[redacted] Potential Offset Site, Fauna Assessment

Banksia menziesii cones chewed by Carnaby's Black-Cockatoo. Photo: Mike Bamford.

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Executive Summary

Bamford Consulting Ecologists (BCE) was commissioned by MBS Environmental on behalf of Meteor Stone to conduct a black-cockatoo habitat assessment, as well as a brief assessment regarding other conservation significant fauna, of a potential offset site (the project area) in [redacted]. The assessment includes a brief desktop component and field investigations. The primary purpose of these field investigations is to provide information on the foraging value (for black-cockatoos) of the potential offset sites to help determine the suitability of the site as an offset for Carnaby's Black-Cockatoo. This includes identifying Vegetation and Substate Associations (VSAs; provide habitat for fauna), which also informs a discussion of the conservation significant fauna likely to be present and how they are expected to use the project area. This report presents the results of the targeted black-cockatoo assessment for the project area, along with a discussion of other conservation significant fauna likely to use the project area, patterns of biodiversity across the landscape, and key ecological processes influencing fauna. The project area was visited on 17th March 2024.

Description of project area

The project area is c. [redacted] in size and is comprised primarily of banksia woodland. It is located approximately [redacted] north of Perth, in the Perth (SWA02) subregion of the Swan Coastal Plain bioregion. This bioregion can broadly be defined as a low lying coastal plain, mainly covered with woodlands, dominated by *Banksia* or Tuart on sandy soils, *Allocasuarina obesa* on outwash plains, and paperbark in swampy areas. It has a warm Mediterranean climate.

Carnaby's Black-Cockatoo

The project area is not within the range of the Forest Red-tailed Black-Cockatoo, *Calyptorhynchus banksii naso*) or Baudin's Black-Cockatoo (*Zanda baudinii*). Carnaby's Black-Cockatoo (*Zanda latirostris*) is likely to be a regular visitor to the project area and is known to breed in the region (c. 16 km from the project area). Carnaby's Black-Cockatoo is listed as Endangered under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and Schedule 2, Division 2 (Endangered) under the *WA Biodiversity Conservation (BC) Act 2016.*

Vegetation and Substrate Associations (VSAs)

VSAs combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. Three VSAs were identified in relation to fauna in the project area. The majority of the project area is made up of Banksia Open, Low Woodland (VSA 1), comprised of *Banksia* spp. with scattered Coastal Blackbutt (*Eucalyptus todtiana*) over grass trees and mixed shrubs on sandplain. The remainder of the project area comprises two small areas of Banksia Low Woodland (VSA 2) which is similar to VSA 1 but less open and slightly taller, and an area of Melaleuca dampland (VSA 3), which comprises a patchy woodland of *Melaleuca preissiana* over damp heath of mixed shrubs including *Hakea trifurcata*(?), on dark, peaty soil. The majority of the project area was burnt c. 3 years prior to the current site inspection but has substantially regenerated.

Key species of conservation significance

The project area is expected to support four key conservation significant vertebrate species: the Jewelled Ctenotus (CS2 (P3)), Black-striped Burrowing Snake (CS2 (P3), Carnaby's Black-Cockatoo (CS1 (EN, S2D2)) and the Brush Wallaby (CS2 (P4)). The targeted black-cockatoo assessment is summarised below.

It is likely that the Banksia woodlands of the project area will support a variety of conservation significant invertebrates, including species listed under federal and/or state publications, as well as a suite of short-range endemic (SRE) or potential SRE species.

Black-cockatoo assessment

Carnaby's Black-Cockatoo was not observed in the project area during the site inspection, but old and recent foraging evidence and a feather from this species were found. Suitable foraging habitat for Carnaby's Black-Cockatoo is present throughout the project area, in the form of *Banksia* spp. in VSA 1 and VSA 2, and *Hakea* shrubs in VSA 3.

Summary of black-cockatoo assessment

- Foraging value – overall the project area is of moderate foraging value for Carnaby's Black-Cockatoo, with a (rounded) weight average foraging score of 7/10. Foraging scores ranged from 8/10 for small areas with the highest density of *Banksia* trees (VSA 2), to 7/10 for areas with a lower density of *Banksia* trees (VSA 1) and 3/10 for areas with no *Banksia*, but which contained palatable *Hakea* shrubs (VSA 3).
- Breeding value – no trees were large enough to be assessed as potential nesting trees. The closest known breeding sites are within the Cataby Important Bird Area, c. 16 km from the boundary of the project area.
- Roosting value – No suitable areas for roosting sites were apparent within the project area. The closest known and confirmed roost is c. 10 km from the project area and was last confirmed used in 2022, when 1510 birds were counted. It is expected that this roost site would also have been confirmed used in 2023; the dataset available does not extend past 2022.

Patterns of biodiversity

The project area is relatively uniform, with the two *Banksia* woodland VSAs only differing slightly in the height and density of *Banksia* trees but having a similar understorey in terms of structure and composition. The loose sand and leaf litter of these VSAs is likely to support the conservation significant Black-striped Burrowing Snake and Jewelled Ctenotus. Both have been recorded at Cooljarloo, about [redacted] north-east, in similar VSAs (BCE database). The *Banksia* trees of these VSAs provide the highest foraging value for Carnaby's Black-Cockatoo (of all VSAs present). The *Melaleuca* dampland of VSA 3 is expected to support a high abundance and variety of fauna species; the assemblage supported may vary seasonally depending on inundation of this area. The plant species present provide low value foraging habitat for Carnaby's Black-Cockatoo, in the form of *Hakea* shrubs. It is likely that the Brush Wallaby will utilise all VSAs of the project area, so long as the understorey is dense enough to provide sufficient shelter.

Key ecological processes.

The ecological processes that are expected to influence the fauna assemblage include existing habitat loss, landscape connectivity and the presence of feral species. Local hydrology may impact fauna as there is a small area of damplands that appears to be seasonally inundated and which may support certain fauna species. The bushfire c. 3 years prior to the current site inspection may have had a short-term impact on the fauna assemblage but it is expected that being part of a large, continuous patch of native vegetation would have buffered the project area against any long-term impacts.

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1 Introduction

Bamford Consulting Ecologists (BCE) was commissioned by MBS Environmental on behalf of Meteor Stone to conduct a black-cockatoo habitat assessment, as well as a brief assessment regarding other conservation significant fauna, of a potential offset site (the project area) in [redacted]. The project area is comprised primarily of Banksia woodland. The assessment includes a brief desktop component (regarding nearby black-cockatoo records and other species of conservation significance), and field investigations. The primary purpose of these field investigations is to provide information on the foraging value (for black-cockatoos) of the potential offset sites to help determine the suitability of the site as an offset for Carnaby's Black-Cockatoo. This includes identifying Vegetation and Substate Associations (VSAs; habitats for fauna), which also informs a discussion of the conservation significant fauna likely to be present and how they are expected to use the project area. During field investigations, information regarding black-cockatoo nesting and roosting habitat was obtained opportunistically.

This report presents the results of the black-cockatoo habitat assessment for the project area, along with a discussion of conservation significant fauna likely to use the project area, patterns of biodiversity across the landscape, and key ecological processes influencing fauna.

Figure 1-1. Location of the project area.

1.1 Carnaby's Black-Cockatoo

The project area is out of range for the Forest Red-tailed Black-Cockatoo and Baudin's Black-Cockatoo and, as such, Carnaby's Black-Cockatoo is the only black-cockatoo expected to occur in the project area. The project area is within the species' range, and the species is known from within 15 km of the project area (see Section 3.2.1.1). Carnaby's Black-Cockatoo is listed as Endangered under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* (EPBC Act) and falls under Schedule 2 Division 2 (Endangered) of the Western Australian *Biodiversity Conservation Act 2016* (BC Act). See Appendix 1 and 2 for conservation significance categories and descriptions. The species is expected to occur as a regular visitor in the project area.

1.2 Project area

The project area is c. [redacted] in size and located approximately [redacted] north of Perth in the very south of the Midwest region (DBCA, 2023b). The Interim Biogeographic Regionalisation of Australia (IBRA v7) has identified 27 bioregions in Western Australia which are further divided into subregions (DCCEEW, 2023a). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway & Cresswell, 1995). The project area is in the north of the Perth subregion (SWA02) of the Swan Coastal Plain bioregion. The Perth (SWA02) subregion was described by Mitchell *et al.*(2003) and a summary of their work follows here. The Swan Coastal Plain bioregion is a low lying coastal plain, with woodlands the predominant vegetation type, and dominant species comprising *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The Perth subregion is made up of colluvial sands and alluvial river flats (dominated by Marri vegetation), aeolian sands/dunes (dominated by Banksia and Jarrah-Banksia woodlands), and coastal limestone (with heath and/or Tuart woodlands). This subregion also includes a complex series of seasonal wetlands and several offshore islands (including Garden Island). The Swan Coastal Plain bioregion falls into the Southern Climatic Region (EPA, 2020) and the climate of the Perth subregion is Mediterranean (Mitchell *et al*., 2003). Average rainfall for the station closest to the project area is 588 mm (Station: Lancelin, Number 009114, BOM, 2023).

The dominant land uses within the Perth (SWA02) subregion are Cultivation (both dry land agriculture, and irrigated horticulture, agriculture and plantations), Conservation, UCL and Crown reserves, Urban, Rural residential, Forestry plantations, Roads and other easements and Grazing (improved pastures), with smaller areas of Mining and Defence lands (Mitchell *et al*., 2003). The project area is comprised of intact remnant vegetation surrounded by areas cleared for agriculture (mostly to the west) and large areas of native vegetation. Existing development within 15 km consists of cleared agricultural land and a network of sealed and unsealed roads.

Within 15 km of the project area, the landscape comprises 39 soil subsystems, from six systems within four zones (details from Schoknecht *et al.*(2004):

1. Perth Coastal Zone (characterised by calcareous and siliceous sands and calcarenite (a type of limestone)): Quindalup and Spearwood systems
2. Bassendean Zone (fixed dunes inland from coastal dune zone, characterised by non-calcareous sands and podsolised soils with low-lying wet areas): Bassendean system
3. Dandaragan Plateau Zone (characterised by areas of sandplain and some laterite on a gently undulating plateau): Capitella and Rowes systems
4. Arrowsmith Zone (sandy and gravelly soils on a lateritic sandplain): Boothendarra system

The project area itself lies entirely within the Bassendean 1 subsystem of the Bassendean system (DPIRD, 2023c), described as an undulating to flat sandplain with minor swamps, and pale to yellow deep sands (Schoknecht et al., 2004). Pre-European vegetation (Beard *et al*., 2013; DPIRD, 2023b) within 15 km of the project area is thought to have consisted of six vegetation types (3, 9, 14, 18, 107 and 108) as well as areas of salt lake and exposed dune sand. The majority of the 15 km buffer, including the entirety of the project area, was thought to have consisted of vegetation type 9: Low woodland or open low woodland, dominated by *Acacia* spp., *Banksia* spp., *Agonis flexuosa* (Peppermint), *Callitris* spp., *Allocasuarina* spp. and *Eucalyptus loxophleba* (York Gum).

1.3 Recognised sensitive sites

A number of recognised sensitive sites occur within 15 km of the project area, including Important Wetlands (DBCA, 2023c), Environmentally Sensitive Areas (ESAs) (DWER, 2023b, 2023a) and several protected terrestrial reserves (DCCEEW, 2020, 2023e). The project area is part of a large, continuous area of native vegetation, which includes the protected areas of [redacted]

A large proportion of the 15 km buffer, including the entire project area, overlaps with Threatened Ecological Communities (TECs) (DBCA, 2023d, 2023g). Based on cross-referencing with the Protected Matters Search Tool (DCCEEW, 2023e), the TEC that overlaps with the project area is likely to be Banksia Woodlands of the Swan Coastal Plain ecological community, which is Endangered. Two other TECs may occur in the project area (DCCEEW, 2023e) but were not observed: Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion (Critically Endangered) and Tuart Woodlands and Forests of the Swan Coastal Plain ecological community (Critically Endangered). One other TEC occurs within 15 km but does not overlap with the project area (DCCEEW, 2023e): Clay pans of the Swan Coastal Plain.

The Key Biodiversity Area (KBA, 2023) of the [redacted]. This area is significant because it supports more than 1% of the breeding population of Carnaby's Black-Cockatoo, with nesting trees and foraging habitat distributed throughout remnant vegetation and isolated paddock trees (Key Biodiversity Areas Partnership, 2024). There are no Ramsar Sites (DBCA, 2023e) within 15 km.

Sensitive sites and protected areas within [redacted] are shown on Figure 1-2.

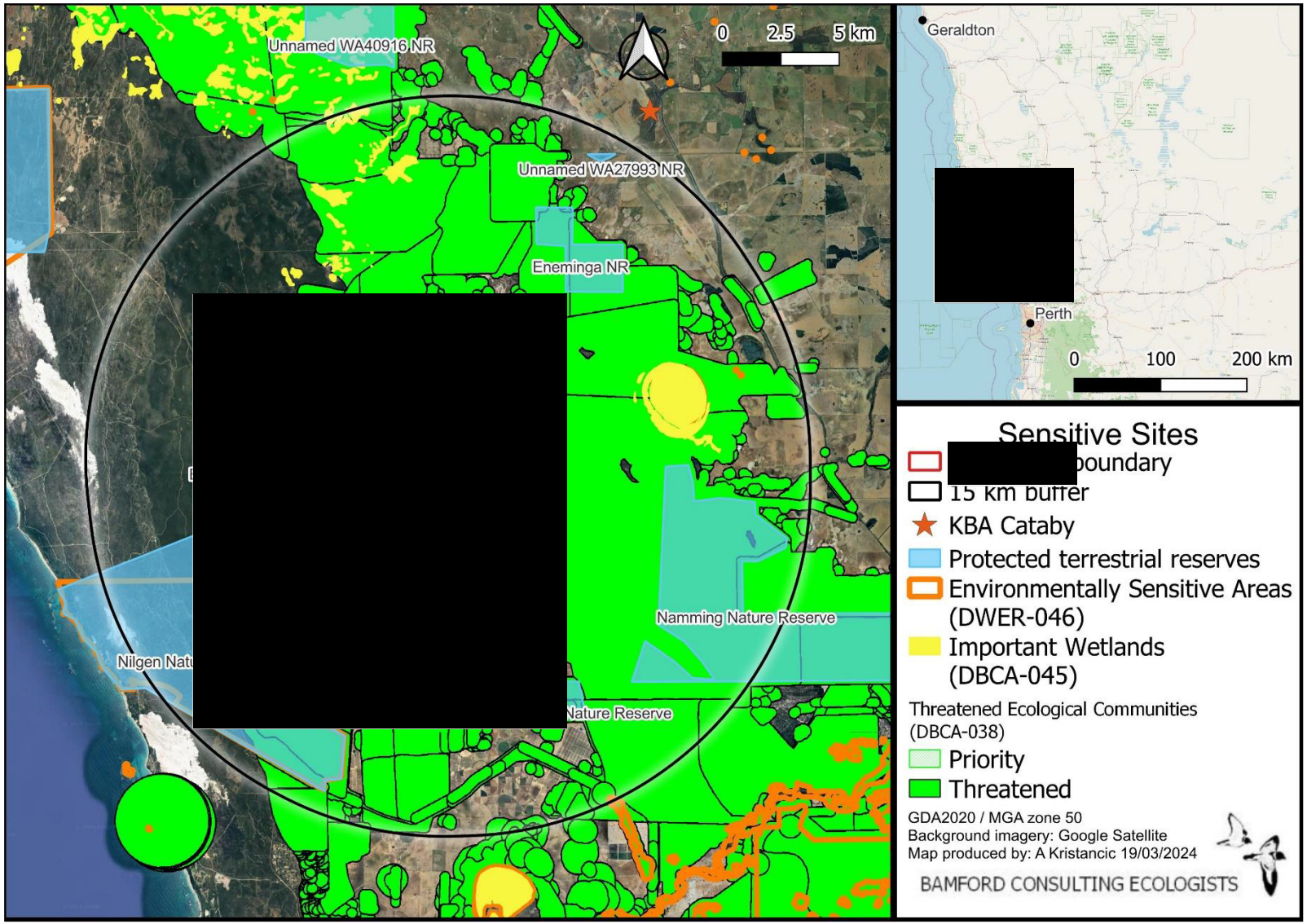

Figure 1-2. Recognised sensitive sites and protected areas within [redacted] of the project area.

2 Methods

2.1 Overview

The primary objective when assessing the value of offset properties for black-cockatoos is to assess the foraging value of existing vegetation. As a score is given for each 'type' of vegetation present, this first requires identification of the broad Vegetation and Substrate Associations (VSAs) present at the site. The foraging preferences of each species of black-cockatoo differ, therefore the foraging value is calculated separately for each black-cockatoo species under consideration. These methods are described in detail in Section 2.5 below and in Appendix 3. Identification of the VSAs in the project area also informs the discussion of conservation significant fauna likely to be present, and how they are expected to use the project area.

2.2 Dates and personnel

Personnel involved in the field investigations and report preparation (including desktop review) are listed in Table 2-1. The potential offset site was visited on the 17th March 2024. The purpose of the field investigations was to provide the following information:

- Identification of Vegetation and Substrate Associations (VSAs) for which foraging value is calculated (a separate score is calculated for each VSA for each black-cockatoo species) and which informs a discussion of conservation significant species likely to be present;
- Assessment of foraging value across the site (described in Section 2.5.2.2); and
- Opportunistic assessment of potential nesting trees, if present, and opportunistic observations of potential roosting sites. Field personnel stayed on high ground adjacent to the site until sunset to check for any flocks of Carnaby's Black-cockatoos moving towards roosting site within or close to the project area.

Table 2-1. Personnel involved in the field investigations and report preparation.

Personnel	EIA Experience	Field Investigations	Report Preparation
Dr Mike Bamford *BSc (Biology), Hons (Biology), PhD (Biology)*	40 years	+	+
Natalia Huang *BEnvSc (Zoology), Hons (Conservation Biology), MBA*	16 years		+
Dr Amanda Kristancic *BSc (Zoology/Biochemistry), Hons (Zoology), PhD (Parasitology)*	3 years		+

2.3 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

For the current assessment, VSAs were identified based on observations made during the field investigations and are described in Section 3.1 below. These VSAs were mapped using aerial imagery as a guide, and this formed the basis for the mapping of foraging scores presented in Section 0.

2.4 Opportunistic observations

At all times, observations of fauna or fauna signs were noted when they contributed to the accumulation of information on the fauna of the site.

2.5 Black-cockatoo habitat analysis

2.5.1 Desktop review

Databases were queried for information regarding black-cockatoos, including records of individuals or flocks, known roosting sites and known breeding sites. Previous reports including black-cockatoo habitat assessment within 15 km were obtained and summarised to supplement information available in databases. These sources of information are summarised in Table 2-2 and Table 2-3.

Table 2-2. Databases searched for records relating to black-cockatoos.

Database	Type of records obtained	Area searched
Atlas of Living Australia (ALA, 2023)	Observations of black-cockatoos	15 km buffer around boundary of project area.
DBCA breeding sites publicly available (DBCA, 2023b)	Known breeding sites for Carnaby's Black-Cockatoo	Broad region.
Roosting sites dataset (BirdLife Australia, 2023)	Records of known roosting sites from the Great Cocky Count (Bird Life Western Australia).	Broad region.
EPBC Protected Matters Search Tool (DCCEEW, 2023e)	Records on MNES protected under the EPBC Act.	15 km buffer around boundary of project area.
Index of Biodiversity Surveys for Assessment (IBSA) (DWER, 2023c)	Previous reports relating to black-cockatoo habitat assessment.	15 km buffer around boundary of project area.

Table 2-3. Reports relating to black-cockatoo habitat assessment, returned from IBSA search during desktop review. Reports that are in italics did not have any resources publicly available and are not included in reference list.

Author	Title	Distance to project area
Eco Logical Australia (2020)	Black Cockatoo Habitat Assessment of Part of [redacted]. Prepared for Public Transport Authority.	10 km
360 Environmental	Flora, Vegetation and Black Cockatoo Assessment. Prepared for: ACOR MCE Consultants Pty Ltd. December 2017	12 km

2.5.2 Field investigations

2.5.2.1 Guidelines

The Department of Climate Change, Energy, the Environment and Water (DCCEEW, formerly DAWE) provides guidelines for the referral of actions that may result in impacts to black-cockatoos (for assessment under the EPBC Act). The survey and analysis reported here have been conducted with strong reference to both the referral guidelines provided by DSEWPaC (2012) and DAWE (2022). This includes application of the foraging habitat scoring tool in DEE (2017). In addition, survey methodology followed the recommendations listed on the DCCEEW's Species Profile and Threats Database (DCCEEW, 2023b, 2023d, 2023c). Ecological values for black-cockatoos within the site were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DSEWPaC, 2012).

Actual scoring of foraging value and assessment of potential breeding habitat was based on systems developed by BCE that are outlined below and in Appendix 3. The DBCA has indicated that the methodology developed and applied previously by BCE (e.g. Bancroft & Bamford, 2021), and as described below, to score nesting value and foraging habitat, is an acceptable approach. BCE has used this system previously in reports and it has been accepted by the regulator.

2.5.2.2 *Assessment of foraging value*

The foraging value of the study area was assessed by calculating a foraging score for each VSA (areas of similar vegetation type/condition, see Appendix 3). The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for black-cockatoos, and this numerical value is designed to provide the sort of information needed by federal DCCEEW, the state Department of Water and Environmental Regulation (DWER) and Department of Energy, Mines, Industry Regulation and Safety (DMIRS), and the WA Environmental Protection Authority (EPA) to assess impact significance and offset requirements. The foraging value (also referred to as 'habitat quality score ' (HQS)) of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed in Appendix 3. These three components are drawn from the DCCEEW offset calculator (DCCEEW, undated) but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
  This is based on the presence, abundance and condition of vegetation that is used for foraging by the black-cockatoo under consideration (as described in Appendix 3).

- A score out of three for the context of the site.
  The context score is a function of the proportion of native vegetation within the local area that lies within the offset area, and is also affected by the vegetation condition score (as described in Appendix 3. The local area for site context is considered to be a 15km radius around the offset area. Native vegetation within the local area (15 km radius) is based on the Department of Primary Industry and Regional Development's online shapefile of native remnant vegetation polygons in Western Australia (DPIRD, 2023a).
- A score out of one for species density.
  As described in Appendix 3, the species density score (out of 1) is assigned on the basis of observed or predicted regular presence of foraging birds. For example, birds may not be observed and foraging evidence may not be found during a short site visit, but if there are birds and/or foraging evidence nearby, and the habitat has a moderate to high vegetation condition score, then it is certain to be visited regularly by foraging birds and is given a density score of 1 accordingly. If birds or foraging evidence are not observed, and the regular presence of foraging birds is not expected, then the area is given a stocking rate score of 0.

The combination of the vegetation condition score, the context score and the species density score provides an overall foraging value score (the overall HQS) out of 10. A higher score represents better foraging value. A score out of 10 is presented for the purposes of aiding offset calculations. The approach to assigning scores for vegetation, context and species density are outlined in Appendix 3. Foraging value scores are calculated separately for the two black-cockatoo species (Appendix 3) depending upon the vegetation present; thus a separate score is given for each VSA for each species.

An overall foraging score for the project area was calculated based on the individual HQS of each VSA and the proportion of the project area made up of each VSA. This provides an average weighted habitat quality score (HQS) for the project area as a whole, which is always rounded up for comparative purposes; conventional rounding rules could lead to very different sites being considered to be similar.

Black-cockatoo foraging signs were also recorded in conjunction with the foraging value assessments. When foraging signs were observed, the location and tree species were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. Factors that help to establish the time since foraging include: the colour of nuts/foliage, the degree of weathering or decay of debris, the presence of small fragments of nut debris, the position/compression of the foraging debris relative to surrounding vegetation and leaf litter, and the strength of the eucalypt smell emitted. Despite the absence of empirical data, four categories of foraging activity were recognised, based on the time since foraging:

(i) Active – where birds were observed in the act of foraging;
(ii) Recent – foraging signs (e.g. chewed nuts or vegetation) were 'fresh' (i.e. foraging was likely to have occurred within days to weeks). Recent foraging signs were typically green and/or with very little sign of weathering. Approximately less than four weeks old;
(iii) Intermediate – foraging was likely to have occurred within weeks to months previously. Approximately one to six months old; and
(iv) Old – foraging was likely to have occurred months to years previously. Approximately more than six months old.

2.5.2.3 *Black-cockatoo breeding*

The aim of the breeding surveys was to opportunistically record presence of potential hollow-bearing trees (suitable for black-cockatoo nesting) within the project area. A potential nesting tree is considered any tree with a diameter at breast height (DBH) equal to or greater than 500 mm (or 300 mm for Wandoo/Salmon Gum) (DCCEEW, 2023d, 2023c, 2023b). The following information was recorded for suitable trees:

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 2-4.

Table 2-4. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 21/08/2023).

As per information from DCCEEW (2023d, 2023c, 2023b), a potential nest-tree is any tree with a diameter at breast height >500 mm (or >300 mm for *Eucalyptus salmonophloia* and *E. wandoo*). Note that black-cockatoos favour vertical hollows for the nest chamber, but the hollow entrance may be vertical (a chimney hollow), have a side entrance or have a horizontal spout entrance.

Rank	Description of tree and hollows/activity
1	Activity at hollow observed; adult (or immature) bird seen entering or emerging from hollow. Can also be used for a known nest tree active in the previous 12 months (although this should be noted in the description). Note that activity at a hollow does not absolutely mean that breeding is occurring unless a young bird in hollow is observed.
2	Hollow of suitable size visible with chew marks around entrance. Record if chew-marks are recent or old.
3	Potentially suitable hollow visible but no chew marks present at entrance; or potentially suitable hollow suspected to be present - as suggested by structure of tree, such as large, vertical trunk broken off at a height of >8m; but note that hollow height is contextual. Carnaby's Black-Cockatoo will nest in hollows <5m so in a Wheatbelt breeding site a lower criterion may be more appropriate.
4	Tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows (nest chamber) are not vertical or near-vertical; thus, a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black-Cockatoos. Trees with low but otherwise suitable hollows can also be assigned a rank or 4, depending on the species of Black-Cockatoo likely to be present.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

2.5.2.4 Black-cockatoo night roosting

As per the guidance of DAWE (2022), areas likely to be used as night roosting sites were noted during field investigations, based on the topographical, physical and vegetation characteristics present (such as sites adjacent to watercourses with large trees) and/or indirect evidence of roosting (e.g. guano deposits, discarded feathers).

2.5.2.5 Potential watering points

During the desktop review and site inspection, any potential watering points for black-cockatoos were noted and details are presented in the relevant sections below.

2.6 Conservation significant fauna

A list of conservation significant vertebrate and invertebrate fauna expected in the project was compiled based on previous BCE surveys nearby, general literature regarding expected distributions of species, and the consultants' extensive previous experience and familiarity with the fauna of this region. This list is provided in Appendix 4 and key conservation significant species are discussed in Section 3.3 below. Several conservation significant species are considered locally extinct in this region; these are detailed in Appendix 4.

2.7 Mapping

Low resolution maps (300-400dpi) have been provided within the body this report. As per the recommendation of EPA (2020), maps use the GDA2020 datum and are projected into the appropriate Map Grid of Australia (MGA94) zone.

2.8 Survey Limitations

The EPA Guidance Statement 56 (EPA, 2004) and the EPA (2020) outline a number of limitations that may arise during field investigations for Environmental Impact Assessment. These survey limitations are discussed in the context of the BCE investigation of the project area in Table 2-5. No limitations were identified.

Table 2-5. Survey limitations as outlined by EPA (2020).

EPA Survey Limitations	BCE Comment
Availability of data and information	Sufficient information from databases and previous studies. Not a limitation.
Competency/experience of the survey team, including experience in the bioregion surveyed	The ecologists have had extensive experience in conducting field surveys for environmental impact assessment fauna studies, particularly for black-cockatoo habitat assessments and have undertaken a number of studies within the region. Not a limitation.
Scope of the survey (e.g. were faunal groups were excluded from the survey)	The scope of the assessment was a targeted survey for black-cockatoo foraging habitat, and identification of fauna habitats. The latter informs a discussion of conservation significant fauna likely to be present. Not a limitation.
Timing, weather and season	Seasonality is not of great importance for this type of assessment. Not a limitation.
Disturbance that may have affected results	None. Not a limitation.
The proportion of fauna identified, recorded or collected	All fauna observed were identified. Not a limitation.
Adequacy of the survey intensity and proportion of survey achieved (e.g. the extent to which the area was surveyed)	The project area was adequately surveyed to the level appropriate for a black-cockatoo foraging values assessment. Not a limitation.
Access problems	No access problems were encountered. Not a limitation.
Problems with data and analysis, including sampling biases	There were no data problems. Not a limitation.

3 Results

3.1 Vegetation and Substrate Associations

Almost the entire project area was burnt c. 3 years prior to the site inspection but has substantially regenerated. Both key Banksia species (*B. attenuata* and *B. menziesii*) have flowered since the fire. It appears that some small areas in the south-west and north-east of the project area, as well as the dampland area in the north-west, were not burnt. Based on observations made during the site inspection, three broad VSAs were identified in relation to fauna in the project area:

VSA 1: Banksia Open, Low Woodland. Open, low woodland of *Banksia* spp. (predominantly *Banksia attenuata* with c. 10% *B. menziesii* and occasional *B. prionotes* along southern border and single *B. grandis* on margin of dampland) with scattered Coastal Blackbutt (*Eucalyptus todtiana*) over grass trees and mixed shrubs on sandplain. The projected foliage cover was temporarily reduced by the recent fire, with canopies still regenerating. This VSA makes up c. 76 % of the project area. See Plate 1.

VSA 2: Banksia Low Woodland. Low woodland of *Banksia* spp. (predominantly *Banksia attenuata* with c. 10% *B. menziesii*) over grass trees and mixed shrubs on sandplain, undulating in south-east. Trees slightly taller than in VSA 1 as well as at a higher density. This VSA makes up c. 13 % of the project area. See Plate 2.

VSA 3: Melaleuca Dampland. Patchy woodland of *Melaleuca preissiana* over damp heath of mixed shrubs including *Hakea trifurcata*(?), on dark, peaty soil. A slight depression retains water but was dry at the time of the site inspection. This VSA makes up c. 11 % of the project area. See Plate 3.

The distribution of VSAs across the project area is shown in Figure 3-1.

Plate 1. Representative photograph of VSA 1 (Banksia Open, Low Woodland). This photograph is from the south-west corner and is approximately 3 years post fire.

Plate 2. Example of VSA 2 (Banksia Low Woodland). This photograph is from the north-east corner of project area (unburnt).

Plate 3. Examples of VSA 3 (Melaleuca Dampland) within the project area.

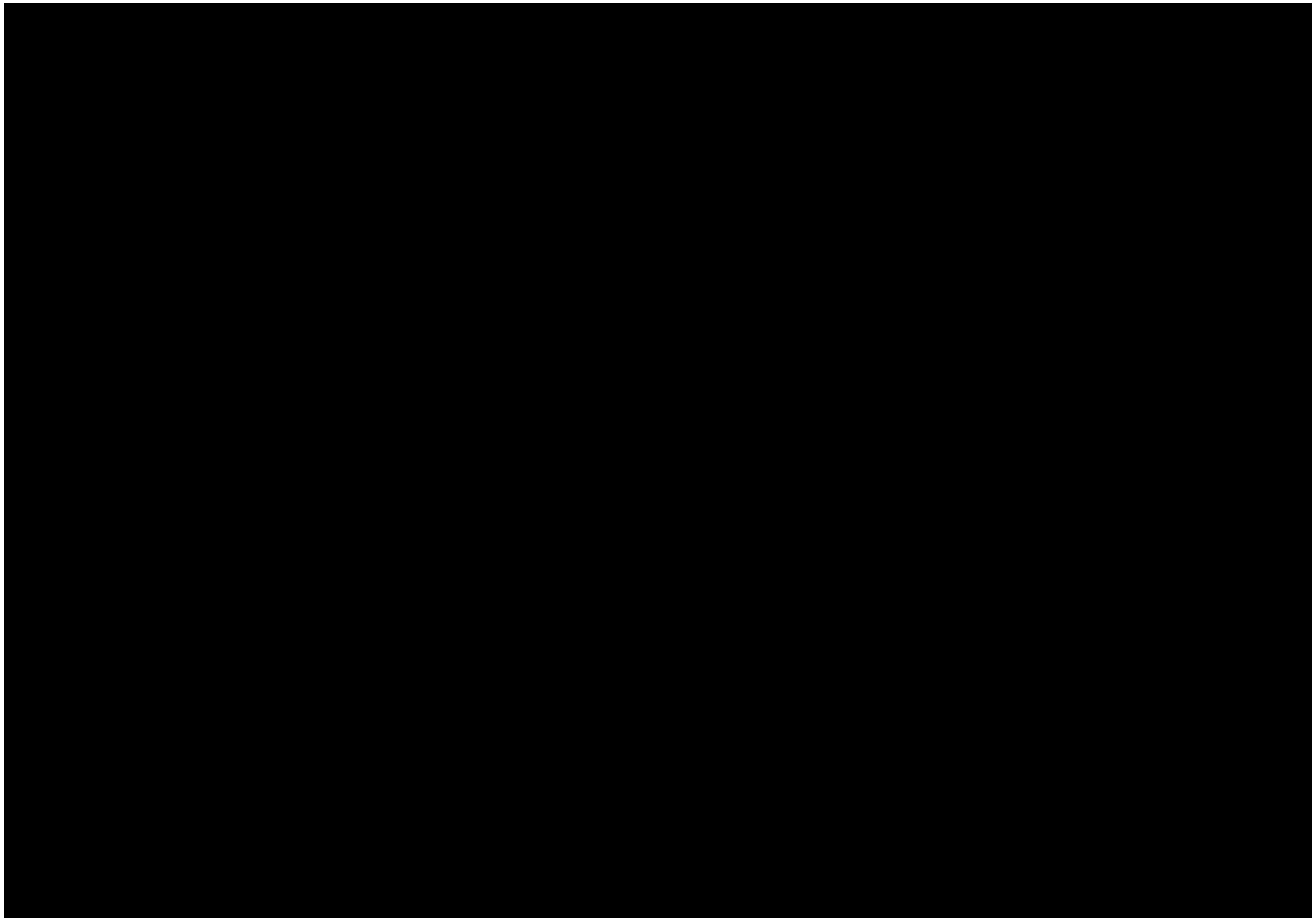

Figure 3-1. Distribution of VSAs within the project area.

3.2 Black-cockatoo habitat assessment

3.2.1 Black-cockatoo presence

3.2.1.1 Observations of black-cockatoos

Carnaby's Black-Cockatoo is known from the area, with 23 records of individuals or flocks (of up to 230 birds) within 15 km of the project area (ALA, 2024) and species or species habitat known to occur within this 15 km buffer (DCCEEW, 2023e). Breeding is known to occur in the Cataby Important Bird Area (Johnstone et al., 2015), which is [redacted] around the project area. No Carnaby's Black-Cockatoos were observed during the site inspection either in the project area or nearby, but the birds are highly mobile and cannot be expected to be present at all times.

3.2.1.2 Black-cockatoo foraging evidence

Evidence of foraging by Carnaby's Black-Cockatoo was found during the site inspection, on *Banksia attenuata* and *B. menziesii* cones. Plate 4 shows an example of the foraging evidence observed. The foraging evidence on *B. menziesii* was recent (probably weeks old) but was old (possibly around a year old) on *B. attenuata*.

Plate 4. Firewood Banksia (*Banksia menziesii*) cones chewed by Carnaby's Black-Cockatoo

3.2.2 Foraging value (Habitat Quality Score (HQS))

Foraging habitat for Carnaby's Black-Cockatoo was present throughout the project area, predominantly due to the presence of *Banksia* tree species and proteaceous shrubs such as *Hakea* spp. that are known to be palatable to the species. For Carnaby's Black-Cockatoo, the majority of the site consists of VSA 2 (Banksia Open Low Woodland) with a moderate to high foraging value of 7/10. The remaining VSAs were small and had low (VSA 3) or moderate to high (VSA 2) foraging value for Carnaby's Black-Cockatoo. The foraging scores for Carnaby's Black-Cockatoo for each VSA are presented in Table 3-1 and Figure 3-2, and details regarding the different elements (vegetation condition, context and stocking rate) are described in detail in Sections 3.2.2.1, 3.2.2.2 and 3.2.2.3.

The overall (rounded) weighted habitat quality score (HQS) for the project area is 6/10.

Table 3-1. Foraging scores for each VSA for Carnaby's Black-Cockatoo

Vegetation and Substrate Association (VSA)	Area (ha)	% of total area	Veg'n (/6)	Context (/3)	Density (/1)	HQS (/10)
VSA 1 – Banksia Open, Low Woodland	104	76	4	2	1	**7**
VSA 2 – Banksia Low Woodland	17	13	5	2	1	**8**
VSA 3 – Melaleuca Dampland	15	11	2	0	1	**3**
Total	136	100.0	Rounded weighted average HQS			**7/10**

3.2.2.1 Vegetation condition score

The project area consists primarily of VSA 1 (Banksia Low Open Woodland), with a projected foliage coverage of suitable foraging species (mostly *B. attenuata* with a small amount of *B. menziesii*) of about 10%, but this was temporarily reduced by the time since fire (about three years) and the canopy of the Banksias was still regenerating (for example, see Plate 1). As a result, a vegetation condition score of 3/6 was assigned to this VSA in recognition that the foliage cover will increase post-fire.

Small areas of VSA 2 (Banksia Low Woodland) occur in the north-east and south-east of the project area; the projected foliage coverage of suitable foraging species in this VSA is about 20-30%, but is patchy with occasional denser areas. As in VSA 1, the projected foliage cover has also been temporarily reduced across part of VSA 2 by the recent fire. Recognising the patchy density and the impact of fire, VSA 2 was assigned a vegetation condition score of 5/6.

The remainder of the project area consists of VSA 3 (Melaleuca Dampland) which contains lower quality foraging vegetation due to the absence of *Banksia* species. The vegetation condition score for this VSA is 2/6.

3.2.2.2 Calculation of context score

Based on the native vegetation dataset from DPIRD (2023a) the amount of native vegetation remaining within 15 km of the project area is c. 51, 431 ha. Therefore, the project area (c. 136 ha) comprises 0.26 % of the native vegetation in the 'local area' (see Appendix 3).

For VSA 1 and VSA 2, a context score of 2/3 was given. This is slightly higher than suggested by the extensive foraging habitat nearby, but the project area is adjacent to cleared land to the west. In addition, while there is no recorded breeding nearby, there is a likelihood that breeding is occurring in

the region with large trees likely around wetlands to the east. For VSA 3, the vegetation score was low, and so a context score of 0/3 was given. This recognises that this patch of vegetation, while providing some foraging value, is less important in the local landscape given the abundance of higher quality foraging habitat nearby.

3.2.2.3 Species density score

Evidence of foraging was observed within the project area, and there are abundant records of Carnaby's Black-Cockatoo nearby (see Section 3.2.1.1). Therefore, it is considered that this species is likely to be regularly present in the project area. A species density score of 1 was therefore given for all VSAs, as all provide foraging habitat.

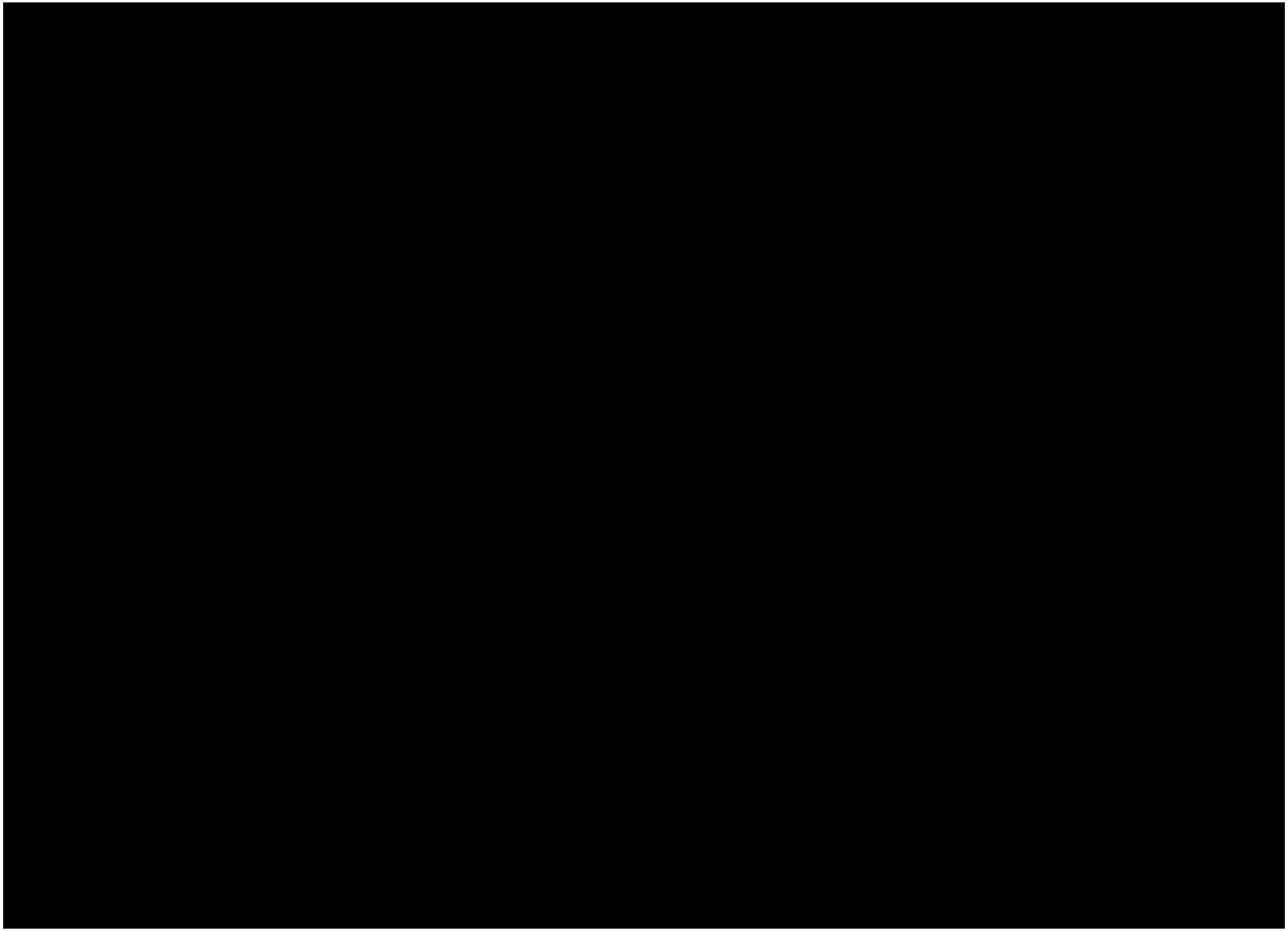

Figure 3-2. Distribution of foraging scores (HQS out of 10) for Carnaby's Black-Cockatoo.

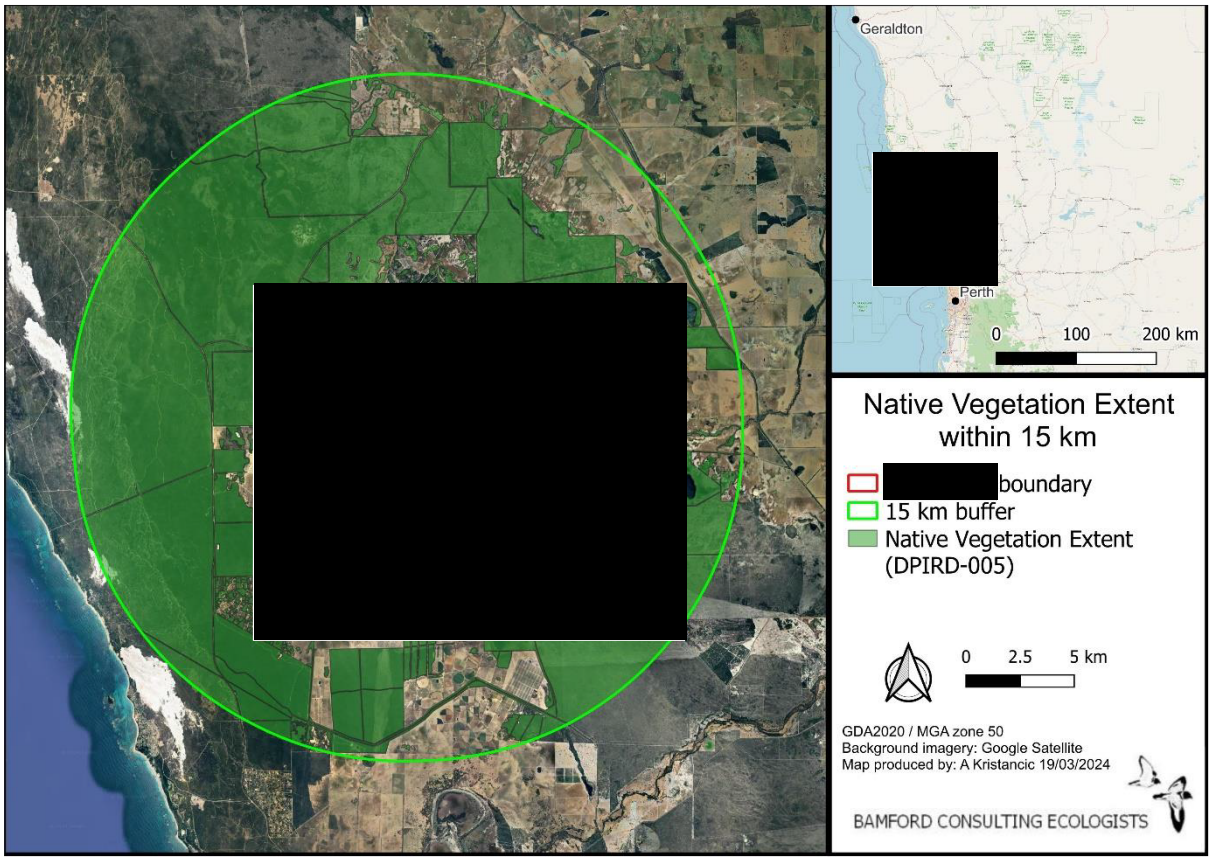

Figure 3-3. Estimated native vegetation in the local area (15 km buffer around the project area).

3.2.3 Black-cockatoo breeding

There were no large trees within the project area, so no trees were assessed as potential nest trees. There are no known breeding sites within 15 km of the project area, based on publicly available records from DBCA (2023a). About [redacted] of the project area, breeding is known to occur in the Cataby Important Bird Area (Johnstone *et al.*, 2015). About [redacted] the project area, Eco Logical Australia (2020) assessed another potential offset site and found that it contained six potential breeding trees, based on their size (diameter at breast height >500mm), but none contained hollows. Known breeding areas in the region are shown on Figure 3-4.

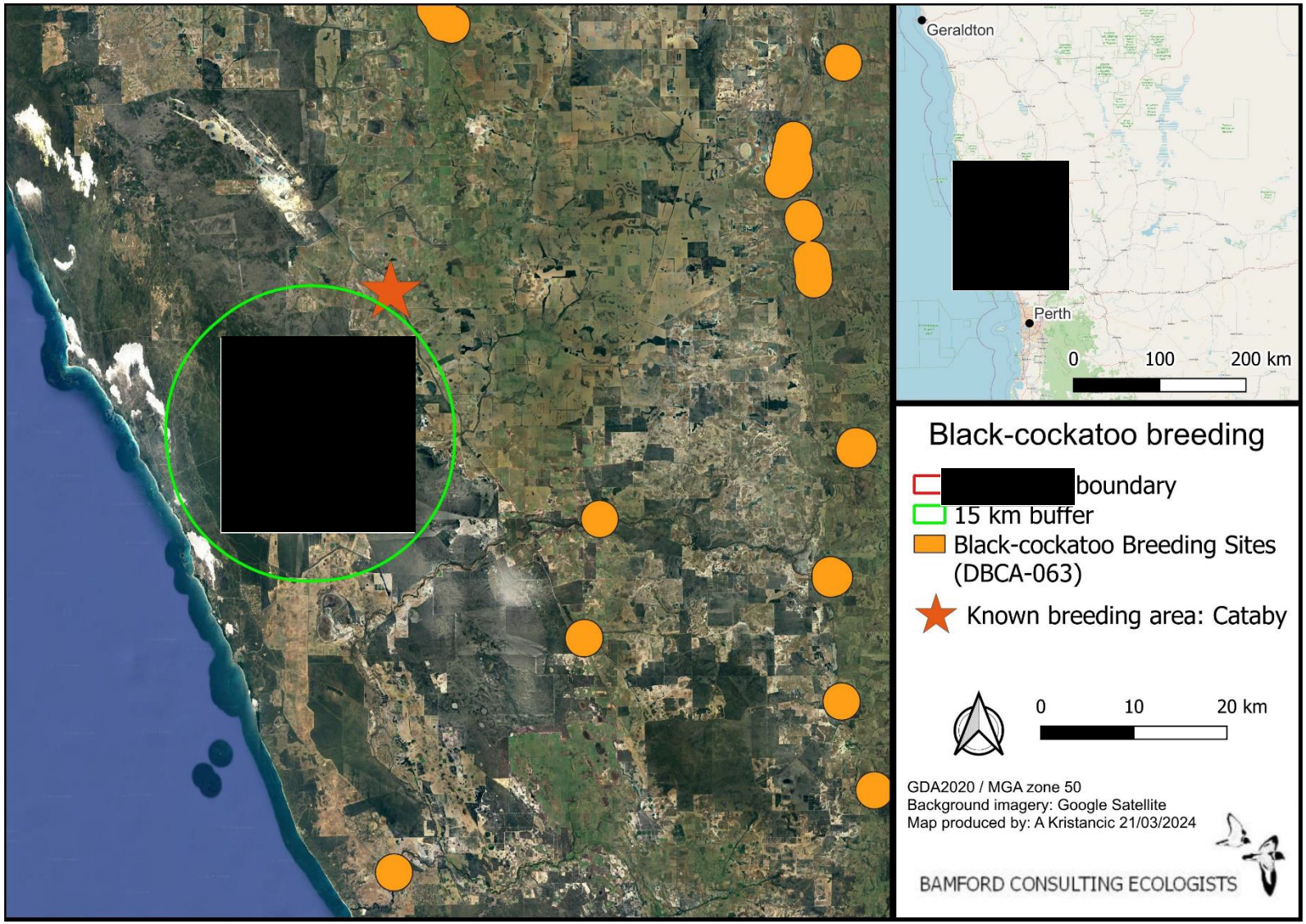

Figure 3-4. Known breeding sites in the region.

3.2.4 Black-cockatoo night roosting

No signs of roosting were observed during the site inspection, and the environment is not typical of that used for roosting as it lacks tall trees.

There is one confirmed roost within 15 km of the project area (BirdLife Australia, 2023; DBCA, 2023b). This site was last confirmed used in 2022 when 1510 white-tailed black-cockatoos (presumably Carnaby's) were counted. This site has been used every year since surveys began at this site in 2013. Note that the dataset available (BirdLife Australia, 2023) contains data up to 2022; therefore this site may have been used in 2023. Within the broader region, there are several more confirmed and unconfirmed roosts; unconfirmed roosts are not yet confirmed to have black-cockatoos using them but are considered likely (or anecdotally noted) roost locations. Known roost locations within the region are shown on Figure 3-5.

The limited number of known roosts close to the project area is not due to a lack of suitable roosting habitat but likely reflects a lack of survey effort in this area. Roosting is very likely to take place closer to the project area than available data indicate; this is suggested by the foraging evidence observed during the site inspection, as black-cockatoos typically travel <6 km from their roosts when foraging (Department of Environment and Conservation, 2012). The presence of roost sites nearby could be determined by conducting evening roost site surveys in the appropriate season.

3.2.5 Black-cockatoo watering points

There were no potential water sources for black-cockatoos within the project area. Within 15 km of the project area, there are several farm dams to the south and several lakes to the east, which may provide suitable watering points. It is likely that there are also several stock troughs/dams in the vicinity and, if so, it is probable that these sites could provide water for much of the year.

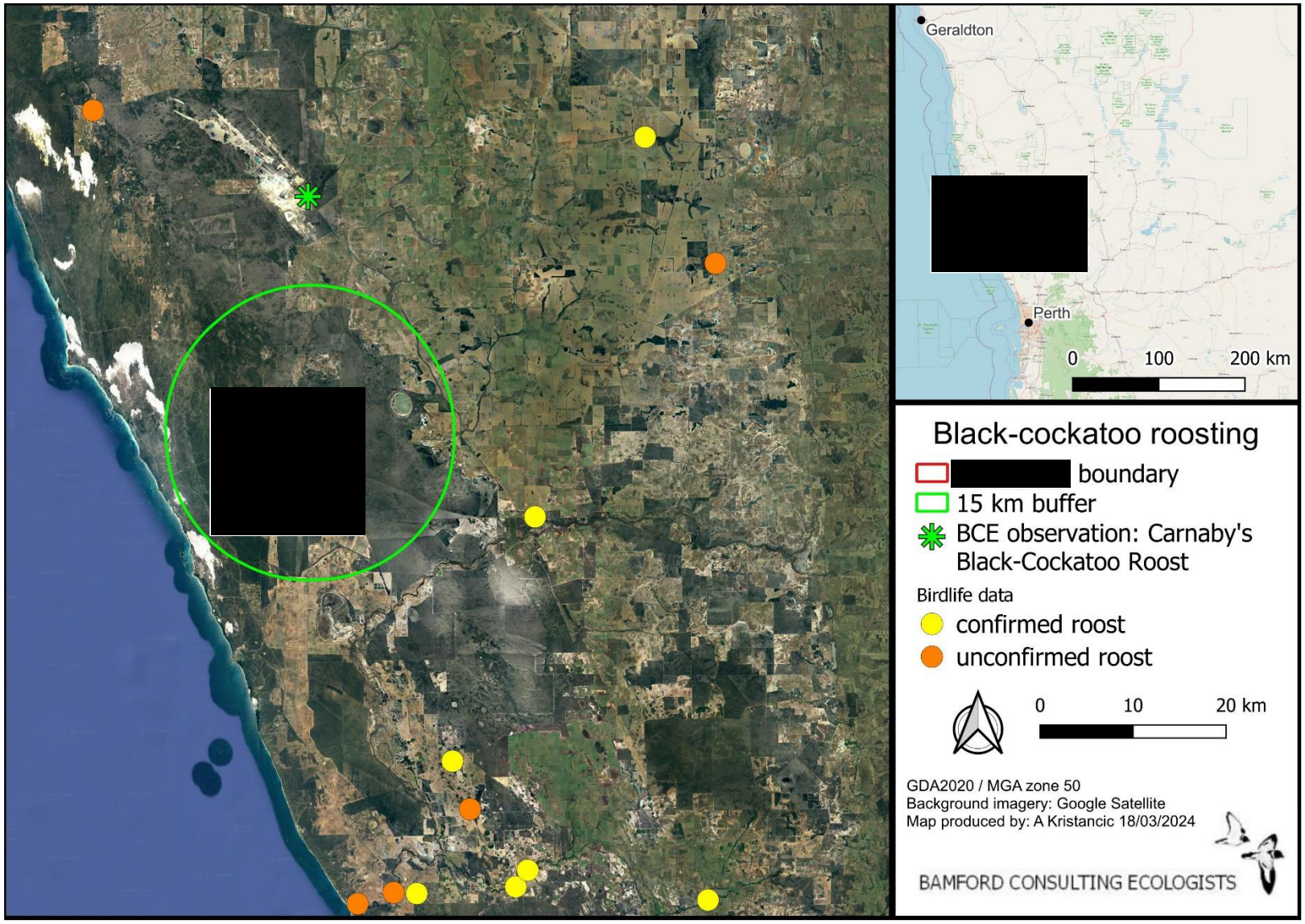

Figure 3-5. Known black-cockatoo roost locations within the region.

3.3 Conservation significant fauna

3.3.1 Vertebrate fauna

Key conservation significant fauna expected in the project area, other than Carnaby's Black-Cockatoo, include the Jewelled Ctenotus (Swan Coastal Plain), Black-striped Burrowing Snake and Brush Wallaby (*Notamacropus irma*), which are all expected to have resident populations within the project area. The Quenda, Woylie and Tammar Wallaby were recorded in Nambung National Park in the early 2000s as part of a translocation project but are otherwise not expected in the project area as they are all considered locally extinct in this area. The Peregrine Falcon is known from the area and may utilise the project area when foraging, but the project area does not contain suitable nesting sites (tall trees or cliff faces). Information on the conservation status, distribution and habitat, salient ecology and expected occurrence within the project area is provided below for key conservation significant vertebrate fauna, including Carnaby's Black-Cockatoo.

Jewelled Ctenotus (Swan Coastal Plain subpopulation) (*Ctenotus gemmula*) CS2 (P3)

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: The Jewelled Ctenotus occurs in two isolated subpopulations in Western Australia: one on the Swan Coastal Plain from Cataby south to Perth, and another along the south coast (IUCN, 2017). The Swan Coastal Plain subpopulation is listed as Priority 3 by DBCA, and is threatened by habitat loss associated with mining and urbanisation (IUCN, 2017). Typical habitat for this species includes *Banksia* and Mallee woodlands and heath on sandplains (IUCN, 2017).

Ecology: A fossorial skink that shelters in leaf litter (Huang, 2009).

Expected occurrence: **Resident.** This species has been recorded by BCE during trapping in Cooljarloo (c. 30 km north-north-east). The *Banksia* woodland on sandy soil that makes up the majority of the project area provides suitable habitat for this species.

Black-striped Burrowing Snake (*Neelaps calonotos*) CS2 (P3)

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: Restricted to coastal sandplains from near Dongara to Mandurah **(Bush *et al*., 2010)**. Appears to be absent from the eastern coastal plain (M. Bamford pers. obs.). Within the Perth Metropolitan area this species may be restricted to large reserves **(How & Shine, 1999)**.

Ecology: A fossorial species that preys upon small, fossorial skinks in the upper layers of loose sand (Bush *et al*., 2010).

Expected occurrence: **Resident.** This species has been recorded by BCE during trapping in Cooljarloo (c. 30 km north-north-east). The project area is within the distribution of this species and there is suitable habitat within the project area; it is therefore expected to be resident.

Western Brush Wallaby (*Notamacropus irma*) CS2 (P4)

Conservation status: Listed as Priority 4 by DBCA.

Distribution and habitat: Endemic to the South-West more or less south of line from Geraldton to Esperance, although it has disappeared from much of the Wheatbelt due to clearing. Occurs in a wide range of vegetation types from Eucalypt Woodland to Banksia Woodland, Shrublands and Kwongan. Locally common in dry sclerophyll forest and woodland in the south-west however it has declined in recent decades due to predation and habitat destruction (Menkhorst & Knight, 2011).

Ecology: Based on detailed radio-tracking study in Banksia Woodland in Whiteman Park (Bamford & Bamford, 1999), a largely solitary species that browses on shrubs and bushes; rarely on grass. Rarely drinks free-standing water and rarely ventures from dense vegetation. Individuals occupy home ranges of up to c. 10 ha; larger in males than females and those of females overlap.

Expected occurrence: **Resident.** It is expected to be present in the project area, in areas where the understorey is dense and provides sufficient shelter. It is regularly recorded in the Cooljarloo area (BCE database).

Carnaby's Black-Cockatoo (*Zanda latirostris*) CS1 (E, S2D2)

Conservation status: Endangered under the EPBC Act and Schedule 2 Division 2 under the BC Act.

Distribution and habitat: Endemic to south-western Western Australia, from Kalbarri in the north, east to Merredin and Ravensthorpe, and then further east along the south coast to the Esperance area (DCCEEW, 2023d; Johnstone & Storr, 1998). Breeds (July to December) predominantly in the east of its range with a migration to coastal areas in the non-breeding period. In recent years, however, the species has expanded its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain (DCCEEW, 2023d). Heavily reliant on areas of Banksia woodland and proteaceous shrubland/heath for foraging (DCCEEW, 2023d; Johnstone & Storr, 1998).

Ecology: Diurnal granivore, feeding predominantly on the seeds of the Proteaceae (especially banksias) but also known to feed on a very wide variety of plants, including non-native ornamentals and plantation species such as pine (DCCEEW, 2023d; DPaW, 2013; Groom, 2011; Johnston *et al*., 2016; Valentine & Stock, 2008). Reliant on large tree-hollows in eucalypts (especially smooth-barked species such as Wandoo and Salmon Gum) for breeding (DCCEEW, 2023d; Johnstone & Storr, 1998; Saunders, 1974). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees, illegal shooting and illegal trade (Burbidge, 2004; DCCEEW, 2023d).

Expected occurrence: **Regular visitor.** There is moderate quality foraging habitat in the project area and evidence of foraging was observed during the site inspection in March 2024, as well as a feather from an individual. It is likely that Carnaby's Black-Cockatoo visits the project area regularly to forage, but there were no potential nest trees and no signs of roosting observed in the project area. Full details of the black-cockatoo habitat assessment are provided below in Section 3.2

3.3.2 Invertebrate fauna

Invertebrate fauna of conservation significance include listed threatened species and short-range endemic (SRE) (or potential SRE) species; although it should be noted that SRE and potential SRE species are often not well documented. The project area sits within DBCA's Midwest management region (DBCA, 2023b), within which (DBCA, 2023f) have listed 22 threatened or priority invertebrate fauna. The project area is not within the range of all 22 species. Based on previous surveys and records within the region, some of these listed species may be present in the project area.

Bothriembryon perobesus (a bothriembryontid land snail (Moore River), P1) was collected about 20 km north of the project area in 2012 (Bennelongia, 2013). Suitable habitat includes *Banksia* woodland and low shrubland on sandy soils (Bennelongia, 2021), similar to that present in the project area.

The Banksia woodland of the project area is also likely to provide suitable habitat for several conservation significant insects, possibly including:

- *Austrosaga spinifer*, spiny katydid (Swan Coastal Plain) (P2)
- *Hemisaga vepreculae*, thorny bush katydid (Moora) (P2)
- *Hylaeus globuliferus*, woolybush bee (P3)
- *Synemon gratiosa*, Graceful Sunmoth, (P4), dependent on presence of host plant species (*Lomandra hermaphrodita* or *Lomandra maritima*)

Based on previous surveys in the region, several SRE or potential SRE species may also be present, including the following:

Spiders: several mygalomorph spiders (genera include *Aname, Idiosoma, Kwonkan, Aganippe*) have been collected in the region (BCE database), and it is expected that mygalomorph spiders will be present in the project area. Suitable habitat for these species generally includes areas with a substrate where a burrow can be dug, in areas with shrub cover to provide protection and create leaf litter (used for shelter and to create burrow lid/door). Such habitat occurs throughout the project area.

Millipedes: several species of *Antichiropus* millipedes thought to be SRE species have been recorded in the region in previous surveys by BCE (Bamford *et al*., 2012). Two of these were collected in Banksia woodland similar to that found in the current project area.

3.4 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of detailed or targeted investigations, but it is possible to draw some general conclusions based upon the VSAs present in the project area. The landscape in the project area is relatively uniform, with the two *Banksia* woodland VSAs only differing slightly in the height and density of *Banksia* trees but having a similar understorey in terms of structure and composition. The understorey of these VSAs is likely to provide shelter for a variety of ground-dwelling fauna (such as reptiles, frogs, and small mammals). The loose sand and leaf litter of these VSAs is likely to support the conservation significant Black-striped Burrowing Snake and Jewelled Ctenotus. The *Banksia* trees of these VSAs provide the highest foraging value for Carnaby's Black-Cockatoo (of all VSAs present) and are also likely to provide habitat for other birds as well as bats and small arboreal reptiles. The *Melaleuca* dampland of VSA 3 is expected to have a lower fauna species richness but the heavier and seasonally damp soils may be important for range restricted invertebrates, and the small area of seasonal inundation may be sufficient for frogs to breed. The plant species present provide low value foraging habitat for Carnaby's Black-Cockatoo, in the form of *Hakea* shrubs. The understorey of this VSA contains a mix of shrubs that provide complex vegetation structure and therefore shelter for a variety of fauna species. The substrate here may be less suitable for the Black-striped Burrowing Snake and Jewelled Ctenotus, particularly during inundation. It is likely that the Brush Wallaby will utilise all VSAs of the project area, so long as the understorey is dense enough to provide sufficient shelter.

3.5 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 1 for descriptions and other ecological processes). The main ecological processes which have affected and continue to affect the fauna assemblage are likely to be: (i) existing habitat loss, as the region has experienced very high levels of land clearing historically, and only small, generally isolated patches of remnant vegetation remain; (ii) landscape connectivity, because of the highly fragmented nature of vegetation in the area; and (iii) the presence and abundance of feral and some native species. These and additional ecological processes which are affecting fauna are discussed here:

Existing habitat loss

The survey area is located in a region where native vegetation has been cleared for agriculture and only a small proportion of the original native vegetation remains. The vegetation within the project area is relatively intact, and large areas of native vegetation remain within 15 km. However, the high level of land clearing in the region as a whole will have contributed to the loss and decline of many fauna species, such as the locally extinct species detailed in Appendix 6. As the current project area is being considered as an offset, there is no proposed reduction in existing habitat. However, localised events such as bushfires can temporarily result in habitat loss for native fauna. The connection between the project area and the large area of native vegetation to the east is likely to provide a buffer against such events, as fauna can escape into adjacent habitat and return once the habitat has regenerated.

Landscape connectivity

In the broader region, habitat loss has led to fragmentation of vegetation and loss of landscape connectivity, which has also contributed to the loss and decline of many fauna species, as indicated by the large number of species (especially mammals) that are considered locally extinct in the area. The project area is currently part of a large area of continuous native vegetation (that includes several protected areas in the form of Nature Reserves), and landscape connectivity on a local scale within this native vegetation is expected to be good.

Should the project area become isolated from this large area of native vegetation, the resultant loss of landscape connectivity is likely to negatively impact the fauna assemblage. The conservation significant reptiles may not be adversely affected by a loss of landscape connectivity as reptiles are known to persist in small patches of remnant native vegetation. For example, Bamford and Calver **(2012)** have documented the persistence of some species (about 25% of the original assemblage) at the level of the urban garden, but also found that some species disappear from small reserves due to cat predation. Loss of landscape connectivity is likely to result in the project area no longer being able to support the Western Brush Wallaby. The impact of local events such as bushfires or temporary increased abundance of feral predators is also likely to have a larger impact on fauna within an isolated remnant (as they cannot easily escape from threats).

Feral/introduced species and interactions with over-abundant native species

Introduced species occur throughout Western Australia and it is expected that species such as the Feral Cat, Red Fox, European Rabbit and House Mouse a will be present in the project area. Introduced

species are likely to be placing considerable pressure on the native fauna in the region, including the key conservation significant species supported by the project area. Foxes and Feral cats impact native fauna via predation, and Rabbits may compete with native fauna for resources and cause degradation of vegetation.

Local hydrology

The *Melaleuca* dampland appears to be subject to seasonal inundation and this may influence the fauna assemblage supported by the project area. The fauna assemblage may vary seasonally depending on inundation. Banksias can also be sensitive to local hydrology.

Fire

Native vegetation in the survey areas is subject to fire and while appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity. There is probably no current managed fire regime. The majority of the project area was burnt c. 3 years prior to the current site inspection, but the vegetation has substantially regenerated. During this regeneration, the project area may not have been able to support the usual fauna assemblage, due to a lack of shelter and food resources. It is expected that due to the connectivity between the project area and native vegetation to the east, this would have only influenced the fauna assemblage in the short-term, while vegetation was regenerating.

4 Summary of fauna values

Vegetation and Substrate Associations (VSAs). Three VSAs were identified in relation to fauna in the project area. The majority of the project area is made up of Banksia Open, Low Woodland (VSA 1), comprised of *Banksia* spp. with scattered Coastal Blackbutt (*Eucalyptus todtiana*) over grass trees and mixed shrubs on sandplain. The remainder of the project area comprises two small areas of Banksia Low Woodland (VSA 2) which is similar to VSA 1 but less open and slightly taller, and an area of Melaleuca dampland (VSA 3), which comprises a patchy woodland of *Melaleuca preissiana* over damp heath of mixed shrubs including *Hakea trifurcata*(?), on dark, peaty soil. The majority of the project area was burnt c. 3 years prior to the current site inspection but has substantially regenerated.

Key species of conservation significance. The project area is expected to support four key conservation significant vertebrate species: the Jewelled Ctenotus (CS2 (P3)), Black-striped Burrowing Snake (CS2 (P3), Carnaby's Black-Cockatoo (CS1 (EN, S2D2)) and the Brush Wallaby (CS2 (P4)). The targeted black-cockatoo assessment is summarised below.

It is likely that the Banksia woodlands of the project area will support a variety of conservation significant invertebrates, including species listed under federal and/or state publications, as well as a suite of short-range endemic (SRE) or potential SRE species.

Black-cockatoo assessment. The survey area is out of range for the Forest Red-tailed Black-Cockatoo and Baudin's Black-Cockatoo. Carnaby's Black-Cockatoo is expected as a regular visitor. Foraging evidence and a feather from Carnaby's Black-Cockatoo were recorded in the project area. Suitable foraging habitat for Carnaby's Black-Cockatoo is present throughout the project area, in the form of *Banksia* spp. in VSA 1 and VSA 2, and *Hakea* shrubs in VSA 3. The *Banksia* woodland of VSA 2 is less

open than VSA 1, resulting in a higher density of *Banksia* trees (compared with VSA 1) and therefore the highest foraging value of all VSAs.

No suitable nesting hollows were observed during the site inspection; the vegetation consists primarily of *Banksia* woodland containing tree species that do not readily provide breeding sites for black-cockatoos. There are no known breeding sites within 15 km of the project area, but breeding is known to occur just outside this radius, in the Cataby Important Bird Area. There did not appear to be any suitable roost-site locations within the project area; night-roosting is not expected to occur in the project area. The area in general is known to support black-cockatoo roosting, and the closest known roosting site is c. 10 km from the boundary of the project area.

Summary of black-cockatoo assessment

- Foraging value – overall the project area is of moderate foraging value for Carnaby's Black-Cockatoo, with a (rounded) weight average foraging score of 6/10. Foraging scores ranged from 7/10 for areas with the highest density of *Banksia* trees (VSA 2), to 6/10 for areas with a lower density of *Banksia* trees (VSA 1) and 3/10 for areas with no *Banksia*, but which contained palatable *Hakea* shrubs (VSA 3).
- Breeding value – no trees were large enough to be assessed as potential nesting trees. The closest known breeding sites are within the Cataby Important Bird Area, c. 16 km from the boundary of the project area.
- Roosting value – No suitable areas for roosting sites were apparent within the project area. The closest known and confirmed roost is c. 10 km from the project area and was last confirmed used in 2022, when 1510 birds were counted. It is expected that this roost site would also have been confirmed used in 2023; the dataset available does not extend past 2022.

Patterns of biodiversity. Vegetation in the project area is relatively uniform, with the two *Banksia* woodland VSAs only differing slightly in the height and density of *Banksia* trees but having a similar understorey in terms of structure and composition. The understorey of these VSAs is likely to provide shelter for a variety of ground-dwelling fauna (such as reptiles, frogs, and small mammals). The loose sand and leaf litter of these VSAs is likely to support the conservation significant Black-striped Burrowing Snake and Jewelled Ctenotus. The *Banksia* trees of these VSAs provide the highest foraging value for Carnaby's Black-Cockatoo (of all VSAs present) and are also likely to provide habitat for other birds as well as bats and small arboreal reptiles. The *Melaleuca* dampland of VSA 3 is distinctive and likely to be less rich in fauna species, but with some restricted to the heavy soils and seasonally damp conditions. The substrate here may be less suitable for the Black-striped Burrowing Snake and Jewelled Ctenotus, particularly during inundation. It is likely that the Brush Wallaby will utilise all VSAs of the project area, so long as the understorey is dense enough to provide sufficient shelter.

Key ecological processes. The ecological processes that are expected to influence the fauna assemblage include existing habitat loss, landscape connectivity and the presence of feral species. Local hydrology may impact fauna as there is a small area of damplands that appears to be seasonally inundated. It is not expected that fire is currently having a significant impact on the fauna assemblage, but changes to natural fire regimes have the potential to negatively affect the fauna assemblage. The bushfire c. 3 years prior to the current site inspection may have had a short-term impact on the fauna assemblage but it is expected that being part of a large, continuous patch of native vegetation would have buffered the project area against any long-term impacts.

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6 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation and substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver et al., 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

VSA assessment was made with reference to the key attributes provided by (EPA, 2020):

- soil type and characteristics
- extent and type of ground surfaces and landforms
- height, cover and dominant flora within each vegetation stratum
- presence of specific flora or vegetation of known importance to fauna
- evidence of fire history including, where possible, estimates of time since fire
- evidence and degree of other disturbance or threats, e.g. feral species
- presence of microhabitats and significant habitat features, such as coarse woody debris, rocky
- outcrops, tree hollows, water sources and caves
- evidence of potential to support significant fauna
- function of the habitat as a fauna refuge or part of an ecological linkage.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in

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Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN, 2012), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Biodiversity Conservation Act 2016* uses a series of divisions within three Schedules to classify conservation status that largely reflect the IUCN categories (IUCN, 2012).

Conservation Significance (CS) 2: Species listed as Priority by DBCA but not listed under State or Commonwealth Acts.

In Western Australia, DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Biodiversity Conservation Act 2016* but for which DBCA feels there is cause for concern.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA, 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (Dell & Banyard, 2000).

Marine-listed species

Some conservation significant species may also be listed as 'Marine' under the EPBC Act. This listing protects these species in 'Commonwealth areas' which include "marine areas beyond the coastal waters of each State and the Northern Territory, and includes all of Australia's Exclusive Economic Zone (EEZ)" (DEH, 2000). The EEZ extends to 200 nautical miles (approximately 350 kilometres) from the coast (DEH, 2006). This may mean that the 'Marine' listing does not apply to the project/survey area (depending on its location). Therefore, when a species is otherwise protected (under the EPBC Act or BC Act) or priority-listed (by the DBCA) then the Marine listing is also noted but it does not have site-specific relevance. In cases where a species is solely Marine-listed (for a list see DEH, 2000) and a project/survey area is not within a Commonwealth area then it is treated like all other fauna.

Invertebrates

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or

confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey, 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes and conditions that apply to the existing environment and that affect and maintain fauna populations in an area. As such they are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a survey area may be affected and effectively determined by processes such as:

- fire regime.
- landscape patterns (such as extent of existing habitat, fragmentation and/or linkage).
- the presence of feral species.
- hydrology.

Appendix 2. Categories used in the assessment of conservation status.

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided at the end of this appendix.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN, 2012), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Wildlife Conservation Act 1950* uses a series of seven Schedules to classify conservation status that largely reflect the IUCN categories (IUCN, 2012).

Conservation Significance (CS) 2: Species listed as Priority by DBCA but not listed under State or Commonwealth Acts.

In Western Australia, DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Wildlife Conservation Act 1950* but for which DBCA feels there is cause for concern.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA, 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (Dell & Banyard, 2000).

Conservation significance categories under legislation and the DBCA Priority system

IUCN (International Union for the Conservation of Nature) categories, as outlined by IUCN (2012), and as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Biodiversity Conservation Act 2016, updated 2023*

Schedule 1	Specially protected fauna Division 1 – Species of special conservation interest (S1D1) Division 2 – Migratory species (S1D2) Division 3 – Species otherwise in need of special protection (S1D3)
Schedule 2	Threatened species Division 1 – Critically endangered species (S2D1) Division 2 – Endangered species (S2D2) Division 3 – Vulnerable species (S2D3)
Schedule 3	Extinct species (S3)

WA DBCA Priority species (species not listed under the *WA Biodiversity Conservation Act 2016*, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands. Taxa in need of monitoring.
Priority 4. (P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 3. Scoring system for the assessment of foraging value of vegetation for Black-Cockatoos.

Bamford Consulting Ecologists. Revised 4th April 2021

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing Black-Cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting Ecologists (BCE) with assistance from Quessentia Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of Agriculture, Water and the Environment (DAWE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DAWE offsets guide but the scoring approach was developed by BCE and includes a fourth (moderation) component.

Note that the scoring system can only be applied within the range of the species or at least where the species could reasonably be expected to occur based upon existing information.

Calculating the total score (out of 10) requires the following steps:

A. Site condition. Determining a score out of six for the vegetation composition, condition and structure; plus
B. Site context. Determining a score out of three for the context of the site; plus
C. Species stocking rate. Determining a score out of one for species density.
D. Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value.

The BCE scoring system places the greatest weight on site condition (scale of 0 to 6) because this has the highest influence on the foraging values of a site, which in turn is the fundamental driver in meeting ecological requirements for continued survival.

Site context has a lower weight (scale of 0 to 3) in recognition of the mobility of the species, which means they can access good foraging habitat even in fragmented landscapes, but allowing for recognition of the extent of available habitat in a region and context in relation to activity (such as breeding and roosting). The application of scoring site context is further discussed below.

Species stocking rate is given a low weight (0 to 1) as it is a means only of recognising that a species may or may not be abundant at a site, but that abundance is dependent upon site condition and context and is thus not an independent variable. The abundance of a species is also sensitive to sampling effort, and to seasonal and annual variation, and is therefore an unreliable indicator of actual importance of a site to a species.

Calculation of scores and the moderation process are described in detail below.

A. Site condition. Vegetation composition, condition and structure scoring

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. • Mown grass	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).
1	Negligible to low foraging value. Examples: • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual).	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Woodland with tree banksias (of key species *B. attenuata* and *B. menziesii*) with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered foraging trees.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Woodland with <10% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Woodland with tree banksias (of key species *B. attenuata* and *B. menziesii*) with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah; also Pricklybark (Coastal Blackbutt) where it occurs in Banksia Woodlands) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 10-40% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
4	Moderate foraging value. Examples: • Woodland/low forest with tree banksias (of key species *B. attenuata* and *B. menziesii*) 20-40% projected foliage cover; • Woodland/low forest with tree banksias (of key species *B. attenuata* and *B. menziesii*) with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability); • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 40-60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
5	Moderate to High foraging value. Examples: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with 40-60% projected foliage cover; • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 40-60% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Pine plantations with trees more than 10 years old (but see pine note below in moderation section).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with > 60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
6	High foraging value. Example: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have >60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

A. Site context.

Site Context is a function of site size, availability of nearby habitat and the availability of nearby breeding areas. Site context includes consideration of connectivity, although Black-Cockatoos are very mobile and will fly across paddocks to access foraging sites. Based on BCE observations, Black-Cockatoos are unlikely to regularly go over open ground for a distance of more than a few kilometres and prefer to follow tree-lines.

The maximum score for site context is 3, and because it is effectively a function of presence/absence of nearby breeding and the distribution of foraging habitat across the landscape, the following table, developed by Bamford Consulting in conjunction with the Department of the Environment and Energy (DEE), provides a *guide* to the assignation of site context scores. Note that 'local area' is defined as within a 15 km radius of the centre point of the study site. This is greater than the maximum distance of 12 km known to be flown by Carnaby's Black-Cockatoo when feeding chicks in the nest.

Site Context Score	Percentage of the existing native vegetation within the 'local' area that the study site represents.	
	'Local' breeding known/likely	'Local' breeding unlikely
3	> 5%	> 10%
2	1 - 5%	5 - 10%
1	0.1 - 1%	1 - 5%
0	< 0.1%	< 1%

The table above provides weighting for where nearby breeding is known (or suspected) and for the proportion of foraging habitat within 15 km represented by the site being assessed. Some adjustments may be needed based on the judgement of the assessor and in relation to the likely function of the site. For example, a small area of foraging habitat (e.g. 0.5% of such habitat within 15 km) could be upgraded to a context of 2 if it formed part of a critical movement corridor. In contrast, the same sized area of habitat, of the same local proportion, could be downgraded if it were so isolated that birds could never access it.

B. Species density (stocking rate).

Species stocking rate is described as "the usage and/or density of a species at a particular site" in the offsets guide. The description also implies that a site supports a discrete population, which is unlikely in the case of very mobile black-cockatoos. Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence. Where information on actual presence of birds is lacking, a species density score can be assigned by interpreting the landscape and the site context. For example, a site with a moderate condition score that is part of a network of such habitat where a black-cockatoo species is known would

get a species density score of 1 even without clear presence data, while a species density score of 0 can be assigned to a site where the level of usage can confidently be predicted to be low.

C. Moderation of scores for the calculation of a value out of 10.

The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a Condition score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat ($\geq$3). The approach to calculating a score out of 10 can be summarised as follows:

Vegetation composition, condition and structure score	Context score	Species density score
3-6 (low/moderate to high value)	Assessed as per B above	Assessed as per C above
0-2 (no to low value)	0	0

Note that this moderation approach may require interpretation depending on the context. For example, vegetation with a condition score of 2 could be given a context score of 1 under special circumstances. Such as when very close to a major breeding area or if strategically located along a movement corridor.

Pine plantations

Pine plantations are an important foraging resource for Carnaby's Black-Cockatoo (only) but are not directly comparable with native vegetation. In comparing native vegetation with pine plantations for the purpose of calculating offsets, the following should be noted:

- Pine plantations are a commercial crop established with the intention of being harvested and thus have short-term availability (30-50 years), whereas native vegetation is available indefinitely if protected. Due to the temporary nature of pines as a food source, site condition and context differs between pines and native vegetation.
- Although pines provide a high abundance of food in the form of seeds, they are a limited food resource compared with native vegetation which provides seeds, insect larvae, flowers and nectar. The value of insect larvae in the diet of Carnaby's Black-Cockatoo has not been quantified, but in the vicinity of Perth, the birds forage very heavily on insect larvae in young cones of *Banksia attenuata* in winter, ignoring the seeds in these cones and seeds in older cones on the same trees (Scott & Black, 1981; M. Bamford pers obs.). This suggests that insect larvae are of high nutritional importance immediately prior to the breeding season.
- Pine plantations have very little biodiversity value other than their importance as a food source for Carnaby's Black-Cockatoos. They inhibit growth of other flora. While this is not a factor for direct consideration with respect to Carnaby's Black-Cockatoo, it is a factor in regional conservation planning of which offsets for the cockatoos are a part.

Taking the above points into consideration, it is possible to assign pine plantations a foraging value as follows:

- Site condition. The actual foraging value of pines is high. Stock *et al.*(2013) report that it takes nearly twice as many seeds of *Pinus pinaster* to meet the daily energy requirements for Carnaby's Black-Cockatoo compared with Marri, and three times as many *P. pinaster* seeds compared with Slender Banksia. However, pines are planted at a high density so the food supply per hectare can be high. Taking account of the lack of variety of food from pines, this suggests a site condition score of 4 or 5 out of 6 (5 is used in Section A above). As a source of food, pines are thus comparable to the best banksia woodland. This site condition score then needs to be adjusted to take account of the short-term nature of the food supply (for pine plantations to be harvested. Where pines are 'ornamental, such as in some urban contexts, they can be treated as with other trees in urban landscapes). The foraging value of a site after pines are harvested will effectively be 0, or possibly 1 if there is some retention. It is proposed that this should approximately halve the site condition score; young pine plantations could be redacted slightly less than old plantations on the basis that a young plantation provides a slightly longer term food supply. If a maximum site condition score of 5 is given, then a young plantation (>10 but <30 years old) could be assigned a score of 3, and an old plantation (>30 years old) could be assigned a score of 2. Plantations <10 years old and thus not producing large quantities of cones could also get a score of 2, but recognising they may increase in value.
- Site context. Although a temporary food source, pines can be very important for Carnaby's Black-Cockatoo in some contexts; they could be said to carry populations in areas where there is little native vegetation. The system for assigning a context score as outlined above (Section B) also applies to pines. Thus, a context score of 3 can be given where pines are a significant

proportion of foraging habitat (>5% if breeding occurs; >10% if no breeding), but where pines are a small part of the foraging landscape they will receive a context score of less than this.

- Species density. As outlined above (Section C), pines will receive a species density score of 1 where Carnaby's Black-Cockatoo are regular visitors. This is irrespective of an old plantation having a moderated condition score of 2.

Based on the above, pine plantations that represent a substantial part of the foraging landscape, such as in the region immediately north of Perth, would receive a total score (out of 10) of 6; young plantations in this area would receive a score of 7. In contrast, isolated and small plantations in rural landscapes could receive a score of just 2 if they are only a small proportion of foraging habitat and Carnaby's Black-Cockatoos are not regularly present.

Appendix 4. Conservation significant fauna species expected in the project area.

Latin Name	Common Name	Status	Expected Occurrence
INVERTEBRATES			
Austrosaga spinifer	Spiny Katydid (Swan Coastal Plain)	CS2 (P2)	
Hemisaga vepreculae	Thorny Bush Katydid (Moora)	CS2 (P2)	
Hylaeus globuliferus	Woolybush Bee	CS2 (P3)	
Synemon gratiosa	Graceful Sunmoth	CS2 (P4)	
Bothriembryon perobesus		CS2 (P1)	
REPTILES			
Ctenotus gemmula (Swan Coastal Plain subpopulation)	Jewelled Ctenotus	CS2 (P3)	Resident
Neelaps calonotos	Black-striped Snake	CS2 (P3)	Resident
BIRDS			
Apus pacificus	Fork-tailed Swift	CS1 (MI, S1D2)	Irregular visitor
Falco peregrinus	Peregrine Falcon	CS1 (S1D3)	Irregular visitor
Zanda latirostris	Carnaby's Black-Cockatoo	CS1 (EN, S2D2)	Regular visitor
MAMMALS			
Notamacropus irma	Brush Wallaby	CS2 (P4)	Resident

Appendix 5. Vertebrate fauna species observed (sightings unless otherwise indicated) during field investigations.

Latin Name	Common Name	Status	Notes
REPTILES			
Tiliqua rugosa	Bobtail		Tracks
BIRDS			
Dromaius novaehollandiae	Emu		droppings
Phaps chalcoptera	Common Bronzewing		
Cacatua pastinator	Western Corella		
Eolophus roseicapilla	Galah		
Zanda latirostris	Carnaby's Black-Cockatoo	CS1 (EN, S2D2)	Foraging signs, feather
Barnardius zonarius	Australian Ringneck		
Malurus assimilis	Purple-backed Fairy-wren		
Anthochaera carunculata	Red Wattlebird		
Gavicalis virescens	Singing Honeyeater		
Lichmera indistincta	Brown Honeyeater		
Manorina flavigula	Yellow-throated Miner		
Phylidonyris niger	White-cheeked Honeyeater		
Acanthiza inornata	Western Thornbill		
Sericornis maculatus	Spotted Scrubwren		
Pachycephala rufiventris	Rufous Whistler		
Cracticus torquatus	Grey Butcherbird		
Rhipidura albiscapa	Grey Fantail		
Grallina cyanoleuca	Magpie-lark		
Corvus coronoides	Australian Raven		
MAMMALS			
Tachyglossus aculeatus	Short-beaked Echidna		Tracks and scats
Macropus fuliginosus	Western Grey Kangaroo		Tracks and scats
Vulpes vulpes	Red Fox	Int	Tracks
Felis catus	Feral Cat	Int	Tracks

Appendix 6. Locally extinct conservation significant fauna species.

Latin Name	Common Name	Status
Dasyurus geoffroii	Chuditch	CS1 (VU, S2D3)
Parantechinus apicalis	Dibbler	CS1 (EN, S2D2)
Isoodon fusciventer	Quenda	CS2 (P4)
Macrotis lagotis	Greater Bilby	CS1 (VU, S2D3)
Bettongia penicillata ogilbyi	Woylie	CS1 (EN, S2D1)
Notamacropus eugenii derbianus	Tammar Wallaby	CS2 (P4)
Lagostrophus fasciatus	Banded Hare-Wallaby	CS1 (VU, S2D3)
Pseudomys fieldi	Djoongari/Shark Bay Mouse	CS1 (VU, S2D3)
Macroderma gigas	Ghost Bat	CS1 (VU, S2D3)

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