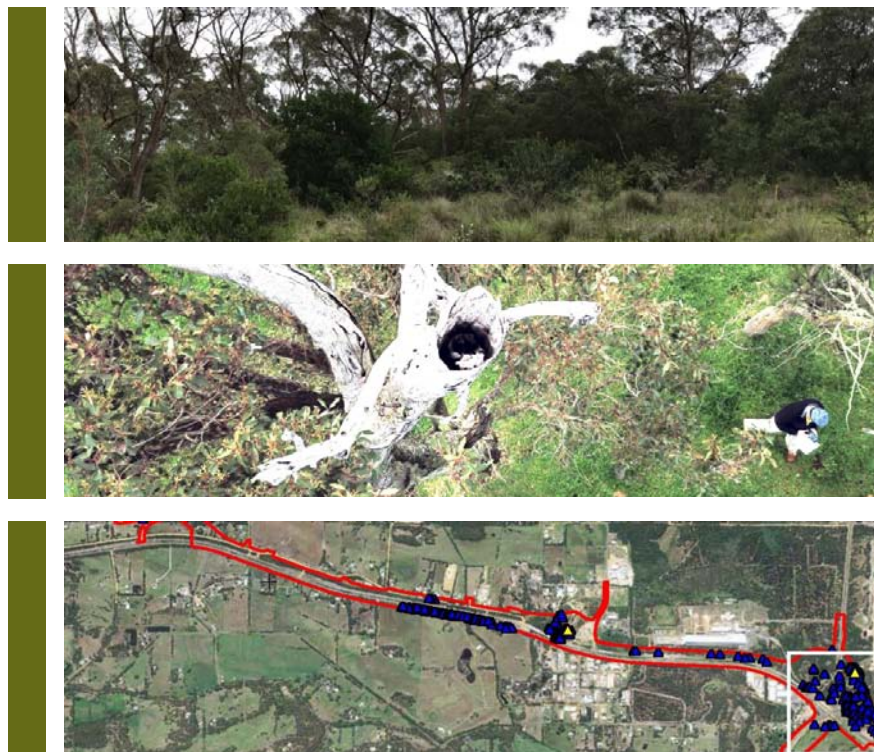
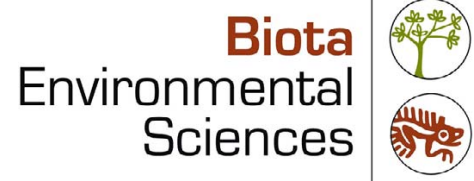




Albany Ring Road Black-Cockatoo Habitat Assessment





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Albany Ring Road Black-cockatoo Habitat Assessment

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1.0 Summary

Main Roads Western Australia (Main Roads) is proposing to construct the Albany Ring Road, a staged development with the purpose of redirecting heavy vehicle traffic bound for the Port away from built up urban areas of the City of Albany. With Stage 1 completed in 2017, Main Roads is now proposing to undertake construction of Stages 2 and 3 of the Albany Ring Road project. The survey area for Stages 2 and 3 is known as the Ultimate Footprint (the area to which this report pertains). It is 12 km in length and consists of 185 ha, of which 144.7 ha are vegetated.

Habitat for black-cockatoos was assessed by foot-traversing as much of the woodland habitat in the study area as practicable. In larger vegetation fragments, a systematic approach was applied, whereby transects of 25 m spacing were overlain on the study area in GIS. A zoologist then walked down the middle of two 25 m transects, effectively using them as the boundary of a strip-search, and recorded the location of all trees within the strip. This was continued until the entire fragment had been searched. In small fragments or where there were singular trees, foot traverses were also undertaken and recorded via a track file. Foraging habitat descriptions were recorded while conducting foot traverses. For any tree supporting hollow/s, details of the hollows were taken, and a differential GPS was used to record an accurate location of the tree. These trees were also subject to a dedicated breeding hollow assessment, which included the use of a remotely piloted aircraft (RPA) to obtain images of the hollows.

A total of 516 'suitable diameter at breast height (DBH) trees' (>50 cm DBH) were recorded in the Ultimate Footprint during the survey. From these trees, a total of 48 hollows with entrance diameters of 10 cm or greater were recorded, 37 of which were considered to warrant further investigation during a dedicated hollow assessment. This follow-up hollow assessment included the use of an RPA with a camera mounted to take photographs of the hollows. This assessment indicated that none of the hollows were suitable for black-cockatoo breeding, primarily due to inadequate chamber size.

Potential foraging habitat within the study area was assessed using the detailed vegetation mapping of the study area (Rathbone and Gilfillan 2018). This comprised 17.4 ha of predominantly Jarrah and/or Marri woodland with varying mid- and under-storeys, in some places included foraging plants. Individual planted *Pinus radiata* were also recorded throughout the study area and represent foraging plants for white-tailed black-cockatoos.

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2.0 Introduction

2.1 Project Background

Main Roads is proposing to construct the Albany Ring Road (ARR), a staged development with the purpose of redirecting heavy vehicle traffic bound for the Port away from built up urban areas of the City of Albany. When complete, the ARR will link four major roads (Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road), allowing alternative access to the Port and developing industrial area. With Stage 1 completed in 2017, Main Roads is now proposing to undertake construction of Stages 2 and 3 of the ARR project. The survey area for Stages 2 and 3 is known as the Ultimate Footprint. This is the subject of this report and is referred to as the study area throughout. It is 12 km in length and consists of 185 ha, of which 144.7 ha are vegetated.

Three species of black cockatoo are known to inhabit the Albany area, and all have been recorded within 10 km of the study area: Carnaby's Black-Cockatoo (*Calyptrorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptrorhynchus baudinii*) and the Forest Red-tailed Black-Cockatoo (*Calyptrorhynchus banksii naso*) (DSEWPaC 2012). All three species represent threatened fauna and are protected under both the Western Australian *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The area contains old growth remnant Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) trees, which have the potential to represent foraging and nesting habitat for all three species (DSEWPaC 2012). As part of a Biological Survey of the Albany Ring Road in 2017, Southern Ecology assessed threatened black-cockatoo habitat covering an area of 247 ha (Rathbone and Gilfillan 2018), of which 117.2 ha overlapped the Ultimate Footprint study area. During the 2017 survey, 265 habitat trees were identified within the area that intersects with the Ultimate Footprint survey area, and 53 hollows with diameters greater than 10 cm were recorded.

Since some sections of the study area had not been surveyed, and the status and value of some of the habitat trees that were surveyed may have changed since 2017, Main Roads commissioned Biota Environmental Sciences (Biota) to complete an updated assessment of black-cockatoo breeding habitat trees across the entire Ultimate Footprint study area.

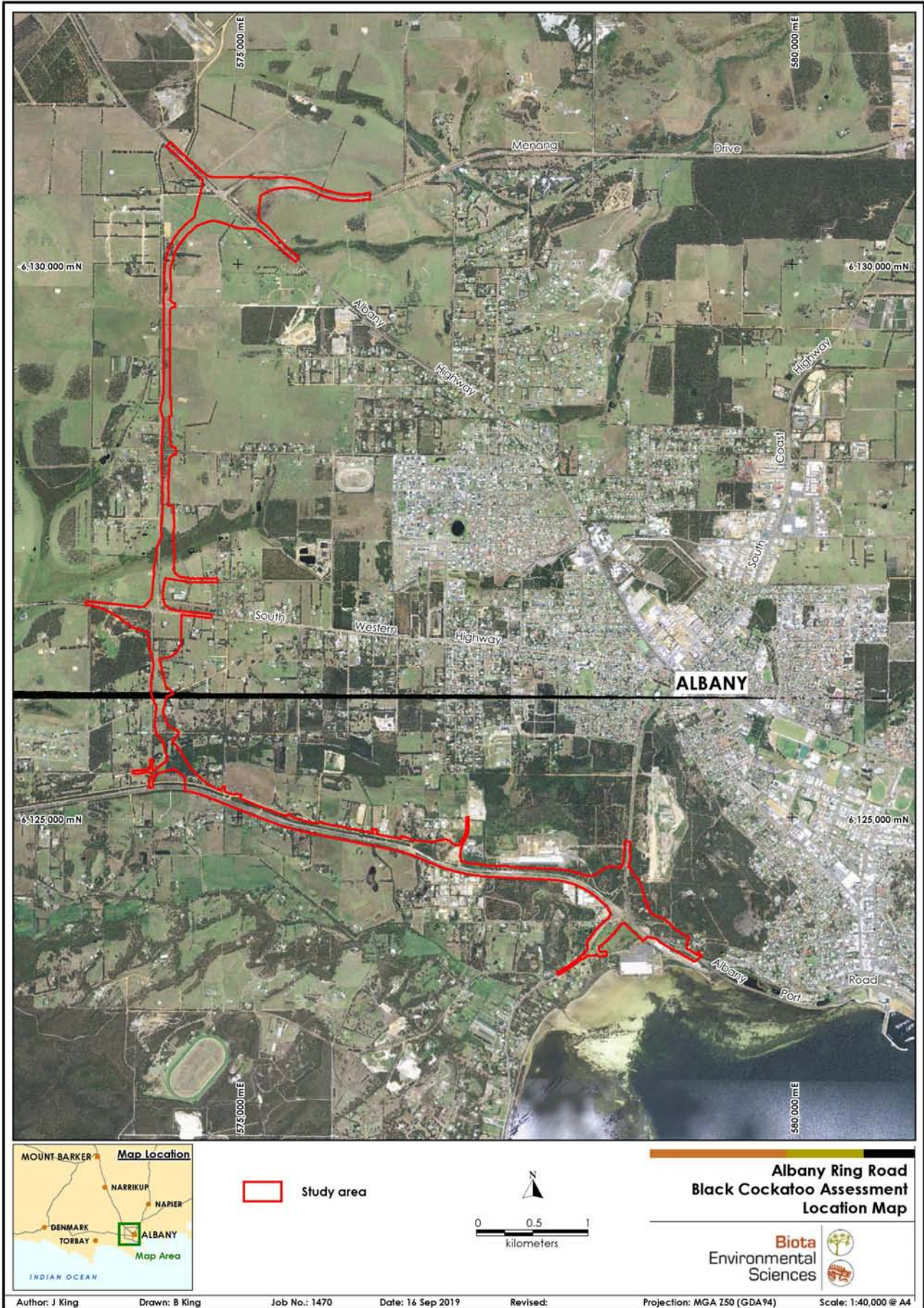


Figure 2.1: Location of the study area.

2.2 Scope and Purpose of the Study

The aim of the survey was to re-assess black cockatoo habitat values within the Ultimate Footprint (hereafter 'the study area'). This was undertaken by identifying trees suitable for black-cockatoo nesting, which represent breeding habitat as defined in the EPBC Act referral guidelines (DSEWPaC 2012)

Specifically, this was achieved by undertaking the following scope:

- assessment of black-cockatoo habitat trees (diameter at breast height (DBH) >500 mm) within the Ultimate Footprint study area, including a re-assessment of those trees previously identified by Southern Ecology (Rathbone and Gilfillan 2018);
- identification of habitat trees containing hollows >100 mm and corresponding measurements of diameter, depth and angle, as well as details on suitability/evidence of use by black-cockatoos;
- further investigation using a drone for hollows deemed suitable based on risk assessment criteria; and
- recording evidence of roosting or feeding and any physical observations of black-cockatoo species during the survey.

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3.0 Target Species Overview

All three species of black-cockatoo are endemic to the southwest of Western Australia and have documented breeding areas overlapping the study area (Johnstone and Storr 1998, DSEWPaC 2012). Black-cockatoos require tree hollows with suitable dimensions for nesting and breeding, which typically occur in larger trees over 200 years old (DSEWPaC 2012). As such, breeding habitat trees are defined in the Federal guidelines as any tree with DBH equal to or greater than 500 mm (DSEWPaC 2012). Activities such as logging and deforestation for agriculture have contributed to a decline in abundance and range of black-cockatoos, hence their listing as conservation significant species.

3.1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 2 - Endangered) and the Commonwealth EPBC Act (Endangered).

This species is distributed from Kalbarri to Esperance. During the breeding season, between July and November, they have been historically concentrated in the Wheatbelt region (Johnstone and Storr 1998, Saunders et al. 2014b). Here, they primarily nest in Salmon Gum (*E. salmonophloia*) and Wandoo (*E. wandoo*) but are also known to nest in Tuart (*E. gomphocephala*), Marri (*Corymbia calophylla*), Red Morrel (*E. longicornis*) and York Gum (*E. loxophleba*) (Johnstone and Storr 1998).

Expansion in breeding range further south and west towards the Jarrah - Marri forests of the Darling Scarp and Tuart forests of the Swan Coastal Plain has occurred in the past 10 to 30 years (Johnstone et al. 2010). Long term studies show that Carnaby's Black-Cockatoos utilise hollows ranging from 10 – 65 cm in diameter (average 26 cm) and approximately 130 cm deep (Saunders et al. 2014a, 2014b). They also frequent coastal areas outside of the breeding season where they forage in large flocks (Saunders et al. 2011), feeding on the seeds of *Banksia*, *Dryandra* and *Eucalyptus* species such as Jarrah, Marri and Karri (*E. diversicolor*).

3.2 Baudin's Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 2 - Endangered) and the Commonwealth EPBC Act (Vulnerable).

Baudin's Black-Cockatoo occurs in the humid and subhumid areas of the Southwest, distributed from Gidgegannup in the north to Naturaliste National Park and Augusta; also occurring in the Stirling and Porongurup Ranges and east along the south coast to Waychinicup (Johnstone and Storr 1998). Between March and September, the majority of the population migrates north from the cooler Karri forest to the central and northern Darling Range and eastern Swan Coastal Plain (Johnstone et al. 2010). They feed mainly on the seeds of Marri trees, as well as various species of *Banksia* and *Hakea* (Johnstone and Storr 1998).

Although the breeding requirements of this species are still poorly known, breeding has been recorded in the Southwest, north to Serpentine and east to Kojonup and Albany (Johnstone et al. 2010). They nest mainly in hollows of Karri, Marri and Wandoo trees. Breeding typically occurs between March and October, but egg laying has also been reported less frequently in November and December (Johnstone and Storr 1998, 1998, Johnstone et al. 2010). Specific dimensions of hollows used for breeding have not previously been studied for Baudin's Black-Cockatoo, but are likely to be similar to those hollows used by Carnaby's Black-Cockatoo.

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

The Forest Red-tailed Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 3 - Vulnerable) and the Commonwealth EPBC Act (Vulnerable).

This species occurs from Gingin in the north across to near Albany in the south (Johnstone and Storr 1998), typically nesting in Marri, Jarrah and Karri tree hollows with entrance diameters ranging from 10 x 12 cm to 44 x 150 cm (mean 28 x 30 cm), and depths of between 100 cm and 500 cm (average 144 cm) (Johnstone and Storr 1998, Johnstone et al. 2013). This species lays eggs between October and November and incubation is approximately 29 – 31 days, during which time the female stays with the egg and is fed by the male (Johnstone and Storr 1998). They feed mainly on Jarrah and Marri seeds but also Sheoak (*Allocasuarina fraseriana*), Snottygobble (*Persoonia longifolia*) and Swan River Blackbutt (*E. patens*) (Johnstone et al. 2010).

4.0 Survey Methodology

4.1 Desktop Review

The following sources of information were reviewed in relation to the study area:

1. A search of NatureMap, carried out on 9th September 2019 in relation to the three black-cockatoo species using a line search with a 10 km buffer on the following points: (i) 34° 57' 52.5168" S, 117° 49' 14.2968" E; (ii) 34° 59' 47.6592" S, 117° 48' 49.7844" E; (iii) 35° 0' 51.1164" S, 117° 49' 24.2292" E; and (iv) 35° 1' 23.9988" S, 117° 51' 44.3268" E;
2. Results of the Great Cocky Count Report (Peck et al. 2018), particularly in relation to known roosting areas for black-cockatoos;
3. The vegetation and fauna report of Southern Ecology (Rathbone and Gilfillan 2018), which addressed an overlapping study area. Detailed vegetation mapping over the study area was completed by Southern Ecology and provided to Biota as shapefiles;
4. Southdown Magnetite Project Summary of studies and impact assessment for Carnaby's Black-Cockatoo (Rev 12.7) (Everard and Bamford 2016)
5. Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DoEE 2017).

4.2 Field Survey

The field survey methodology was performed in accordance with the Commonwealth referral guidelines for threatened black cockatoos (DSEWPoC 2012, DoEE 2017).

4.2.1 Breeding Habitat Assessment

The field assessment aimed to determine whether suitable breeding habitat for black-cockatoos was present within the Ultimate Footprint study area. This included the reassessment of the 663 habitat trees identified by Southern Ecology during earlier assessments (Rathbone and Gilfillan 2018), which were relocated during the survey using a GPS.

The Commonwealth *Revised draft referral guideline for three black cockatoo species* (DoEE 2017) defines breeding habitat as those species of trees known to support breeding within the range of the species, which either have a suitable nest hollow or are of a suitable DBH to develop a nest hollow (being greater than 50 cm DBH for most Eucalypts, or 30 cm in the case of Wandoo and Salmon Gum).

The aim was to assess, as far as practicable, all potential breeding trees within the study area. Two approaches were taken:

1. Larger areas of continuous vegetation were identified from aerial imagery and overlain with 25 m spaced transects in GIS. Using a GPS, a biologist walked up the middle of each 25 m wide transect, assessing all trees within it;
2. In smaller treed areas (e.g. roadside verges and paddocks containing singular trees), a biologist would maintain a GPS track file while using aerial imagery to visit as many trees as possible.

All individual trees of species with the potential to form hollows (primarily Jarrah, Marri and Tuart) and with sufficient diameter to be considered breeding habitat trees (i.e. DBH >50 cm) were recorded using a GPS with accuracy equivalent to that of a differential GPS (i.e. accurate to within 1.5 m).

For trees that were observed to contain hollows potentially suitable for black-cockatoo nesting, the following information was recorded:

- DBH (approximately 1.3 m above the ground);
- tree height;
- tree species;
- height above the ground of each hollow;
- the estimated size of entry of the hollow;

Hollows that met the following risk assessment criteria were considered a potential breeding hollow warranting further investigation using a remotely piloted aircraft (RPA), as described in Section 4.2.1.1:

- whether the hollow was suitably open for access (i.e. not covered by branches);
- whether the orientation of the hollow was suitable for access (i.e. horizontal to upright; downward-facing hollows being unsuitable);
- whether the location of the hollow allows for the formation of a nesting cavity (e.g. if on a spout branch, was the branch large enough to support a nesting cavity);
- signs of cockatoo use (including wear around hollows, nut chews, scarring, scratch marks on trunks and branches, secondary evidence of feeding sites and moulted feathers).

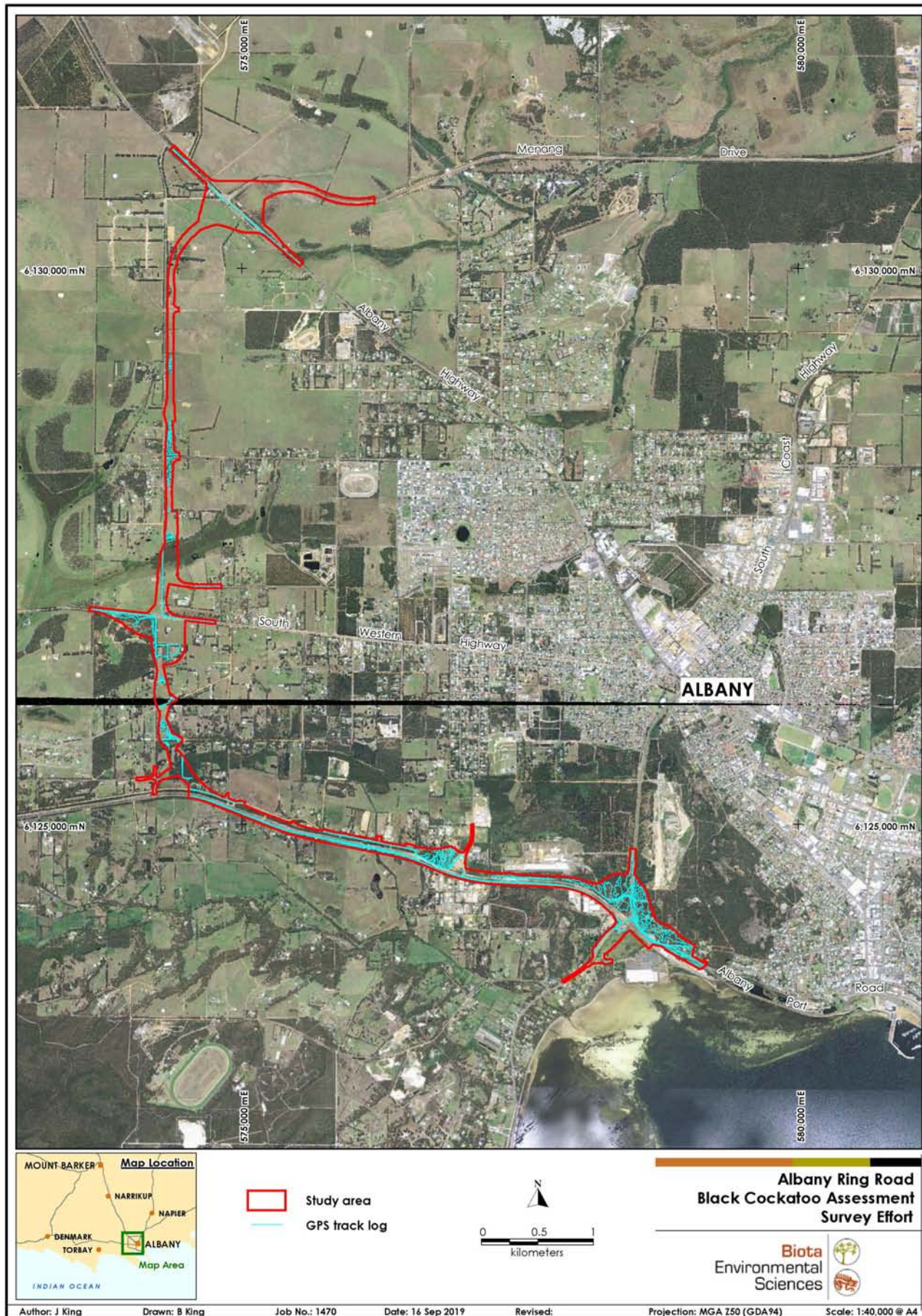


Figure 4.1: Effort applied to the recording of black-cockatoo habitat trees within the study area.

4.2.1.1 Black-cockatoo Breeding Hollow Assessment Field Methodology

Black-cockatoos breed in large hollow-bearing trees, generally within woodlands and forests (Johnstone and Kirkby 2011). Hollow formation results from a number of processes including fungal infection, termite activity and fire, and propensity for hollow formation varies between eucalyptus species (Whitford and Williams 2002). Studies on hollow formation in Jarrah/Marri forests identified a minimum tree age of 130 years before a tree would be suitable for hollow-dependent fauna (Whitford and Williams 2002). Habitat destruction, and the subsequent loss of suitable breeding hollows, has been identified as a process leading to population decline of black-cockatoos (Johnstone and Kirkby 2008). Furthermore, increased competition with both native and introduced species (e.g. Galahs, ducks and European honey bees) continues to reduce the availability of such trees for breeding sites (Johnstone et al. 2013).

Studies of the breeding behaviours of the three threatened black-cockatoo species have identified variation between the tree species and characteristics of hollows chosen for nesting (Table 4.1). For example, hollows formed in Jarrah are typically smaller than those in Marri, and Forest Red-tailed Black-Cockatoos breed predominantly in Marri in the Jarrah-Marri forest of the South-west (Johnstone et al. 2013). Breeding records of Carnaby's Black-Cockatoo on the Swan Coastal Plain indicate that the majority of their nests are in Tuart (Johnstone and Kirkby 2011).

Table 4.1: Breeding habitat for the three Threatened black-cockatoo species.

	Baudin's	Carnaby's	Forest Red-Tailed
Specific breeding habitat for the three black-cockatoo species	Nest in hollows in live or dead trees of Karri, Marri, Wandoo and Tuart.	Nest in hollows in live or dead trees of Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, York Gum, Powderbark, Karri and Marri.	Nest in hollows in live or dead trees of Karri, Marri, Bullich, Swan River Blackbutt, Tuart and Jarrah.
Hollow Characteristics			
Aspect	No preference. Does not affect nesting success (Saunders 1979).	No preference. Does not affect nesting success (Saunders 1979).	–
Depth	Ranges from 0.1 to 2.5+ m (Johnstone and Kirkby 2011).	Majority between 0.5 and over 2.0 m, average just over 1 m (Saunders 1979).	1.0 - 5.0 m (Johnstone and Kirkby 2011).
Height above ground	No preference (Serventy and Whittell 1976).	No evidence that higher hollows are preferred (Saunders 1979).	No preference (Johnstone and Kirkby 2011).
Living or dead	No preference (Saunders 1979).	No preference (Saunders 1979).	No preference (Saunders 1979).
Entrance Diameter	–	–	>12 cm (Johnstone and Kirkby 2011).

For all hollow-bearing trees >50 cm DBH, which also contained hollows greater than approximately 10 cm dimension that were recorded during the black-cockatoo habitat mapping exercise (see Section 4.2.1), a follow-up survey was conducted using an RPA (DJI Mavic Pro). This aimed to assess the likelihood or evidence of black-cockatoo breeding within each hollow, as well as a better assessment of its suitability for breeding.

The RPA exercise was carried out by two biologists, one of whom is also an experienced RPA pilot. A pre-flight assessment of the tree was completed to ensure proper flight conditions and confirm the order in which hollows would be assessed. Prior to flight, the side of the tree was raked with a branch, which will generally cause any black-cockatoo or other bird species within a hollow to emerge. This provides an indication of hollow use and also reduces the likelihood of RPA-fauna collision.

During the flight stage of the RPA survey, the two participants were each tasked with a specific duty: (i) the pilot was responsible for flying the RPA; and (ii) the spotter monitored the surroundings to ensure the aircraft was not in close proximity to branches, and informed the pilot if any birds fled the hollows.

All accessible hollows with an entrance of 10 cm were examined with the RPA. Photographs were also taken as a visual reference and to aid future identification of the tree. These were also assessed in detail to determine if they represented suitable hollows and/or if they showed any signs of current or previous use by black-cockatoos (e.g. chew marks around hollow entrance, presence of chicks, eggs, feathers, chew/scratch marks).

Breeding suitability of the hollows examined was assessed against the criteria detailed in Table 4.2.

Table 4.2: Categories of hollow suitability for black-cockatoo nesting.

Category	Characteristics
Suitable with Evidence of Use	As for "Suitable" above, but also showing evidence of use that may be from black-cockatoos. The following represent the types of use that were searched for: <ul style="list-style-type: none"> • Fresh chews around the rim and inside of the hollow. • Freshly cleared vegetation around the entrance. • Eggs that were similar in appearance to those of black-cockatoos.
Suitable	<ul style="list-style-type: none"> • Entrance greater than 10 cm. • Branch width and depth large enough to support a nesting chamber. • Angle of entrance/egress suitable for black-cockatoo. • Entrance is clear of large branches would block access for black-cockatoo.
Not Suitable	Not a hollow, or hollow not suitable for black-cockatoo nesting.
Ground Assessment Only	The hollow could only be assessed from the ground due to limitations with RPA access (e.g. proximity to road traffic, within a prescribed no-fly zone, foliage covering hollow).

4.2.2 Foraging Habitat Assessment

Foraging habitat is defined as areas including plants of species known to support foraging within the range of each black-cockatoo species. While a broader range of species is utilised for foraging (including introduced species such as pines, **Pinus spp.*), Marri and Jarrah woodlands are particularly important to Baudin's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo, while proteaceous heaths (i.e. shrublands dominated by *Banksia*, *Hakea* and *Grevillea* species) are also utilised by Carnaby's Black-Cockatoo (DSEWPaC 2012). The quality of the foraging habitat was scored using the elements of the habitat scoring tool described in the referral guideline (DotEE 2017) (Appendix 2).

The detailed vegetation mapping of the study area (Rathbone and Gilfillan 2018) was used in conjunction with the on-site breeding habitat assessment in order to apply the Foraging Habitat Scoring Tool (DotEE 2017) to the vegetation of the study area. Consideration was also given to the wider availability of foraging habitat for black-cockatoos by placing the study area in a 12 km context using mapping from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010).

4.3 Survey Team and Timing

The field work was carried out over two phases, with the initial phase consisting of a habitat tree assessment, and the follow-up second phase involving investigation of hollows (>100 mm opening) potentially suitable for cockatoo nesting using a drone. The first phase was carried out over a period of three days from 5 – 7 August 2019 by two Biota biologists, Brandon King and Simon Colwill, together with Shane Priddle from Southwest Environmental. Shane Priddle and Brandon King carried out the assessment using the RPA in the following week, on 15 August 2019.

The survey timing fell within the recommended (DotEE 2017) South Coast regional window for Baudin's Black-cockatoo (March to September), as the species is likely to occur in foraging habitat and may occur in areas of the south coast region if breeding. Carnaby's Black-cockatoo would primarily occur in the Albany area from January to July to forage, following breeding further inland, however the species may also occur after July if breeding in local areas. Forest Red-tailed Black-Cockatoos are known to breed throughout the year.

The timing of the survey overlapped the beginning of the breeding period for the Carnaby's and Baudin's Black Cockatoo species, taking place near the end of winter, but was not within the usual peak breeding times.

A total of 46.2 mm of rainfall was recorded over the survey period from 5 – 14 August and temperatures were mild, ranging from a minimum of 8°C to a maximum of 21.6°C (data from the Bureau of Meteorology's Albany recording station (No. 9500)).

4.4 Legislation and Policy Conformance

All surveys were completed as far as practicable in accordance with relevant State and Commonwealth policy, and to a standard that would provide adequate information to assess the Proposal against principles and environmental aims relating to the environmental factor 'Terrestrial Fauna' (EPA 2016a).

Table 4.3 provides a summary of the most important and relevant legislation, policy and guidelines relating to this study.

Consistent with the most practically applicable and current policy in relation to the three black-cockatoo species occurring within South-west Western Australia, the current study primarily represents a habitat assessment, and as recommended under DSEWPaC (2012) the following was undertaken:

*“Assess the extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by the black cockatoos. In potential breeding habitat, measurements of the diameter at breast height of trees in the patch of woodland/forest must be made to determine whether the habitat meets the definition of 'breeding habitat'. Surveys for black cockatoo foraging habitat should be done in any remaining vegetation containing proteaceous heath/woodland, eucalypt woodlands or forest (particularly marri and jarrah forest) and in areas dominated by *Pinus* spp. Any area within the range of the black cockatoos that contains known food or nesting plant species is considered to be potential habitat for the species.”*

While in draft form, the current assessment was conducted to the standard of “Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris* Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii* Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso*” (DotEE 2017), particularly in relation to assessment of foraging habitat.

Table 4.3: State and Commonwealth legislation, policy and guidelines of most relevance to this study.

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act).	The Australian Government's central piece of environmental legislation.	The Department of the Environment and Energy
Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (DotE 2013).	Details the species falling within the MNES category and what constitutes a significant impact.	The Department of the Environment and Energy
EPBC Act referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>), Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) and the Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (DSEWPaC 2012)	Details distribution, ecology and recommended survey methodology.	The Department of the Environment and Energy

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Western Australia		
<i>Biodiversity Conservation Act 2016</i> (BC Act) and <i>Biodiversity Conservation Regulations 2018</i>	Western Australia's central environmental legislation. Came into effect 1 January 2019 and replaces the <i>Wildlife Conservation Act 1950</i> .	Department of Biodiversity, Conservation and Attractions
<i>Wildlife Conservation Act 1950</i> (WC Act)	Now defunct and replaced by the BC Act, however the most recently published <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> under this act is current at time of writing.	Department of Biodiversity, Conservation and Attractions
Environmental Factor Guideline: <i>Terrestrial Fauna</i> (EPA 2016a).	Overall aim of the study is to provide adequate information to assess the proposal against the objective of the environmental factor <i>Terrestrial Fauna</i> ; stated to be "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained".	Environmental Protection Authority

4.5 Nomenclature

Consistent with the EPA (2016b) technical guidelines for terrestrial vertebrate fauna survey, the avifauna nomenclature is in accordance with Christidis and Boles (2008).

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5.0 Results

5.1 Desktop Review: Presence in the Local Area

NatureMap records indicate that all three species have distributions that include the study area; Albany represents the southeastern extent of the distribution of the Forest Red-tailed Black-cockatoo and is well within the distribution of both Carnaby's Black-cockatoo and Baudin's Black-cockatoo.

The two white-tailed black-cockatoo species appear to be most commonly recorded in the Albany area. For example, the Great Cocky Count assessed 22 potential roost sites in the Albany area in 2018 and recorded 557 white-tailed cockatoos (Peck et al. 2018), while no Forest Red-tailed Black-cockatoo individuals were recorded from roost sites. The study area occurs within 12 km of two roost sites assessed during the Great Cocky Count, identified by the suburb names 'Kalgan' (approximately 12 km northeast of the study area), at which 219 white-tailed black-cockatoos were recorded in the 2018 counts; and 'McKail' (within 2 km of the study area), where 49 white-tail black-cockatoos were recorded. An additional known roost site is known from Lake Seppings, 4.8 km from the study area, however, no cockatoos were recorded there during the 2018 count.

A resident population of Carnaby's Black-cockatoo is known to occur within the Stirling Range National Park (Everard and Bamford 2016) and the species has been recorded from the Porongurup National Park.

5.2 Suitable Diameter at Breast Height (DBH) Trees

A total of 516 'suitable DBH trees' (> 50 cm DBH) were recorded in the study area during the survey (Table 5.1). Tuart (historically planted), Marri and Jarrah accounted for the largest proportion of breeding habitat trees at 42%, 31% and 22% respectively. Only Jarrah and Marri trees were found to support hollows, and in some cases a single tree supported up to three hollows.

Table 5.1 Number of breeding habitat trees and hollows.

Tree Species	Breeding Habitat Trees	Number of Hollows
<i>Corymbia calophylla</i> (Marri)	162	20
<i>Eucalyptus diversicolor</i> (Karri)	9	0
<i>Eucalyptus gomphocephala</i> (Tuart)	216	0
<i>Eucalyptus marginata</i> (Jarrah)	112	28
<i>Eucalyptus megacarpa</i> (Bullich)	17	0
Total	516	48

5.3 Hollow Assessment

A total of 48 'hollows' with an entrance diameter greater than or equal to 10 cm were recorded in Jarrah and Marri. Overall, the large majority of hollows (86%) were marginal in entrance size suitability (between 10 and 15 cm), with only six hollows with entrance dimensions greater than 15 cm and the largest being 30 cm across. Hollow bearing trees had an average DBH of 71.1 ± 2.6 cm; on average, hollows were located 5.7 ± 0.47 m above the ground and were 13.2 ± 0.8 cm in diameter.

Based on the conservative criteria employed during the ground-assessment, 37 of the 48 hollows were considered to warrant further investigation using the RPA. Results from the follow-up survey indicated that none of the hollows were suitable for black-cockatoo nesting, primarily because the depth of the chambers was not adequate (Plate 5.1 - Plate 5.10). While not possible to

ascertain from the ground-assessment, images obtained from the RPA revealed that many of the 'hollows' were actually not hollow or lacked sufficient space for a black-cockatoo to turn around inside (see Plate 5.11 and Plate 5.12). One hollow was occupied by a Common Brushtail Possum and another by feral bees.

The Tuart (*Eucalyptus gomphocephala*) occurring within the study area are not native and have been planted quite a few decades ago as indicated by their DBH but none were found to support hollows. However, Tuarts do have the potential to form hollows and are recognised as important breeding trees on the Swan Coastal Plain (Johnstone et al. 2010).



Plate 5.1: Pic 1_0002. Drone tree ARR_01; spout trunk, 14 cm diameter, depth inadequate.



Plate 5.2: Pic 2_0007.



Plate 5.3: Pic 3_0013.



Plate 5.4: Pic 4_0025.



Plate 5.5: Pic 6_0030.



Plate 5.6: Pic 10_0044.



Plate 5.7: Pic 12_059.



Plate 5.8: Pic 19_0069.



Plate 5.9: Pic 20_0083.



Plate 5.10: Pic 22_0094.



Plate 5.11: Tree ARR_21; drone image before contrast manipulation.

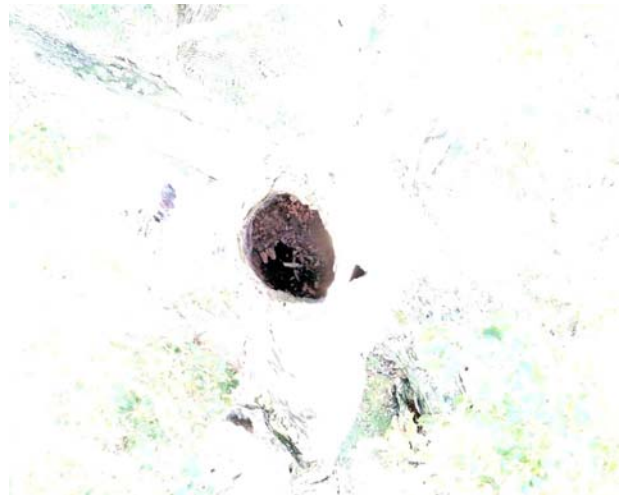


Plate 5.12: Tree ARR_21; drone image after contrast manipulation.

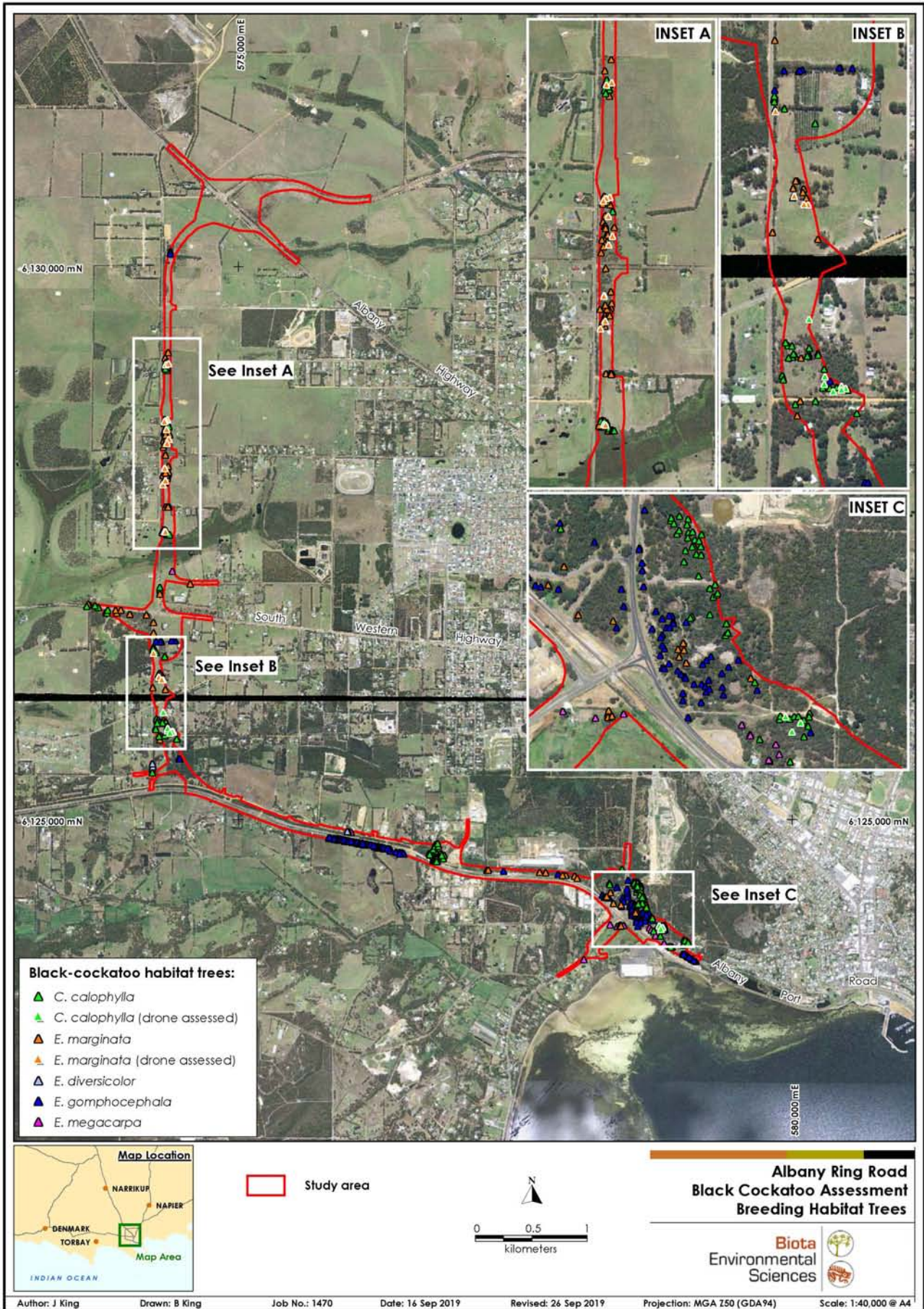


Figure 5.1: Black-cockatoo habitat trees recorded within the study area.

5.4 Foraging Habitat Assessment

The 185.0 ha study area includes 111.8 ha of cleared land, which is devoid of black-cockatoo foraging, breeding or roosting habitat. Using the detailed vegetation mapping of the study area prepared by Rathbone and Gilfillan (2018) as a guide, four vegetation units totalling 17.4 ha of native vegetation are likely to represent black-cockatoo foraging habitat. The foraging habitat quality score for each of these four vegetation units is shown in Table 5.2, while the scoring details are provided in Appendix 3. The distribution of this foraging habitat over the study area is shown in Figure 5.2. Table 5.3 includes descriptions of those vegetation units that are largely devoid of black-cockatoo foraging plants, however, in some areas of revegetation Jarrah and Marri have been planted which represent foraging plants.

Foraging habitat within the study area was largely represented by areas of Marri and Jarrah woodland, and evidence of all three species of black-cockatoo species utilising this habitat type has been previously described from characteristic chew marks on Marri nuts (Rathbone and Gilfillan 2018). The following vegetation units as described by Rathbone and Gilfillan (2018) were considered to represent the primary foraging habitat within the study area.

- Jarrah/Marri/Sheoak Laterite Forest with additional foraging plants including *Banksia grandis*, *Persoonia longifolia* and *Hakea amplexicaulis*;
- Marri/Jarrah Forest/Peppermint Woodland;
- Hakea spp. Shrubland/Woodland Complex with additional foraging plants including *E. marginata* and *Allocasuarina fraseriana*; and,
- Jarrah/Sheoak/*E. staeri* Sandy Woodland with additional foraging plants include *Banksia grandis* and *Hakea ruscifolia*.

In addition to these vegetation units, planted *Pinus radiata*, Jarrah and Marri occurred throughout the study area and also represent potential foraging habitat.

The Foraging Habitat Scoring Tool (DotEE 2017) has been applied to each vegetation type to assist with planning and offsetting (Table 5.2). It is important to note that the study area includes a buffer on the actual project disturbance footprint. Taking the entire study area into account, a starting score of High Quality is appropriate in many cases, as more than individual plants or small stands are included within this boundary, however, this is not necessarily the case for the smaller disturbance footprint, which should be scored separately.

Areas of Jarrah/Marri woodland returned foraging habitat scores indicative of very high quality for all three species of black-cockatoo. Areas largely devoid of Marri received lower scores for Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo (ranging from Low Quality to Quality). The scattered *Pinus radiata* throughout the study area were considered to represent singular/small groups of foraging plants for Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo, and as such qualified for a score indicating quality foraging habitat.

The Foraging Habitat Scoring Tool does include criteria that adjust the quality score downward, such as greater distances from known breeding areas and roosting sites. The study area occurs within the known breeding ranges of all three species as mapped in DotEE (2017), so no negative adjustments were applied on this basis. With regards to roosting sites, the Great Cocky Count includes at least two sites within 12 km of the study area, with white-tailed black-cockatoos recorded at both in 2018. In general, numbers of Forest Red-tailed Black-Cockatoos roosting in the vicinity of Albany are lower: no birds were recorded at roosts within 12 km of the study area in 2018, while in 2017 only 22 birds were recorded across the two roosts.

Table 5.2: Application of the Foraging Habitat Scoring Tool (DotEE 2017).

Low quality – 1-3; quality 4 – 5; high quality 6-7; very high quality 8-10.

Vegetation Unit	Area (ha)	Score		
		Baudin's	Carnaby's	Forest Red-tailed
Jarrah/Marri/Sheoak Laterite Forest	5.9	10	9	10
Marri/Jarrah Forest/Peppermint Woodland	5.7	10	9	10
Hakea spp. Shrubland/Woodland Complex	4.4	2	5	3
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1.4	4	3	10
Planted <i>Pinus radiata</i>	-	4	0	-
Planted Jarrah and Marri	-	6	3	1

Table 5.3: Vegetation units (Rathbone and Gilfillan 2018) largely devoid of black-cockatoo foraging plants.

Vegetation Units	Area (ha)
Cleared	111.8
Revegetation or Plantation ¹	33.2
<i>Taxandria juniperina</i> Closed Forest	5.9
>75% Invasive Weeds	5.6
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket ²	4.8
Peppermint Low Forest	1.1
Mosaic <i>T. marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/Yate Woodland	1.0
<i>Evandra aristata</i> Sedgeland	0.5
<i>Taxandria marginata</i> Granite Shrubland	0.3
<i>Melaleuca preissiana</i> Low Woodland	0.1
Total	164.3

1. includes some individual *Pinus radiata* trees.2. *Callistemon* may be a foraging plant for Carnaby's Black-Cockatoo.

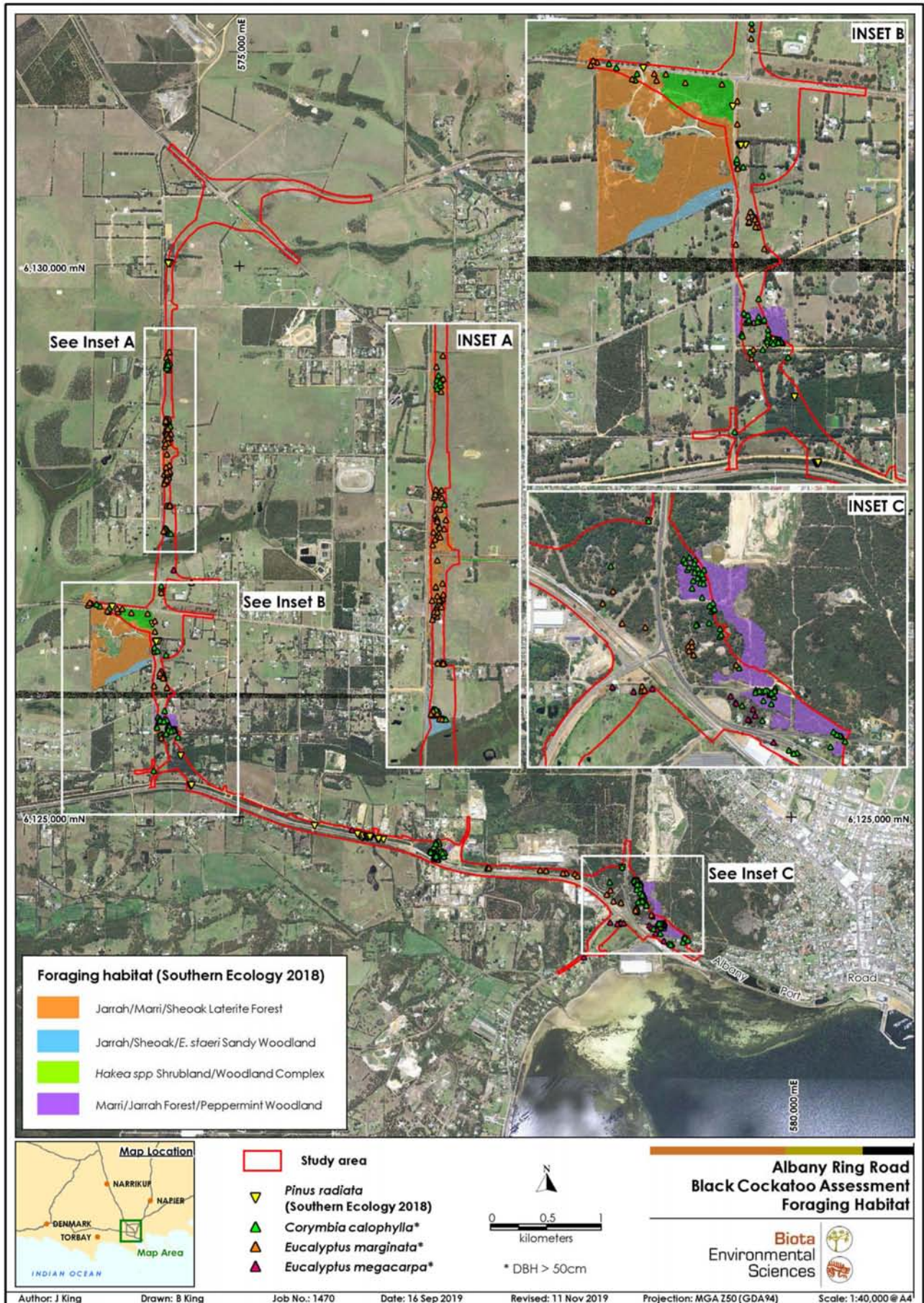


Figure 5.2: Potential black-cockatoo foraging habitat within the study area.

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6.0 Discussion

Within the Ultimate Footprint study area, up to 516 'suitable DBH trees' and 48 hollows were identified and marked. None of the 37 hollows followed up during the RPA assessment were found to be suitable for nesting. For the most part, the dimensions of the hollow entrances were marginal and caverns inside were far too small to support nesting.

The black-cockatoo foraging habitat within the study area has been considered in the context of wider availability using the meso-scale mapping of concordant vegetation units from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010), out to a radius of 12 km around the study area (see Figure 6.1). This radius was chosen as it represents the typical maximum distance that black-cockatoos will fly from roosting locations to forage, under the hypothetical premise that cockatoos were roosting within the study area. The areas of each vegetation unit within the study area and in a 12 km radius are detailed in Table 6.1, while their occurrence is illustrated in Figure 6.1. In the immediate vicinity of the study area, the same foraging vegetation units occur within the Albany Mounts and in the crown reserve south-west of the intersection of South Coast Highway and George Street. Larger swathes of these same vegetation units are found within the Stirling Range National Park, Down Road Nature Reserve and Bakers Junction Nature Reserve.

Table 6.1: Foraging habitat within the study area and ARVS equivalent within 12 km.

Study Area	ARVS Code	Complex Definition	Within Study Area (ha)	Within 12 km (ha)
Afra/Emar/Ccal/Athe	12a	Jarrah/Marri/Sheoak Laterite Forest	5.9	5,077.5
Ccal/Afle	10	Marri/Jarrah Forest/Peppermint Woodland	5.7	475.8
Hspp/Complex	31	Hakea spp. Shrubland/Woodland Complex	4.4	1,101.8
Emar/Afra/Esta	13	Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1.4	2,101.7
		Total	17.4	8,756.8

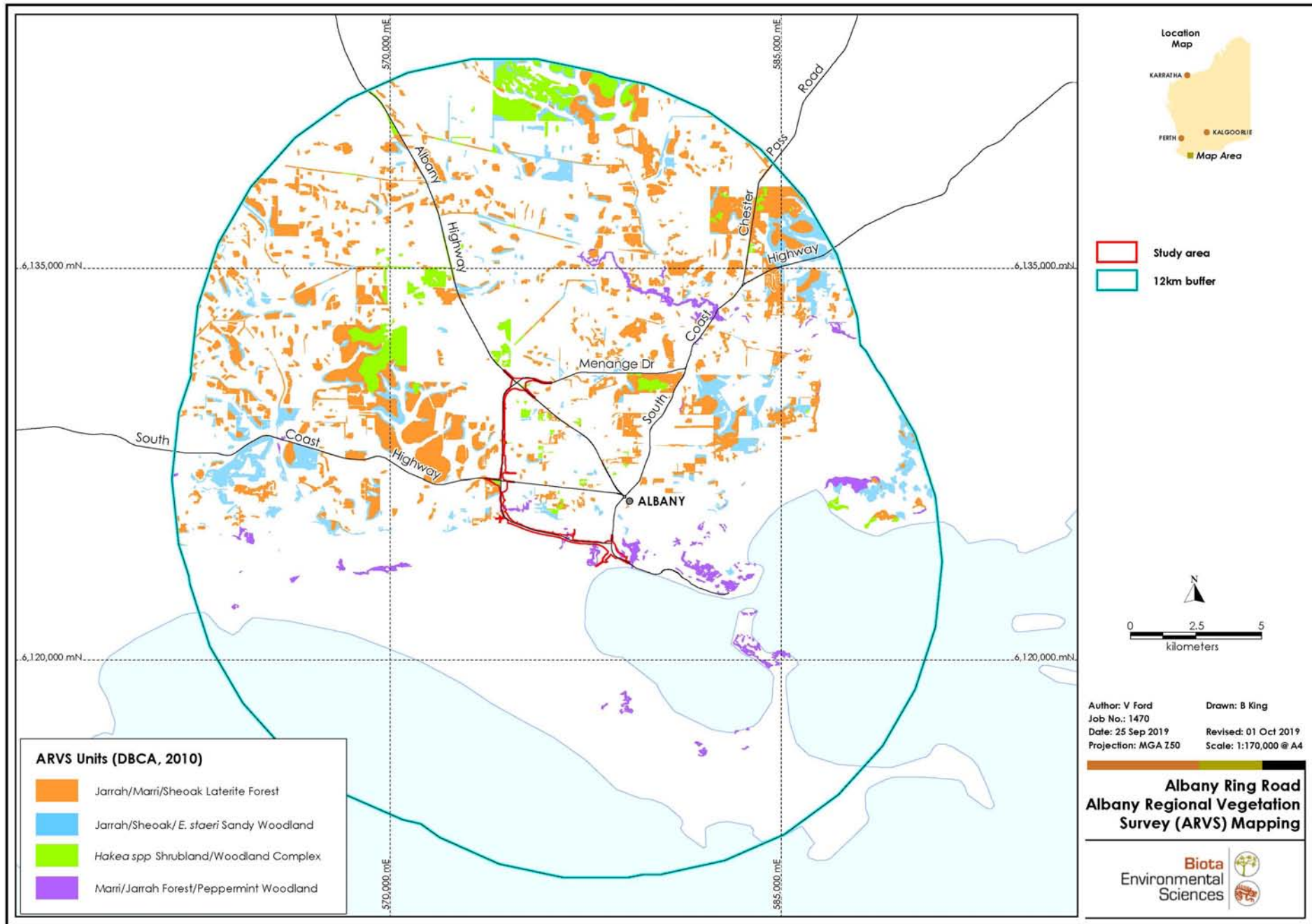


Figure 6.1: Extent of the vegetation units found within the study area in a 12 km radius based on the Albany Regional Vegetation Survey (Sandiford and Barrett 2010).

7.0 References

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Appendix 1

Tree Hollow Data



Flora Species	DBH (mm)	Latitude	Longitude	Number of Hollows	Hollow Size/s (mm)	Comment
<i>Corymbia calophylla</i>	500	-35.0176983	117.8421097	2	100,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	500	-35.0233359	117.8641153	1	150	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	550	-35.02327559	117.8636603	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	550	-34.9914124	117.8145234	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	610	-35.0232296	117.8637886	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	700	-35.0077357	117.8155675	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	740	-35.0076863	117.8154499	1	300	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	750	-35.0077681	117.8154498	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	770	-35.0176226	117.8422384	2	100,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	850	-35.020017	117.8616057	1	200	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	870	-35.0076482	117.814969	1	150	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	920	-35.0061519	117.8145263	2	150,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	950	-35.0074739	117.8149892	1	200	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	1010	-35.0234957	117.8639284	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	1080	-35.0078189	117.8152168	1	150	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	500	-34.9862827	117.8144703	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	500	-34.9778163	117.814501	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	520	-34.9772517	117.8144266	2	300,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	530	-34.9777293	117.814756	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	560	-34.9823121	117.8147209	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	570	-34.9823641	117.8145375	1	150	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	570	-34.9914377	117.8146041	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	580	-34.9837872	117.8145984	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	600	-34.9830831	117.8146528	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	600	-34.9840263	117.8143454	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	630	-34.9862442	117.8144751	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	650	-34.98421394	117.8145071	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	680	-34.983879	117.8148551	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	720	-34.9914673	117.8142802	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-34.99167898	117.8148354	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-35.0013403	117.8135289	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-34.9875881	117.8143155	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	750	-35.0029378	117.8141212	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	770	-34.98421476	117.8146859	1	200	Drone result: Unlikely suitable for BC nesting

Flora Species	DBH (mm)	Latitude	Longitude	Number of Hollows	Hollow Size/s (mm)	Comment
<i>Eucalyptus marginata</i>	820	-35.0034959	117.8144761	2	200,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	870	-35.0032962	117.8140749	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	910	-34.9872888	117.8145547	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	930	-34.9824702	117.8144144	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	950	-35.0034871	117.8143589	1	100	Drone result: Unlikely suitable for BC nesting

Appendix 2

Foraging Habitat Scoring Tool



Table 3: Foraging habitat scoring tool

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black cockatoo
10 (Very high quality)	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of, successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .
7 (High quality)	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as <i>Banksia</i> spp. (including <i>Dryandra</i> spp.), <i>Hakea</i> spp. and <i>Grevillea</i> spp., as well as native eucalypt woodland and forest that contains foraging species, including along roadsides. Does not include orchards, canola, or areas under a RFA.	Native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly marri, including along roadsides. Does not include orchards or areas under a RFA.	Jarrah and marri woodlands and forest, and edges of karri forests, including wandoo and blackbutt, within the range of the subspecies, including along roadsides. Does not include areas under a RFA.
5 (Quality)	Pine plantation or introduced eucalypts.	Pine plantation or introduced eucalypts.	Introduced eucalypts as well as the introduced Cape lilac (<i>Melia azedarach</i>).
1 (Low quality)	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.
Additions	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat
+3	Is within the Swan Coastal Plain (important foraging area).	Is within the known foraging area (see map).	Jarrah and/or marri show good recruitment (i.e. evidence of young trees).
+3	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.
+2	Primarily comprises marri.	Primarily contains marri.	Primarily contains marri and/or jarrah.
+2	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).
+1	Is known to be a roosting site.	Is known to be a roosting site.	Is known to be a roosting site.
Subtractions	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat quality
-2	No clear evidence of feeding debris.	No clear evidence of feeding debris.	No clear evidence of feeding debris.
-2	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.
-1	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.
-1	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.
-1	Is > 2 km from a watering point.	Is > 2 km from a watering point.	Is > 2 km from a watering point.
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).

Appendix 3

Foraging Habitat Scoring



Appendix 3.1: Carnaby's Black-Cockatoo

Vegetation Description	Starting Score	+3: Is within the Swan Coastal Plain (important foraging area).	+3: Contains trees with suitable nest hollows.	+2: Primarily comprises Marri	+2: Contains trees with potential to be used for breeding (DBH \geq 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is > 12 km from a known breeding location	-1: Is > 12 km from a known roosting site	-1: Is > 2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7				2								9
Marri/Jarrah Forest/Peppermint Woodland	5			2	2								9
Hakea spp. Shrubland/Woodland Complex	7						-2						5
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1				2								3
Planted <i>Pinus radiata</i>	1						-2						0
Planted Jarrah and Marri	1				2								3

Appendix 3.2: Baudin's Black-Cockatoo

Vegetation Description	Starting Score	+3: Is within the known foraging area	+3: Contains trees with suitable nest hollows.	+2: Primarily comprises Marri	+2: Contains trees with potential to be used for breeding (DBH \geq 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is > 12 km from a known breeding location	-1: Is > 12 km from a known roosting site	-1: Is > 2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7	3			2								12
Marri/Jarrah Forest/Peppermint Woodland	7	3		2	2								14
Hakea spp. Shrubland/Woodland Complex	1	3					-2						2
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1	3			2								4
Planted <i>Pinus radiata</i>	1	3											4
Planted Jarrah and Marri	1	3			2								6

Appendix 3.3: Forest Red-tailed Black-Cockatoo

Vegetation Description	Starting Score	+3: Jarrah shows good recruitment.	+3: Contains trees with suitable nest hollows.	+2: Primarily Contains Marri and/or Jarrah	+2: Contains trees with potential to be used for breeding (DBH \geq 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is >12 km from a known breeding location	-1: Is >12 km from a known roosting site	-1: Is >2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7	3		2	2								14
Marri/Jarrah Forest/Peppermint Woodland	7	3		2	2								14
Hakea spp. Shrubland/Woodland Complex	1	3											4
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	7	3			2		-2						10
Planted <i>Pinus radiata</i>	-												-
Planted Jarrah and Marri	1				2		-2						1