Kellerberrin

Targeted Black-Cockatoo and Trapdoor Spider Assessment

York Gum with potential black-cockatoo breeding hollow in project area (Photo: J. Wadey)

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Executive Summary

Introduction

CBH Group (CBH) manages grain storage facilities across the Wheatbelt region of Western Australia, extending from Geraldton to Esperance. At many of these sites, CBH is considering the potential for expansion of roads and/or infrastructure into undeveloped areas. Therefore, as part of understanding the environmental values of their properties and immediate surrounds, Bamford Consulting Ecologists (BCE) was commissioned by CBH to conduct targeted assessments for black-cockatoo trapdoor spider for the site at Kellerberrin. This report presents the results of the targeted black-cockatoo assessment and targeted trapdoor spider assessment for the Kellerberrin project area. The project area was visited on 6th October 2023.

Project area description

The project area is c. 15 ha in size and located in the wheatbelt, on the outskirts of the town of Kellerberrin and approximately 180 km east of Perth. The project area is characterized by cleared areas and infrastructure, with isolated patches of remnant and planted vegetation. The surrounding landscape consists primarily of cleared paddocks and isolated areas of remnant vegetation, and there is a chain of salt lakes to the south.

Results

The project area encompasses three Vegetation and Substrate Associations (VSAs) which are typical of rural areas in the wheatbelt of Western Australia and areas of built environment such as roads and existing CBH infrastructure. The majority of the project area consists of Open Areas (VSA 1) such as roadside verges and cleared areas with weedy grasses, which provides little habitat for fauna but tends to support farmland species. Other VSAs include Eucalypt Woodland (VSA 2), consisting of York Gum with scattered Salmon Gum over weedy grasses, and Planted Trees (VSA 3), consisting of Red River Gum and ornamental eucalypt species over weedy grasses.

Black-cockatoo assessment. Carnaby's Black-Cockatoo was not recorded during the site inspection and there was no evidence of foraging by this species. The project area is within the range of the species, but due to isolation and degradation of the habitat, Carnaby's Black-Cockatoo is expected to occur only as an irregular visitor in the project area. The project area is out of range for the Forest Red-tailed and Baudin's Black-Cockatoos. There are at least seven records of the Carnaby's Black-Cockatoo within 40 km of the project area, and four records within 15 km. The most recent record of the species (in 2020) is also the closest record to the project area (c. 2 km southwest).

Foraging value – the foraging value of the project area is low, with about 80% of the project area having a score of 0/10 (for built environments) or 1/10 (Open Areas). Due to the presence of eucalypt species in varying densities, VSA 2 received a moderate score of 4/10 and VSA 3 received a score of 3/10.

Breeding value – eight trees in the project area contained hollows that were suitable for black-cockatoo breeding, but there was no evidence that these hollows had been recently used by black-cockatoos (rank 3); one tree ranked 4 (trees with large hollows, but they are not the size or shape

preferred by black-cockatoos) and 22 trees ranked 5 (trees of a sufficient size to be assessed, but which lack large hollows). The closest known record of breeding for Carnaby's Black-Cockatoo is c. 120 km from the project area.

Roosting value – VSA 2 and VSA 3 contain large trees that would be suitable for roosting by Carnaby's Black-Cockatoo. The closest confirmed black-cockatoo roost site is 94 km from the project area and was last confirmed to be used in 2011.

Trapdoor Spider assessment. Four conservation significant trapdoor spider species have been previously recorded within 40 km of the project area, but none of these is within 15 km of the project area. The Shield-backed Trapdoor Spider *Idiosoma nigrum* was recorded 35 km northeast of the project area by BCE in 2020. There was no evidence of trapdoor spiders recorded during field investigations. Given the project area is within its range and the abundance of records within 40 km of the project area, the Shield-backed Trapdoor Spider is considered likely to occur within the vicinity of the project area, but probably not within the actual project area due to the paucity of suitable habitat.

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1 Introduction

1.1 Introduction

CBH Group (CBH) manages grain storage facilities across the Wheatbelt region of Western Australia, extending from Geraldton to Esperance. At many of these sites, CBH is considering the potential for expansion of roads and/or infrastructure into undeveloped areas. In order to minimise impacts upon biodiversity where possible, and in recognition of the high level of biodiversity loss that has already occurred across the Wheatbelt, CBH has commissioned Bamford Consulting Ecologists (BCE) to conduct fauna value assessments of a suite of their properties. For some properties, these are to consist of only targeted investigations for conservation significant species such as black-cockatoos. For the Kellerberrin project area, CBH requested a targeted assessment for black-cockatoos and conservation significant trapdoor spiders. This report presents the results of these targeted assessments.

The purpose of these assessments and the following report is to provide information regarding the black-cockatoo and trapdoor spider values of the project area to be used by CBH to guide future decisions regarding potential developments.

1.2 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. All references to 'black-cockatoo' from hereon (within the main text) refer to Carnaby's Black-Cockatoo. Note that some databases use 'white-tailed black-cockatoo' when the species was not confirmed as the Carnaby's (and may be the Baudin's), but based on range it is expected they were likely to be Carnaby's Black-Cockatoo. 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 project area is within the species' range, and there is a small number of fairly old records nearby and within 40 km (see Section 3.3.1); the most recent of these is from 2006. The species is expected to occur as an Irregular Visitor to the project area (see Section 2.1.3).

1.3 Trapdoor spiders

Several conservation significant trapdoor spiders are present in the Wheatbelt region of Western Australia, as indicated in the DBCA Threatened and Priority fauna list for each region (DBCA, 2023b). These are included in desktop investigations. The species of particular interest, based on known occurrence in the area, is the Shield-backed Trapdoor Spider *Idiosoma nigrum*, listed as Vulnerable under the EPBC Act and Schedule 2 Division 2 (Endangered) under the Western Australian BC Act. This species is endemic to WA and listed as Vulnerable under the EPBC Act due to the restricted geographic distribution and the nature of ongoing threats towards its survival (DSEWPaC, 2013). The Shield-backed Trapdoor Spider is adapted for living in semi-arid habitats such as those found in the wheatbelt, and makes burrows with a lightweight trapdoor (DSEWPaC, 2013); the spider builds a distinctive trapdoor which makes it conspicuous during surveys. This spider usually inhabits clay soils and requires leaf litter and twigs to build its burrow; these typically come from *Eucalypt* woodlands

and *Acacia* vegetation (DSEWPaC, 2013). Documented threats to the Shield-backed Trapdoor Spider include land clearing and habitat fragmentation, degradation of habitat via grazing by livestock and feral animals, and inappropriate fire regimes (DSEWPaC, 2013).

1.4 Project area

The project area is located in the central Wheatbelt region of Western Australia (DBCA, 2023d), on the outskirts of the town of Kellerberrin and approximately 180 km east of Perth (Figure 1-1). The project area is approximately 15 ha in size and consists of remnant native vegetation, planted gardens, roads and existing CBH infrastructure, and areas of open ground with weedy grasses. Additional CBH infrastructure exists outside the project area. The surrounding landscape is predominantly paddocks, with some isolated areas of remnant vegetation. A chain of salt lakes occurs to the south of the project area, with closest lake being approximately 3 km from the project area.

A range of terms is used through this report to refer to the spatial environment including and around the Kellerberrin project area; these are defined below and illustrated in Figure 1-1:

- Project area – the project area boundary was provided by CBH and is comprised of a mixture of land over which CBH has tenure (including land containing existing CBH infrastructure) and Main Roads land. It is the area to which the results of the desktop analysis are directed and the area within which field investigations were conducted.
- Study area – the outermost boundary of the desktop assessment area that is almost always a specified buffer distance (see Section 2.1.1 below) around the *project area*. The study area thus encompasses the *project area* but includes the area from which database records are sourced for the desktop assessment. This is the area from which database records relating to black-cockatoos and conservation significant trapdoor spiders were sourced. For most databases queried for the current report, this is a 40 km radius around the centroid of the project area (see Figure 1-1). For the DBCA threatened and priority fauna database, the search area was a truncated 40 km buffer (see Section 3.3) as this database was queried based on a subset of CBH sites that did not at the time include Kellerberrin.

Note that for the purposes of context and mapping, a 15 km buffer from the centroid of the project area is used; this is based upon guidance for regional context from the EPA (EPA, 2016).

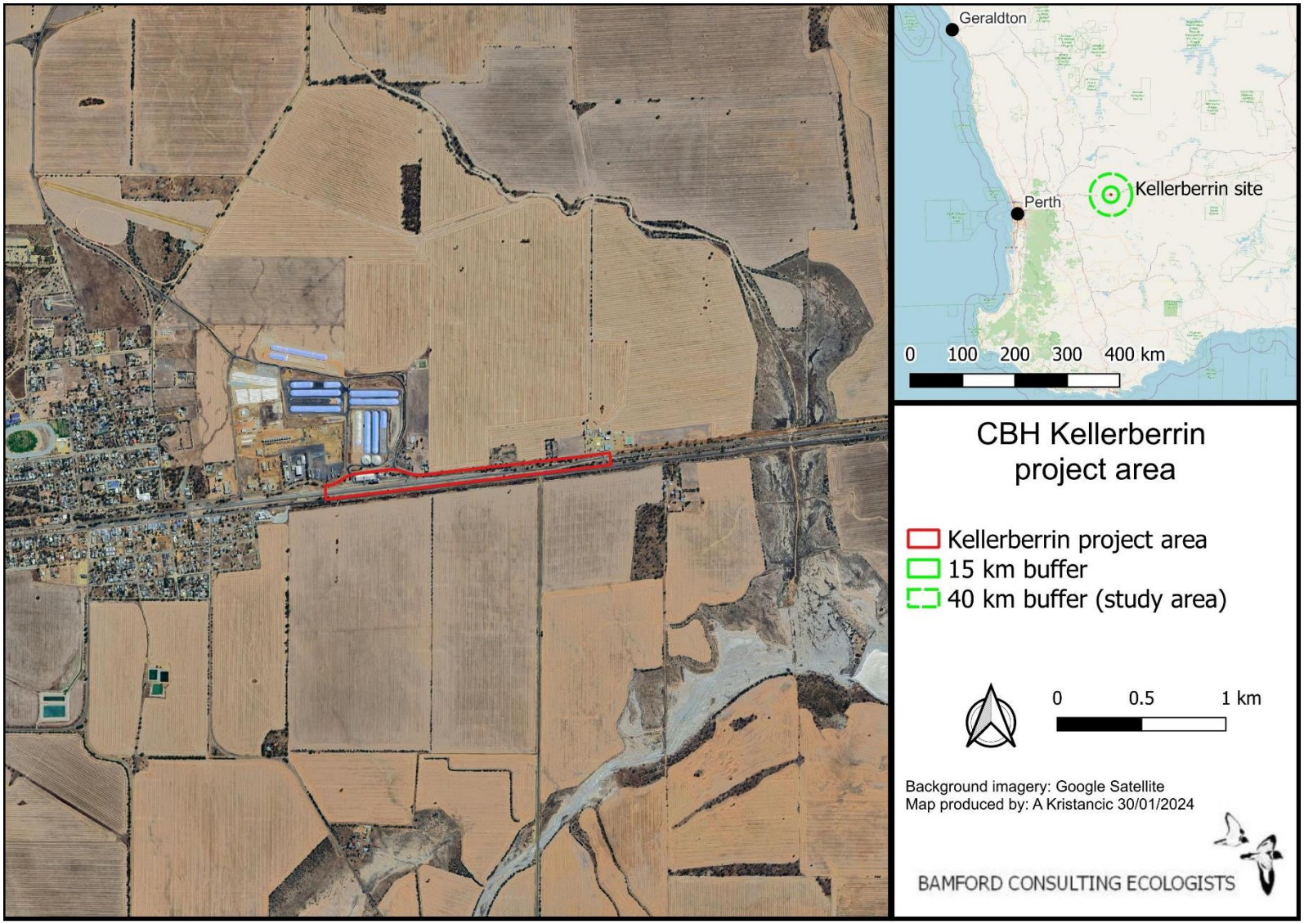

Figure 1-1. Location of Kellerberrin project area and study area.

2 Methods

2.1 Desktop investigations

2.1.1 Sources of information

Information on black-cockatoos and conservation significant trapdoor spiders was drawn from a range of sources including databases and previous BCE surveys (as listed in Table 2-1).

Table 2-1. Databases searched for the desktop review; accessed March 2023 unless stated otherwise.

Database	Type of records held in database	Area searched/queried
BCE Database	Fauna recorded by BCE in the vicinity of the project area and region.	Wheatbelt region.
DBCA Threatened and Priority Fauna (DBCA, 2023a), accessed February 2023	Records from the DBCA Threatened and Priority species database, including black-cockatoo nesting/roosting data.	truncated 40km search buffer for subset of southern Wheatbelt CBH sites, see Figure 3-2.
BirdLife Australia databases (BirdLife Australia, 2023b, 2023a, 2023c)	Records from Bird Life Australia, including birdata and black-cockatoo datasets	40km buffer around centroid of project area.
EPBC Protected Matters Search Tool (DCCEEW, 2023d)	Records on MNES protected under the EPBC Act.	15km and 40km buffer around centroid of project area.
Index of Biodiversity Surveys for Assessment (IBSA) (DWER, 2023)	Flora and fauna data contained in EIA biodiversity survey reports.	40km buffer around Kellerberrin townsite.

2.1.2 Previous reports

There was one previous report found via IBSA within 40 km of Kellerberrin; this was for a flora, vegetation, and targeted threatened ecological community survey along a large stretch of Great Eastern Hwy east of Kellerberrin (from Walgoonan to Southern Cross); listed in Table 2-2. This report may contain information relevant to habitat for trapdoor spiders, but no resources were available to download from IBSA.

Table 2-2. Relevant vertebrate fauna study returned from desktop review.

Note: there were no resources (report or data) publicly available for this study.

Author	Title	Source	Distance to site
Astron (2018)	*Great Eastern Highway to Merredin to Southern Cross SLK 258.5 - 365.5, Biological Assessment. Unpublished report prepared for Main Roads WA.*	*IBSA*	*n/a*

2.1.3 Nomenclature and taxonomy

As per the recommendations of the EPA (2020), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2020. In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds (BirdLife Australia, 2022), and the International Ornithological Congress' 'World Bird List'). Similarly, the group name 'black-cockatoo' is consistently used for all three taxa in the South-West. English common names of species, where available, are used throughout the text; Latin names are presented with corresponding English names in tables in the appendices. The use of subspecies is limited to situations where there is an important (and relevant) geographically distinct population, or where the taxonomic distinction has direct relevance to the conservation status or listing of a taxon.

2.1.4 Expected occurrence

For each species of black-cockatoo that may be present, an expected occurrence category is assigned to describe how each species is expected to use the project area. The status categories used are:

- **Resident:** species with a population permanently present in the project area.
- **Regular visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of an annual cycle (thus includes migrants).
- **Irregular Visitor:** species that occur within the project area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time.
- **Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species.
- **Locally extinct:** species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

Note that these categories are not assigned to trapdoor spiders as they are either expected to occur (and, therefore, would be as resident) or not expected to occur.

2.1.5 Conservation significance

Two broad levels of conservation significance are used in this report (see Appendix 2):

- Conservation Significance 1 (CS1) – species listed under State or Commonwealth Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act);
- Conservation Significance 2 (CS2) – species listed as Priority by DBCA but not listed under State or Commonwealth Acts; and

2.2 Field investigations

2.2.1 Overview

The project area was visited on 6th October 2023. The site visit involved driving around and walking across as much of the project area as possible. GPS tracks are indicated on Figure 2-1. Within the project area, field investigations that were conducted included:

- identification of VSAs (that provide fauna habitats);
- targeted black-cockatoo assessment;
- targeted trapdoor spider assessment; and
- opportunistic fauna observations (birds and other fauna, including signs such as diggings, scats and tracks).

Personnel involved in the field investigations and report preparation (including desktop review) are listed in Table 2-3.

Table 2-3. Personnel involved in the field investigations and report preparation.

Personnel	EIA/Wildlife Survey Experience	Field Investigations	Report Preparation
Dr Mike Bamford *BSc (Biology), Hons (Biology), PhD (Biology)*	40 years		+
Dr Jamie Wadey *BSc (Zoology/Ecology), Hons (Ecology), PhD (Movement Ecology)*	7 years	+	+
Natalia Huang *BEnvSc (Zoology), Hons (Conservation Biology), MBA*	16 years		+
Dr Amanda Kristancic *BSc (Zoology/Biochemistry), Hons (Zoology), PhD (Parasitology)*	3 years		+

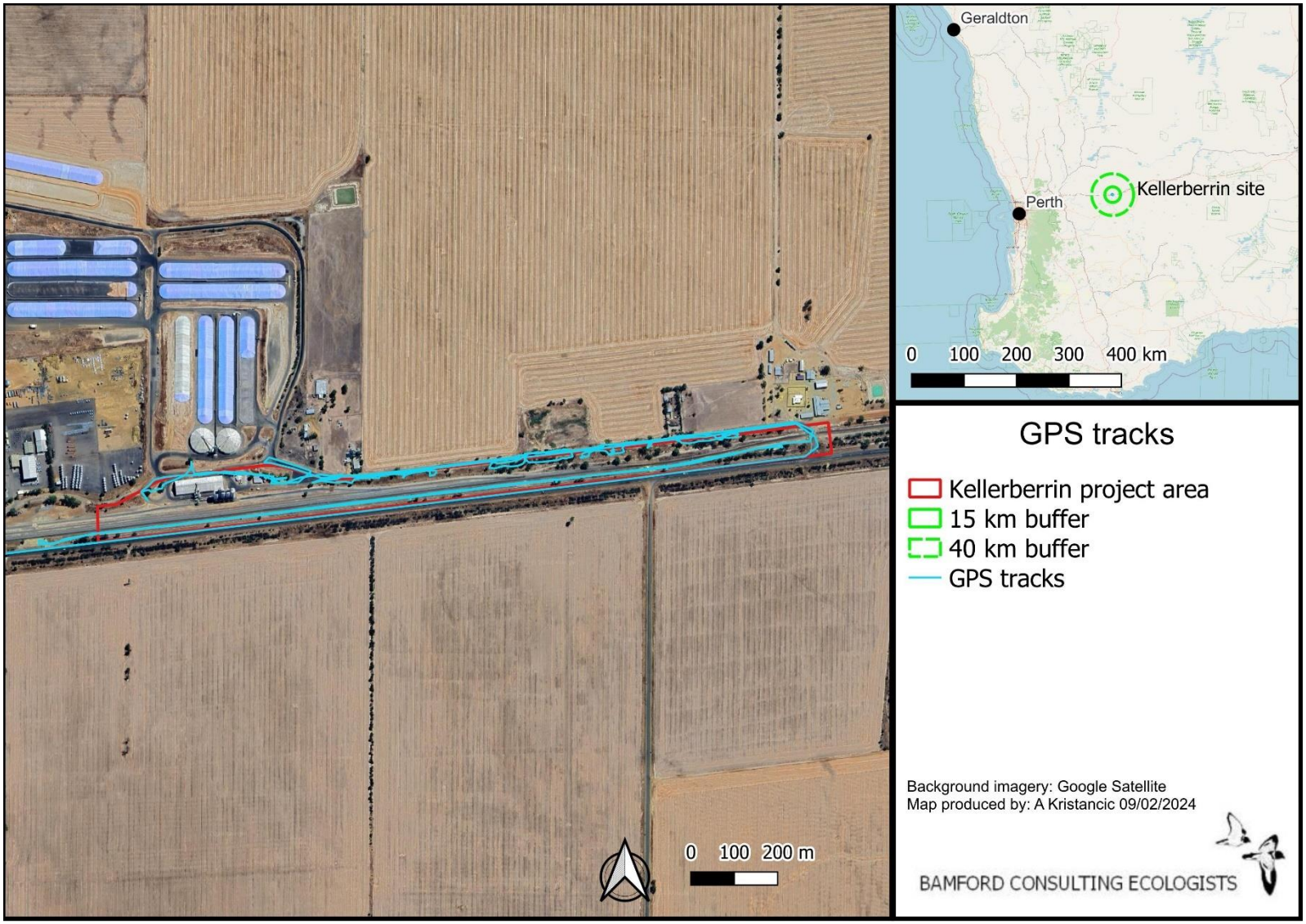

Figure 2-1. GPS tracks of BCE personnel during the field investigations.

2.2.2 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.

BCE deliberately makes the distinction between 'habitat' (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and 'VSA' (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader EIA literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g.' habitat assessment' used by EPA, 2020). Further discussion is provided in Appendix 1.

2.2.3 Black-cockatoo assessment

2.2.3.1 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) (DAWE, 2022). The survey and analysis reported here have been conducted with reference to both the referral guidelines provided by DSEWPaC (2012) and DAWE (2022) and recommendations listed on the DCCEEW's Species Profile and Threats Database (DCCEEW, 2023a, 2023c, 2023b). 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 detailed in Appendix 3. The Department of Biodiversity, Conservation and Attractions (DBCA) has indicated that the methods developed and applied previously by BCE are an acceptable approach.

2.2.3.2 Foraging

The foraging value of the project area was assessed by calculating a foraging score for 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 the federal DCCEEW, the state Department of Water and Environmental Regulation (DWER) and the WA Environmental Protection Authority (EPA) 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 in Appendix 3. These three components are drawn from the DCCEW offset calculator (DCCEEW, undated) but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the site.
- A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 (the Habitat Quality core; HQS) if context and species density are also considered. 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 differently for the three black-cockatoo species (Appendix 3) depending upon the vegetation present; thus a separate score is given for each VSA for each species.

Black-cockatoo foraging signs were also recorded in conjunction with the breeding tree surveys and general site inspections. If foraging signs were observed, the location, tree species and approximate age of the foraging evidence were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. There is currently no published evidence documenting the deterioration process of foraging evidence. 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 are recognised in the approach used by BCE, 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.

2.2.3.3 Breeding

The aim of the breeding surveys was to record all potential hollow-bearing trees (suitable for black-cockatoo nesting) within the project area. The following information was recorded for every suitable tree[1] with a diameter at breast height (DBH) equal to or greater than 500 mm (or 300 mm for Wandoo/Salmon Gum):

- 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.

The DBCA threatened species database (DBCA, 2023a) and BirdLife Australia's black-cockatoo breeding/nesting dataset (BirdLife Australia, 2023a) were queried for black-cockatoo breeding sites

[1] the draft revised EPBC Act study guidelines (DEE, 2017) stress that <u>any</u> tree species may provide suitable hollows.

and these are presented in the relevant section below. These databases were queried in February 2023.

Table 2-4. Ranking system for the assessment of potential nest-trees for black-cockatoos.

As per information from DCCEEW (2023c, 2023b, 2023a), 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. The tree may be dead or alive.

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.

2.2.3.4 Roosting

As the breeding and foraging surveys were conducted, areas likely to be used as roosting sites (e.g. sites adjacent to watercourses with large trees) or areas that had black-cockatoo activity in the late-afternoon were noted. The DBCA threatened species database (DBCA, 2023a) and BirdLife Australia's black-cockatoo roosting dataset (BirdLife Australia, 2023b) were queried for black-cockatoo roosting sites and these are presented in the relevant section below.

2.2.4 Targeted trapdoor spider assessment

Database records were compiled to provide a summary of trapdoor spider records in the surrounding landscape. Areas of suitable habitat (areas surrounding shrubs that provide leaf litter and shelter) were examined for any signs of trapdoor spiders.

2.3 Survey limitations

The EPA Guidance Statement 56 (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 (see Section 2.1.1). Not a limitation.
Competency/experience of the survey team, including experience in the bioregion surveyed	The ecologists have had extensive experience in conducting desktop reviews and targeted field investigations and site inspections, and have undertaken a number of studies within the region. Not a limitation.
Scope of the survey (e.g. were faunal groups excluded from the survey)	The survey focused only on black-cockatoos and trapdoor spiders, as per the scope of this report. Not a limitation.
Timing, weather and season	Timing is not of great importance for targeted field investigations for black-cockatoo habitat and trapdoor spiders in this region. 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 site was adequately surveyed to the level appropriate for the targeted assessments. Not a limitation.
Access problems	There were no access problems encountered. Not a limitation.
Problems with data and analysis, including sampling biases	There were no data problems. Not a limitation.

3 Results

This section presents the results of the desktop and field investigations and includes:

- Recognition of ecotypes or vegetation/substrate associations (VSAs),
- Black-cockatoo foraging, breeding and roosting assessment, and
- Targeted trapdoor spider assessment.

3.1 Vegetation and substrate associations

Three major vegetation and substrate associations (VSAs) were identified in relation to fauna in the project area. Their distribution across the project area is shown in Figure 3-1. The VSAs identified were as follows:

VSA 1. Open Areas. Areas such as roadside verge and cleared areas with weedy grasses and invasive plant species on sandy brown loam. This VSA makes up c. 42% of the project area. See Plate 1.

VSA 2. Eucalypt Woodland. Regrowth York Gum as midstorey with scattered mature Salmon Gum over weedy grasses and invasive plant species on sandy brown loam. This VSA makes up c. 16% of the project area. See Plate 2.

VSA 2. Planted Trees. Species such as Red River Gum and ornamental eucalypt species over cleared understorey with some weeds and grasses on sandy brown loam. This VSA makes up c. 2% of the project area. See Plate 3.

The remainder of the project area (c. 40%) is made up of built environments and infrastructure such as roads and buildings (Plate 4).

Plate 1. VSA 1: Open Areas.

Plate 2. VSA 2. Eucalypt Woodland.

Plate 3. VSA 3. Planted Trees.

Plate 4. Built environment.

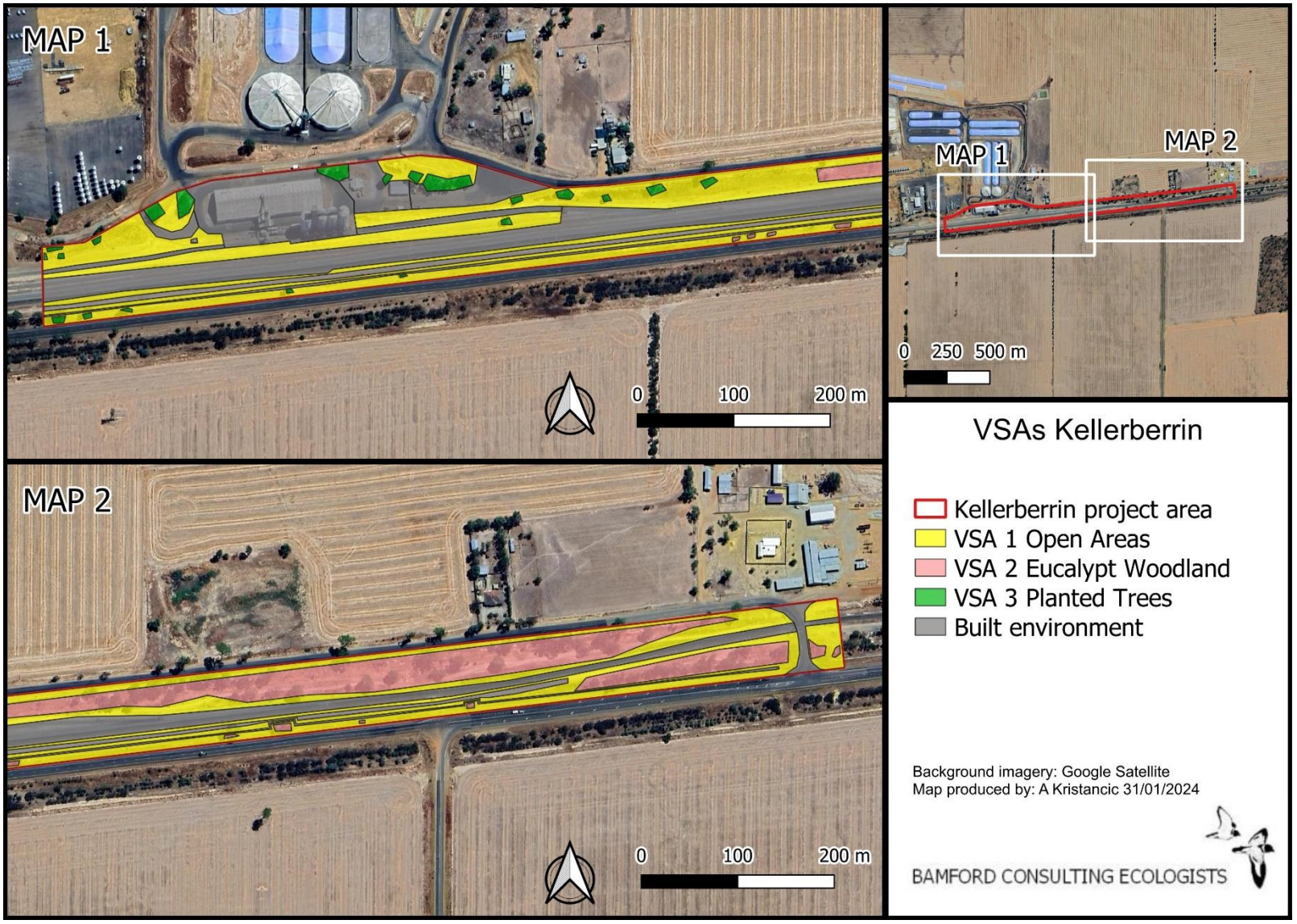

Figure 3-1. The distribution of VSAs in the project area.

3.2 General fauna observations

During field investigations, any fauna observed opportunistically were recorded and are presented in Appendix 5. Eleven fauna species, all commonly-encountered rural birds, were observed during field investigations at the Kellerberrin site.

3.3 Black-cockatoo assessment

3.3.1 Black-cockatoo presence

Carnaby's Black-Cockatoo is expected as an irregular visitor to the Kellerberrin project area. The project area is within the species' range but it is degraded and isolated. There are at least four records of the species within 15 km of the project area, with the most recent being from 2020 located c. 2 km southwest of the project area (Birdata database). There are an additional three locations within 40 km of the project area where the species has been recorded. All records from databases which provided location data are shown in Figure 3-2. Naturemap (which does not provide location data) reports seven records within 40 km of the project area. Carnaby's Black-Cockatoo was not observed and there was no evidence of foraging recorded during field investigations.

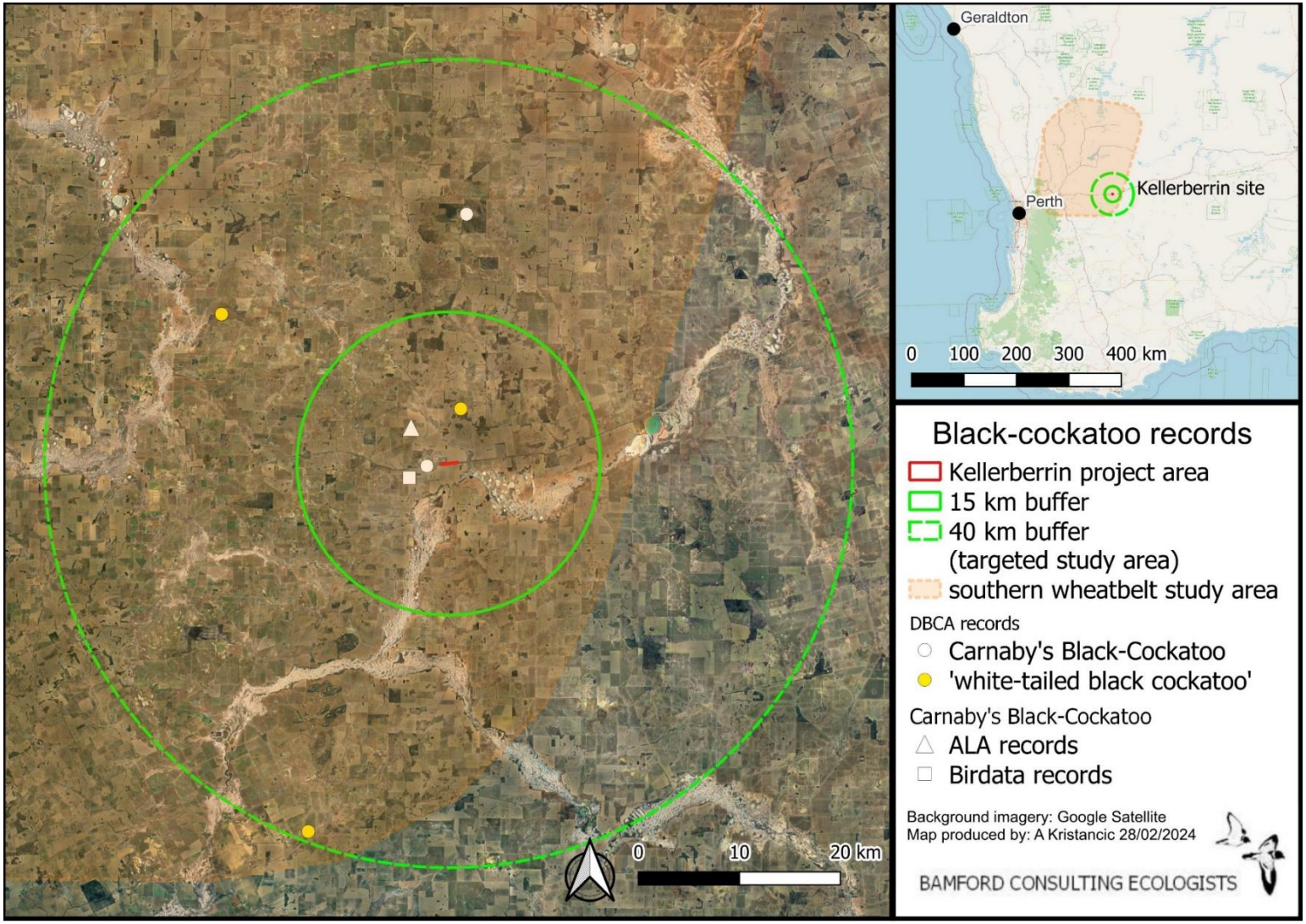

Figure 3-2. Black-cockatoo records from database searches (DBCA, ALA and Birdata). Note that the search area used for the 'southern wheatbelt study area' (for which DBCA threatened and priority data was obtained) covers part of the 40 km buffer as illustrated in the figure.

3.3.2 Black-cockatoo foraging habitat assessment

Based on the foraging assessment outlined in Section 2.2.3, the project area in general is of low foraging value for the Carnaby's Black-Cockatoo, with foraging values for each VSA given in Table 3-1 and shown in Figure 3-3. The highest foraging score was 4/10 for VSA 2 (Eucalypt Woodland), which is moderate but this VSA only makes up a small proportion (16%) of the project area. The foraging value from this VSA comes from the moderate density of eucalypt species (mature Salmon Gums and regrowth York Gums) within an area that is largely cleared, giving a site condition score of 3/6, and a context score of 1. The foraging score for VSA 3 (Planted Trees) was 3/10, comprised of a site condition score of 2/6 due to the low abundance of eucalypts and Red River Gums, plus a context score of 1. The context score of 1 for VSA 2 and VSA 3 reflects the extent of regional clearing as even small areas of low to moderate foraging value vegetation can be important in such a landscape. The foraging score for VSA 1 (Open Areas) was just 1/10 as it provides only very low foraging value for black-cockatoos and is regionally common so received a context score of zero. For all VSAs, a stocking rate (presence) score of zero was given as the species is expected to be an irregular visitor in the project area and was not recorded, nor was there any evidence of recent foraging.

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

VSA	VSA Name	Site Condition (out of 6)	Site Context (out of 3)	Species Stocking Rate (0 or 1)	Total (out of 10)
1	Open Areas	1	0	0	**1**
2	Eucalypt Woodland	3	1	0	**4**
3	Planted Trees	2	1	0	**3**

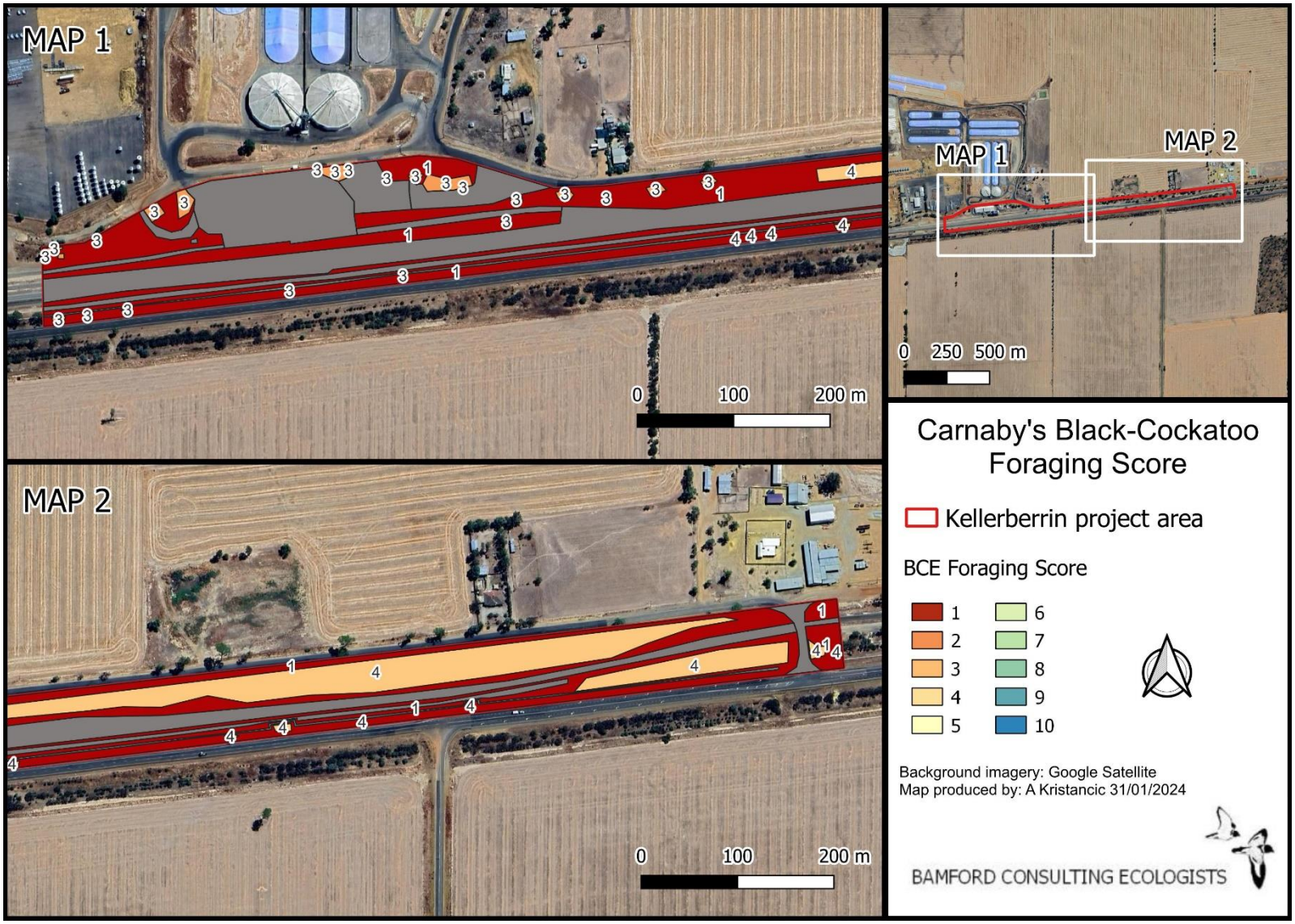

Figure 3-3. Distribution of Carnaby's Black-Cockatoo foraging scores within each VSA.

3.3.3 Black-cockatoo breeding habitat

Within the project area, 31 trees met the potential nest-tree criterion of DAWE and DEE (2017). All except two of these were located within VSA 2 or VSA 3 (two were single trees in the otherwise open areas of VSA 1). There were eight trees ranked 3 (trees with hollows suitable for use by black-cockatoos, but no sign of use by black-cockatoos), one tree ranked 4 (trees with large hollows, but they are not the size or shape preferred by black-cockatoos) and 22 trees ranked 5 (trees of a sufficient size to be assessed, but which lack large hollows). All the trees with large hollows (either rank 3 or 4) were native eucalypts. A summary of potential nest trees is given in Table 3-2, and locations are shown on Figure 3-4. Full details of potential nest trees are given in Appendix 4.

Table 3-2. Summary of potential nest trees identified in the project area.

Tree species	Rank				
	1	2	3	4	5
Salmon Gum	0	0	7	1	2
York Gum	0	0	1	0	0
Introduced eucalypts	0	0	0	0	20
TOTAL	**0**	**0**	**8**	**1**	**22**

There are no known breeding sites within 40 km of the project area and the closest known Carnaby's Black-Cockatoo breeding sites are 120 km west of the project area (Figure 3-5; DBCA, 2023c). Potential nest trees may exist in surrounding areas, as there are scattered examples of eucalypt woodland within 15 km, including some protected nature reserves, and these may contain large trees.

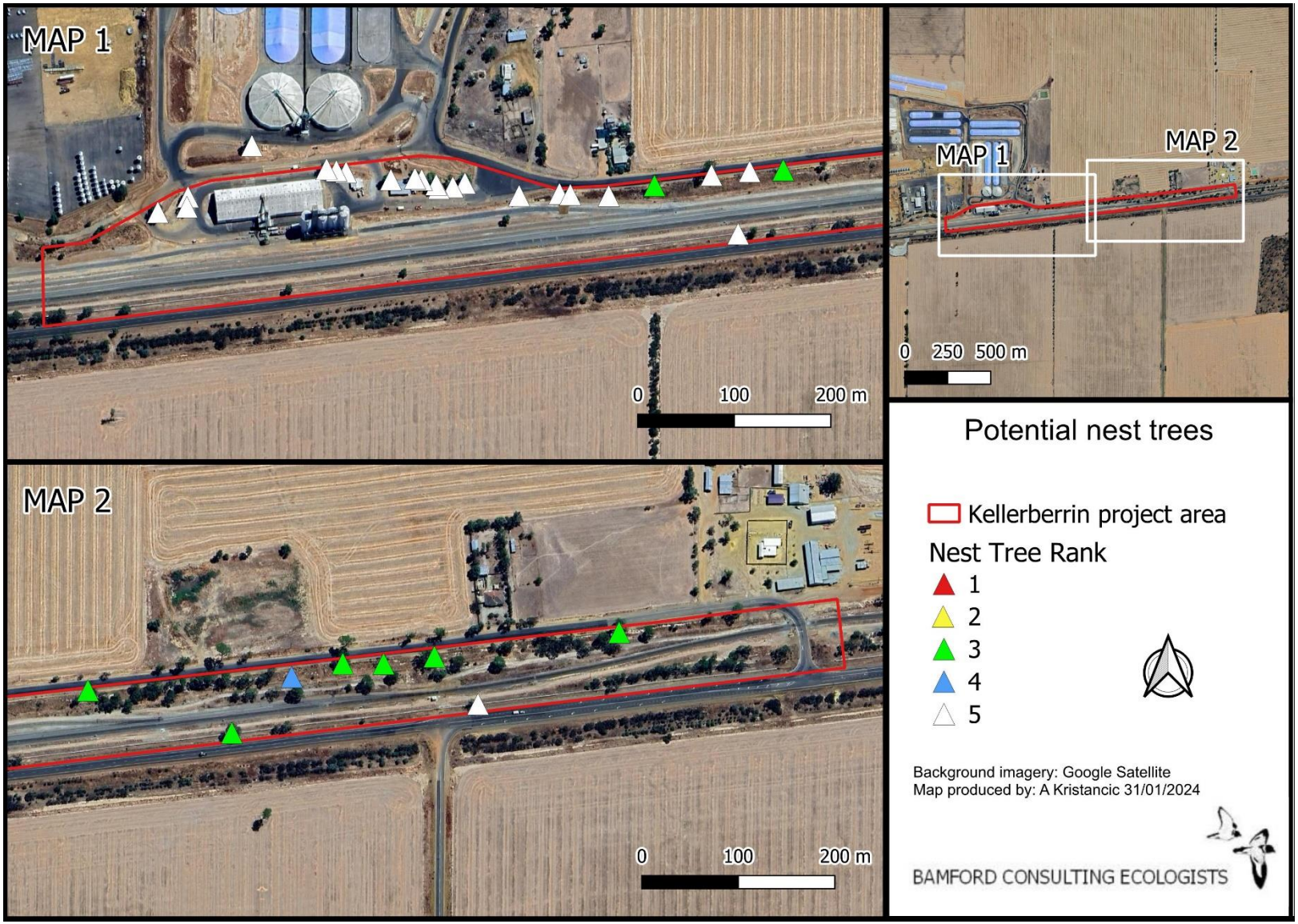

Figure 3-4. Distribution of potential nest trees in the project area.

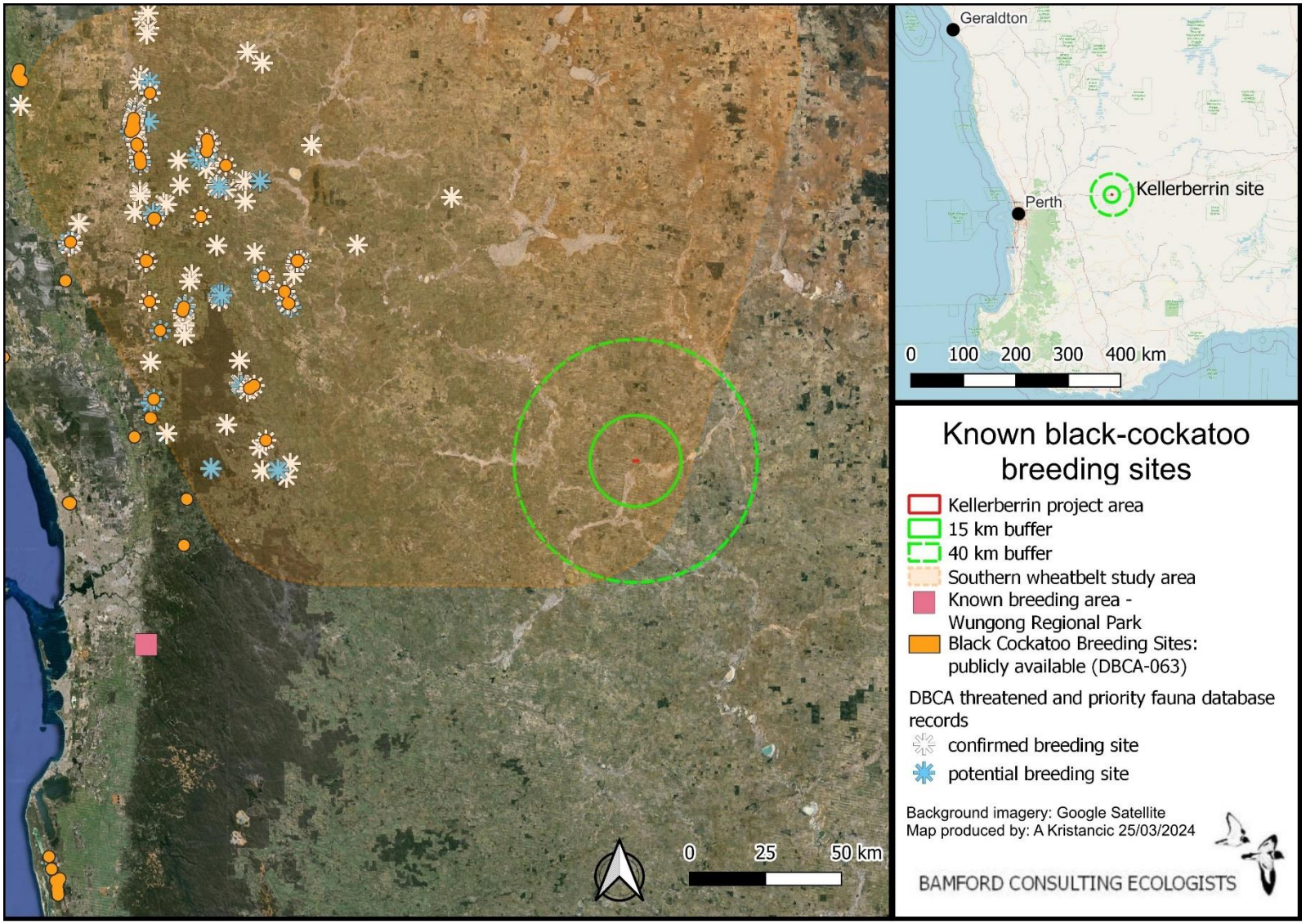

Figure 3-5. Known Carnaby's Black-Cockatoo breeding sites in relation to the project area; note none is within 40 km of the project area (DBCA, 2023c).

3.3.4 Black-cockatoo roosting habitat

There are no known roosting sites within 40 km of the project area (BirdLife Australia, 2023b). The closest unconfirmed roosting site for white-tailed black-cockatoos is c. 50 km from the project area; this site is suspected to be a roosting site but this has not been confirmed during the Great Cocky Count. The closest confirmed roosting site for white-tailed black-cockatoos is c. 94 km from the project area; this site was last confirmed used in 2011 and has not been surveyed since 2016 (when zero birds were counted here) (BirdLife Australia, 2023b). Known roost locations are shown in Figure 3-6.

It is possible that black-cockatoos may roost within the large eucalypt trees within the project area; the presence of a nearby water source is an important feature for a black-cockatoo roost and there are some dams nearby.

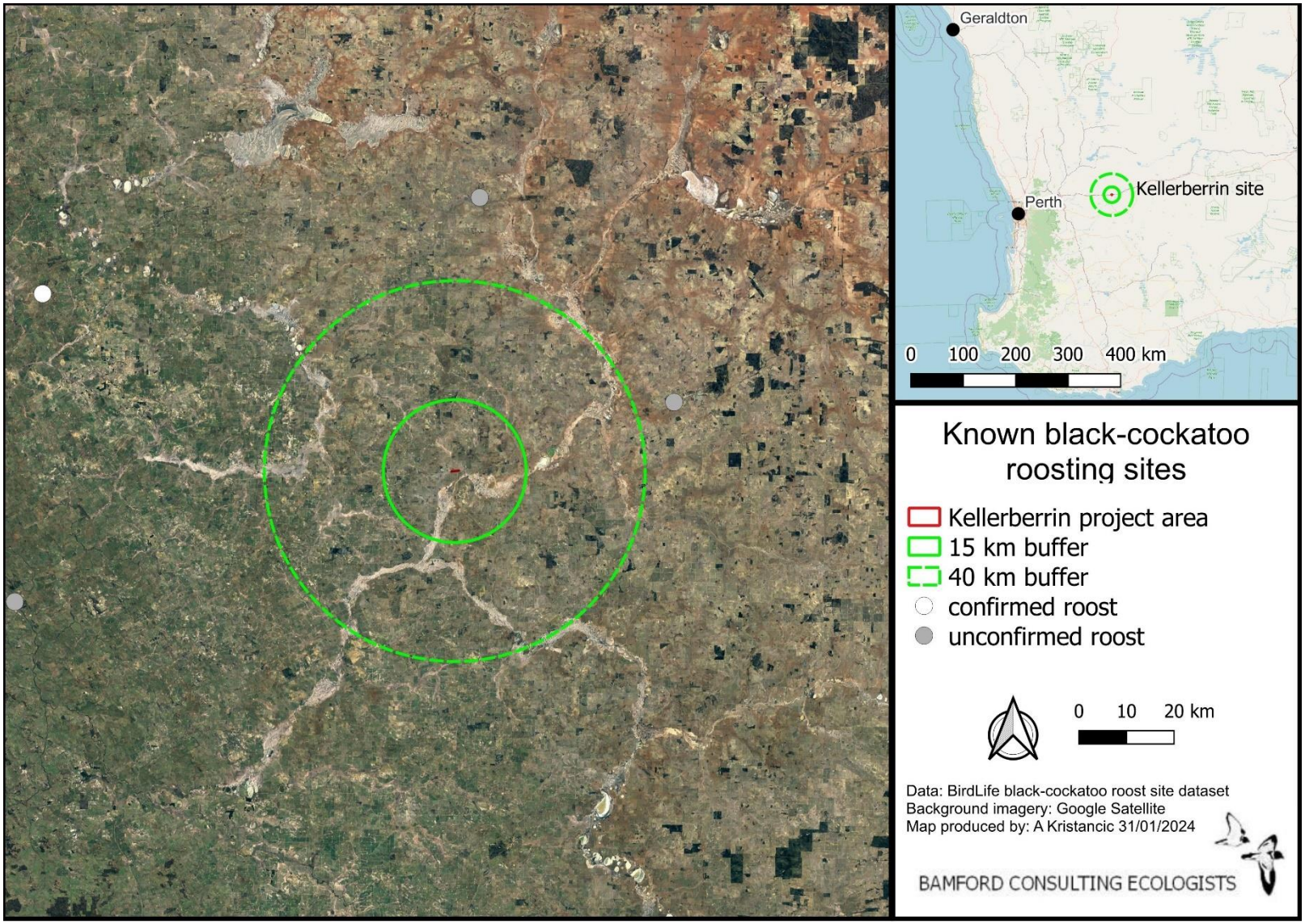

Figure 3-6. Known white-tailed black-cockatoo roost locations surrounding the Kellerberrin project area. Data from BirdLife Australia (2023b).

3.4 Targeted trapdoor spider assessment

3.4.1 Desktop investigations

Database searches returned five conservation significant trapdoor spiders within 46 km of the project area; four of these species have records within 40 km and there are no records within 15 km of the project area (see Table 3-3 and

Figure 3-7). Details of the five species are:

***Idiosoma nigrum,* Shield-backed Trapdoor Spider (listed as Vulnerable under the EPBC Act and Schedule 2 Division 2 (Endangered) under the Western Australian BC Act); likely to occur within the local area. Thirteen burrows of this species were recorded 35 km northeast of Kellerberrin by BCE in 2020; at least nine spiders were seen by milliscope. The location of these records is shown in**

- Figure 3-7.
- *Kwonkan eboracum*, Yorkrakine Trapdoor Spider (listed as Schedule 2 Division 1 (Critically Endangered) under the Western Australian BC Act); likelihood of occurrence unclear.
- *Idiosoma castellum*, Tree-stem Trapdoor Spider (Priority 4, DBCA); likelihood of occurrence unclear.
- *Idiosoma schoknechtorum*, Mortlock River Shield-backed Trapdoor Spider (Priority 3, DBCA); likelihood of occurrence unclear.
- *Idiosoma mcnamarai*, Central-eastern Wheatbelt Shield-backed Trapdoor Spider (Priority 1, DBCA); likelihood of occurrence unclear.

Table 3-3. Summary of database search results for conservation significant trapdoor spiders.

Species	DBCA threatened species database search area (truncated buffer)	ALA (closest record)	Naturemap (# records within 40km)	PMST comments
Idiosoma nigrum	177* records (in figure multiple records are within close proximity of one another), closest 18 km	20 km	315* records	Species or species habitat **likely** to occur within 15 km buffer. Species or species habitat **known** to occur within 40 km buffer.
Kwonkan eboracum	4 records, closest 23 km	23 km	4 records	n/a
Idiosoma mcnamarai	1 record, 28 km	45 km	1 record	n/a
Idiosoma schoknechtorum	No records within 40 km	46 km	n/a	n/a
Idiosoma castellum	6 records, closest 18 km	57 km	6 records	n/a
* The discrepancy between DBCA threatened species database results (177 records) and Naturemap results (315 records) suggests that there are additional records in the south-eastern portion of the buffer (or that they are missing in the DBCA database). This does not affect the results of the assessment as the species is expected to occur in the project area.				

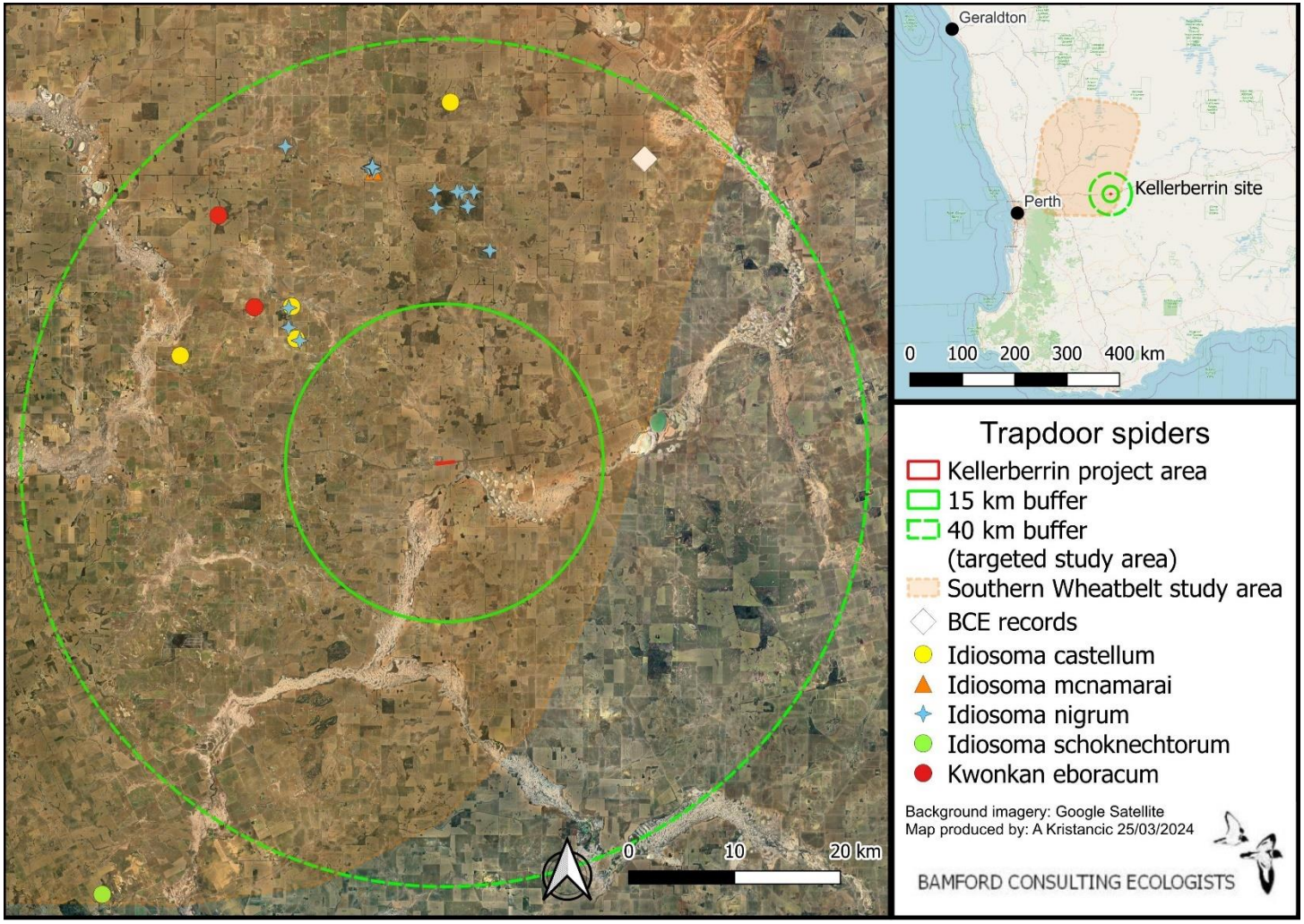

Figure 3-7. Location of records of conservation significant trapdoor spiders from DBCA threatened species database (DBCA, 2023a) and BCE records of *Idiosoma nigrum* in 2020. Note that the search area used for the 'southern wheatbelt study area' (for which DBCA threatened and priority data was obtained) covers part of the 40 km buffer as illustrated in the figure. Additional records are likely to exist within the remaining part of the buffer.

3.4.2 Field investigations

The Kellerberrin project area contained only three small shrubs that may create suitable leaf litter habitat and shelter for trapdoor spiders, including the target species *Idiosoma nigrum* (e.g. Plate 5). All shrubs in the project area were assessed for evidence of trapdoor spider burrows, and no evidence of trapdoor spiders was observed.

Plate 5. Example of shrub assessed for evidence of trapdoor spiders in the Kellerberrin project area.

Given the project area is within its range, and the abundance of previous records within 40 km of the project area, the Shield-backed Trapdoor Spider is considered likely to occur in the vicinity of the project area, but probably not within the actual project area given the paucity of suitable habitat.

3.5 Summary

Vegetation and Substrate Associations (VSAs). About 40% of the project area consists of built environments such as roads and existing CBH infrastructure. The remainder of the project area encompasses three VSAs which are typical of rural areas in the wheatbelt of Western Australia, and all VSAs are relatively simple in structure and lack understorey vegetation. The majority of the project area consists of Open Areas (VSA 1) such as roadside verge or cleared areas with weedy grasses. This VSA provides little habitat for fauna but tends to support farmland species. The remainder of the project area consists of Eucalypt Woodland (VSA 2, regrowth York Gum midstorey with scattered mature Salmon Gum, over weedy grasses) and Planted Trees (VSA 3, Red River Gum and ornamental eucalypts over cleared understorey with weedy grasses).

Black-cockatoo Assessment. Carnaby's Black-Cockatoo was not recorded during the site inspection and there was no evidence of foraging by this species. The project area is within the range of the species, but due to isolation and degradation of the habitat, Carnaby's Black-Cockatoo is expected to occur as an irregular visitor in the project area. The project area is out of range for the Forest Red-tailed and Baudin's Black-Cockatoos. There are at least seven records of the Carnaby's Black-Cockatoo within 40 km of the project area, and four records within 15 km. The most recent record of the species (in 2020) is also the closest record to the project area (c. 2 km southwest).

For Carnaby's Black-Cockatoo:

- Foraging value – the foraging value of the project area is low, with about 80% of the project area having a score of 0/10 (for built environments) or 1/10 (Open Areas). Due to the presence of eucalypt species in varying densities, VSA 2 received a moderate score of 4/10 and VSA 3 received a score of 3/10.
- Breeding value – eight trees in the project area contained hollows that were suitable for black-cockatoo breeding, but there was no evidence that these hollows were used by black-cockatoos (rank 3); one tree ranked 4 (trees with large hollows, but they are not the size or shape preferred by black-cockatoos) and 22 trees ranked 5 (trees of a sufficient size to be assessed, but which lack large hollows). The closest known record of breeding for Carnaby's Black-Cockatoo is c. 120 km from the project area.
- Roosting value – VSAs 2 and 3 contain some large trees that would be suitable for roosting by Carnaby's Black-Cockatoo. The closest known black-cockatoo roost site is 94 km from the project area and was last confirmed to be used in 2011.

Trapdoor Spider assessment. Four conservation significant trapdoor spider species have been previously recorded within 40 km of the project area, and none of these is within 15 km of the project area. The Shield-backed Trapdoor Spider *Idiosoma nigrum* was recorded 35 km northeast of the project area by BCE in 2020, with at least nine spiders seen by milliscope and 13 burrows recorded. There was no evidence of trapdoor spiders recorded during field investigations. Given the project area is within its range and the abundance of records within 40 km of the project area, the Shield-backed Trapdoor Spider is considered likely to occur within the vicinity of the project area, but probably not within the actual project area due to the paucity of suitable habitat.

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5 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 Appendix 2.

<u>Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts</u>.

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).

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, 2006). 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/project 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/project 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 project 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.

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.
Priority 4. (P4)	Taxa in need of monitoring. 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 black-cockatoo foraging value

Scoring system for the assessment of foraging value of vegetation for black-cockatoos.

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 DCCEEW (formerly 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[2] 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

[2] https://www.agriculture.gov.au/sites/default/files/documents/offsets-how-use.pdf

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; • 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; • Urban areas with scattered foraging trees. • Paddocks with *Erodium* spp. and other weeds.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah or Sheoak) 1-5% projected foliage cover; • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*. • Paddocks with *Erodium* spp. and other weeds.
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; • Eucalypt Woodland with Marri 5- 10% projected foliage cover. • Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly degraded understorey (poor long-term viability without management);	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-10% projected foliage cover; • Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly degraded understorey (poor long-term viability without management); • 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) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly-degraded understorey (poor long-term viability without management); • 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; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-60% projected foliage cover. Depending on understorey condition (and thus long-term viability) and Marri density, may downgrade to 3 or upgrade to 5.	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. • Eucalypt Woodland/Forest with diverse, healthy understorey and known food trees (especially Marri) 10-20% projected foliage cover. • 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.
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; • 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.	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.

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).	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).

B. 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 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 12km 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 15km 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 (eg 0.5% of such habitat within 15km) 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. Adjustments to context score are further discussed below (moderation of scores).

C. 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.

D. 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 (out of 6)	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. It could also get an elevated context score if it is the only foraging habitat in an area and birds are present, and also if it is immediately alongside at least moderately good foraging habitat, on the basis that birds are more likely to utilise it if they are nearby. Species density score might also be raised if there is a high likelihood of the birds actually being present. Context score can also be used to give a fine adjustment to the total score, such as if there are two vegetation types with the same vegetation composition score, but one may be slightly better foraging habitat and covers a larger area. Moderation is a means by which fairly subtle differences in overarching foraging value can be recognised.

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. Potential nest-trees in Kellerberrin project area

Table 5-1. Details of all potential nest trees in the Kellerberrin project area. Coordinates are for Zone 50J.

Waypoint	Easting	Northing	Species	DBH	Rank	Status	Comment
576	569784.199	6500232.174	Introduced Eucalypts	500	5	Alive	
577	569771.651	6500228.04	Introduced Eucalypts	500	5	Alive	
578	569757.127	6500226.698	Introduced Eucalypts	500	5	Alive	
579	569754.402	6500230.6	Introduced Eucalypts	500	5	Alive	
580	569739.364	6500235.579	Introduced Eucalypts	500	5	Alive	
581	569732.354	6500236.955	Introduced Eucalypts	500	5	Alive	
582	569707.401	6500235.794	Introduced Eucalypts	500	5	Alive	
583	569660.981	6500243.53	Introduced Eucalypts	500	5	Alive	
584	569650.935	6500244.926	Introduced Eucalypts	500	5	Alive	
585	569640.804	6500246.768	Introduced Eucalypts	500	5	Alive	
586	569563.388	6500271.008	Introduced Eucalypts	500	5	Alive	
587	569497.211	6500217.918	Introduced Eucalypts	500	5	Alive	
588	569496.004	6500207.39	Introduced Eucalypts	500	5	Alive	
589	569465.903	6500201.943	Introduced Eucalypts	500	5	Alive	
590	569840.345	6500219.16	Introduced Eucalypts	500	5	Alive	
591	569882.094	6500221.312	Introduced Eucalypts	500	5	Alive	
592	569893.375	6500220.242	Introduced Eucalypts	500	5	Alive	
593	569933.192	6500218.97	Introduced Eucalypts	500	5	Alive	
594	569980.594	6500229.52	Salmon Gum	800	3	Alive	Side Entrance.15m.
595	570039.652	6500240.419	Salmon Gum	800	5	Alive	
596	570079.226	6500244.258	Salmon Gum	600	5	Dead	

Waypoint	Easting	Northing	Species	DBH	Rank	Status	Comment
597	570114.046	6500245.686	Salmon Gum	700	3	Dead	Chimney.15m.
598	570256.245	6500264.447	York Gum	600	3	Dead	Spout. 4m.
599	570467.357	6500278.427	Salmon Gum	500	4	Dead	
600	570520.37	6500292.253	Salmon Gum	800	3	Alive	Side Entrance.15m.
601	570562.572	6500292.077	Salmon Gum	800	3	Dead	Chimney.15m.
602	570615.264	6500299.476	Salmon Gum	1000	3	Alive	x2 Hollows(Chimney, Side). 10-15m.
603	570806.723	6500324.658	Salmon Gum	800	3	Alive	x3 Hollows (Chimney, Spout, Side). 10-15m.
604	570660.446	6500250.177	Introduced Eucalypts	500	5	Alive	
605	570405.314	6500220.325	Salmon Gum	600	3	Alive	Spout. 4m.
606	570067.317	6500179.497	Introduced Eucalypts	500	5	Dead	

Appendix 5. Fauna observed during field investigations.

Latin Name	Common Name
Ocyphaps lophotes	Crested Pigeon
Phaps chalcoptera	Common Bronzewing
Eolophus roseicapilla	Galah
Barnardius zonarius	Australian Ringneck
Manorina flavigula	Yellow-throated Miner
Pardalotus striatus	Striated Pardalote
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Artamus cyanopterus	Dusky Woodswallow
Cracticus nigrogularis	Pied Butcherbird
Grallina cyanoleuca	Magpie-lark
Corvus coronoides	Australian Raven

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