	Black-faced Cuckoo-shrike					●		
CHARADRIIDAE								
Charadrius dubius	Little Ringed Plover	MI	MI				●	
Charadrius ruficapillus	Red-capped Plover					●		
Erythrogonys cinctus	Red-kneed Dotterel					●		
Pluvialis squatarola	Grey Plover	MI	MI			●		
Vanellus tricolor	Banded Lapwing					●		
COLUMBIDAE								
Columba livia	*Domestic Pigeon					●		
Ocyphaps lophotes	Crested Pigeon					●		
Phaps chalcoptera	Common Bronzewing					●		
Streptopelia chinensis	*Spotted Turtle-Dove					●		
Streptopelia senegalensis	*Laughing Turtle-Dove					●		
CORVIDAE								
Corvus coronoides	Australian Raven					●		
CRACTICIDAE								
Strepera versicolor	Grey Currawong					●		
CUCULIDAE								
Cacomantis flabelliformis	Fan-tailed Cuckoo					●		
Cacomantis pallidus	Pallid Cuckoo					●		
ESTRILDIDAE								
Lonchura castaneothorax	Chestnut-breasted Mannikin					●		
FALCONIDAE								
Falco berigora	Brown Falcon					●		
Falco cenchroides	Australian Kestrel					●		
Falco longipennis	Australian Hobby					●		
Falco peregrinus	Peregrine Falcon		S7			●		●
HIRUNDINIDAE								
Hirundo neoxena	Welcome Swallow					●		
Petrochelidon nigricans	Tree Martin					●		
LARIDAE								
Sterna dougallii	Roseate Tern	MI	MI				●	
Sterna leucoptera	White-winged Black Tern	MI	MI					●
Sterna nereis nereis	Fairy Tern	VU	VU		VU		●	
Cladorhynchus leucocephalus	Banded Stilt					●		
LOCUSTELLIDAE								
Megalurus gramineus	Little Grassbird					●		
MALURIDAE								
Malurus lamberti	Variegated Fairy-wren					●		
Malurus splendens	Splendid Fairy-wren					●		
MEGAPODIIDAE								
Leipoa ocellata	Malleefowl	VU	VU				●	
Acanthorhynchus superciliosus	Western Spinebill					●		
Anthochaera carunculata	Red Wattlebird					●		
Anthochaera lunulata	Western Little Wattlebird					●		
Epthianura albifrons	White-fronted Chat					●		

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
Glyciphila melanops	Tawny-crowned Honeyeater					●		
Lichmera indistincta	Brown Honeyeater					●		
Melithreptus brevirostris	Brown-headed Honeyeater					●		
Phylidonyris novaehollandiae	New Holland Honeyeater					●		
MEROPIDAE								
Merops ornatus	Rainbow Bee-eater					●		
MONARCHIDAE								
Grallina cyanoleuca	Magpie-lark					●		
MOTACILLIDAE								
Motacilla cinerea	Grey Wagtail	MI	MI				●	
NEOSITTIDAE								
Daphoenositta chrysoptera	Varied Sittella					●		
PACHYCEPHALIDAE								
Colluricincla harmonica	Grey Shrike-thrush					●		
Pachycephala rufiventris	Rufous Whistler					●		
PARDALOTIDAE								
Pardalotus punctatus	Spotted Pardalote					●		
Pardalotus striatus	Striated Pardalote					●		
PASSERIDAE								
Passer montanus	*Eurasian Tree Sparrow					●		
PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican					●		
PETROICIDAE								
Microeca fascinans	Jacky Winter					●		
Petroica goodenovii	Red-capped Robin					●		
PHAETHONTIDAE								
Phaethon rubricauda	Red-tailed Tropicbird	MI	MI	P4		●		●
PHAETHONTIDAE								
Phalacrocorax carbo	Great Cormorant					●		
Phalacrocorax melanoleucos	Little Pied Cormorant					●		
Phalacrocorax sulcirostris	Little Black Cormorant					●		
Phalacrocorax varius	Pied Cormorant					●		
PHASIANIDAE								
Coturnix pectoralis	Stubble Quail					●		
Coturnix ypsilophora	Brown Quail					●		
PODARGIDAE								
Podargus strigoides	Tawny Frogmouth					●		
PODICIPEDIDAE								
Podiceps cristatus	Great Crested Grebe					●		
Poliocephalus poliocephalus	Hoary-headed Grebe					●		
Tachybaptus novaehollandiae	Australasian Grebe					●		
PROCELLARIIDAE								
Puffinus carneipes	Fleshy-footed Shearwater	MI	VU/ MI				●	
PSITTACIDAE								
Neophema elegans	Elegant Parrot					●		
Platycercus icterotis	Western Rosella					●		
Polytelis anthopeplus	Regent Parrot					●		
RALLIDAE								
Fulica atra	Eurasian Coot					●		
Gallinula tenebrosa	Dusky Moorhen					●		
Gallirallus philippensis	Buff-banded Rail					●		
Porphyrio porphyrio	Purple Swamphen					●		
Porzana fluminea	Australian Spotted Crake					●		

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
Porzana pusilla	Baillon's Crake					●		
Porzana tabuensis	Spotless Crake					●		
Tribonyx ventralis	Black-tailed Native-hen					●		
RECURVIROSTRIDAE								
Himantopus himantopus	Black-winged Stilt					●		
Recurvirostra novaehollandiae	Red-necked Avocet					●		
RHIPIDURIDAE								
Rhipidura albiscapa	Grey Fantail					●		
Rhipidura leucophrys	Willie Wagtail					●		
ROSTRATULIDAE								
Rostratula australis	Australian Painted Snipe	EN	EN		EN		●	
SCOLOPACIDAE								
Calidris acuminata	Sharp-tailed Sandpiper	MI	MI			●	●	●
Calidris canutus	Red Knot	EN/ MI	EN/ MI		NT		●	
Calidris ferruginea	Curlew Sandpiper	CR/ MI	CR/ MI		NT	●	●	●
Calidris melanotos	Pectoral Sandpiper	MI	MI			●	●	●
Calidris ruficollis	Red-necked Stint	MI	MI		NT	●	●	●
Calidris subminuta	Long-toed Stint	MI	MI			●	●	●
Limosa limosa	Black-tailed Godwit	MI	MI		NT	●	●	●
Numenius madagascariensis	Eastern Curlew	CR/ MI	CR/ MI		EN		●	
Philomachus pugnax	Ruff	MI	MI				●	
Tringa glareola	Wood Sandpiper	MI	MI			●	●	●
Tringa hypoleucos	Common Sandpiper	MI	MI				●	●
Tringa nebularia	Common Greenshank	MI	MI			●	●	●
Tringa stagnatilis	Marsh Sandpiper	MI	MI			●	●	
THRESKIORNITHIDAE								
Platalea flavipes	Yellow-billed Spoonbill					●		
Platalea regia	Royal Spoonbill					●		
Plegadis falcinellus	Glossy Ibis	MI	MI			●		●
Threskiornis spinicollis	Straw-necked Ibis					●		
ZOSTEROPIDAE								
Zosterops lateralis	Silvereye					●		
MAMMALS								
DASYURIDAE								
Dasyurus geoffroii	Chuditch	VU	VU			●	●	●
Phascogale tapoatafa wambenger	Wambenger Brush-tailed Phascogale		CD					●
FELIDAE								
Felis catus	*Cat					●		
LEPORIDAE								
Oryctolagus cuniculus	*Rabbit					●		
MACROPODIDAE								
Macropus fuliginosus	Western Grey Kangaroo					●		
Notamacropus eugenii derbianus	Tammar			P4				●
Notamacropus irma	Western Brush Wallaby			P4				●
MURIDAE								
Hydromys chrysogaster	Water-rat			P4		●		●
Mus musculus	*House Mouse					●		
Rattus fuscipes	Western Bush Rat					●		
Rattus rattus	*Black Rat					●		
MYRMECOBIIDAE								
Myrmecobius fasciatus	Numbat	EN	EN			●		●
PERAMELIDAE								

		Conservation status				Database		
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA Listing**	**IUCN**	**NatureMap (5 km)**	**EPBC Protected Matters (5km)**	**DBCA (5km)**
Isoodon fusciventer	Southern Brown Bandicoot			P4				•
PHALANGERIDAE								
Trichosurus vulpecula	Common Brushtail Possum					•		
PSEUDOCHEIRIDAE								
Pseudocheirus occidentalis	Western Ringtail Possum, ngwayir	CR	CR				•	
TACHYGLOSSIDAE								
Tachyglossus aculeatus	Short-beaked Echidna					•		
TARSIPEDIDAE								
Tarsipes rostratus	Honey Possum					•		
VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat					•		
Chalinolobus morio	Chocolate Wattled Bat					•		
Falsistrellus mackenziei	Western False Pipistrelle			P4		•		•
Nyctophilus geoffroyi	Lesser Long-eared Bat					•		
Vespadelus regulus	Southern Forest Bat					•		

Appendix C NatureMap Database Search

NatureMap
Mapping Western Australia's biodiversity

Mandogalup Level 1

Created By Guest user on 10/08/2020

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 51' 30" E,32° 10' 26" S
Buffer 5km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
2.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
3.	24262	*Acanthiza inornata (Western Thornbill)*			
4.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
5.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
6.	25536	*Accipiter fasciatus (Brown Goshawk)*			
7.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
8.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
9.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
10.	24310	*Anas castanea (Chestnut Teal)*			
11.	24312	*Anas gracilis (Grey Teal)*			
12.	24313	*Anas platyrhynchos (Mallard)*			
13.	24315	*Anas rhynchotis (Australasian Shoveler)*			
14.	24316	*Anas superciliosa (Pacific Black Duck)*			
15.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
16.	24561	*Anthochaera carunculata (Red Wattlebird)*			
17.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
18.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
19.	24285	*Aquila audax (Wedge-tailed Eagle)*			
20.		*Arachnura higginsi*			
21.	41324	*Ardea modesta (great egret, white egret)*			
22.	24340	*Ardea novaehollandiae (White-faced Heron)*			
23.	24341	*Ardea pacifica (White-necked Heron)*			
24.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
25.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
26.		*Artoria flavimana*			
27.		*Austracantha minax*			
28.	24318	*Aythya australis (Hardhead)*			
29.		*Barnardius zonarius*			
30.	24319	*Biziura lobata (Musk Duck)*			
31.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
32.	25716	*Cacatua sanguinea (Little Corella)*			
33.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*	Y		
34.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
35.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
36.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
37.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
38.	24786	*Calidris melanotos (Pectoral Sandpiper)*		IA	
39.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
40.	24789	*Calidris subminuta (Long-toed Stint)*		IA	
41.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
42.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
43.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
44.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
45.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
46.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
47.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
48.	24377	*Charadrius ruficapillus (Red-capped Plover)*			
49.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
50.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
51.	33939	*Cherax cainii (Marron)*			
52.		*Cherax destructor*			
53.		*Cherax preissii*			
54.		*Cherax quinquecarinatus*			
55.		*Cherax sp.*			
56.	41332	*Chlidonias leucopterus (White-winged Black Tern, white-winged tern)*		IA	
57.	24980	*Christinus marmoratus (Marbled Gecko)*			
58.		*Chroicocephalus novaehollandiae*			
59.	24288	*Circus approximans (Swamp Harrier)*			
60.	24774	*Cladorhynchus leucocephalus (Banded Stilt)*			
61.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
62.	24399	*Columba livia (Domestic Pigeon)*	Y		
63.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
64.		*Cormocephalus novaehollandiae*			
65.	25592	*Corvus coronoides (Australian Raven)*			
66.	24671	*Coturnix pectoralis (Stubble Quail)*			
67.	25701	*Coturnix ypsilophora (Brown Quail)*			
68.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
69.	25595	*Cracticus tibicen (Australian Magpie)*			
70.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
71.	25596	*Cracticus torquatus (Grey Butcherbird)*			
72.	25399	*Crinia glauerti (Clicking Frog)*			
73.	25400	*Crinia insignifera (Squelching Froglet)*			
74.		*Crustulina bicruciata*			
75.	30893	*Cryptoblepharus buchananii*			
76.	25020	*Cryptoblepharus plagiocephalus*			
77.	30899	*Ctenophorus adelaidensis (Southern Heath Dragon, Western Heath Dragon)*			
78.	25027	*Ctenotus australis*			
79.	25039	*Ctenotus fallens*			
80.	24322	*Cygnus atratus (Black Swan)*			
81.		*Cyrtophora parnasia*			
82.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
83.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
84.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
85.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
86.	25296	*Demansia psammophis subsp. reticulata (Yellow-faced Whipsnake)*			
87.	25100	*Egernia napoleonis*			
88.		*Egretta garzetta*			
89.		*Egretta novaehollandiae*			
90.		*Elanus axillaris*			
91.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
92.		*Eolophus roseicapillus*			
93.	24567	*Epthianura albifrons (White-fronted Chat)*			
94.		*Eriophora biapicata*			
95.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
96.	25621	*Falco berigora (Brown Falcon)*			
97.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
98.	25623	*Falco longipennis (Australian Hobby)*			
99.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
100.	24189	*Falsistrellus mackenziei (Western False Pipistrelle, Western Falsistrelle)*		P4	
101.	24041	*Felis catus (Cat)*	Y		
102.	25727	*Fulica atra (Eurasian Coot)*			
103.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
104.	25729	*Gallinula tenebrosa (Dusky Moorhen)*			
105.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
106.	25730	*Gallirallus philippensis (Buff-banded Rail)*			
107.	24959	*Gehyra variegata*			
108.	25530	*Gerygone fusca (Western Gerygone)*			
109.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
110.	24443	*Grallina cyanoleuca (Magpie-lark)*			
111.	24293	*Haliaeetus leucogaster (White-bellied Sea-Eagle)*			
112.	24295	*Haliastur sphenurus (Whistling Kite)*			
113.	25410	*Heleioporus eyrei (Moaning Frog)*			
114.	25119	*Hemiergis quadrilineata*			
115.		*Heurodes turritus*			
116.	47965	*Hieraaetus morphnoides (Little Eagle)*			
117.	25734	*Himantopus himantopus (Black-winged Stilt)*			
118.	24491	*Hirundo neoxena (Welcome Swallow)*			
119.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
120.		*Idiommata blackwalli*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
121.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
122.		*Isopeda leishmanni*			
123.	47975	*Ixobrychus dubius (Australian Little Bittern)*		P4	
124.		*Kangarosa properipes*			
125.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
126.	25133	*Lerista elegans*			
127.	25147	*Lerista lineata (Perth Slider, Lined Skink)*		P3	
128.	25005	*Lialis burtonis*			
129.	25661	*Lichmera indistincta (Brown Honeyeater)*			
130.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
131.	25741	*Limosa limosa (Black-tailed Godwit)*		IA	
132.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
133.	25388	*Litoria moorei (Motorbike Frog)*			
134.	25683	*Lonchura castaneothorax (Chestnut-breasted Mannikin)*			
135.		*Lophoictinia isura*			
136.		*Lycosa ariadnae*			
137.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
138.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
139.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
140.	25654	*Malurus splendens (Splendid Fairy-wren)*			
141.	25758	*Megalurus gramineus (Little Grassbird)*			
142.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
143.	25184	*Menetia greyii*			
144.	24598	*Merops ornatus (Rainbow Bee-eater)*			
145.		*Microcarbo melanoleucos*			
146.	25693	*Microeca fascinans (Jacky Winter)*			
147.	25191	*Morethia lineoocellata*			
148.	25192	*Morethia obscura*			
149.	24223	*Mus musculus (House Mouse)*	Y		
150.	25420	*Myobatrachus gouldii (Turtle Frog)*			
151.	24146	*Myrmecobius fasciatus (Numbat, Walpurti)*		T	
152.		*Nanometa gentilis*			
153.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
154.	25249	*Neelaps calonotos (Black-striped Snake, black-striped burrowing snake)*		P3	
155.	24738	*Neophema elegans (Elegant Parrot)*			
156.		*Nephila edulis*			
157.	48024	*Notamacropus eugenii subsp. derbianus (Tammar Wallaby, Tammar)*		P4	
158.	25252	*Notechis scutatus (Tiger Snake)*			
159.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
160.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
161.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
162.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
163.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
164.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
165.	48591	*Pandion cristatus (Osprey, Eastern Osprey)*		IA	
166.	25253	*Parasuta gouldii*			
167.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
168.	25682	*Pardalotus striatus (Striated Pardalote)*			
169.	24642	*Passer montanus (Eurasian Tree Sparrow)*	Y		
170.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
171.	48061	*Petrochelidon nigricans (Tree Martin)*			
172.	48066	*Petroica boodang (Scarlet Robin)*			
173.	24659	*Petroica goodenovii (Red-capped Robin)*			
174.	24663	*Phaethon rubricauda (Red-tailed Tropicbird)*		P4	
175.	25697	*Phalacrocorax carbo (Great Cormorant)*			
176.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
177.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
178.	25699	*Phalacrocorax varius (Pied Cormorant)*			
179.	24409	*Phaps chalcoptera (Common Bronzewing)*			
180.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
181.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
182.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
183.	24842	*Platalea regia (Royal Spoonbill)*			
184.	25720	*Platycercus icterotis (Western Rosella)*			
185.	24843	*Plegadis falcinellus (Glossy Ibis)*		IA	
186.	25509	*Pletholax gracilis (Keeled Legless Lizard)*			
187.	25007	*Pletholax gracilis subsp. gracilis (Keeled Legless Lizard)*			
188.	24383	*Pluvialis squatarola (Grey Plover)*		IA	
189.	25703	*Podargus strigoides (Tawny Frogmouth)*			
190.	25704	*Podiceps cristatus (Great Crested Grebe)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
191.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
192.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
193.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
194.	25722	*Polytelis anthopeplus (Regent Parrot)*			
195.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
196.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
197.	24769	*Porzana fluminea (Australian Spotted Crake)*			
198.	25732	*Porzana pusilla (Baillon's Crake)*			
199.	24771	*Porzana tabuensis (Spotless Crake)*			
200.	25511	*Pseudonaja affinis (Dugite)*			
201.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
202.		*Purpureicephalus spurius*			
203.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
204.	24243	*Rattus fuscipes (Western Bush Rat)*			
205.	24245	*Rattus rattus (Black Rat)*	Y		
206.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
207.	48096	*Rhipidura albiscapa (Grey Fantail)*			
208.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
209.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
210.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
211.	30948	*Smicrornis brevirostris (Weebill)*			
212.	24329	*Stictonetta naevosa (Freckled Duck)*			
213.	25597	*Strepera versicolor (Grey Currawong)*			
214.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
215.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
216.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
217.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
218.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
219.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
220.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
221.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
222.	48135	*Thinornis rubricollis (Hooded Plover, Hooded Dotterel)*		P4	
223.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
224.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
225.	25519	*Tiliqua rugosa*			
226.	25204	*Tiliqua rugosa subsp. aspera*			
227.	25207	*Tiliqua rugosa subsp. rugosa*			
228.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
229.	48141	*Tribonyx ventralis (Black-tailed Native-hen)*			
230.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
231.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
232.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
233.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
234.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
235.	24809	*Tringa stagnatilis (Marsh Sandpiper, little greenshank)*		IA	
236.	48147	*Turnix varius (Painted Button-quail)*			
237.		*Urodacus novaehollandiae*			
238.	24386	*Vanellus tricolor (Banded Lapwing)*			
239.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
240.		*Venator immansueta*			
241.	24206	*Vespadelus regulus (Southern Forest Bat)*			
242.	41351	*Xenus cinereus (Terek Sandpiper)*		IA	
243.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix D EPBC Protected Matters Database Search

Australian Government
Department of the Environment and Energy

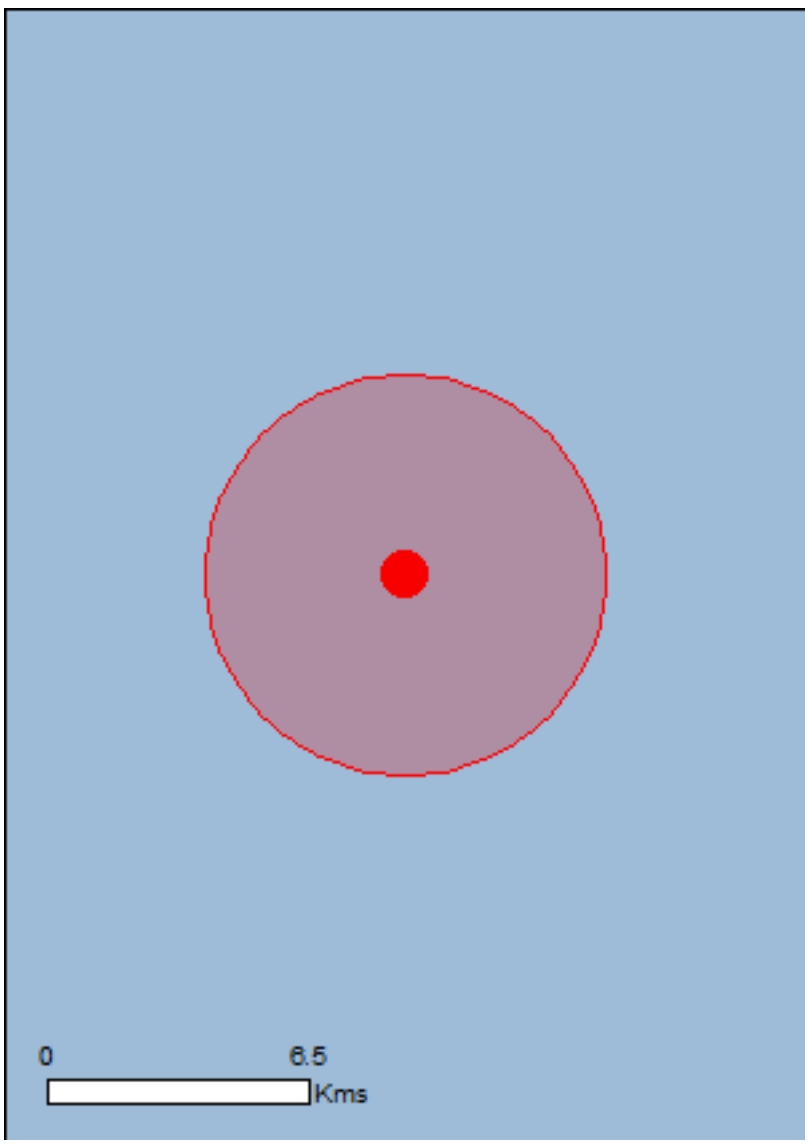
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

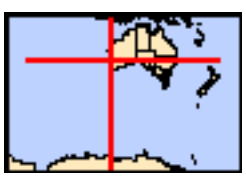
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/11/19 15:20:14



Coordinates

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	22
Listed Migratory Species:	19

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	28
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	5
Regional Forest Agreements:	None
Invasive Species:	40
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site
Peel-yalgorup system	30 - 40km upstream

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii		
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis		
Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat likely to occur within area
Other		
Westralunio carteri		
Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Andersonia gracilis		
Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Diuris drummondii		
Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat may occur within area
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei		
Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica		
Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha		
Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Eleocharis keigheryi		
Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat may occur within area
Lepidosperma rostratum		
Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Sterna dougallii		
Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Harry Waring Marsupial Reserve	WA
Thomsons Lake	WA
Unnamed WA48291	WA
Unnamed WA49561	WA
Wandi	WA

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Gibbs Road Swamp System	WA
Spectacles Swamp	WA
Thomsons Lake	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-32.1855 115.8449

Acknowledgements

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

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

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

Please feel free to provide feedback via the Contact Us page.

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