



## The 2019 Great Cocky Count:

A community-based survey for

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*),

Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) and

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



Department of **Biodiversity,  
Conservation and Attractions**

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

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**Final Report – September 2019**

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Front cover: Aerial view of a section of the Gngangara pine plantation. Courtesy WWF and Pixel Pilot

Back cover: Baudin's Black-Cockatoo in flight by Steve Castan



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We thank the volunteers who surveyed for the 2019 Great Cocky Count – we greatly appreciate the effort and commitment of all those who contributed. The Great Cocky Count would not be possible without you! Many volunteered their time to search for new roost sites or to survey distant sites. Others pulled together teams of observers to survey the larger, more difficult sites. Some volunteers tracked flocks of birds over the weeks before the count, without this work many birds would be missed on the big day. This commitment and dedication is what makes citizen science such a rewarding field to work in.

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The Great Cocky Count takes place on the country of many groups of the Noongar Nation. We acknowledge them as the original custodians of these lands and pay our respects to their Elders past, present and emerging. We thank them for their care of the country of *Ngoolark* (white-tailed black-cockatoo) and *Karak* (red-tailed black-cockatoo).

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## SUMMARY

### Background

- The Great Cocky Count (GCC) is an annual citizen science survey for three threatened black-cockatoos in the southwest of Western Australia (WA). Volunteers are allocated to a known or potential roost site and use a standard protocol to record the numbers of black-cockatoos arriving at the site to roost for the night.
- The 2019 GCC occurred on Sunday 7 April 2019. This year's GCC was the tenth consecutive count.
- The 2019 GCC surveyed roost sites for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos (FRTBC). All are endemic to south western WA and listed as threatened species under State and Commonwealth legislation.
- This report builds on the substantial contribution made by previous Great Cocky Counts to our knowledge of black-cockatoos in the greater Perth Region and regional Western Australia.

### Key Outcomes

- The Great Cocky Count is one of the largest citizen science surveys of its kind in Australia. Community interest is significant – this year over 750 registered volunteers surveyed 397 sites across the southwest of WA. Total volunteer participation likely exceeded 1,200 community members.
- The minimum population count for Carnaby's Black-Cockatoo in the Greater Perth-Peel Region was 13,984 (similar to 2018 and over twice the average for 2010-15). The Greater Perth-Peel Region consists of the Perth-Peel Coastal Plain, which encompasses all of the Perth-Peel metropolitan area along the Swan Coastal Plain, and the Northern Darling Scarp and Plateau, which includes the northern Jarrah-Marri Forest (Table 4).
- Most (70%) of the Carnaby's Black-Cockatoos recorded in the Perth-Peel Coastal Plain were associated with the Gngangara pine plantation, north of Perth. The large number of Carnaby's Black-Cockatoos (9,330) recorded in roosts associated with the pine plantation is similar to the last three years. In previous years, the pine plantation has supported 28 – 73% of the Carnaby's Black-Cockatoos recorded in the Perth-Peel Coastal Plain during the non-breeding season, emphasising the importance of pines as both a roosting area and food resource during this period.
- A single roost site located east of Yanchep had a count of 5,145 Carnaby's Black-Cockatoos. This accounted for 39% of all of the Carnaby's Black-Cockatoos recorded on the Perth-Peel Coastal Plain, and is the second highest single count ever recorded in a Great Cocky Count survey. The same site had counts of 6,226, 4,897 and 3,528 in the last three years and has come to be known as the 'mega roost'.
- The estimated change in the population of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain indicates a decline during the early years of the GCC (2010 – 2015) with the population being approximately constant since then. However, the overall change in the estimated population of Carnaby's Black-Cockatoos on the Perth-Peel Coastal Plain between 2010 and 2019 is a decline of 35%, or an average of 4% per year.



- Trend analysis of roost counts for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain found significant declines in both the fraction of occupied roosts and average flock size over the past ten Great Cocky Counts (2010-2019). The combined effect of fewer occupied roosts with fewer birds in each roosting flock is an estimated current decline rate of 4% per year in the number of Carnaby's Black-Cockatoos on the Perth-Peel Coastal Plain. This trend estimate should be treated with some caution, however, given the 'snapshot' sampling method and the need to consider the assumptions underlying both the survey method and trend analysis. There are two potential explanations for the observed trend: the decline at known roost sites may be attributable to the loss of birds from the study area, or birds may have relocated from known to new roost sites, and the trend is the result of birds being displaced from existing to new sites each year. For the former, the trend analysis reported here is appropriate and provides an estimate of the losses from the region, although the true fate of such birds (mortality or emigration) is unknown. For the latter, the total counts provide a better estimate of abundance and population trend, provided that the birds at newly discovered roosts have relocated from previously occupied roosts. A combination of both these mechanisms may be the reason for the observed decline in mean roost counts and occupancy rate. However, there are no completed studies that provide support for either scenario and it would be prudent to take a precautionary approach until better information becomes available. Nonetheless, this apparent ongoing decline is of serious concern for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain.
- On the Perth-Peel Coastal Plain, the majority of the Carnaby's Black-Cockatoos are restricted to relatively few roost sites. For example, 67% of all the birds recorded in the 2010-2019 Great Cocky Counts were in just five roost sites. Four of these sites are associated with pines. Trend analysis shows that the rate of decline in pine-associated roosts is similar to that of non pine-associated roosts. Provision of adequate roost sites and feeding habitat is needed to ensure the persistence of Carnaby's Black-Cockatoo in this region. Continued removal of pine without replacement from the Gngangara pine plantation, will remove significant roost and food resources for the Perth population.
- The overall estimated rate of decline in the total number of white-tailed black cockatoos (Carnaby's and Baudin's combined) on the Northern Darling Scarp is 13% per year.
- The 2019 GCC confirmed the presence of FRTBC at various locations throughout the inner metropolitan suburbs of Perth. Their numbers rose from an average count of 559 (2014-2016) to 1,934 in 2017, 4,037 in 2018 and 3,499 in 2019. This may be due to a redistribution of birds from forested areas to more urbanised locations.
- With the total population estimated at 40,000 for Carnaby's Black-Cockatoo, 12,000 for Baudin's Black-Cockatoo and 15,000 for FRTBC, the 2018 GCC recorded over 40% of all black-cockatoos in south western WA.
- The Great Cocky Count is well-placed to continue monitoring Black-Cockatoos on the Perth-Peel Coastal Plain, and potentially across the south west, due to high volunteer numbers and survey effort and the integration of statistically rigorous trend analyses.
- The Great Cocky Count is a valuable way to educate the public and raise awareness of the plight of Black-Cockatoos and ways in which the public can help protect the three local species.



## Results for Carnaby's and Baudin's Black-Cockatoos

### Perth-Peel Coastal Plain

- Volunteers surveyed 161 sites in the Perth-Peel Coastal Plain and counted 13,343 Carnaby's Black-Cockatoos. The Perth-Peel Coastal Plain encompasses most of the Swan Coastal Plain between Lancelin and Waroona.
- Six of the largest ten roost sites in the 2019 GCC were in the Perth-Peel Coastal Plain.
- Significant counts in the Perth-Peel Coastal Plain occurred in the Gnangara pine plantation (notably 5,145, 369 and 239 in Yeal, 1,830 in Pinjar, 753 in Lexia, 739 in Mariginiup; the total of 8,467 birds in these four areas was 63% of the total count) and Dawesville (915 across two sites), in Como (563 birds), at the Gingin town site (544 birds), 506 in Hamilton Hill, 353 in Nedlands, 283 in Floreat, 255 in Gnangara, 249 in Murdoch and 133 in Wellard.
- The population of Carnaby's Black-Cockatoos inhabiting the Perth-Peel Coastal Plain is significant at a species-scale, with four of the five largest and five of the ten largest known roosts in 2019.

### Northern Darling Scarp and Plateau

- Volunteers surveyed 91 sites in the Northern Darling Scarp and Plateau areas, which encompasses the northern Jarrah-Marri Forest between Bindoon and Waroona, and counted 2,137 white-tailed black-cockatoos. Counts of white-tailed black-cockatoos in these areas include Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo, of which 30% (641) were estimated to be Carnaby's Black-Cockatoos.
- Significant white-tailed black-cockatoo counts occurred at nine sites in the Shire of Mundaring (448 birds), seven sites in the City of Kalamunda (392 birds) and three sites in Armadale (138 birds).

### Regional areas

- Volunteers surveyed 145 sites in regional locations outside of the Greater Perth-Peel Region and recorded 7,167 white-tailed black-cockatoos. Counts of white-tailed black-cockatoos in forested areas may include Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo.
- Four of the largest ten roost sites in the 2019 GCC were in regional areas.
- In regional areas, volunteers surveyed roosts ranging from Chapman Valley in the north, inland to Narrogin, east to Esperance, and along the south and west coasts.
- Significant counts occurred on the northern Swan Coastal Plain (650 at Nilgen), in Hopetoun (640), in Wellesley (616), in Glenlynn (532), the Shire of Esperance (1,090 birds across five sites), the Shire of Dandaragan (1,032 across four sites), the Shire of Harvey (880 across four sites), the Shire of Busselton (579 across seven sites), the Shire of Albany (524 birds across four sites), the Shire of Capel (301 across three sites) and the Shire of Carnamah (260 across two sites).



## Results for Forest Red-tailed Black-Cockatoo (FRTBC)

- Volunteers documented 119 occupied roost sites, similar to 2018 and a large increase on previous years (29, 23, 71 and 95 occupied roosts in the years 2014 to 2017). 34 of these sites had both FRTBC and white-tailed black-cockatoos roosting.
- Occupied roosts were located in the Perth-Peel Coastal Plain (44), the Northern Darling Scarp and Plateau (47) and regional areas (28).
- 6,104 FRTBC were counted in 2019: 3,499 on the Perth-Peel Coastal Plain; 1,816 in the Northern Darling Scarp and Plateau, and 789 in regional areas. The total count was similar to 2018 and up markedly on previous years.
- 2018 and 2019 recorded a large increase in the numbers of FRTBCs on the Perth-Peel Coastal Plain, up 100% on 2017.
- Significant FRTBC roosts occurred in the Town of Cambridge (856 birds across two roosts), Yokine (533 birds across two roosts), the Shire of Murray (474 birds across six sites), the Town of Cambridge (403 birds across three roosts), Bayswater (305 birds across three roosts), Morley (300 birds), the City of Swan (276 birds across five roosts), Jandabup (243 birds), Murdoch (214 birds), Ballajura (151 birds) and Kensington (140 birds).
- Over the past 5 years FRTBC have been recorded exclusively using 33 confirmed roost sites previously used by white-tailed black-cockatoos.
- A similar roost count carried out in October 2018 suggests that few FRTBC spend the whole year in the Perth-Peel region. The average count of 3 birds at each roost compares to the average of 125 in April 2014-2019.



## ▪ KEY TERMS and ABBREVIATIONS

### General terms and abbreviations

**Great Cocky Count (GCC):** An annual, community-based survey for black-cockatoos in Western Australia. The survey occurs at sites across the southwest of the state on a single evening in early to mid-April each year. Volunteers are allocated to a particular *roost site* and use a standard protocol to count the numbers of black-cockatoos that arrive at the site to roost for the night. This year's GCC occurred on Sunday 7 April 2019.

**DBCA:** Western Australian Department of Biodiversity, Conservation and Attractions; formerly known as the Departments of Parks and Wildlife (DPaW), Environment and Conservation (DEC), and Conservation and Land Management (CALM).

**FRTBC:** Forest Red-tailed Black-Cockatoo.

**Roost count:** A count of the number of black-cockatoos arriving at a location at dusk to roost for the night. A roost count only includes birds that remain overnight at the roost site.

**Formal roost survey:** A *roost count* performed using the standard GCC survey protocol and completed by BirdLife Australia staff and volunteers, DBCA staff, or WA Museum staff.

**Additional survey:** A *formal roost survey* that is conducted before or after the GCC each year. Additional surveys may occur on designated dates (e.g. one month after the GCC).

**White-tailed black-cockatoos (WT):** Two white-tailed black-cockatoos (Baudin's Black-Cockatoo *Calyptorhynchus baudinii* and Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*) are endemic to the southwest of WA. In areas where both species occur, volunteers record a single "white-tailed black-cockatoo" count unless they are sure which species they are.

**Corrected count:** For the 2019 GCC the proportion of Carnaby's in the Northern Darling Scarp and Plateau was set at 0.3 of white-tailed black-cockatoos. This is based on audio recordings, counts after the GCC by Tony Kirkby and known proportions at some sites (e.g. 100% Carnaby's at Bullsbrook and 100% Baudin's in Keysbrook). Between 2010 and 2018 the proportion of Carnaby's has consistently been between 0.2 and 0.4, therefore a decision was made to standardise the corrected count for all years at 0.3.

**Berry recruitment model:** A model which assumes that (1) a pair of cockatoos flying together represents an adult mated pair, (2) a group of three cockatoos flying together (i.e. a trio) represents a mated pair with the fledgling from the current or previous breeding season, and (3) the number of trios present correlates positively with breeding success for the current or previous breeding season (Berry and Owen, 2010).

**Great Cocky Count roost site database:** A database of known or potential roost sites for black-cockatoos, maintained jointly by Birdlife WA and DBCA.

### Terms relating to roosts

**Roost:** An area or site with *roost trees* where black-cockatoos congregate at dusk to rest overnight.

**Roost trees:** All large trees (>8m height) within 1000m of the main roosting area for large roosts ( $\geq 150$  cockatoos) and within 500m for smaller roosts (<150 cockatoos) are considered to be *roost trees* or potential *roost trees* (Glossop *et al.* 2011).

**Roost site:** Any location that has been recorded in the GCC roost site database and has been categorised as a *confirmed roost*, *unconfirmed roost*, *FRTBC roost*, *joint roost* or *potential site*.

**Confirmed roost:** Any site where white-tailed black-cockatoos were recorded roosting as part of the GCC. This includes joint roosts, where both white-tailed and FRTBC have been recorded in the GCC.

**Occupied roost:** A *confirmed roost* that had a positive count (i.e.  $\geq 1$  bird roosting for the night) recorded in a particular GCC. The suite of occupied roosts varies between GCCs – while some roost sites are occupied in every GCC, most roosts are occupied in some GCCs and unoccupied in others.





**Unconfirmed roost:** Sites where roosting black-cockatoos have been reported, but have not had a positive count recorded ( $\geq 1$  bird) during any GCC.

**Potential site:** Any area that is considered a likely roost site for black-cockatoos, based on factors such as proximity to other roosting birds, potential roost trees, feeding habitat and standing water nearby. Cockatoos have not yet been reported as roosting in these sites.

**FRTBC roost:** Any site where a positive count (i.e.  $\geq 1$  bird roosting for the night) of FRTBC has been recorded in the GCC and no white-tailed black-cockatoos have been recorded.

**Joint roost:** Any roost where a positive count (i.e.  $\geq 1$  bird roosting for the night) of both white-tailed black-cockatoos and FRTBC has been recorded in the GCC, either in the same year or different years.

**New roost:** An unconfirmed roost or potential site documented to be a *confirmed roost* during a GCC.

**Roost codes:** The first three letters refer to the shire/local council; the next three to the location/suburb; R stands for roost; the code ends with three numbers (e.g. COCHAMR001 is in Cockburn, in the suburb of Hamilton Hill and was the first roost recorded in that suburb).

## Terms and abbreviations relating to localities

**Greater Perth-Peel Region:** This region includes the greater Perth-Peel metropolitan area (from Moore River in the north to Waroona in the south) and the northern Darling Plateau (from Bindoon in the north to Boddington in the south). The region includes parts of two IBRA (Interim Biogeographical Regionalisation for Australia) bioregions – the Jarrah Forest and Swan Coastal Plain bioregions. The Greater Perth-Peel Region coincides with the DBCA Swan Region (a DBCA administrative area).

**Perth-Peel Coastal Plain:** This area comprises the coastal (and western) portions of the Greater Perth-Peel Region and encompasses most of the Swan Coastal Plain between Lancelin and Moore River south to Lake Clifton and Waroona. The Perth-Peel Coastal Plain coincides with the DBCA Swan Coastal District (a DBCA administrative area).

**Northern Darling Scarp and Plateau:** This area comprises the eastern portions of the Greater Perth-Peel Region and encompasses the Darling Scarp and Plateau from north of Bindoon to south of Boddington. Most of this area occurs within the Jarrah (*Eucalyptus marginata*)-Marri (*Corymbia calophylla*) forest. The Northern Darling Scarp and Plateau coincides with the DBCA Perth Hills District (a DBCA administrative area).

**Gnangara pine plantation:** A pine plantation, managed by the Forest Products Commission, located north of Perth. The plantation system includes three sections: Gnangara (southern), Pinjar (middle), and Yanchep (north). At its peak, the plantation encompassed 23,000 ha of pine. The plantation system is an important feeding habitat for Carnaby's Black-Cockatoos during the non-breeding season (January – June) (Saunders 1974, 1980; Finn *et al.* 2009; Stock *et al.* 2013). The plantation currently stands at approximately 6,000ha.

**Regional areas:** All locations containing black-cockatoo roosts that are outside the Greater Perth-Peel Region.

**IBRA:** Interim Biogeographical Regionalisation for Australia – further information is available at:

<http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra>



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## I. INTRODUCTION

### Background

The Great Cocky Count is an annual, community-based survey for black-cockatoos in Western Australia. The survey occurs at sites across the southwest of the state on a single evening in early to mid-April each year. Volunteers are allocated to a particular roost site and use a standard protocol to count the number of black-cockatoos that arrive at the site to roost for the night. This year's GCC occurred on Sunday 7 April 2019.

The 2019 GCC is the tenth consecutive GCC and the eleventh overall (a trial was conducted in 2006). BirdLife Australia coordinates the count each year with significant support from the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA). Funding for the 2019 GCC came from The Alcoa Foundation, Lotterywest and the State NRM office.

Key aims for the GCC are to improve the scientific basis for the conservation of threatened black-cockatoos in Western Australia and to engage the community in conservation and monitoring efforts.

For ease of comparison with previous years' findings, this report uses a similar structure and analysis to previous reports, in particular the 2014 Great Cocky Count Report (Finn *et al.* 2014).

### Conservation Status of Black-Cockatoos in south western Australia

Three black-cockatoos are endemic to the southwest of Western Australia: Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*), and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) (FRTBC).<sup>1</sup>

Internationally, Carnaby's and Baudin's Black-Cockatoos are listed as endangered under the IUCN Red List of Threatened Species (BirdLife International 2012a, b). Carnaby's and Baudin's Black-Cockatoos are listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, while FRTBC are listed as vulnerable. Any potential impacts on listed threatened species constitute a Matter of National Environmental Significance (MNES) under the act and require assessment by the Commonwealth government.

At the state level, all three black-cockatoos are listed as fauna that are "rare or likely to become extinct and therefore in need of special protection" under the Western Australia *Biodiversity Conservation Act 2016*. Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo are listed as endangered, and the Forest Red-tailed Black-Cockatoo is listed as vulnerable on the Wildlife Conservation (Specially Protected Fauna) Notice 2017.

Descriptions of the biology and natural history of Carnaby's and Baudin's Black-Cockatoo and FRTBC are available in the recovery plans prepared for the species (see links below). Additional information is available at:

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<sup>1</sup> This report uses the nomenclature (naming conventions) from Christidis and Boles (2008). The WA Museum and DBCA use the alternate nomenclature 'Carnaby's Cockatoo', 'Baudin's Cockatoo', and 'Forest Red-tailed Black Cockatoo'.



<http://birdlife.org.au/documents/SWBC-SouthwestBlackCockatoolD.pdf>. Further information on the ecology of black-cockatoos on the Swan Coastal Plain is available in Johnstone *et al.* (2010)<sup>2</sup>, Stock *et al.* (2013)<sup>3</sup> and Williams *et al.* (2017).

## History of the Great Cocky Count

### Origins

The GCC began in 2006 as a project initiated and led by BirdLife Australia (then Birds Australia). The aim for the 2006 GCC was to document patterns of abundance for Carnaby's Black-Cockatoo on the northern Swan Coastal Plain and to provide a minimum population estimate for the species in that area (Shah 2006). The second GCC was in 2010, after which it became an annual survey.

### Methods for Surveying

The 2006 GCC determined that counting black-cockatoos as they flew into night-time roosts was the best available method for assessing their local abundance and distribution. Since 2010, roost counts have been completed using a standard methodology developed by Ron Johnstone and Tony Kirkby from the WA Museum. This methodology was trialled in the 2006 GCC (Shah 2006) and now includes refinements developed by Paddy Berry to assess the demographic structure of flocks (Berry 2008; Berry and Owen 2010).

### Evolution of the GCC

While the principal aim of the GCC – to conduct a community-based survey of black-cockatoos in south-western Australia using roosts counts – has remained, the broader objectives of the GCC have evolved over time. The 2006 and 2010 GCCs focused on Carnaby's Black-Cockatoo on the Swan Coastal Plain and the adjacent Darling Plateau, with the surveyed roost sites occurring almost exclusively within the Greater Perth-Peel Region. In 2011, the GCC was broadened to include the whole of south western WA, with the expanded aim of gathering information about Carnaby's Black-Cockatoo across the species range. In 2014, the GCC was further extended to include the identification and survey of roost sites for FRTBC, and this has continued to date. In 2018 BirdLife WA appointed Rebecca Boyland as Forest Black-Cockatoo Project Coordinator in order to gain more data and awareness of FRTBC and Baudin's Black-Cockatoos. This has contributed to more regional sites being surveyed, giving us more data on these lesser-known species within the Jarrah-Marri and Karri forests. For the last five years Murdoch University has been tracking all three species of Black-Cockatoos using both satellite and GPS trackers. This work has allowed them to locate new roosts which are then added to BirdLife's database and targeted for survey in the GCC. In this way the GCC has been able to survey more roosts each year.

Additional background information on the GCC can be found in previous reports (Shah 2006; Burnham *et al.* 2010; Kabat *et al.* 2012a; Kabat *et al.* 2012b, 2013; Finn *et al.* 2014, Byrne *et al.* 2015 and Peck *et al.* 2016, 2017 and 2018). The most recent (2016, 2017 and 2018) reports are available on the following webpage:

<http://birdlife.org.au/projects/southwest-black-cockatoo-recovery/publications-and-forms>

Earlier reports are also available online (see references for links).

<sup>2</sup> Available from: [http://www.nrm.wa.gov.au/media/41434/black\\_cockatoos\\_on\\_swan\\_coastal\\_plain.pdf](http://www.nrm.wa.gov.au/media/41434/black_cockatoos_on_swan_coastal_plain.pdf)

<sup>3</sup> Available from: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0061145>



## Contribution to Black-Cockatoo Conservation

Recovery plans exist to guide the conservation of Black-Cockatoos in south-western Australia and can be accessed at these web pages<sup>4</sup>:

- <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/calyptorhynchus-latiostris-recovery-plan>
- <http://www.environment.gov.au/resource/forest-black-cockatoo-baudin%E2%80%99s-cockatoo-calyptorhynchus-baudinii-and-forest-red-tailed>

The GCC contributes to the recovery actions identified in these recovery plans, as listed below.

### Carnaby's Black-Cockatoo

The Carnaby's Black-Cockatoo Recovery Plan (DBCA 2013) identifies six recovery actions for Carnaby's Black-Cockatoo. The Great Cocky Count addresses three of these:

- **Action 14.3** – *Undertake regular monitoring*
- **Action 14.5** – *Undertake information and communication activities*
- **Action 14.6** – *Engage with the broader community*

### Forest Black-Cockatoos

The GCC addresses two of the recovery actions identified in the Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan (Chapman 2008):

- **Action 14.9** – *Identify and manage important sites and protect from threatening processes*
- **Action 14.11** – *Monitor population numbers and distribution*

## Objectives of the Great Cocky Count

The objectives of the 2019 GCC were to:

- (1) train and engage community members in the monitoring of black-cockatoos;
- (2) identify roost sites and conduct roost counts for all three species of Black-Cockatoo across the species range;
- (3) provide a minimum population count for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain and the Greater Perth-Peel Region;
- (4) assess trends in roost counts for white-tailed black-cockatoos (2010-2019) and Forest Red-tailed Black-Cockatoos (2014-2019) within the Greater Perth-Peel region;

<sup>4</sup> Webpages are current as at July 2019.



## II. METHODS

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### Survey Timing and Area

#### Timing

This year's GCC occurred on Sunday 7 April 2019, consistent with the timing of previous GCCs.

#### Survey area

The GCC survey area encompasses the geographic range of all three species of black-cockatoo and extends across most of southwestern WA (Figure 1). The survey area includes part or all of six IBRA bioregions: Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, and Warren.<sup>5</sup>

#### Greater Perth-Peel Region

The Greater Perth-Peel Region remains a key focus for the GCC because this area: (a) maintains significant populations of Carnaby's Black-Cockatoo and FRTBC; and (b) experiences ongoing habitat changes due to urban and industrial development, agriculture, forestry, and other land uses. This area encompasses the greater Perth-Peel metropolitan region and includes the *Perth and Peel Regional Sustainability and Strategic Assessment area*.<sup>6</sup> Threatening processes for black-cockatoos in the Greater Perth-Peel Region include habitat loss through land-clearing, collisions with cars, disease, climate change, altered fire and hydrological regimes and competitive interactions with other native and non-native species. These threats are discussed further in the recovery plans.

In this report, the Greater Perth-Peel Region was divided into two sub-areas: the Perth-Peel Coastal Plain and the Northern Darling Scarp and Plateau. The Perth-Peel Coastal Plain sub-area encompasses much of the Swan Coastal Plain and includes nearly all of the densely-populated portions of the Perth-Peel metropolitan area. Habitats important for cockatoos in the Perth-Peel Coastal Plain include coastal heathland, Banksia woodland (principally mixed *Banksia attenuata* and *B. menziesii*), Tuart (*Eucalyptus gomphocephala*) woodland, other eucalypt woodlands, pine plantations, and various anthropogenic habitats (e.g. street trees, urban and market gardens, nut orchards). The Northern Darling Scarp and Plateau sub-area lies largely within the northern Jarrah-Marri Forest.

### Community Engagement and Training

To recruit volunteers for the 2019 GCC, we distributed information and invitations to participate to various community groups, NRM networks and their publications, via Facebook and emailed a BirdLife Australia contact list (this included all of the 2018 GCC counters). We updated the GCC webpage on BirdLife Australia's website<sup>7</sup>, which provides information about the GCC, including forms, protocols and previous reports. This was the fourth year that we used a Google Form for registrations. Most people registered this way and it makes

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<sup>5</sup> A map of the IBRA bioregions is available at: <http://www.environment.gov.au/land/nrs/science/ibra>

<sup>6</sup> For information on the Strategic Assessment of the Perth & Peel Regions, see:

<http://www.environment.gov.au/node/18607> and

<http://www.dpc.wa.gov.au/Consultation/StrategicAssessment/Pages/Default.aspx>

<sup>7</sup> <http://www.birdlife.org.au/projects/southwest-black-cockatoo-recovery/great-cocky-count-swbc>



updating the volunteer list much easier than in earlier years. We also promoted the event on BirdLife WA's social media sites, including Instagram and Facebook.

To train volunteers to do surveys, we conducted several workshops at various locations within the greater Perth-Peel metropolitan area and in regional centres. The workshops provided information about the GCC, including the general ecology of black-cockatoos, threats, information about their occurrence in the local area and guidelines for identifying and counting black-cockatoos at roost sites.

Volunteers who registered to undertake a survey for the 2019 GCC were allocated to a specific roost site, provided with information about the site and a roost count form (Appendix I), and given supporting material (including the 'how to' guide for conducting roost counts).

The volunteer engagement and training process followed that used in previous GCCs, which is described in the previous GCC reports (Burnham *et al.* 2010; Kabat *et al.* 2012a; Kabat *et al.* 2012b, 2013; Finn *et al.* 2014, Byrne *et al.* 2015 and Peck *et al.* 2016, 2017 and 2018).

## Roost Site Identification

Information about the 2019 GCC also included a request to report roost sites for black-cockatoos. Sites reported to BirdLife Australia prior to the 2019 GCC, which came from community members, Sam Rycken and Karen Riley (PhD researchers with Murdoch University's Black-Cockatoo Ecology Project) and other sources, were collated into the GCC database. Sites in this database were assigned to one of five categories (confirmed roost, FRTBC roost, joint roost, unconfirmed roost, or potential site) based on any prior roost count records for the site (see Key Terms and Abbreviations). For the 2019 GCC, we prioritised the allocation of observers to confirmed roosts, joint roosts and FRTBC roosts, and then to unconfirmed roosts; potential sites received the lowest priority. Not all of the sites in the database were assigned for survey. A subset of 15 sites was selected for a count of FRTBC on Sunday, October 14 2018. These sites were chosen as the 12 largest FRTBC roosts on the Perth-Peel region and three large Darling Scarp and Plateau roosts.

## Roost Count Methodology

The 2019 GCC followed the standard survey methodology described in previous GCC reports (Burnham *et al.* 2010; Kabat *et al.* 2012a; Kabat *et al.* 2012b, 2013; Finn *et al.* 2014, Byrne *et al.* 2015 and Peck *et al.* 2016, 2017 and 2018). Roost count instructions were included on the roost count survey form and in other written materials provided to each volunteer. The October 2018 FRTBC roost count followed the same methodology as the GCC.

### Counting protocol

Volunteers were instructed to: (a) count the number of black-cockatoos that arrived to roost at a designated site at sunset on Sunday 7 April 2019; (b) conduct the roost count for at least 30 minutes before and 30 minutes after sunset; (c) exclude any black-cockatoos that arrived at the site but subsequently departed to roost elsewhere; (d) ignore any black-cockatoos that flew over, but did not roost at the site; and (e) record the number of cockatoos that arrived at the site within each of several sub-groups (i.e. whether the birds arrived in trios, pairs, as single individuals, or other multiples).





## Species identification protocol

The distributions of Baudin's and Carnaby's Black-Cockatoo overlap in portions of the southwest, particularly in forested areas. Distinguishing between Carnaby's and Baudin's Black-Cockatoos may be difficult, particularly during roost count surveys when large numbers of birds may arrive together. Another difficulty is that the two species commonly occur together in mixed flocks. To avoid potential errors associated with incorrect species attributions, volunteers were instructed to record just one overall count of the number of white-tailed black-cockatoos roosting at the site.

In contrast, even inexperienced observers can easily distinguish between the FRTBC and the white-tailed black-cockatoo species, because FRTBC calls and markings are markedly different from those of the two white-tailed black-cockatoos. Thus, volunteers were instructed to record the number of Red-tailed Black-Cockatoos that roosted at the site and if FRTBC and white-tailed black-cockatoos both roosted at a site, to record separate counts for each.

## Data Analysis

### Organisation of roost count data

We used the roost survey results from each site to estimate the total number of Carnaby's Black-Cockatoo (or white-tailed black-cockatoos) and FRTBC counted within five areas:

- (1) The Perth-Peel Coastal Plain,
- (2) The Northern Darling Scarp and Plateau,
- (3) The Greater Perth-Peel Region (i.e., (1) + (2)),
- (4) Regional Areas (i.e. outside the Greater Perth-Peel Region), and
- (5) Across the species' range (i.e., all sites, (3) + (4)).

The total counts for Regional areas and across the species range are presented as the total number of white-tailed and Forest Red-tailed Black-Cockatoos counted. We combined the counts for white-tailed species because the distributions of Carnaby's and Baudin's Black-Cockatoos overlap in this area and due to the difficulty in distinguishing between the two white-tailed black-cockatoo species. Unlike in the Northern Darling Scarp and Plateau area, we did not have estimates from expert observers from which to infer species proportions for Baudin's and Carnaby's Black-Cockatoo in those areas where mixed flocks may occur. The procedure for determining total counts of Carnaby's Black-Cockatoo in the Northern Darling Scarp and Plateau and the Greater Perth-Peel Region is described below.

The roost counts are presented as means ( $\pm$  standard errors) and as medians. We calculated roost occupancy rates by dividing the number of occupied roosts by the number of known roosts that were surveyed, for each year. 'Known roosts' were those sites that had been occupied at least once in any of the GCCs between 2010 and 2019.

### Total counts for the Greater Perth-Peel Region

All roosting flocks in the Perth-Peel Coastal Plain were assumed to contain only Carnaby's Black-Cockatoo because the distribution of Baudin's Black-Cockatoos within the Greater Perth-Peel Region is generally confined to the Northern Darling Scarp and Plateau, particularly in early April (Johnstone *et al.* 2010; Tony Kirkby, WA Museum, personal communication). Across sites on the Northern Darling Scarp, the 2019 GCC assumed percentages of Carnaby's at 30% and Baudin's at 70% based on audio recordings, counts soon after



the 2018 GCC by Tony Kirkby and known proportions at some sites (e.g. 100% Carnaby's at Bullsbrook and 100% Baudin's in Keysbrook). Between 2010 and 2018 the proportion of Carnaby's has consistently been between 0.2 and 0.4, therefore a decision was made to standardise the corrected count for all years at 0.3. We therefore multiplied the total white-tailed black-cockatoo count by 0.3 to derive a 'corrected' count of the numbers of Carnaby's Black-Cockatoo for the Northern Darling Scarp and Plateau area.

## Trend analysis

A key aim for the Great Cocky Count is to assess population trends for Black-Cockatoos. As many surveys recorded counts of zero and there are instances where surveys of known roosts were not conducted, statistical analysis that accounted for these features of the data was needed.

Counts of zero at a surveyed site may reflect variation in the use of the roost (for example, the site is sometimes occupied, but not during a particular survey), inaccuracy in counting (the site was occupied, but no birds were observed), or may reflect changes that have occurred at the site (birds no longer roost at the site because it is now unsuitable). Zero counts affect estimates of average roost size and therefore any trends (Zuur *et al.* 2009), and may result in a large number of zero counts in the dataset ('zero-inflation' or 'excess zeros'). These excess zeros often arise in citizen science surveys (Kery and Schmid 2004; Schmeller *et al.* 2012) and especially in count data for rare species (Cunningham and Lindenmayer 2005), where the number of observers may exceed the number of occupied sites – as is the case for the Great Cocky Count. Additionally, missing counts (i.e. where no survey was done, even though birds may have been present) also require some method of estimating the probable number of birds present, in order to obtain an accurate trend estimate. Some roosts have been cleared and are no longer available to the birds and these must be excluded from the analysis. Using only the 'raw' total counts, which do not account for excess zeros and variable sampling effort may give inaccurate and potentially misleading results.

To deal with these issues, we used a statistical model that accounted for the large number of zero counts present in the GCC data and for the variation in survey effort each year. This model uses a zero-inflated, generalised Poisson distribution to account for the excess zeros, and for the likely over-dispersion in the counts due to any other sources of variation, such as differences between observers (Link and Sauer 1997; Dobbie and Welsh 2001; Sauer *et al.* 2004). Following expert statistical advice, we have modified the method of analysis slightly from that used in previous years (Potts 2018) by treating roost sites as a random effect. The roost count data were modelled in two stages: a logistic regression model was used to estimate any trend in roost occupancy rate; and then a log-linear regression model was used to estimate any trend in average roost size. The model for the occupied roosts assumes a generalised Poisson distribution for the count data (with the mean being determined by an annual trend in average roost size) with a random site effect to allow for any correlation in the repeated surveys at each site. A generalised Poisson distribution was appropriate because it allows for the potentially excess variation that may arise through any unmodelled sources of variation in the roost counts. Further details about this approach, including its advantages and limitations, are discussed in Dobbie and Welsh (2001), Sauer *et al.* (2004), Cunningham and Lindenmayer (2005), and Humbert *et al.* (2009). This statistical approach models variation in counts more realistically than simple linear regression models of counts or log-transformed counts (Cunningham and Lindenmayer 2005). This analysis of the population trend in Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain was the subject of a separate scientific paper published in the International Journal of Conservation, *Oryx*.<sup>8</sup>

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<sup>8</sup> Williams, M. R., C. J. Yates, H. Finn, W. Stock, and G. Barrett. 2015. Trend analysis of roost counts reveals a significant, ongoing decline of the endangered Carnaby's Black-Cockatoo. *Oryx*. <http://dx.doi.org/10.1017/S0030605315000320>.



We also assessed trends separately for roost sites within or associated with the Gngangara pine plantation (see Key Terms and Abbreviations) and for those not associated with the pine plantation. We defined 'pine-associated' sites as sites that occurred within or immediately adjacent to (<1 km from the boundary) of the plantation system, or have been documented as roost sites for Carnaby's Black-Cockatoo feeding in the Gngangara pine plantation (Shah 2006; Saunders 1980, Finn *et al.* 2009, Stock *et al.* 2013).

### **Breeding success**

Black-cockatoos are commonly observed in small groups, believed to comprise a mated pair of birds and, often, their offspring ('family units'). For Carnaby's Black-Cockatoo, these family units comprise a trio – the adult mated pair and a fledgling from the most recent, or a previous, breeding season. As such, the number of trios in roosting flocks should correlate positively with the level of breeding success for the most recent or previous breeding seasons. If pairs of birds represent breeding pairs without offspring, the ratio of trios to pairs will provide a measure of breeding success. We refer to this as the Berry recruitment model (Berry 2008; Berry and Owen 2010).

In determining the proportions of trios versus pairs, we included data from all GCC surveys and from all sites, on the basis that flocks observed anywhere in the southwest in April would contain pairs that bred (or failed to breed) during the previous breeding season (July – December each year: Saunders 1982). We did not adjust counts for the presence of any Baudin's Black-Cockatoos. The chi-square test of independence was used to test whether the proportions of trios to pairs differed across the years 2010–2019.

### **Statistical analysis**

We used Microsoft Office Excel 2010 and SPSS Statistics Version 22 for basic statistical analyses. The trend analyses were performed using generalised linear mixed model procedures (GLIMMIX and NLMIXED) of the SAS software (SAS Institute Inc., 2011). The SAS programming code used to analyse the data is included in Appendix VIII.



## RESULTS

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### A. Community Engagement and Training

#### Workshops

Approximately 300 people attended the 12 Great Cocky Count workshops conducted in February and March 2019. Workshops were held at locations throughout the south west, including one each at Denmark, Dwellingup, Gelorup, Greenbushes, Joondalup, Kwinana, Mandurah, Margaret River, Muchea, Mundaring, Mundijong and Murdoch University.

Supporters for the workshops included the Cape to Cape Catchment Group, City of Kwinana, Greenskills Albany, Mundaring Blue Sky Festival, City of Joondalup, Shire of Murray, Blackwood Basin Group, South West Catchments Council (SWCC), Landcare Serpentine-Jarrahdale, Murdoch University, Chittering Landcare and Peel Harvey Catchment Council.

#### Volunteer participation

We assigned 427 survey sites to the 752 registered volunteers (Table 1). Roost counts were conducted at 397 (93%) of these sites. This compares well with previous completion rates for the 2018 (95%), 2017 and 2016 (93%), 2015 (97%), 2013 (92%), 2014 (90%), and 2012 (84%) GCCs. Of the volunteers that registered in 2019, approximately half were new to the GCC and half had registered previously. Since 2010, more than 3,300 people have participated in at least one GCC as a registered volunteer.

Actual volunteer participation for the 2019 GCC likely exceeded 1,200 community members, as registered volunteers often received support from non-registered volunteers (e.g. family and friends). In addition, Murdoch University and Aquinas College coordinated roost counts at the Murdoch University Campus and Salter Point, respectively, using volunteers, staff and students from those organisations. About 60 volunteers participated in total in these two surveys.



**Table 1: Volunteer participation and survey effort for all Great Cocky Counts (2010-2019). The percentages show the proportion of the sites that were surveyed in each GCC in the Greater Perth-Peel Region (further subdivided into the Perth-Peel Coastal Plain and the Northern Darling Scarp and Plateau), or in Regional areas.**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Registered volunteers	250	263	294	335	592	606	707	895	750	752
Sites assigned for survey	unknown	248	244	262	322	301	426	504	440	427
Sites surveyed	187	165	205	241	290	293	398	469	416	397
In Greater Perth-Peel Region	183 (98%)	150 (91%)	157 (77%)	186 (77%)	230 (79%)	228 (78%)	310 (78%)	345 (74%)	270 (65%)	252 (63%)
(i) Perth-Peel Coastal Plain	157 (84%)	124 (75%)	127 (62%)	144 (60%)	186 (64%)	185 (63%)	231 (58%)	240 (51%)	180 (43%)	161 (41%)
(ii) N. Darling Scarp/Plateau	26 (14%)	26 (16%)	30 (15%)	42 (17%)	44 (15%)	43 (15%)	79 (20%)	105 (22%)	90 (22%)	91 (23%)
– In Regional areas	4 (2%)	15 (9%)	48 (23%)	55 (23%)	60 (21%)	65 (22%)	88 (22%)	124 (26%)	146 (35%)	145 (37%)



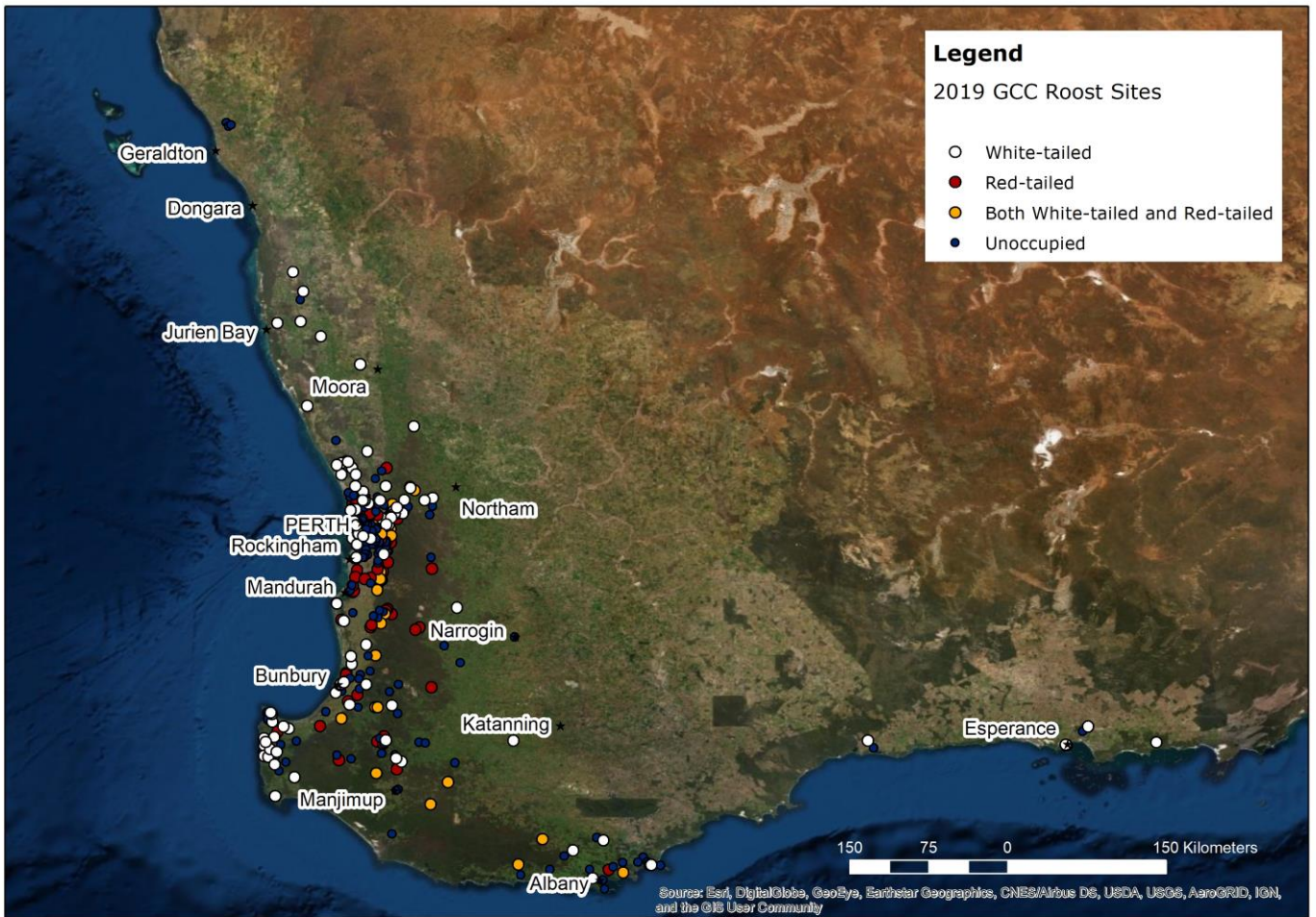
## B. Black-Cockatoos: Roost Site Identification

56 new sites were added to the GCC database this year. This enabled 58 sites which had not previously been surveyed to be surveyed in 2019 (some were already on the database but had never been surveyed). Of these, 19 had just white-tailed species roosting, 26 had FRTBC roosting, seven had both roosting and six were unoccupied. Of the 842 sites in the database, 55 have not been surveyed to date. One confirmed site was cleared in between the 2018 and 2019 GCCs.

**Table 2: Number of White-tailed Black-Cockatoo (WT) confirmed roosts, FRTBC confirmed roosts, joint roosts, unconfirmed roosts, potential sites and cleared sites in the GCC site database for each Great Cockey Count (2010-2019). Cleared roosts are confirmed roosts that have been cleared of vegetation since 2010. Numbers for confirmed WT roosts and FRTBC roosts include joint sites. Joint roosts are sites where >0 White-tailed Black-Cockatoo and >0 FRTBC have been counted since 2010.**

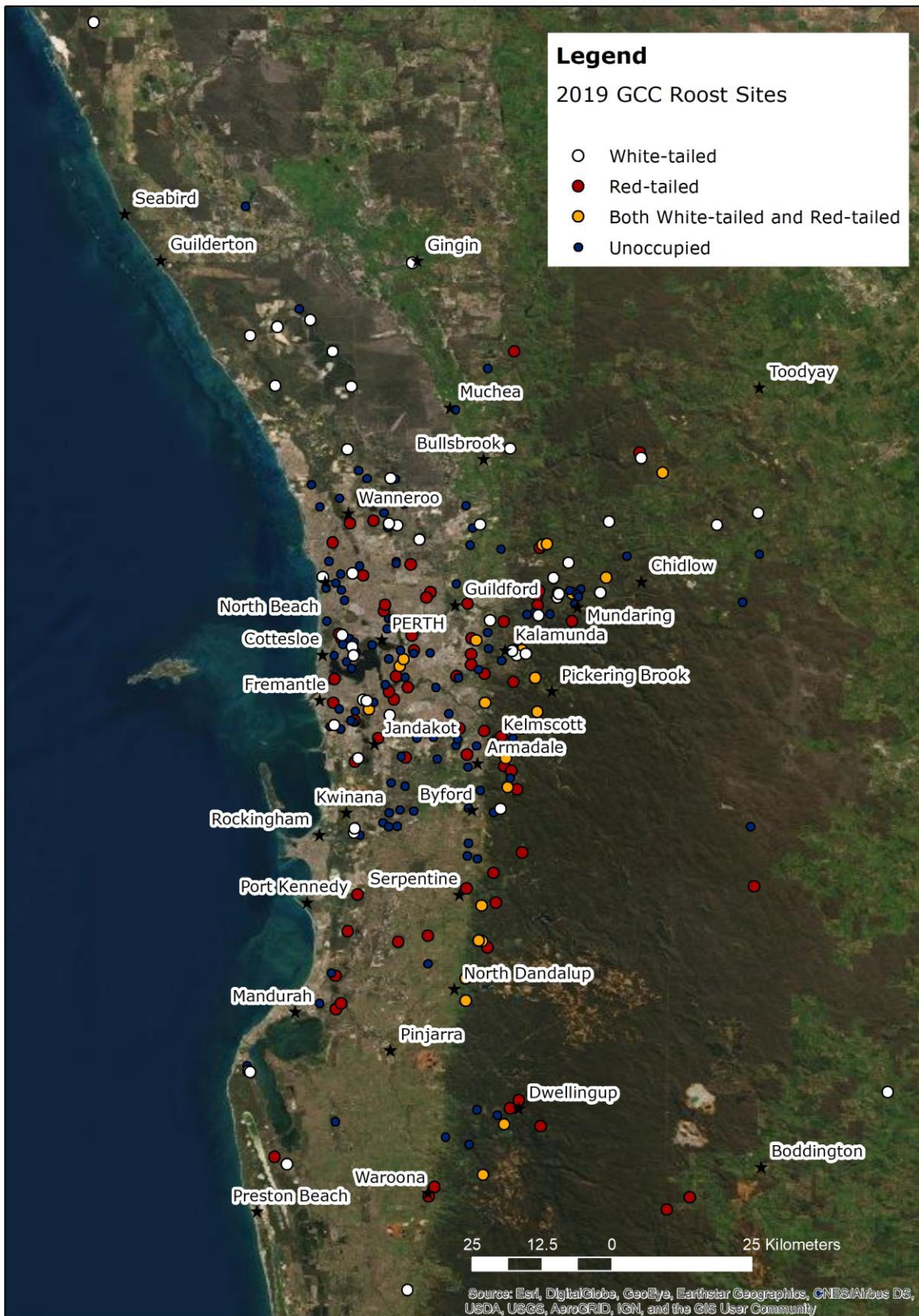
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Confirmed WTBC roosts	52	90	124	153	177	197	234	287	328	357
Confirmed FRTBC roosts	n/a	n/a	n/a	n/a	28	43	95	152	193	237
Joint roosts	n/a	n/a	n/a	n/a	14	22	46	71	91	119
Unconfirmed roosts	unknown	48	73	110	126	133	159	154	166	170
Potential roosts	unknown	161	158	184	194	193	187	203	181	187
Cleared roosts	0	1	4	4	5	5	9	9	9	10
<b>Total no. of sites</b>	<b>222</b>	<b>300</b>	<b>359</b>	<b>452</b>	<b>516</b>	<b>549</b>	<b>638</b>	<b>734</b>	<b>786</b>	<b>842</b>





**Figure 1:** The locations of the 397 sites where surveys were conducted for the 2019 Great Cocky Count. Sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Forest Red-tailed Black-Cockatoo roost sites, or sites where both red- and white-tailed black-cockatoos roosted. Figure credit: Tegan Douglas.





**Figure 2:** The locations of the 252 sites in the Greater Perth-Peel Region where roost counts were conducted for the 2019 Great Cocky Count. Roosting sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Forest Red-tailed Black-Cockatoo roost sites, or sites where both red- and white-tailed black-cockatoos roosted. The map includes the Perth-Peel Coastal Plain and the Northern Darling Scarp and Plateau. Figure credit: Tegan Douglas.





## C. Carnaby's Black-Cockatoo: Roost Counts

### Survey effort

#### *Greater Perth-Peel Region*

Volunteers surveyed 252 sites in the Greater Perth-Peel Region. Roost counts occurred in 37 local government areas (LGAs), with occupied roosts recorded in 22 (59%) of these (Appendix II). Survey effort was greatest in the Cities of Mundaring (24), Serpentine-Jarrahdale (22), Swan, Wanneroo and Armadale (18 each) and Kalamunda (17). Of these, nine occupied roosts were recorded in the City of Mundaring and seven each in the Cities of Swan, Wanneroo and Kalamunda.

#### *Regional areas*

Volunteers surveyed 145 sites in regional areas (Table 1). Roost counts occurred in 24 LGAs, with occupied (White-tailed Black-Cockatoo) roosts recorded in 19 (79%) of these (Appendix II). The greatest survey effort in regional areas occurred in the Shires of Albany and Augusta-Margaret River (19 each), Bridgetown-Greenbushes (14) and Busselton (12) and Harvey and Donnybrook-Balingup (11 each). Of these, ten occupied roosts were recorded in Augusta-Margaret River and seven were recorded in Busselton.

#### *Across GCCs (2010-2019)*

The number of sites surveyed dipped in the Greater Perth-Peel Region but increased in regional areas (Table 1). This year the regional count increased from 35% to 37% of all sites surveyed.

### Total counts

#### *Greater Perth-Peel Region*

In 2019 the GCC recorded 13,984 Carnaby's Black-Cockatoos in the region. This is similar to 2018, slightly higher than 2016 and 2017 (11,668 and 10,902 respectively) and is over double the average for the years 2010-15 (5,468 birds) (Table 4).

#### *Regional areas*

The count for regional areas of 7,167 white-tailed black-cockatoos is greater than 2017 and 2018 (5,106 and 5,585) and a marked increase on earlier years (average of 3,527 birds between 2012 and 2016), with more sites being surveyed this year (Table 4).

#### *Across species range*

The total count of 22,647 birds is higher than the period 2016-18 (18,202 on average) and is over double the average of the years 2010-15 (8,705 birds) (Table 4). It should be noted that this total includes an unknown number of Baudin's Black-Cockatoos outside the Perth-Peel Coastal Plain.

### Roost counts – across species range

At occupied roosts, counts of white-tailed black-cockatoos in the 2019 GCC ranged from 1 to 5,145, with a mean of  $174 \pm 44$  (standard error) and a median of 40 (130 roost counts). Roost count sizes varied across the three principal survey areas. The lowest was for the Northern Darling Scarp and Plateau (mean  $59 \pm 12$ ); then Regional areas (mean  $119 \pm 23$ ), with the Perth Peel Coastal Plain being the highest (mean  $392 \pm 157$ ).



Across the species range, the five largest roosts accounted for 40% (9,117 of 22,647 birds) of the total number of white-tailed black-cockatoos counted (Appendices III and IV). The ten largest roosts accounted for 53% (12,012) of the total number of white-tailed black-cockatoos counted. Four of the five largest roosts, and five of the ten largest, occurred in the Perth-Peel Coastal Plain.

### **Roost counts – Perth-Peel Coastal Plain**

Within the Perth-Peel Coastal Plain, the five largest roosts (counts of 5145, 1830, 753, 739 and 616 birds) accounted for 68% (9,083 of 13,343) of the Carnaby's Black-Cockatoo counted in this region (Appendix IIIa). Four of these were within the Gnangara pine plantation north of Perth (Appendix IIIb). The roost occupancy rate was 37% for the Perth-Peel Coastal Plain (34 occupied roosts of the 91 confirmed roosts surveyed) (Table 5).

#### *Gnangara pine plantation*

Volunteers recorded 9,422 birds at ten occupied roosts located within or immediately adjacent to (i.e. < 1 km from the boundary of) the Gnangara pine plantation, and at one roost in the Yanchep National Park that has, historically, been used by Carnaby's Black-Cockatoo feeding in the Gnangara pine plantation (Saunders 1980, Finn *et al.* 2009, Stock *et al.* 2013) (Appendix IIIb). These roosts accounted for 71% (9,422 of 13,343) of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain. In previous GCCs (2010-2017), birds roosting in the Gnangara pine plantation have accounted for 27% to 73% of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain, with total counts ranging from 1077 to 8072 birds.

#### *Other large roosts*

Large counts were recorded at Como (563), Gingin (544), Dawesville (501 and 414), Hamilton Hill (506), Nedlands (353), Floreat (283) and Murdoch (249).

### **Roost counts – Northern Darling Scarp and Plateau**

Within the Northern Darling Scarp and Plateau, the five largest roosts accounted for 47% (1009 of 2137) of the white-tailed black-cockatoos counted in this region. These counts were recorded at a site in Wandering (321), Keysbrook (211 Baudin's), Bullsbrook (172 Carnaby's), Bakers Hill (160) and Parkerville and Piesse Brook (145 each) (Appendix IIIc). The roost occupancy rate was 59% (36 occupied roosts of the 61 confirmed roosts surveyed) (Table 5).

White-tailed black-cockatoos were recorded at nine sites in the Shire of Mundaring (24 sites surveyed and 448 birds), seven sites in Kalamunda (17 sites surveyed and 392 birds) and three in the City of Armadale (18 sites surveyed and 138 birds) (Appendix IIa).

### **Roost counts – Regional areas**

In regional areas, the five largest roosts (650,640, 616,532 and 498 birds) accounted for 41% (2936 of 7167) of the white-tailed black-cockatoos counted regionally (Appendix IV). These sites were located at Nilgen, Hopetoun, Wellesley, Glenlynn and Kalgan.

Sites with large counts were recorded in the Shires of Esperance (1090 at five sites), Dandaragan (1032 at four sites), Harvey (880 at four sites), Gingin (650 at one site), Ravensthorpe (640 at one site), Bridgetown-Greenbushes (610 at three sites) and Busselton (579 at seven sites) (Appendix IIa).



## Breeding success

The fraction of white-tailed black-cockatoo groups returning to roosts as either pairs or trios was recorded at 43 sites in 2019. The proportion of groups flying into roosts as trios (33%) was significantly lower ( $\chi^2 = 9.9$ ,  $p = 0.0017$ ) than the average proportion recorded over previous GCCs (average 40% between 2010–2018, range 31% – 47%) (Table 3). There is no evidence of a trend in the ratio of trios to pairs ( $p=0.20$ ). Further analysis and a comparison of the fraction of trios recorded in the GCC with breeding rates in the Wheatbelt should be undertaken to determine if this measure is correlated with breeding success.

**Table 3:** The number of white-tailed black-cockatoos arriving at roosts in pairs or trios, 2010– 2019, with percentages in parentheses. Sites is the number of sites at which the observations were taken. The totals are not corrected for proportions of Baudin’s Black-Cockatoos and Carnaby’s Black-Cockatoo.

Year	Pairs	Trios	Sites
2010	329 (64%)	186 (36%)	32
2011	175 (60%)	118 (40%)	36
2012	317 (62%)	197 (38%)	36
2013	349 (69%)	157 (31%)	36
2014	250 (60%)	170 (40%)	37
2015	156 (54%)	132 (46%)	38
2016	391 (57%)	299 (43%)	57
2017	266(43%)	158 (37%)	56
2018	280 (53%)	245 (47%)	49
2019	452 (67%)	227 (33%)	43



**Table 4: Roost count summary for Carnaby's Black-Cockatoo across all Great Cocky Counts (2010-2019). The counts for the Perth-Peel Coastal Plain are assumed to include only Carnaby's Black-Cockatoo, whereas the counts for the Northern Darling Scarp and Plateau are corrected to account for the mixed flocks of Baudin's and Carnaby's Black-Cockatoos. The counts for the Greater Perth-Peel Region are the combined counts for Carnaby's Black-Cockatoo from the two areas. The counts for Regional areas and across the species range are the totals for white-tailed black-cockatoos and not corrected for the presence of both white-tailed cockatoo species. The number of roosts is the number of occupied roosts (i.e. roosts where at least one white-tailed black-cockatoo roosted). WT=white-tailed Black-Cockatoo. \* Assumption of 30% Carnaby's and 70% Baudin's.\*\*represents a total count for white-tailed Black-Cockatoos**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>Greater Perth-Peel Region</b>										
No. of Carnaby's Black-Cockatoo counted in Perth-Peel Coastal Plain	6330	3912	3791	5591	6662	4692	10919	10248	12465	13343
	(35 roosts)	(37 roosts)	(25 roosts)	(35 roosts)	(37 roosts)	(37 roosts)	(43 roosts)	(42 roosts)	(42 roosts)	(34 roosts)
No. of Carnaby's Black-Cockatoo counted in Northern Darling Scarp and Plateau (corrected)	579*	118*	248*	305*	418*	162*	749*	654*	680*	641*
	(total WT count = 1929; 15 roosts)	(total WT count = 393; 13 roosts)	(total WT count = 826; 15 roosts)	(total WT count = 1016; 14 roosts)	(total WT count = 1393; 13 roosts)	(total WT count = 540; 9 roosts)	(total WT count = 2496; 29 roosts)	(total WT count = 2180; 27 roosts)	(total WT count = 2266; 35 roosts)	(total WT count = 2137; 36 roosts)
No. of Carnaby's Black-Cockatoo counted in Greater Perth-Peel Region	6909	4030	4039	5896	7080	4854	11668	10902	13145	13984
	(50 roosts)	(50 roosts)	(40 roosts)	(49 roosts)	(50 roosts)	(46 roosts)	(72 roosts)	(69 roosts)	(77 roosts)	(70 roosts)
<b>Regional areas</b>										
No. of white-tailed black-cockatoos counted in Regional areas**	246	610	3329	3744	4041	3182	3340	5106	5585	7167
	(2 roosts)	(9 roosts)	(23 roosts)	(26 roosts)	(29 roosts)	(21 roosts)	(32 roosts)	(56 roosts)	(63 roosts)	(60 roosts)
<b>Across Species Range</b>										
No. of white-tailed black-cockatoos counted across species range**	8505	4915	7946	10351	12096	8414	16755	17534	20316	22647
	(52 roosts)	(59 roosts)	(63 roosts)	(75 roosts)	(79 roosts)	(67 roosts)	(104 roosts)	(125 roosts)	(140 roosts)	(130 roosts)

**Table 5: The number of sites surveyed, occupied roosts, new roosts discovered, and roost occupancy rates for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain, and for white-tailed black-cockatoos in the Northern Darling Scarp and Plateau and Regions, for each Great Cocky Count 2010 – 2019.**

Sites with a positive count in a GCC had >1 white-tailed black-cockatoo roosting in at least one GCC up to that year. Percentage (%) of all sites with a positive count in a GCC up to that year is the percentage of the total number of sites with a positive count in a GCC up to that year that were surveyed. New roosts discovered are sites that were surveyed and had white-tailed black-cockatoos present for the first time. Occupied roosts are sites at which at least one white-tailed black-cockatoo was recorded roosting. Percentage (%) of all sites surveyed is the number of occupied roosts divided by the total number of sites volunteers surveyed during that GCC. Roost occupancy rate is the number of occupied roosts divided by the number of sites surveyed with a positive count in at least one GCC up to that year.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>No. of sites surveyed, of those that had a positive count in a GCC up to that year</b>										
Perth-Peel Coastal Plain		29	32	37	54	58	78	92	78	66
Northern Darling Scarp and Plateau	n/a	8	15	20	18	26	29	49	50	49
Regional		1	5	10	15	16	18	29	48	63
<b>% of sites surveyed, of those that had a positive count in a GCC up to that year (not including cleared sites)</b>										
Perth-Peel Coastal Plain		85% (n=34)	59% (n=54)	56% (n=66)	69% (n=78)	67% (n=87)	82% (n=95)	85% (n=108)	64% (n=122)	52% (n=126)
Northern Darling Scarp and Plateau	n/a	53% (n=15)	65% (n=23)	71% (n=28)	56% (n=32)	70% (n=37)	76% (n=38)	94% (n=52)	81% (n=62)	69% (n=71)
Regional		50% (n=2)	50% (n=10)	34% (n=29)	35% (n=43)	30% (n=53)	30% (n=60)	39% (n=74)	47% (n=103)	48% (n=130)
<b>No. of new roost sites discovered</b>										
Perth-Peel Coastal Plain	35	22	12	12	9	12	13	14	5	5
Northern Darling Scarp and Plateau	15	9	5	4	5	1	14	10	9	8
Regional	2	8	20	14	10	7	14	29	27	17
<b>No. of occupied roosts (% of all sites surveyed)</b>										
Perth-Peel Coastal Plain	35 (22%)	37 (30%)	25 (20%)	35 (24%)	37 (20%)	37 (22%)	43 (19%)	42 (18%)	42 (23%)	34 (21%)
Northern Darling Scarp and Plateau	15 (58%)	13 (50%)	15 (50%)	14 (33%)	13 (29%)	9 (22%)	30 (38%)	27 (26%)	35 (39%)	36 (40%)
Regional	2 (50%)	9 (60%)	23 (49%)	26 (48%)	29 (49%)	21 (33%)	32 (36%)	56 (45%)	63 (43%)	60 (41%)
<b>Roost occupancy rate (% of confirmed sites surveyed)</b>										
Perth-Peel Coastal Plain	51%	60%	38%	47%	40%	41%	41%	37%	39%	37%
Northern Darling Scarp and Plateau	83%	68%	68%	50%	39%	31%	57%	42%	58%	59%
Regional	67%	82%	74%	65%	63%	53%	58%	70%	57%	57%

## D. Carnaby's Black-Cockatoo and white-tailed black-cockatoos: Trend Analysis for the Perth-Peel Coastal Plain, Northern Darling Scarp and Plateau and regions (2010-2019)

### *Perth-Peel Coastal Plain*

#### **General survey trends**

The number of sites surveyed in the Perth-Peel Coastal Plain has varied from 124 to 240 across the ten GCCs (2010-2019; Table 1). The number of occupied roosts varied between 25 and 43, with occupied roosts representing 18-30% of the total number of sites surveyed each year (Table 4). The discovery rate of new roost sites was high in 2010 and 2011 (35 and 22), averaged 12 per year between 2012 and 2017 and has dropped to five per year in the last two years.

Positive counts (i.e.  $\geq 1$  Carnaby's Black-Cockatoo roosting in at least one GCC, not including cleared sites) have now been recorded from 131 sites.

Eight confirmed roosts have been cleared since the 2010 GCC: One was cleared prior to the 2011 GCC (COCSCCR001); two more before the 2012 GCC (COCSCCR002 and ROCBALR001), four before the 2016 count (SWALEXR002, WANJANR007, WANPINR005 and WANYANR004) and one last year (WANMARR005) (Appendix IIIa).

#### **Largest roosts**

Within the Perth-Peel Coastal Plain, the ten largest roosts (based on combined counts across years) accounted for almost two thirds (67%, or 52,095 of 77,953) of the Carnaby's Black-Cockatoos counted in the 2010-2019 GCCs (Appendix IIIa). Three of these are within the Gnangara pine plantation (GINYEAR003, WANPINR001 and WANMARR003), another two are within smaller suburban pine plantings (SOUCOMR001 in Kensington and MELMURR001 at Murdoch University). The other five are at Gingin (GINGINR001), Underwood Avenue in Floreat (CAMFLOR001), Hollywood Hospital in Nedlands (NEDNEDR001) and Dawesville (MANDAWR002 and MANDAWR007).

The next ten largest roosts accounted for a further 14% (10,752 of 77,953) of the Carnaby's Black-Cockatoos counted in the ten GCCs. Nine of these are within or associated with the Gnangara pine plantation (GINYEAR001, SWAMELR001, SWALEXR001, WANPINR011, WANPINR002, WANTWOR001, WANYANR006, WANGNAR001 and WANMARR001) and the other is in Hamilton Hill COCHAMR002).

Overall, the 40 largest roosts accounted for 92% (71,626 of 77,953) of the Carnaby's Black-Cockatoos counted in the Perth-Peel Coastal Plain across the ten GCCs.

#### **Occupancy rate**

The fraction of occupied roosts within the Perth-Peel Coastal Plain is estimated to be declining at a rate of approximately 3% per year. This decline is statistically significant ( $p=0.0002$ ), and equates to the loss of about 4 of the 131 known roosts each year. The trends for both pine-associated ( $n=28$ , estimated decline of 2% per year) and non-pine-associated roosts ( $n=103$ , estimated decline of 3% per year) are not significantly different; both are declining.

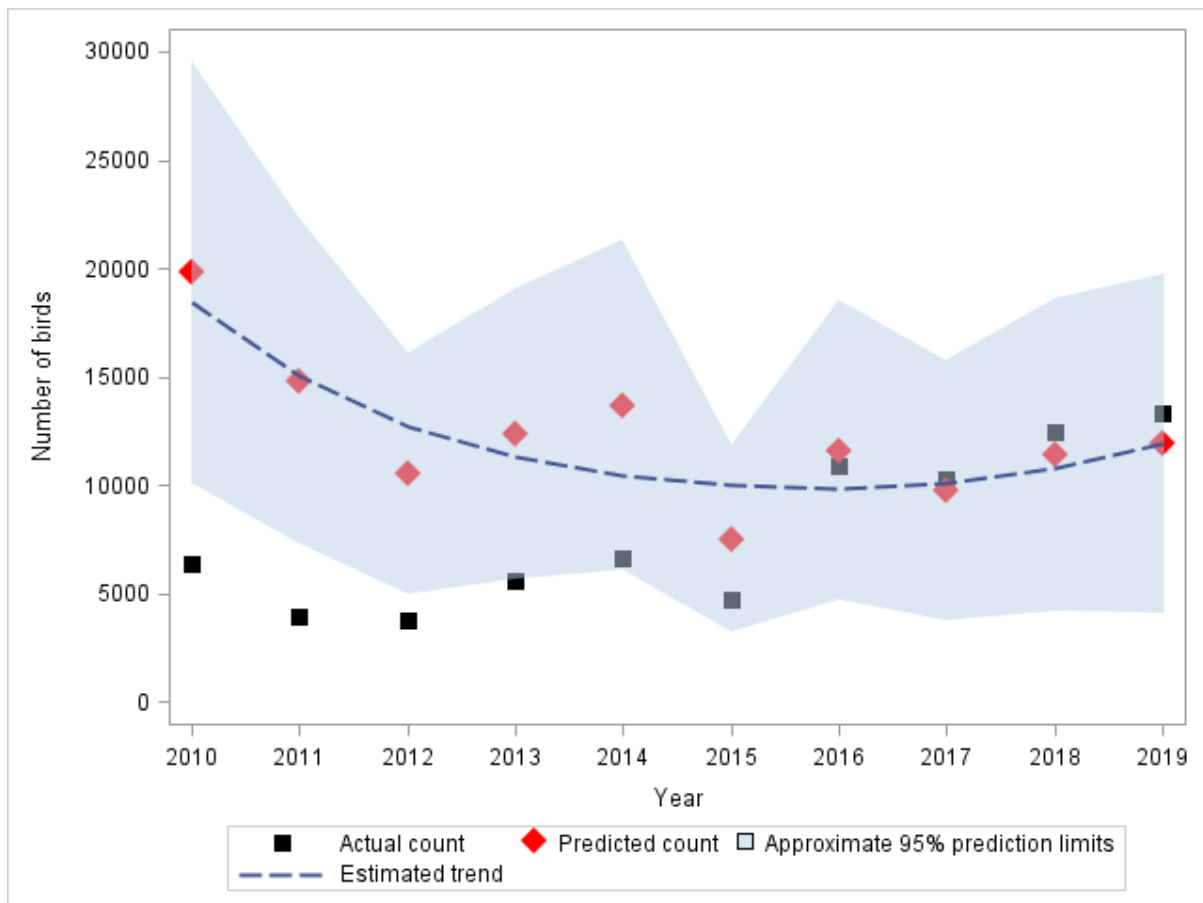


### Average size of roosting flocks

Within the Perth-Peel Coastal Plain, the average number of birds in each roosting flock is estimated to be declining, but not at a fixed rate. Between 2010 and 2015 it is estimated to have declined by a total of approximately 36% (about 7% per year), but since 2015 has increased, so that the overall decline between 2010 and 2019 is about 10% (about 1% per year). The trends for pine-associated and non-pine-associated roosts are not significantly different.

### Estimated trend in the Perth-Peel Region

The estimated change in the total count of Carnaby’s Black-Cockatoo over the period 2010 – 2019 indicates a decline during the early years of the GCC (2010 – 2015) with the count being approximately constant since then (Figure 3). The roost occupancy rate is estimated to be declining at a rate of about 3% each year. Removal of the ‘mega’ roost (which could be seen as an outlier) had no effect on these results. Between 2010 and 2014 it is estimated that the total counts of Carnaby’s Black-Cockatoo were substantial underestimates of the number of birds present in the region, whereas counts after 2015 have been in close agreement with the predicted total count. This is consistent with a change in the number of occupied roosts surveyed, from 25 – 37 in 2010 – 2014, to 42 – 43 in 2016 – 2018. The low number of occupied roosts in 2019 (34) is likely due to the slightly fewer surveys undertaken this year and that several roosts in the Gngangara-Pinjar pine plantation were not surveyed. The overall change in the estimated total count of Carnaby’s Black-Cockatoos on the Perth-Peel Coastal Plain between 2010 and 2019 is a decline of 35%, or an average of 4% per year.



**Figure 3:** Change in the estimated abundance of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain region 2010–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.



## *Northern Darling Scarp and Plateau (white-tailed black-cockatoos, including Baudin's and Carnaby's)*

### **General survey trends**

The number of sites surveyed in the Northern Darling Scarp and Plateau has varied from 26 to 105 across the ten GCCs (Table 1). The number of occupied roosts varied between 9 and 36, with occupied roosts representing 22-58% of the total number of sites surveyed each year (Table 5). The discovery rate for new roosts was high in 2010 and 2011 but declined to 2015. This trend has been reversed in the last four years with 41 new roosts discovered.

Positive counts (i.e.  $\geq 1$  white-tailed black-cockatoo roosting in at least one GCC, not including cleared sites) have now been recorded from 79 sites. Only one confirmed roost has been cleared, prior to the 2015 GCC (MUNCHIR001) (Appendix IIIc).

### **Largest roosts**

Within the Northern Darling Scarp and Plateau, the ten largest roosts (based on combined counts across years) accounted for 47% (7,186 of 15,176) of the white-tailed black-cockatoos counted in the 2010-2019 GCCs (Appendix IIIc).

### **Occupancy rate**

The fraction of occupied roosts within the Northern Darling Scarp and Plateau is estimated to be declining at a rate of approximately 4% per year. This decline is statistically significant ( $p = 0.0017$ ), and equates to the loss of about 3 of the 79 known roosts each year.

### **Average size of roosting flocks**

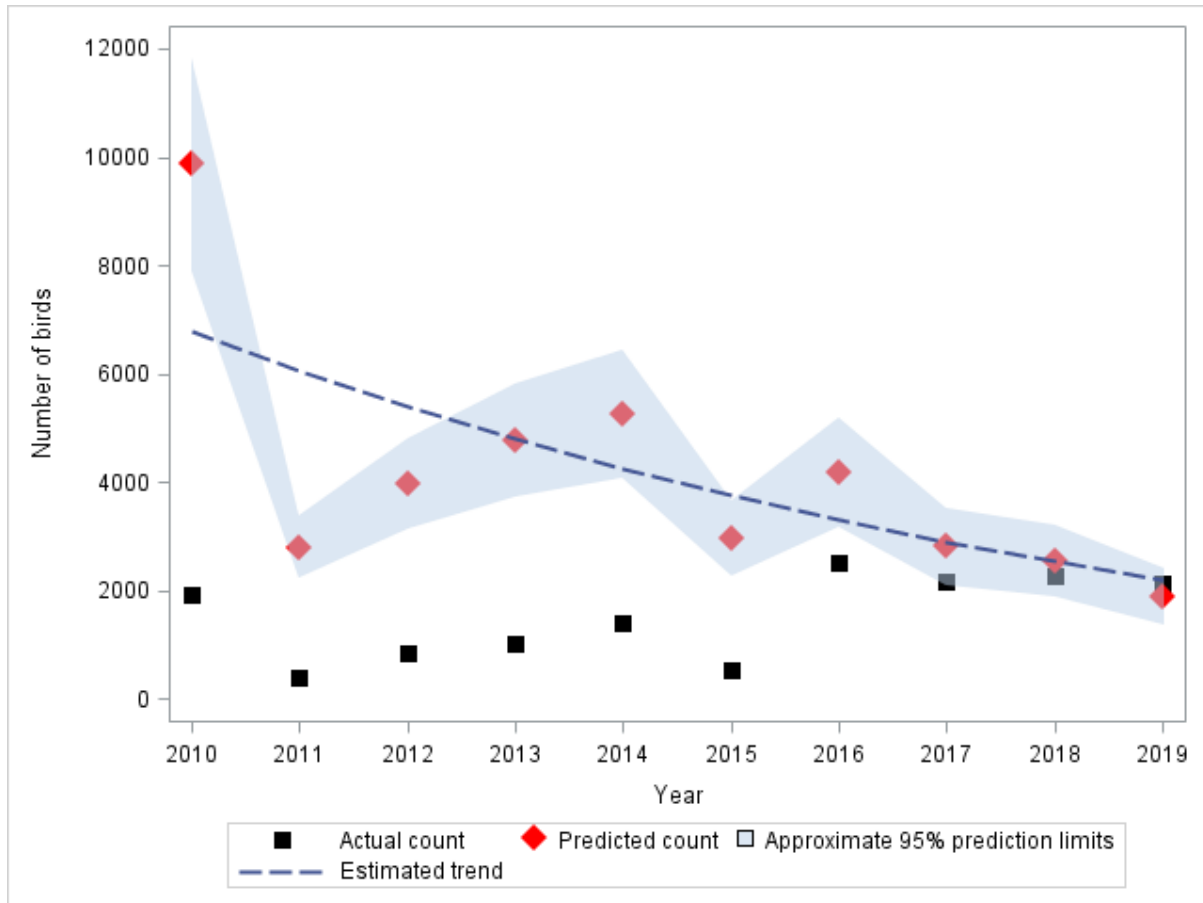
Within the Northern Darling Scarp and Plateau, the average number of birds in each roosting flock is estimated to be declining at approximately 8% per year. This decline is statistically significant ( $p = 0.0002$ ), and equates to the loss of about 5 birds per year from the overall average of around 60 birds at each roost.

### **Estimated trend in the Northern Darling Scarp and Plateau**

Combining the estimated annual declines in average roost size and roost occupancy rate, the overall estimated rate of decline in the total number of birds is thus 13% per year (Figure 4). Between 2010 and 2015 it is estimated that the total counts of white-tailed black cockatoos were substantial underestimates of the number of birds present in the region, whereas counts after 2015 have been in close agreement with the predicted total count. This is consistent with a change in the number of occupied roosts surveyed, from 9 – 15 in 2010 – 2015, to 27 – 36 in 2016 – 2019.







**Figure 4:** Change in the estimated abundance of White-tailed Black-Cockatoo in the Northern Darling Scarp and Plateau region 2010–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.

### Regional areas (white-tailed black-cockatoos, including Baudin’s and Carnaby’s)

#### General survey trends

The number of sites surveyed in Regional areas has varied from four to 146 across the ten GCCs (Table 1). The number of occupied roosts varied between two and 63, with occupied roosts representing 33-60% of the total number of sites surveyed each year (Table 5). The discovery rate for new roosts has been good since 2012, with 87 new roosts discovered in the last four years. Positive counts (i.e.  $\geq 1$  white-tailed black-cockatoo roosting in at least one GCC, not including cleared sites) have now been recorded from 147 sites. Only one confirmed roost has been cleared, prior to the 2012 GCC (HARMYAR002) (Appendix IIIc).

#### Estimated trend in Regional areas

##### Albany region

#### Occupancy rate

The fraction of occupied roosts within the Albany region is estimated to be declining at a rate of approximately 1% per year, but this is not statistically significant ( $p=0.57$ ).

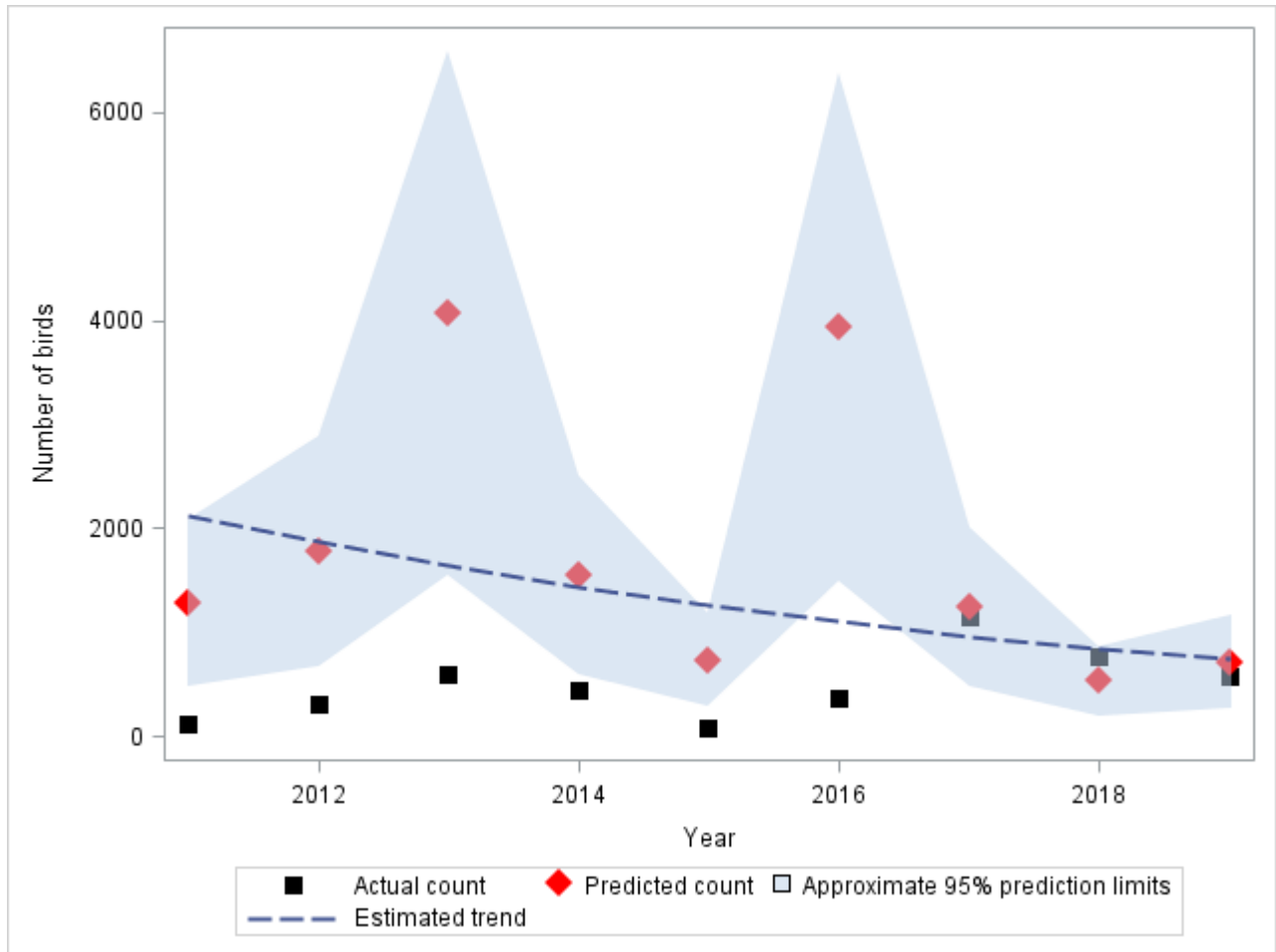


### Average size of roosting flocks

Within the Albany region, the average number of birds in each roosting flock is estimated to be declining at approximately 10% per year, but this is not statistically significant ( $p=0.08$ ).

### Estimated trend in the Albany region

Combining the estimated annual changes in average roost size and roost occupancy the overall estimated rate of decline in the total number of birds is about 13% per year (Figure 5).



**Figure 5:** Change in the estimated abundance of White-tailed Black-Cockatoo in the Albany region 2011–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.

### Esperance region

#### Occupancy rate

The fraction of occupied roosts within the Esperance region is estimated to be decreasing at a rate of approximately 6% per year, but this is not statistically significant ( $p=0.23$ ).

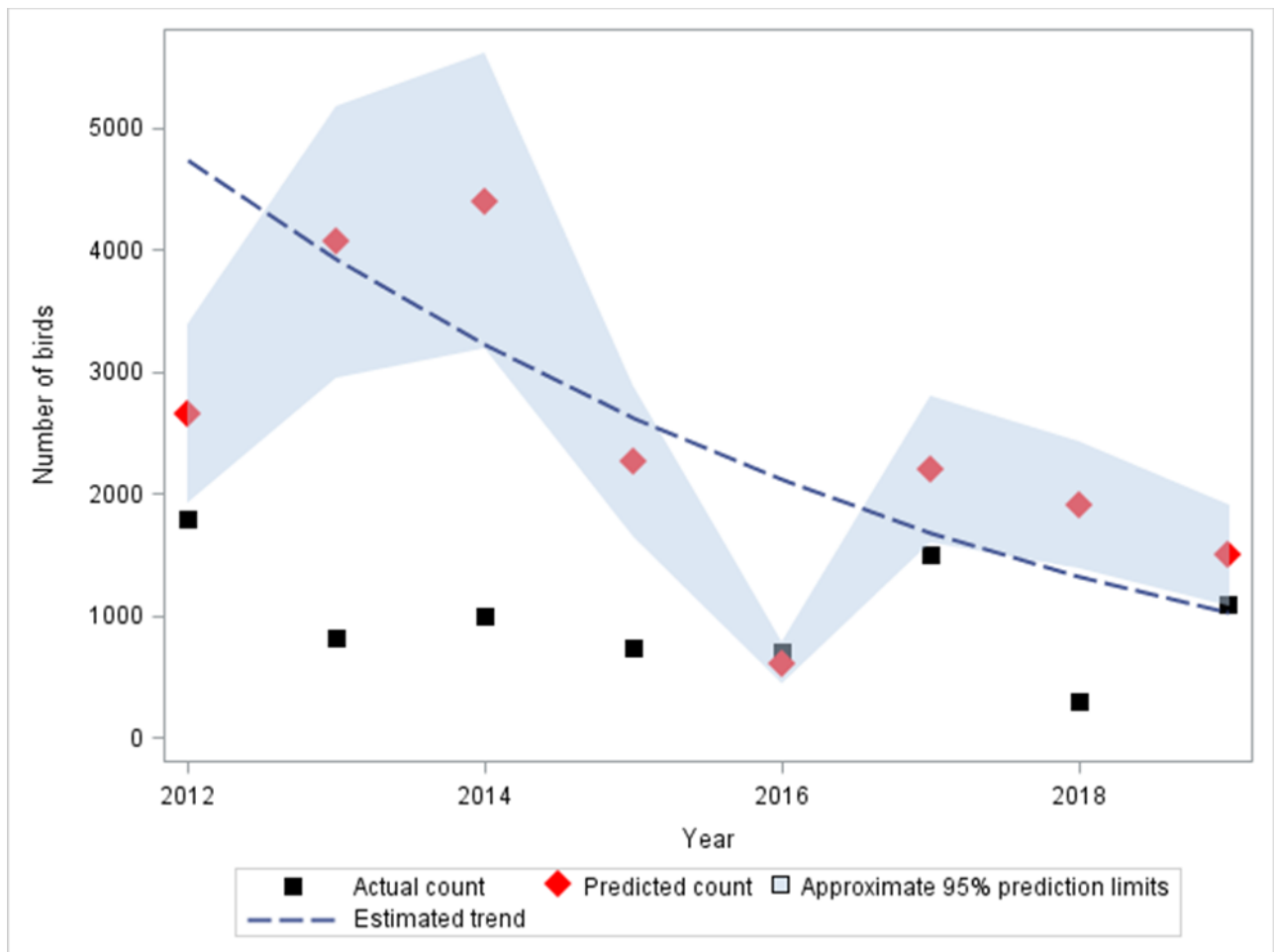


### Average size of roosting flocks

Within the Esperance region, the average number of birds in each roosting flock is estimated to be decreasing at a rate of approximately 15% per year. This increase is statistically significant ( $p=0.021$ ), and equates to a decrease of about 33 birds per year in the overall average of around 225 birds at each roost.

### Estimated trend in the Esperance region

Combining the estimated annual increase in average roost size and roost occupancy the overall estimated rate of decline in the total number of birds is about 23% per year (Figure 6). The total counts of WTBC, although based on an increasing number of surveys each year (from 3 to 7 between 2012 and 2019), have not shown any increase.



**Figure 6:** Change in the estimated abundance of White-tailed Black-Cockatoo in the Esperance region 2012–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.



## E. Forest Red-tailed Black-Cockatoo

### Total counts

#### *Greater Perth-Peel Region*

In 2019 the GCC recorded 5,315 FRTBC in the region. This is similar to 2018 and much higher than the years before (Table 6).

#### *Regional areas*

The count for regional areas of 789 FRTBC is roughly twice that of 2018 (Table 6).

#### *Across species range*

The total count of 6,104 birds is similar to 2018 and twice that of 2017 (Table 6).

**Table 6: Roost count summary for FRTBC across six Great Cocky Counts (2014-2019). The number of roosts is the number of occupied roosts (i.e. roosts where at least one FRTBC roosted).**

	2014	2015	2016	2017	2018	2019
<b>Greater Perth-Peel Region</b>						
No. of FRTBC counted in <b>Perth-Peel Coastal Plain</b>	601	305	771	1934	4037	3499
	(13 roosts)	(10 roosts)	(24 roosts)	(39 roosts)	(60 roosts)	(44 roosts)
No. of FRTBC counted in <b>Northern Darling Scarp and Plateau</b>	211	107	859	836	1023	1816
	(9 roosts)	(7 roosts)	(26 roosts)	(38 roosts)	(30 roosts)	(47 roosts)
No. of FRTBC counted in <b>Greater Perth-Peel Region</b>	812	412	1630	2770	5060	5315
	(22 roosts)	(17 roosts)	(50 roosts)	(77 roosts)	(90 roosts)	(91 roosts)
<b>Regional areas</b>						
No. of FRTBC counted in <b>Regional areas</b>	84	39	374	219	437	789
	(6 roosts)	(5 roosts)	(20 roosts)	(18 roosts)	(24 roosts)	(28 roosts)
<b>Across Species Range</b>						
No. of FRTBC counted <b>across species range</b>	896	451	2004	2989	5497	6104
	(28 roosts)	(22 roosts)	(70 roosts)	(95 roosts)	(114 roosts)	(119 roosts)

### Roost counts – across species range

FRTBC were recorded roosting at 119 sites across the GCC survey area, with relatively few sites in regional areas (Table 6; Appendix V). 26 of these (22%) were new sites that had not been surveyed prior to the 2019 GCC. Of the 119 occupied roosts 85 had only FRTBC, while 34 had both FRTBC and white-tailed black-cockatoos.



At occupied roosts, counts of FRTBC in the 2019 GCC ranged from 1 to 837, with a mean of  $151 \pm 9$  (standard error) and a median of 19 (119 roost counts). Roost count sizes varied across the three principal survey areas. The lowest was for the Regional areas (mean  $28 \pm 5$ ); then the Northern Darling Scarp and Plateau (mean  $39 \pm 8$ ), with the Perth Peel Coastal Plain being the highest (mean  $79 \pm 22$ ).

Across the species range, the five largest roosts accounted for 34% (2,090 of 6,104 birds) of the total number of FRTBC counted (Appendix V). The ten largest roosts accounted for 49% (3,007) of the total number of FRTBC counted. Four of the five largest roosts, and eight of the ten largest, occurred in the Perth-Peel Coastal Plain.

FRTBC have been exclusively recorded at 33 confirmed sites that were previously occupied by white-tailed black-cockatoos: four confirmed roosts in 2014, another four in 2015, a further two in 2016, seven in 2017, six in 2018 and ten in 2019 (Appendix Vd). Of these, 12 were in the Perth-Peel Coastal Plain and 16 in the Northern Darling Scarp and Plateau.

In the October 14 2018 FRTBC roost count, 15 sites were surveyed. The average count was 3, which compares to an average of 125 for the same sites between 2014 and 2019 in the April surveys conducted as part of the GCC (Appendix Ve). Another similar count will take place in October 2019.

### **Roost counts – Perth-Peel Coastal Plain**

Within the Perth-Peel Coastal Plain, the five largest roosts (counts of 837, 391, 299, 259 and 243 birds) accounted for 58% (2,029 of 3,499) of the FRTBC counted in this region (Appendix Va). These counts were recorded at Floreat (837), Yokine (391), Morley (299), Munster (259) and Jandabup (243). The roost occupancy rate was 56% for the Perth-Peel Coastal Plain (44 occupied roosts of the 78 confirmed roosts surveyed) (Table 7).

### **Roost counts – Northern Darling Scarp and Plateau**

Within the Northern Darling Scarp and Plateau, the five largest roosts accounted for 45% (822 of 1,816) of the FRTBC counted. These counts were recorded at sites in Maida Vale (304), Dwellingup (167, 120 and 97) and Marradong (134 (Appendix Vb). The roost occupancy rate was 69% (47 occupied roosts of the 68 confirmed roosts surveyed) (Table 7).

FRTBC were recorded at nine sites in the City of Kalamunda (12 sites surveyed and 518 birds), eight sites in the City of Armadale (ten sites surveyed and 139 birds) and seven sites in both the Shire of Mundaring and the Shire of Serpentine-Jarrahdale (17 sites surveyed and 110 birds and eight sites surveyed and 208 birds respectively) (Appendix IIb).

### **Roost counts – Regional areas**

In regional areas, the five largest roosts (96, 82, 75, 68 and 66 birds) accounted for 49% (387 of 789) of the FRTBC counted (Appendix Vc). These sites were located at Margaret River, Donnelly River, Balingup, Perup and Bowelling.



FRTBC were recorded at five sites in the Shire of Donnybrook-Balingup (11 sites surveyed and 264 birds) and four sites in the Shire of Bridgetown-Greenbushes (14 sites surveyed and 101 birds) (Appendix IIb).

**Table 7: The numbers of sites surveyed, occupied roosts, new roosts discovered, and roost occupancy rates for FRTBC for Great Cocky Counts 2014 – 2019.**

Sites with a positive count in a GCC had >1 FRTBC roosting in at least one GCC up to that year. Percentage (%) of all sites with a positive count in a GCC up to that year is the percentage of the total number of sites with a positive FRTBC count in a GCC up to that year that were surveyed. New roosts discovered are sites that were surveyed and had FRTBC present for the first time. Occupied roosts are sites at which at least one FRTBC was recorded roosting. Percentage (%) of all sites surveyed is the number of occupied roosts divided by the total number of sites volunteers surveyed during that GCC. Roost occupancy rate is the number of occupied roosts divided by the number of sites surveyed with a positive count in at least one GCC up to that year.

	2014	2015	2016	2017	2018	2019
<b>No. of sites surveyed, of those that had a positive count in a GCC up to that year</b>						
Perth-Peel Coastal Plain		8	9	16	22	36
Northern Darling Scarp and Plateau	n/a	2	7	30	44	45
Regional		2	2	10	16	22
<b>% of sites surveyed, of those that had a positive count in a GCC up to that year (not including cleared sites)</b>						
Perth-Peel Coastal Plain		62% (n=13)	50% (n=18)	47% (n=34)	37% (n=59)	47% (n=77)
Northern Darling Scarp and Plateau	n/a	22% (n=9)	47% (n=15)	81% (n=37)	76% (n=58)	66% (n=68)
Regional		33% (n=6)	20% (n=10)	42% (n=24)	46% (n=35)	46% (n=48)
<b>No. of new roost sites discovered</b>						
Perth-Peel Coastal Plain	13	5	16	25	18	13
Northern Darling Scarp and Plateau	9	6	22	21	10	17
Regional	6	4	14	11	13	14
<b>No. of occupied roosts (% of all sites surveyed)</b>						
Perth-Peel Coastal Plain	13 (7%)	10 (6%)	24 (10%)	39 (16%)	60 (33%)	44 (27%)
Northern Darling Scarp and Plateau	9 (20%)	7 (17%)	26 (33%)	38 (36%)	30 (33%)	47 (52%)
Regional	6 (10%)	5 (8%)	20 (23%)	18 (15%)	24 (16%)	28 (19%)
<b>Roost occupancy rate (% of confirmed sites surveyed)</b>						
Perth-Peel Coastal Plain	39%	34%	47%	63%	78%	56%
Northern Darling Scarp and Plateau	41%	44%	60%	61%	48%	69%
Regional	75%	63%	83%	51%	55%	57%



## Breeding success

**Table 8:** The number of FRTBC arriving at roosts in pairs or trios 2016– 2019, with percentages in parentheses. N sites is the number of sites at which the observations were taken.

Year	Pairs	Trios	N sites
2016	55 (50%)	55 (50%)	34
2017	46 (44%)	58 (56%)	39
2018	75 (49%)	77 (51%)	47
2019	174 (55%)	143 (45%)	52

The fraction of FRTBC groups returning to roosts as either pairs or trios was recorded at 52 sites in 2019. The proportion of groups flying into roosts as trios was 45% (Table 8). Comparison of these ratios is less meaningful than for white-tailed black-cockatoos. This is because groups of three, four and even five FRTBC may include juveniles (pers comm Tony Kirkby).

## Trend analysis

### *Perth-Peel Coastal Plain*

#### General survey trends

The number of sites surveyed in the Perth-Peel Coastal Plain varied from 185 to 240 (Table 1). The number of occupied roosts varied between 10 and 60, with occupied roosts representing 6-33% of the total number of sites surveyed each year. The discovery rate of new roosts was fairly low in 2014 and 2015 but has averaged 18 per year since then.

Positive counts (i.e.  $\geq 1$  FRTBC roosting in at least one GCC, not including cleared sites) have now been recorded from 77 sites. No confirmed FRTBC roosts have been cleared since 2014, although one (VICLATR001) has been partially cleared.

#### Largest roosts

Within the Perth-Peel Coastal Plain, the ten largest roosts (based on combined counts across years) accounted for 68% (7,553 of 11,147) of the FRTBCs counted in the 2014-2019 GCCs (Appendix Va).

#### Occupancy rate

The fraction of occupied roosts within the Perth-Peel Coastal Plain is estimated to be increasing at a rate of approximately 6% per year. This increase is statistically significant ( $p=0.0006$ ), and equates to an addition of about 5 roosts to the 77 known roosts each year.

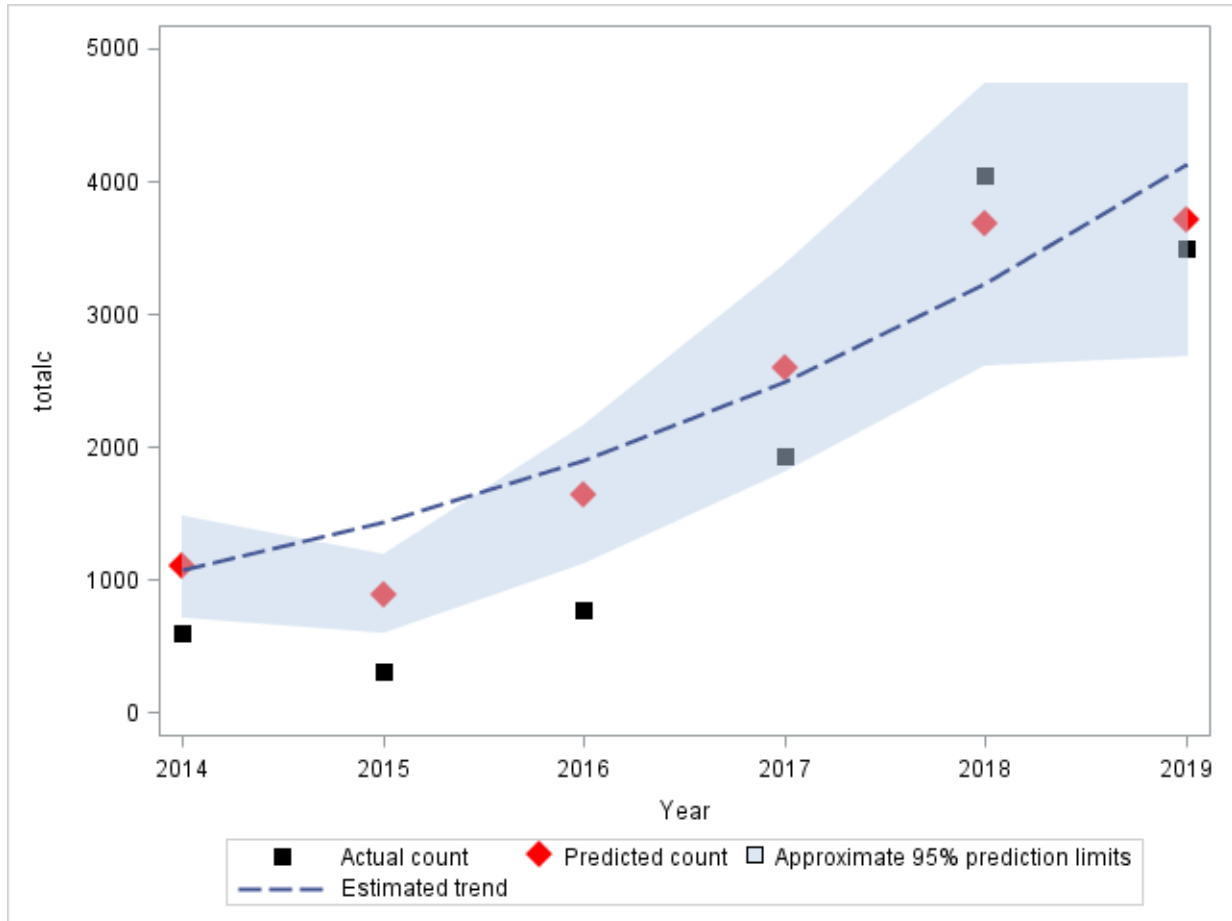
#### Average size of roosting flocks

Within the Perth-Peel Coastal Plain, the average number of birds in each roosting flock is estimated to be increasing at approximately 21% per year. This increase is statistically significant ( $p=0.0001$ ), and equates to an increase of about 14 birds per year to the overall average of around 67 birds at each roost.



### Estimated trend in the Perth-Peel region

Combining the estimated annual increase in average roost size and roost occupancy the overall estimated rate of increase in the total number of birds is about 28% per year (Figure 7). The total counts of FRTBC have been in close agreement with the predicted total count.



**Figure 7:** Change in the estimated abundance of Forest Red-tailed Black-Cockatoo in the Perth-Peel Coastal Plain region 2014–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.





## *Northern Darling Scarp and Plateau*

### **General survey trends**

The number of sites surveyed in the Northern Darling Scarp and Plateau varied from 43 to 105 (2014-2019; Table 1). The number of occupied roosts varied between 7 and 47, with occupied roosts representing 17-52% of the total number of sites surveyed each year. The discovery rate of new roosts was fairly low in 2014 and 2015 but has averaged 17 per year since then.

Positive counts (i.e.  $\geq 1$  FRTBC roosting in at least one GCC) have now been recorded from 85 sites.

No confirmed FRTBC roosts have been cleared since 2014.

### **Largest roosts**

Within the Northern Darling Scarp and Plateau, the ten largest roosts (based on combined counts across years) accounted for 46% (1,557 of 4,852) of the FRTBCs counted in the 2014-2019 GCCs (Appendix Vb).

### **Occupancy rate**

The fraction of occupied roosts within the Northern Darling Scarp and Plateau is estimated to be increasing at a rate of approximately 4% per year, but is not statistically significant. This equates to an increase of 2 roosts of the 85 known roosts each year.

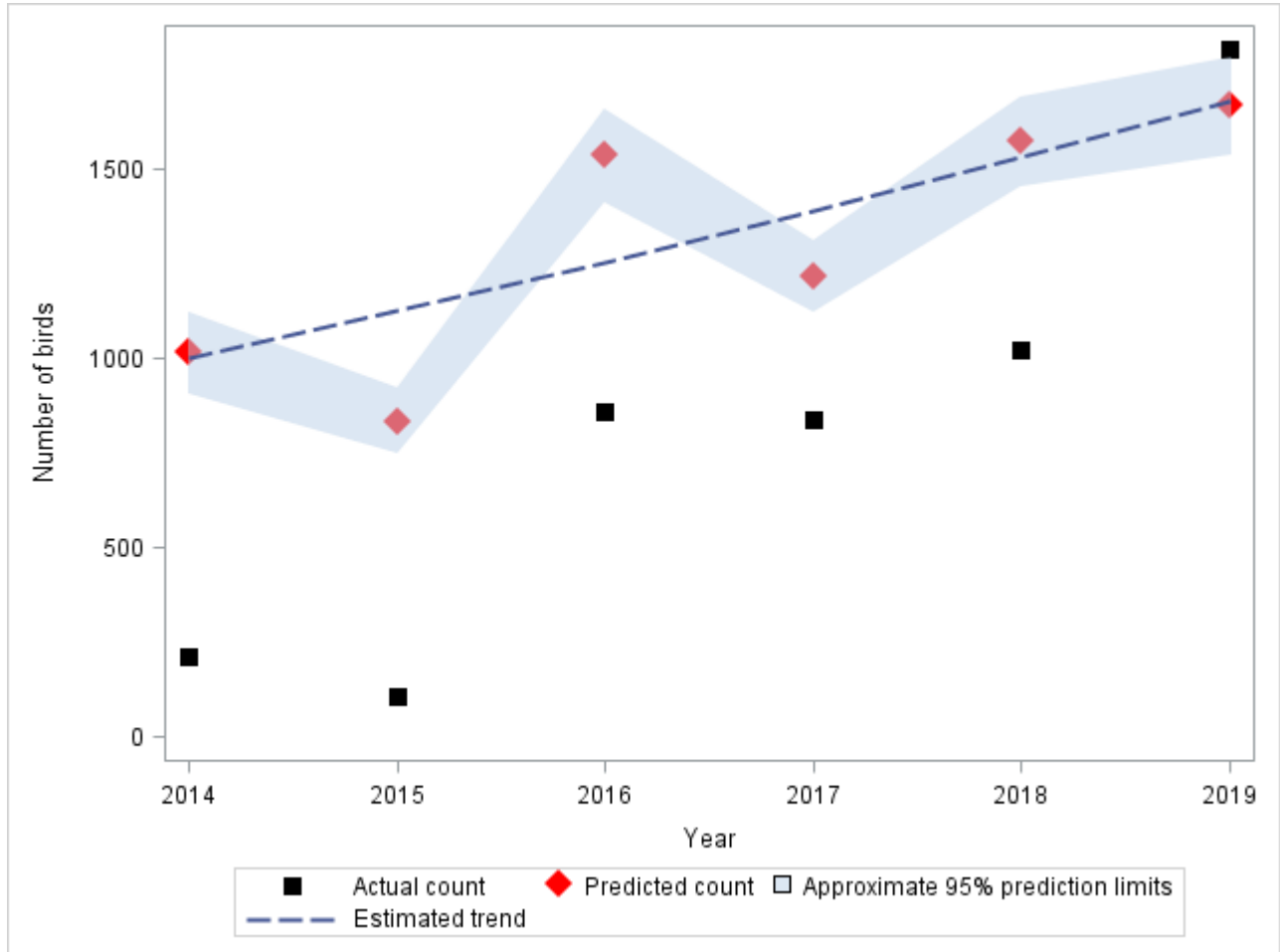
### **Average size of roosting flocks**

Within the Northern Darling Scarp and Plateau, the average number of birds in each roosting flock is estimated to be increasing at approximately 3% per year, but this increase is not statistically significant.



### Estimated trend in the Northern Darling Scarp and Plateau

The overall estimated rate of increase in the total number of birds is 10 % per year (Figure 8). In 2014 and 2015 it is estimated that the total counts of FRTBC were substantial underestimates of the number of birds present in the region, whereas counts since 2017 have been in closer agreement with the predicted total count. This is consistent with a change in the number of occupied roosts surveyed, from 7 – 9 in 2014 – 2015, to 30 – 47 in 2017 – 2019.



**Figure 8:** Change in the estimated abundance of Forest Red-tailed Black-Cockatoo in the Northern Darling Scarp and Plateau region 2014–2019 based on results of the Great Cocky Counts. The estimated trend in abundance (dashed line) is based on the predicted total count (red diamonds, with approximate 95% prediction limits) after accounting for roosts that were not surveyed or had been cleared. The actual roost counts for each year are shown as black squares.



## F. Baudin's Black-Cockatoo

The estimated number of Baudin's counted has varied between 275 and 1,747 over the last ten GCCs, with an average of 1,062. Counts for white-tailed black-cockatoos can be used as a proxy for Baudin's Black-Cockatoos in the Northern Darling Scarp and Plateau since we estimate that 70% of these are Baudin's. The estimated decline in this region is 13% per year since 2010 (Figure 4).

**Table 9: Roost count summary for Baudin's Black-Cockatoo across all Great Cocky Counts (2010-2019). The counts are corrected to account for the mixed flocks of Baudin's (70%) and Carnaby's Black-Cockatoos (30%). For regional counts see Table 3 for total counts of White-tailed Black-Cockatoos. The number of roosts is the number of occupied roosts (i.e. roosts where at least one white-tailed black-cockatoo roosted).**

WT=white-tailed Black-Cockatoo

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
No. of Baudin's Black-Cockatoo counted in Northern Darling Scarp and Plateau (corrected)	1350	275	578	711	975	378	1747	1526	1586	1496
	(total WT count = 1929; 15 roosts)	(total WT count = 393; 13 roosts)	(total WT count = 826; 15 roosts)	(total WT count = 1016; 14 roosts)	(total WT count = 1393; 13 roosts)	(total WT count = 540; 9 roosts)	(total WT count = 2496; 29 roosts)	(total WT count = 2180; 27 roosts)	(total WT count = 2266; 35 roosts)	(total WT count = 2137; 36 roosts)



### III. DISCUSSION

#### Community Engagement and Training

##### Participation in the 2019 count

The 2019 Great Cocky Count included 752 registered volunteers and is likely to have exceeded 1,200 participants overall, making the GCC once again one of the largest citizen science field surveys in Australia. Volunteers surveyed 397 sites throughout the southwest of the state. Surveying was a collective activity at most locations, with many sites surveyed by teams of volunteers, including large (>30 participants) groups at Murdoch University and Salter Point (Aquinas College).

##### Workshops

About 300 people attended training workshops in 2019, with five in the Perth-Peel Coastal Plain, three in the Northern Darling Scarp and Plateau and four in Regional areas. The workshops focus on Black-Cockatoo behaviour, identification, ecology and threats, as well as training in counting them for the GCC. They have multiple goals: education, training, awareness raising and community networking. Every attempt is made to make them engaging and entertaining and they will continue to evolve and be an integral part of the GCC calendar.

##### Volunteer retention

More than 3,300 volunteers have participated in at least one GCC since 2010. Volunteer retention from year to year has been reasonably strong, with 26-50% of the volunteers for the 2012-2019 GCCs having participated in at least one previous GCC. Some participants volunteer to survey particular sites each year, leading to the accumulation of skill and experience for survey of those roosts. Nonetheless, many volunteers participate only once and the annual turnover in volunteers is approximately 50%. This may be because many survey sites were unoccupied at the time of the GCC, and some volunteers have expressed disappointment at not being able to count black-cockatoos at their site. Birdlife has endeavoured to communicate the importance of 'nil results' in building our overall understanding of the black-cockatoo species in the southwest, and we are strongly encouraging participants to return each year to help build on previous GCC's findings. Some roosts in the database may be day roosts or feeding areas and Birdlife is in the process of reflecting this in the database. Nil results as a percentage of all surveys have been below 50% for the last two years. They have fallen in the last four years and we hope this trend continues in future years (Table 10). A survey of volunteers after the count showed that an overwhelming majority (96%) enjoyed participating in the GCC and 99% said they would participate in the future. However, 3% of respondents expressed disappointment and 5% felt instructions on counting and how to locate their site were poor (Appendix VI). This is an issue which is being addressed and improvements have been made.

**Table 10: Nil results as a percentage of all sites surveyed in the GCC (2010-2019)**

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
72%	64%	69%	69%	66%	71%	62%	57%	46%	46%





**Figure 9:** The 2018 Chapman Valley GCC team. Photo by Vanessa Brown.

### **Ongoing monitoring**

Many volunteers undertake ongoing, systematic monitoring of several sites in the Greater Perth-Peel Region, including Collier Park (Appendix VIIb), Hollywood Hospital roost in Nedlands (Berry, 2008), the Underwood Avenue roost in Floreat, roosts in the towns of Gingin (Appendix VIIa) and Bullsbrook, and roosts in Yanchep National Park and surrounds. This monitoring provides valuable data on Carnaby's numbers throughout the year.

### **Evaluation of community engagement and training**

The Great Cocky Count remains an effective program for training and engaging community members in the monitoring of black-cockatoos. While building a skilled and engaged citizenry is essential for the GCC to meet its primary objective – to conduct a community-based survey of black-cockatoos in southwestern Australia using roost counts – it is also important to evaluate whether the Great Cocky Count is succeeding as a community engagement initiative and what improvements could be made in this regard.



### *Positive aspects of the volunteer experience*

For volunteers, positive aspects of the GCC experience may include: (1) active, field-based participation in a scientific activity, (2) satisfaction that decision-makers use the information volunteers collected, (3) confidence that observations are collected according to a valid scientific protocol, (4) increased awareness about black-cockatoo ecology and conservation, (5) competence in species identification and counting techniques, and (6) relationships with particular places (roost sites) and with other volunteers (co-observers).

### *Adverse aspects of the volunteer experience*

Adverse aspects of the volunteer experience may include: (1) disappointment if black-cockatoos are not present, (2) costs (e.g. in time and fuel) and inconvenience associated with surveying sites, (3) difficulties and stress involved in locating the roost site, (4) any injuries or property damage sustained while surveying, (5) anxiety about the quality of the observations collected, and (6) insufficient positive reinforcement for involvement.

## **Improving community training and engagement**

The expertise and dedication of the GCC volunteers are essential to the success of the Great Cocky Count. As the coordinating organisation for the GCC, BirdLife Australia strives to continually improve the scientific quality of the GCC and the experience of the volunteers involved. Changes made in 2018 included the development of a [GCC FAQ sheet](#), more information on land tenure and land owner contact details, more information given on adjacent roosts and increased coverage in regional areas via campouts. Strategies under consideration for improving future GCCs include:

- online booking of some survey sites to be trialled
- increasing engagement with volunteers in regional, rural and peri-urban areas
- keeping volunteers engaged in black-cockatoo recovery events throughout the year
- facilitating interaction between GCC staff and the community of GCC volunteers



## Carnaby's Black-Cockatoo: Roost site identification

Community reporting of roost sites remains a useful means of identifying previously unknown roosts for white-tailed black-cockatoos in rural and peri-urban areas in the Greater Perth-Peel Region and in regional areas across the species range. Significant roosts for this species continue to be identified in these areas.

In 2019 it is likely that nearly all of the larger, frequently utilised roosts in the urban portions of the Perth metropolitan area have now been identified, keeping in mind that many roost sites are used infrequently (making their use difficult to document) and that Carnaby's Black-Cockatoos may occupy new sites if existing roosts are degraded or cleared, or the availability of nearby food resources changes.

The rate of discovery of previously undetected roosts in the Perth-Peel Coastal Plain was high in 2010 and 2011 (35 and 22 new sites). Between 2012 and 2017 new roosts continued to be detected at a rate averaging 12 per year. In the last two years only ten new roosts were detected. Many of the confirmed roosts identified since 2012 have been identified through a research program, combining satellite tracking of Carnaby's Black-Cockatoos released from rehabilitation centres with field surveys to inspect potential roost sites and conduct roost counts when birds are present (Christine Groom, DBCA, unpublished data; Groom *et al.* 2013). Field surveys by Mark Blythman (DBCA) also identified previously unknown sites within the Perth-Peel Coastal Plain and Northern Darling Scarp and Plateau. Since 2016, research at Murdoch University led by Dr Kris Warren has identified many new roosts by tracking birds which have been injured, rehabilitated and released. These have been incorporated into the GCC database and many of these sites are now confirmed roosts.

It is likely that some roosts remain to be identified in the rural and semi-urban portions of the Perth-Peel Coastal Plain, particularly in the northern (Moore River catchment) and southern (Lake Clifton) extremities of the region. The southern and eastern portions of the Northern Darling Scarp and Plateau remain less well surveyed for roosts of Carnaby's Black-Cockatoo (Johnstone *et al.* 2010; Lee *et al.* 2013) and large roosts will most probably continue to be discovered in regional areas.

## Carnaby's Black-Cockatoo: Perth-Peel Coastal Plain

### **The GCC surveys a substantial (but unknown) fraction of the Carnaby's Black-Cockatoos present**

The number of new roost sites discovered has declined over the years, suggesting that the GCC now surveys a substantial fraction of the Carnaby's Black-Cockatoo roosting sites in the Perth-Peel Coastal Plain and, thus, of the birds present in the region at the time of the survey. In the earlier GCCs, between 2010 and 2015, we estimate that the number of birds counted was substantially less than the number present in the region, simply because not all of the roost sites had been identified or were surveyed each year. The shortfall in the number of birds counted has reduced each year, as more of the roosts were located and more volunteers joined the GCC. As a result, the fraction of roost sites surveyed each year has increased. The large roosts identified since 2010 in the Perth-Peel Coastal Plain have – with a few exceptions (e.g. City of Stirling Nursery – STIKARR001) – generally been roosts associated with the Gnarup pine plantation.



While there are strong indications that a large proportion of the Carnaby's Black-Cockatoos present in the Perth-Peel Coastal Plain is now counted in each GCC, there is currently no reliable method of estimating the proportion of Carnaby's Black-Cockatoos that go undetected. Without this information, the GCC count data can only provide a minimum population estimate. Should a method for estimating the proportion of undetected birds become available, it will be possible to estimate the overall population size for Carnaby's Black-Cockatoo. The statistical approach applied here and the focus on trends in measurable parameters (i.e. roosting flock size and occupancy rates), are appropriate, given these limitations.

### **The timing of the GCC is appropriate for the Perth-Peel region**

The GCC started out as a Perth-Peel survey of Carnaby's Black-Cockatoo and data show that April is a good time of year to survey the species in this area. The charts in Appendix VII show average monthly counts for the Gingin town site roost (GINGINR001) between 2016 and 2018 and counts at Collier Park in Bentley (SOUCOMR001) between 2009 and 2015. The Gingin site is a large roost with three main roosting areas. The counts fluctuate from month to month, with a low of 147 in early September and a high of 1017 in early April (GCC day). The data from Collier Park are similar, with a peak in March and trough between September and November. Data from a site in the western suburbs show similar patterns (Berry, 2008). These fluctuations reflect both seasonal changes in local availability of food and water, and the migration pattern of the species (most adult Carnaby's migrate to the Wheatbelt breeding areas between June and December). These data show that April is a good time to do a survey of the population, as they are present in high numbers in coastal areas at this time of year. This timing, however, may be less appropriate for other areas and species and may change from year to year depending on availability of food and water. This is because in some areas of WA black-cockatoos are not present or are present in low numbers in April. The availability of food and water may also be affected by climate change, since rainfall and temperature patterns influence these critical resources. Since the GCC takes place roughly in the middle of the non-breeding season it is well placed to continue each April. This will also enable the continuation of trend analysis which relies on data that is comparable between years. In future years it is possible that counts outside the Perth region may take place at a different time (in addition to the GCC in April).

### **Abundance and distribution of Carnaby's Black-Cockatoo on the Perth-Peel Coastal Plain**

Based on the 2018 GCC and previous GCCs, several inferences can be made about the abundance and distribution of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain, which encompasses all of the Perth-Peel metropolitan area on the Swan Coastal Plain.

#### **(1) Carnaby's Black-Cockatoo occurs throughout the Perth-Peel Coastal Plain.**

Large roosts occur in densely-populated urban landscapes as well as peri-urban and rural landscapes.

#### **(2) The number of birds inhabiting the Perth-Peel Coastal Plain is a substantial fraction of the species' population.**

The current recovery plan estimates that the total population size of Carnaby's Black-Cockatoo is around 40,000 individuals (DPaW 2013, p. 7), meaning that at least a third of the species' population occurred within the Perth-Peel Coastal Plain at the time of the 2019 count.

#### **(3) The number of birds associated with the Gnangara pine plantation is substantial at a species-scale.**

A species population estimate of 40,000 birds means that roughly 23% of the population occurred within the remaining portions of the Gnangara pine plantation in early April 2019.





**(4) Outside the pine plantation, birds are concentrated at several roosts that are used consistently.**

Sites where Carnaby's Black-Cockatoos roost consistently in large numbers (>100 birds) include the Gingin town site; Curtin University/Collier Park/Technology Park in South Perth; bushland in Dawesville; Murdoch University and associated roosts in nearby reserves; Manning Lake and associated roosts in Spearwood; Underwood Avenue in Floreat; Hollywood Hospital and associated roosts in Nedlands. Some of these sites were unoccupied in 2019 but would be expected to remain as active roosts.

**(5) Important roosts also occur in the southern metropolitan area between Banjup and Keysbrook.**

Use of individual roosts in this area is intermittent, suggesting that birds may move between roosts, rather than occupying them consistently.

**The large count in the Perth-Peel Coastal Plain over the past four years indicates that previous surveys missed large roosts, or that birds are concentrating in fewer roosts**

Volunteer effort has been consistently high since 2016 and the number of roosts surveyed has risen correspondingly. In contrast, more roosting habitat is lost each year and it is possible that the birds may become more concentrated into fewer roosts. This is particularly relevant to Carnaby's Black-Cockatoo utilising the Gngangara pine plantation, which is currently being cleared at about 1,000ha per year, with five confirmed roosts in the Gngangara plantation cleared since 2015. This clearing may have contributed to the congregation of birds at the 'mega roost' (GINYEAR003). This roost is in one of the few remaining large contiguous areas of uncleared pines. In summary, as more habitat is lost and more volunteers are conducting surveys, the likelihood of overlooking large roosts is decreasing.

Another theory is that bush fires have contributed to the concentration of birds to remaining unburnt sites. It has been suggested that recent (2016) fires in Yarloop and Moore River may have caused birds to move to the Gngangara area for suitable feeding and roosting sites. Further work is needed to better understand roost dynamics before these hypotheses can be confirmed.

**Population of Carnaby's Black-Cockatoo is declining in the Perth-Peel Coastal Plain**

Despite the high count this year, there are strong indications that Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain has experienced decline. Analysis of roost counts over the last ten GCCs found a substantial decline between 2010 and 2015, but the estimated total number of Carnaby's Black-Cockatoo on the Perth-Peel Coastal Plain may have stabilised, or even increased slightly, over the past three years. It is not clear whether the overall decline reflects, for example, mortality of adult birds, reduced survivorship of juvenile birds, reduced breeding effort or success, emigration of birds from the Perth-Peel Coastal Plain region, reduced food resources, or the displacement of birds from existing to new roost sites. Similarly, the slight increase in the count over the past few years may be the result of birds moving from other regions onto the coastal plain. Further research is needed to elucidate the relative contribution of these factors to the decline. Nonetheless, it would be prudent to take a precautionary approach and focus conservation efforts on addressing all of these factors, until a better understanding of the demographics of Carnaby's Black-Cockatoo emerges.



## The significance of the Gngangara pine plantation for Carnaby's Black-Cockatoo

Urban areas have been shown to support substantially more threatened species (particularly animals) than non-urban areas on a unit area basis (Ives *et al.* 2016). Perth is no exception to this and Carnaby's Black-Cockatoo is a good example of a species which flourishes in a highly urbanised area. Ives *et al.* explain why this may be (p124):

“Cities may be especially valuable to these kinds of species, as they can provide more stable resources throughout the year as a result of human planting selection and supplementary watering”

For Carnaby's, this stability of resources is in large part due to pine plantations which provide a rich food source to supplement native food sources. 9,422 Carnaby's Black-Cockatoos (71%) were recorded in roosts within or associated with the Gngangara pine plantations in the 2019 GCC. This is consistent with or higher than previous reports on Carnaby's Black-Cockatoo in the plantation system (Perry 1948; Saunders 1974, 1980; Shah 2006; Finn *et al.* 2009; Johnstone *et al.* 2010; Stock *et al.* 2013). Johnstone *et al.* (2010) reported several large aggregations in the Gngangara pine plantation, including flocks of 7,000 in Mariginiup in March 2004, 2,000 in Ellenbrook in February 2005, 3,000 in Gngangara in February 2005, 3,000 in Landsdale in March 2005, 5,000-7,000 in Tamala Park in April 2003, 7,000 in Yanchep National Park in July 2006, and 8,000-10,000 in the pine plantation along Military Road north of Wanneroo in July 2006. Shah (2006) reported that 2,789 birds roosted at sites within or associated with the Gngangara pine plantation in April 2006, as part of the 2006 GCC.<sup>9</sup> Based on observations conducted between January and May 2009, Finn *et al.* (2009) reported that large (~3,000 birds) concentrations of Carnaby's Black-Cockatoo use the pine plantations during the non-breeding season. Murdoch University records of satellite tracked birds show that Carnaby's forage and roost in most of the remaining plantations (Figure 10).

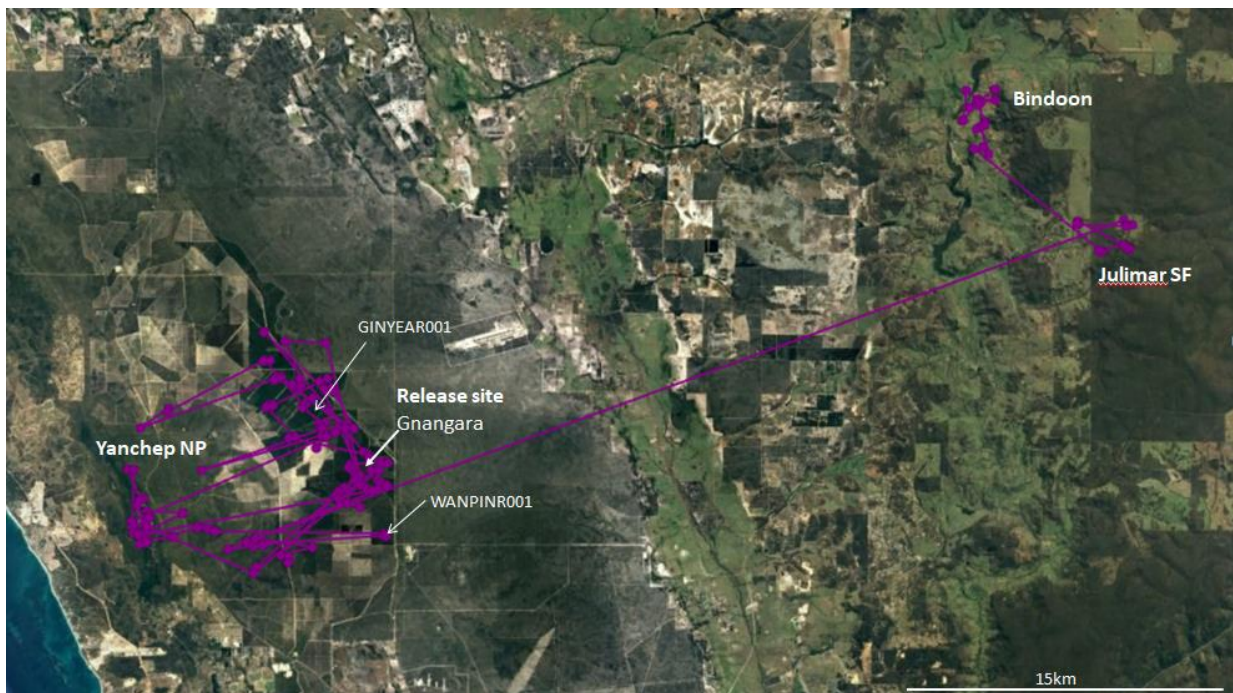


Figure 10. Tracking of Carnaby's Black-Cockatoos between March 2018 and January 2019. The movement to Julimar and Bindoon occurred during the breeding season (K. Riley, Murdoch University).

<sup>9</sup> Another 574 Carnaby's Black-Cockatoo roosted in the Karnup pine plantation in Baldivis which is now cleared.



Given these records, and their consistency with the count recorded for the Gngangara plantation system in the 2019 GCC, it is clear that several thousand Carnaby's Black-Cockatoos feed and roost within the Gngangara pine plantation each year.

GCCs prior to 2016 are likely to have underestimated the number of birds present in the Gngangara pine plantation as it is problematic to survey, for several reasons. Firstly, at their maximum the plantations covered an area of more than 23,000 ha and extended for over 50 km from north to south. Secondly, the density of the pine stands makes it difficult to obtain clear sightlines for locating roost sites or counting birds as they fly into roosts. Thirdly, Carnaby's Black-Cockatoos feed throughout the plantation system (Stock *et al.* 2013) and may roost at sites within the plantation system where they are harder to locate (Finn *et al.* 2009). Fourthly, much of the plantation is remote from human settlement, with few roads, creating issues of access and volunteer safety. Finally, within the plantation there is a high density of food and ample roosting locations – so we expect that Carnaby's Black-Cockatoos may shift between roosting locations, both from day to day and from year to year, making it problematic to select reliable survey sites. For example, 800 birds were recorded at a pine roost (WANPINR011) along the western edge of Lake Pinjar in the 2013 GCC, with 35 birds roosting at another pine roost (WANPINR001) at the northern edge of the lake (10km away), near the Pinjar power station. In contrast, during the 2014 GCC no birds were recorded at WANPINR011, but 1521 roosted at WANPINR001. The ongoing harvesting has reduced the extent of the plantations, to about 5,500 ha at present, but has also increased the ability of roosting flocks to be identified and surveyed.

Williams *et al.* (2017) estimate that clearing of the pine plantations north of Perth without revegetation would result in a 56% drop in the potential food resources available to the Carnaby's Black-Cockatoo population. Revegetation of ex-pine plantations would help to support the population in the post pine era and should be considered.

### **Carnaby's Black-Cockatoo: Northern Darling Scarp and Plateau (Jarrah-Marri Forest)**

Based on data from the last ten GCCs, several inferences can be made about the abundance and distribution of Carnaby's Black-Cockatoo in the Northern Darling Scarp and Plateau, which encompasses the Jarrah-Marri Forest (and Darling Plateau) from north of Bindoon to south of Boddington.

#### **(1) Carnaby's Black-Cockatoo occurs in low densities along the western margin of the Jarrah-Marri Forest between Mundaring and Waroona.**

In each GCC, Baudin's Black-Cockatoos have accounted for the majority of white-tailed black-cockatoos observed at roosts in the Armadale-Kalamunda-Mundaring area, and are also likely to have been the predominant species at roosts in other sections of the Northern Darling Scarp and Plateau (Johnstone and Kirkby 2008). Nonetheless, it is clear that Carnaby's Black-Cockatoo occurs consistently throughout the western margin of the Jarrah-Marri Forest, although in low densities.

#### **(2) The abundance and distribution of Carnaby's Black-Cockatoo within the southern and eastern portions of the Northern Darling Scarp and Plateau is not well understood.**

There are few GCC records for roosts along the southern and eastern portions of the Northern Darling Scarp and Plateau. Carnaby's Black-Cockatoo appears to be present at low densities throughout the Jarrah-Marri Forest (e.g. Lee *et al.* 2013), with breeding records from many locations in northern portions of the forest (Johnstone *et al.* 2010). Two new, significant roosts were discovered and counted for the first time in



Parkerville in 2016 (MUNPARR003 and 004) and one large roost was discovered in Wandering this year (WNDWANR003). Anecdotal evidence also suggests that there are other roosts in the Northern Darling Scarp and Plateau which are not yet in the GCC database (Tony Kirkby pers comm). This means that the area is under-surveyed and should be a priority for future GCCs.

**(3) Significant roosts occur in the Jarrah-Marri Forest north of Mundaring.**

Large roosts have been recorded at Bullsbrook, Toodyay, and Gidgegannup in GCCs since 2010. Substantial roosts also occur around Bindoon (Johnstone *et al.* 2010). The Jarrah-Marri Forest becomes more fragmented north of Mundaring and may sustain greater abundances of Carnaby's Black-Cockatoo than areas of forest to the south. This region should be a priority for future survey.

**(4) Variation in the abundance of white-tailed black-cockatoos may reflect differences in the timing of the northward migration of Baudin's Black-Cockatoos during their non-breeding season.**

Baudin's Black-Cockatoo breeds in the Karri and southern Jarrah-Marri Forests between October and March each year, then migrate northwards through the northern Jarrah-Marri Forest from late March (Johnstone and Kirkby 2008). As the timing of this northward migration varies between years, both the relative proportions of Baudin's Black-Cockatoos and Carnaby's Black-Cockatoos present, and the overall abundance of white-tailed black-cockatoos at roosts in the Northern Darling Scarp and Plateau, can be expected to vary from year to year.

**(5) Trend analysis shows that white-tailed black-cockatoo numbers are declining in the Northern Darling Scarp and Plateau.**

The current estimated rate of decline is 13%, which is a much steeper decline than that of the Carnaby's population on the Perth-Peel Coastal Plain. Again, it is not clear to what extent this decline reflects (e.g.) mortality of adult birds, reduced survivorship of juvenile birds, reduced breeding effort or success, emigration of birds from the region or the displacement of birds from existing to new roost sites. Further research is needed in order to confirm the decline, explain the reasons for the decline and to inform land management decisions.

## Carnaby's Black-Cockatoo: Regional Areas

The Great Cocky Count continues to expand in regional areas, with on-going increases in the number of sites surveyed, the number of occupied roosts recorded, and the total number of white-tailed black-cockatoos counted. Sites were surveyed across much of the species range, with roost counts conducted at sites in the Chapman Valley to the north, Esperance to the east, around the western and southern coasts, and inland to Narrogin. Roost counts have been conducted for at least four years at 70 regional sites, for at least five years at 44 sites and for at least six years at 32 sites. Trend analysis has not shown any significant results to date, but there are still too few data and in future years this should be possible.

Some initial inferences can be made about the distribution of Carnaby's Black-Cockatoo in this region. Firstly, along the west coast, large numbers are present in Chapman Valley, in the Jurien Bay/Hill River area (adjacent to the Coomallo breeding area; Saunders 1982), and the northern Swan Coastal Plain from Guilderton north to Nilgen. Secondly, Carnaby's Black-Cockatoo are present, but at low abundances, along the southern Swan Coastal Plain south of Lake Preston with roosts occurring near pine plantations (e.g. Myalup, Wellesley) and along the



margin of the Darling Scarp (possibly in association with Baudin's Black-Cockatoos). Thirdly, white-tailed black-cockatoos occur in reasonable abundances in the Capes Region and along the south coast from Albany through to Esperance, with some large roosts associated with pine plantations. Finally, the current distribution of Carnaby's Black-Cockatoo in the Wheatbelt and inland portions of the Great Southern is less clear, but birds do occur at Narrogin and large numbers have been recorded in the Stirling Range National Park.

Counts at twelve large roosts (>200 birds) accounted for 72% of white-tailed black-cockatoos recorded in regional areas in the 2019 GCC (5,161 of 7,167 birds). In agricultural landscapes and areas lacking tall trees (e.g. coastal heathlands), the availability of water and suitable roosting trees may lead to birds concentrating at particular roost sites. On-going monitoring of these sites and continued location of similar additional sites will provide valuable information about population trends in regional areas.



## Forest Red-tailed Black-Cockatoo

### Identification of roost sites for FRTBC

The 2019 GCC built on the previous GCCs as the only broad-scale survey for the Forest Red-tailed Black-Cockatoo, with volunteers documenting 119 roosts across southwest WA. This survey, conducted in tandem with the survey for Carnaby's Black-Cockatoo, relied on the existing GCC roost site database which was developed specifically for Carnaby's Black-Cockatoo. Many new FRTBC specific sites were identified and confirmed in the 2019 GCC. This is the result of an increased focus on this species by Birdlife Australia, with the recruitment of a Forest Black-Cockatoo Project Coordinator. It is also the result of roost site information from Sam Rycken and Karen Riley at Murdoch University obtained from satellite telemetry studies. There are now 237 known roost sites for FRTBC.

This year, 34 of the 119 FRTBC roosts were also occupied by White-tailed Black-Cockatoos. Also, FRTBC roosts sometimes occur very close to Carnaby's Black-Cockatoo roosts. Examples of the latter situation include the roosts in Kensington (SOUCOMR001 and VICKENR002).

### Distribution of FRTBC in the Perth metropolitan area

The 2018 and 2019 GCCs showed a large increase in numbers of FRTBC roosting in the Perth-Peel region (average of 3,768 birds compared to an average of 903 between 2014 and 2017). Observations from the 2014 to 2019 GCCs confirmed roosts in 22 LGAs in the Perth-Peel Coastal Plain. In 2019 volunteers recorded sizable counts at Floreat, Yokine (two roosts), Maida Vale, Morley, Munster, Jandabup, Murdoch University, Ballajura and Kensington. These counts are much larger than flock sizes reported for FRTBC in forested regions (Abbott 1998, Lee *et al.* 2013). Indeed, the 2019 average roost size of 79 for the Perth-Peel region is much higher than that of the Darling Scarp and Plateau (39) and regional areas (28) and much higher than in previous years (e.g. 32 in 2016 and 50 in 2017).

These outcomes are consistent with, and extend, previous observations about recent shifts in the abundance and distribution of FRTBC on the Swan Coastal Plain. In reviewing information about FRTBC on the Swan Coastal Plain, Johnstone *et al.* (2010, p. 24) noted that:

On Swan Coastal Plain status uncertain, listed as rare in early 1900s (Alexander 1921), but possibly resident (although patchily distributed) at Mundijong, Baldivis, Karnup, Stakehill, near McLarty, Pinjarra, Coolup, Meelup, Goodale Sanctuary, Lake Clifton area, Dawesville and Wokalup (Storr-Johnstone Bird Data Bank) and also a casual visitor mainly in search of Cape Lilac (*Melia azedarach*) to some Perth suburbs (e.g. Mosman Park, Belmont, Kensington, Murdoch, Kewdale, Bentley, Queens Park, Lynwood, Gosnells, Forrestdale and Armadale). In recent years there has been a very dynamic expansion of foraging from the Darling Range, both west onto the Swan Coastal Plain and east into the wheatbelt.

Johnstone *et al.* (2013, p. 153) also observed that:

The changing foraging ecology of some [FRTBC] populations in the northern Jarrah-Marri forest in recent times has meant that some flocks that were largely sedentary have now developed regular movements onto the Swan Coastal Plain including the establishment of new roost and breeding sites. The movement out onto the coastal plain has, however, led to the erroneous assumption in the Perth area that this subspecies is more common than it really is.



Counts from the 2018 and 2019 GCCs demonstrate the extent of this expansion onto the Swan Coastal Plain and show that significant roosts now occur throughout the Perth area. Additional surveys conducted by GCC volunteers in 2014 also indicate that FRTBCs show strong roost fidelity and year-round residency in at least three locations – Kensington bushland and adjacent reserves, Murdoch University, and the Floreat/Underwood Avenue area (unpublished data: Greg Bell, Department of Fire and Emergency Services; L. Knapp, Murdoch University; and Margaret Owen, Friends of Underwood Avenue Bushland). FRTBC have also bred successfully in artificial nest hollows installed at Murdoch University (Leah Knapp, Murdoch University, personal communication) and in Mandurah (BirdLife WA, 2018). The roost occupancy rate is much higher for FRTBC compared to white-tailed black-cockatoos, but this may be due to greater roost fidelity rather than their population being more stable.

The apparent expansion of FRTBC on the Perth-Peel Coastal Plain may be associated with them including exotic foods such as Cape Lilac in their diet. This is a hypothesis being studied by a PhD student at UWA and has been noted by Johnstone *et al.* 2017:

Over the past 20 years there has been a dynamic change in the foraging ecology of many birds in the northern Darling Range (adjacent to the Perth metropolitan area) driven mainly by their discovery of Cape Lilac as a new food source.

The expansion of FRTBC on the Perth-Peel Coastal Plain may also be a response to changes in water availability with water potentially becoming a scarcer resource on the Darling Scarp by late summer (M. Craig pers. comm). Dr Mike Craig at UWA is currently researching water use by all black-cockatoo species in the northern Jarrah-Marri forest. It is also possible that a decline in the availability of water in the Darling Scarp, due to the drying of seasonal and permanent streams (Petroni *et al.* 2010), has led to birds moving into the Perth metropolitan region.

There is evidence in recent years of changes in the black-cockatoo species using some confirmed roost sites - 33 former confirmed white-tailed black-cockatoo roost sites are now used only by FRTBC (Appendix Vd). Twelve of these are in the Perth-Peel Coastal Plain and this reflects the trend of FRTBC expanding into this area over the last decade. However, some roosts alternate between FRTBC and WTBCs and being joint roosts from year to year. The competitive relationship between cockatoo species for roost sites is another unknown aspect of these species' ecology.

## Trend analysis

Trend analysis shows a large increase in FRTBC numbers in the Greater Perth-Peel region. To what extent this is due to a redistribution of birds from forested areas to more urbanised areas or increased breeding rates is unclear. FRTBC are very slow breeding birds, producing only a single egg every other year, and breeding data from 2016 show a decline in breeding success (Johnstone *et al.* 2017). The observed increase in numbers in the Perth-Peel coastal Plain is well above the maximum possible breeding rate and therefore more likely to be due to a redistribution of birds from other areas. The results of the count conducted in October 2018 contrasts markedly with those in April. The low counts in October suggest that most FRTBC return to forested regions in winter, returning to coastal areas in summer. The return to forested areas may be in order to breed where there are more suitable hollows available. The seasonal pattern may also reflect the availability of food resources such as Cape Lilac and native plants (e.g. Marri, Jarrah).



## Conclusion

The Great Cocky Count is a large-scale citizen science survey that engages local communities in the monitoring of nationally threatened black-cockatoos. The last ten GCCs, involving more than 3,300 volunteers, have identified several hundred black-cockatoo roosts across the southwest of WA. In the Greater Perth-Peel Region, the GCC provides valuable information on the location and use of black-cockatoo roosts and estimates of population trends. This information has improved land-use planning and environmental impact assessment, and informed conservation efforts for black-cockatoos at all levels of government. More broadly, the GCC continues to raise community and industry awareness about the threatened status of black-cockatoos and the need to protect them, their roosts and feeding habitat. These are tangible successes and reflect the contributions of thousands of community members. Ongoing investment in this monitoring program is needed, including volunteer training and engagement, both to improve the scientific quality of the survey and to enhance the experience of the community members involved. The Great Cocky Count succeeds because of the tremendous goodwill of the Western Australia community.

The 2019 GCC and the trend analyses of the ten annual GCCs between 2010 and 2019 identified several issues that have important implications for black-cockatoo conservation efforts. Firstly, there are indications that the population of Carnaby's Black-Cockatoo that inhabit the Perth-Peel Coastal Plain and are counted through the GCC has declined since 2010, although it appears to have stabilised over the past three years. Secondly, as noted in previous GCC reports, the Gnangara pine plantation sustains a large proportion (up to 73%) of the population of Carnaby's Black-Cockatoo on the Perth-Peel Coastal Plain during the non-breeding season. As such, the decline in numbers of Carnaby's Black-Cockatoo may be due to the removal of these pine plantations. Finally, there has been a significant change in the roosting behaviour of Forest Red-tailed Black-Cockatoos from forested areas to the urban portions of the Perth-Peel metropolitan area. These findings provide an important focus for decision-making about the future of the remaining Gnangara pine plantation and revegetation of ex-pine plantations, the conservation of urban and peri-urban Banksia woodland and mature Marri trees, and the protection of roosts and food resources throughout the region.





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APPENDIX I: The 2019 Great Cocky Count survey form

<b>Name of lead observer(s):</b>	<b>Telephone:</b>	<b>Email:</b>
<b>Name of additional observer(s):</b>	<b>Telephone:</b>	<b>Email:</b>

<b>Date:</b>	7 April 2019	<b>Start time:</b>		<b>Finish time:</b>	
<b>Site code:</b>		<b>GPS location:</b>	<b>Latitude</b>	<b>Longitude</b>	
<b>Site Address / Location:</b>					

**What is the main type of tree that the cockatoos are roosting in:** *(tick box)*

Pine  
 Eucalypt  
 Marri  
 Jarrah  
 Tuart  
 Other: \_\_\_\_\_  
 Not Known

<b>White-Tailed Black-Cockatoos Count</b>		<b>Sub-totals</b>
You may wish to tally cockatoos as they fly across an imaginary line in the sky: (for example: 2, 2, 2, 3, 2, 17, 2, 24, 2, 3, 3, 1, ... )		
<b>Total Number of White-Tailed Cockatoos at the Roost</b>		
<b>General direction from which cockatoos arrived:</b>	<input type="checkbox"/> North <input type="checkbox"/> South <input type="checkbox"/> East <input type="checkbox"/> West <input type="checkbox"/> Other (e.g. SW): _____	

<b>Red-Tailed Black-Cockatoos Count</b>		<b>Sub-totals</b>
You may wish to tally cockatoos as they fly across an imaginary line in the sky: (for example: 2, 2, 2, 3, 2, 17, 2, 24, 2, 3, 3, 1, ... )		
<b>Total Number of Red-Tailed Cockatoos at the Roost</b>		
<b>General direction from which cockatoos arrived:</b>	<input type="checkbox"/> North <input type="checkbox"/> South <input type="checkbox"/> East <input type="checkbox"/> West <input type="checkbox"/> Other (e.g. SW): _____	



### Observational Comments

Please provide any additional observational comments.

For example, you may wish to record the numbers and direction of flocks passing by your roost tree that you have not recorded if you are unsure if they will be picked up by someone else (this may particularly be the case in rural areas). **If you are 100% sure whether the White-tailed Cockatoos are Carnaby's or Baudin's please tell us here.**

Other birds roosting. Please tell us below if there are other birds roosting here, eg Rainbow Lorikeets or Corellas.

**If you don't see any cockatoos, please let us know!**

Please return your survey results even if you get a nil result – it is equally important for us to know if the cockies aren't there. Please tell us if you did not end up participating, you won't get in trouble 😊

**\*\* Once you have completed this form, please return to BirdLife as soon as possible \*\***

*via email:*

[greatcockycount@birdlife.org.au](mailto:greatcockycount@birdlife.org.au)

*via post:*

Adam Peck, BirdLife Australia  
Peregrine House, 167 Perry Lakes Drive  
Floreat, WA, 6014



## How to Do a Roost Count

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- 1) **We strongly advise you do a practice count in the week before the GCC**, especially if this is the first time you have surveyed your allocated roost (best to do this at sunset). This will guide you as to travel time and best route, the time birds arrive, best spot to survey from, etc.
- 2) **Arrive at your allocated roost site at least 45 minutes before sunset** so you are ready to record birds as they arrive. **Start counting from 5:30pm (or when they start to arrive)**.
- 3) **Count all black-cockatoos that roost at the site for at least 30 minutes after sunset** (ie. count until at least **6:30pm**, sometimes cockies arrive late and you may need to stay until 7pm).
  - Only count flying cockatoos as they approach and land at the roost site (counting cockatoos already in trees is generally not accurate).
  - Draw an imaginary line across the sky and count the number of cockatoos as they cross the line. Roads or powerlines work well.
  - When possible, record the count of cockatoos in each group as they cross the count line (e.g. 4, 1, 3, 10 3, 2, 6, 1, 3). This helps us to estimate breeding success rates.
  - For large flocks, work out how big a group of 10 cockatoos is and use this to decide the size of the whole flock, e.g. if the group of 10 cockatoos fits into the flock four times, there are 40 cockatoos in the flock.
  - Do not count cockatoos that fly over the top of your roost site and do not stop there – these birds may be going to another person’s survey site.
  - If you see **red-tailed black-cockatoos**, note their numbers on your survey form in the box below the white-tailed box.
  - **Count ALL white-tailed black-cockatoos** landing at your site – don’t worry about telling apart Baudin’s and Carnaby’s Black-Cockatoos *unless you are certain of the difference*. If you see **red-tailed black-cockatoos at your site**, note this on your survey form as well.
  - If you don’t see any cockatoos, don’t despair – it is just as important to record that no cockatoos were present at that roost site. Records of presence and absence help us determine patterns of roost occupancy across the GCC survey area.
- 4) **Equipment to bring:** survey form, clipboard, pen/pencil, tally/click counter, torch, binoculars, GPS (if you have one), compass, watch, map, chair/blanket, water/snacks, insect repellent.
- 5) **Send completed forms to BirdLife WA (see previous page for details).**
- 6) **More questions?** See the FAQ sheet [here](#).

### Please note our safety advice for volunteers taking part in the survey:

- We wish to remind you that you are responsible for your own safety while taking part in roost counts. In addition, you must complete our volunteer registration process before undertaking roost counts.
- Always let someone know where you are going and when you expect to return.
- Wear sturdy, enclosed shoes or walking boots, protective clothing and be prepared for adverse conditions. Carry sufficient food and water.
- You must be fully capable of physical mobility & moderately physically fit to participate in the survey.
- If children are present, they must be supervised by an adult.
- Avoid working under the tree canopy where you are at risk of falling branches and pine cones.
- Survey in groups of at least two people to maximise safety & improve the reliability of survey results.
- If surveying a site close to a road, be aware of traffic.

For inquiries about the 2019 Great Cocky Count please contact Adam Peck, Great Cocky Count Coordinator, at [greatcockycount@birdlife.org.au](mailto:greatcockycount@birdlife.org.au) or (08) 9287 2251/ 0401 840 546.



**APPENDIX IIa: Number of sites surveyed across local government areas (2019) and WT numbers**

Number of roost sites surveyed, occupied roosts and total counts of White-tailed Black-Cockatoos.							
Shire	N sites surveyed	N sites occupied	Total count	Shire	N sites surveyed	N sites occupied	Total count
<b>Regional areas</b>							
Albany	19	4	524	Donnybrook-Balingup	11	4	113
Augusta-Margaret River	19	10	227	Esperance	7	5	1090
Bindoon	0	0	0	Gingin	1	1	650
Bridgetown-Greenbushes	14	3	610	Gnowangerup	0	0	0
Bunbury	4	2	33	Harvey	11	4	880
Busselton	12	7	579	Kojonup	1	1	8
Capel	9	3	301	Manjimup	5	2	46
Carnamah	3	2	260	Nannup	3	0	0
Chapman Valley	3	0	0	Narrogin	1	0	0
Cranbrook	0	0	0	Plantagenet	5	3	67
Dandaragan	4	4	1032	Ravensthorpe	2	1	640
Dardanup	5	2	6	Victoria Plains	1	1	2
Denmark	3	1	99	Williams	1	0	0
<b>Greater Perth-Peel region</b>							
Armadale	18	3	138	Mosman Park	1	0	0
Bayswater	3	0	0	Mundaring	24	9	448
Belmont	1	0	0	Murray	11	3	61
Beverley	2	0	0	Nedlands	5	2	356
Boddington	2	0	0	Northam	4	2	175
Cambridge	6	1	283	Rockingham	2	0	0
Canning	3	0	0	Serpentine-Jarrahdale	22	4	247
Chittering	3	0	0	South Perth	3	1	563
Claremont	1	0	0	Stirling	12	2	70
Cockburn	13	2	509	Subiaco	1	0	0
Fremantle	2	0	0	Swan	18	7	994
Gingin	6	4	6297	Toodyay	3	2	94
Gosnells	11	2	116	Victoria Park	6	1	2
Joondalup	4	0	0	Vincent	1	0	0
Kalamunda	17	7	392	Wandering	1	1	321
Kings Park	1	0	0	Wanneroo	18	7	2916
Kwinana	7	2	173	Waroona	5	2	39
Mandurah	8	2	915	Williams	1	0	0
Melville	6	4	371				



## Appendix IIb: Number of sites surveyed across local government areas (2019) and FRTBC numbers

### Number of roost sites surveyed, occupied roosts and total counts of Forest Red-tailed Black-Cockatoos.

Shire	N sites surveyed	N sites occupied	Total count	Shire	N sites surveyed	N sites occupied	Total count
<b>Regional areas</b>							
Albany	19	3	41	Donnybrook-Balingup	11	5	264
Augusta-Margaret River	19	3	149	Esperance	7	0	0
Bindoon	0	0	0	Gingin	1	0	0
Bridgetown-Greenbushes	14	4	101	Gnowangerup	0	0	0
Bunbury	4	0	0	Harvey	11	3	15
Busselton	12	2	13	Kojonup	1	0	0
Capel	9	3	45	Manjimup	5	2	103
Carnamah	3	0	0	Nannup	3	1	9
Chapman Valley	3	0	0	Narrogin	1	0	0
Cranbrook	0	0	0	Plantagenet	5	1	32
Dandaragan	4	0	0	Ravensthorpe	2	0	0
Dardanup	5	0	0	West Arthur	0	0	0
Denmark	3	1	17	Williams	1	0	0
<b>Greater Perth-Peel region</b>							
Armadale	18	10	149	Mosman Park	1	1	3
Bayswater	3	3	305	Mundaring	24	7	110
Belmont	1	0	0	Murray	11	6	474
Beverley	2	1	14	Nedlands	5	0	0
Boddington	2	2	147	Northam	4	0	0
Cambridge	6	2	856	Rockingham	2	2	74
Canning	3	3	100	Serpentine-Jarrahdale	22	10	223
Chittering	3	1	27	South Perth	3	1	1
Claremont	1	0	0	Stirling	12	3	544
Cockburn	13	4	409	Subiaco	1	0	0
Fremantle	2	1	28	Swan	18	5	276
Gingin	6	0	0	Toodyay	3	2	58
Gosnells	11	3	68	Victoria Park	6	3	223
Joondalup	4	1	9	Vincent	1	0	0
Kalamunda	17	9	518	Wandering	1	0	0
Kings Park	1	0	0	Wanneroo	18	3	266
Kwinana	7	0	0	Waroona	5	4	103
Mandurah	8	3	116	Williams	1	0	0
Melville	6	1	214				





### APPENDIX III: Roost counts for white-tailed black-cockatoos in the Greater Perth-Peel Region.

**Appendix IIIa:** Great Cocky Count (2010-2019) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page vii) in the Perth-Peel Coastal Plain. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals	
ARMCHAR001*	Champion Lakes	.	.	.	.	.	.	.	0	3	0	3	
ARMFORR001	Forrestdale	.	.	.	0	0	18	0	0	.	0	18	
ARMHARR001	Harrisdale	.	0	0	.	0	1	3	0	0	0	4	
ARMKELR001	Kelmscott	14	0	0	0	0	.	.	.	0	0	14	
CAMCITR001*	City Beach	.	.	.	.	2	0	0	0	.	0	2	
CAMFLOR001	Floreat	237	151	148	157	159	86	239	281	259	283	2000	
CANFERR001	Ferndale	.	.	.	5	0	0	0	0	0	.	5	
CANWILR001*	Willetton	0	0	0	0	68	0	0	0	0	0	68	
CLASWAR001	Swanbourne	.	.	0	0	3	0	0	0	0	0	3	
COCBANR001*	Banjup	.	.	.	.	.	45	.	0	20	0	65	
COCBANR002*	Banjup	.	.	.	.	53	.	0	0	0	0	53	
COCBANR003	Banjup	.	.	.	.	.	.	.	6	16	0	22	
COCCOOR005	Coolbellup	.	.	.	.	.	.	.	38	0	0	38	
COCHAMR001	Hamilton Hill	0	169	215	0	168	68	101	0	0	0	721	
COCHAMR002	Hamilton Hill	.	.	.	.	.	263	194	0	369	506	1332	
COCMUNR003*	Munster	.	.	.	.	.	.	0	0	0	3	3	
COCSCCR001	Success	252	cleared									252	
COCSCCR002	Success	15	3	cleared									18
COCSPER001	Spearwood	0	2	.	323	.	0	0	40	0	.	365	
COCSPER002	Spearwood	.	5	0	.	.	0	24	0	.	.	29	
GINGINR001	Gingin	392	378	432	686	879	784	1023	880	1148	544	7146	
GINNEER001	Neergabby	.	.	.	.	.	.	70	.	.	.	70	
GINNEER002	Neergabby	.	.	.	.	.	.	.	34	.	.	34	
GINWANR001	Wanerie	0	0	.	.	0	.	.	50	0	.	50	
GINWOOR001	Woodridge	113	119	0	30	0	0	0	0	0	.	262	
GINYEAR001	Yéal	.	.	387	.	782	.	.	6	0	0	1175	
GINYEAR002	Yéal	49	92	.	.	.	20	.	.	15	369	545	
GINYEAR003	Yéal	.	.	.	.	.	750	4897	3528	6226	5145	20546	
GINYEAR004	Yéal	.	.	.	.	.	.	.	.	.	239	239	
GOSCNVR001*	Canning Vale	0	19	.	.	0	0	0	0	.	80	99	
GOSCNVR002*	Canning Vale	.	.	26	52	0	0	151	0	0	0	229	
GOSMARR001*	Martin	.	.	.	.	.	.	.	0	120	36	156	
GOSSOUR002*	Southern River	.	.	.	.	.	.	50	0	0	0	50	
JOODUNR001	Duncraig	.	.	60	0	0	17	43	110	80	0	310	
JOEDGR001	Edgewater	0	0	.	0	0	23	0	0	0	.	23	
JOOPADR001*	Padbury	0	.	1	17	7	7	0	0	0	0	32	
JOOWARR001	Warwick	0	60	.	0	0	0	0	0	.	0	60	
KINPERR001	Perth	0	.	0	.	0	0	0	8	0	0	8	
KWICASR001*	Casuarina	2	.	.	0	19	.	.	0	59	0	80	
KWIWANR001	Wandi	63	0	0	1	0	0	0	0	0	.	64	
KWIWANR002	Wandi	.	.	.	0	0	0	0	5	0	0	5	
KWIWANR004	Wandi	.	.	.	.	.	.	.	73	0	0	73	
KWIWELR001*	Wellard	.	.	15	50	0	62	0	0	4	40	171	
KWIWELR002	Wellard	.	.	.	.	.	.	.	.	4	133	137	
MANCOOR002*	Coodanup	.	.	.	21	0	0	2	0	0	0	23	
MANDAWR002*	Dawesville	371	199	11	0	257	135	214	86	71	501	1845	
MANDAWR004	Dawesville	159	.	.	0	24	22	0	61	210	.	476	
MANDAWR005	Dawesville	.	30	.	0	0	0	0	.	0	.	30	



Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
MANDAWR006	Dawesville	.	.	.	.	.	11	132	0	200	0	343
MANDAWR007*	Dawesville	.	.	.	.	.	277	167	9	566	414	1433
MELBATR001	Bateman	8	0	0	0	0	0	0	0	0	0	8
MELKARR002	Kardinya	0	0	0	.	0	55	0	0	0	0	55
MELLEER001*	Leeming	0	0	12	0	70	0	0	0	15	2	99
MELMURR001*	Murdoch	700	60	142	127	234	24	78	0	227	249	1841
MELWINR001	Winthrop	.	56	81	70	41	0	21	0	0	12	281
MELWINR003*	Winthrop	117	130	.	.	.	0	7	54	64	108	480
MELWINR004	Winthrop	0	0	0	0	2	0	0	0	0	.	2
NEDDALR002*	Dalkeith	0	.	.	.	.	.	0	0	12	0	12
NEDDALR003	Dalkeith	40	90	0	0	0	0	0	0	0	0	130
NEDNEDR001	Nedlands	73	103	304	183	114	106	216	242	175	353	1869
NEDNEDR002	Nedlands	.	.	.	.	0	11	0	0	0	3	14
NEDNEDR003	Nedlands	.	.	.	.	0	2	33	96	47	0	178
ROCBALR001	Baldivis	346	.	cleared								346
ROCBALR003*	Baldivis	.	78	0	4	0	0	0	.	0	0	82
ROCBALR004	Baldivis	.	40	0	0	0	.	0	0	.	.	40
ROCSECR001	Secret Harbour	0	.	0	0	6	0	0	.	0	.	6
SERBYFR004*	Byford	.	.	.	.	.	.	111	7	0	0	118
SERBYFR006	Byford	.	.	.	.	.	.	.	.	.	11	11
SERDARR001*	Darling Downs	.	.	.	.	.	.	8	0	0	0	8
SERKEYR001*	Keysbrook	0	.	.	100	3	14	53	0	3	0	173
SERMUNR002*	Mundijong	.	.	.	.	.	.	10	12	.	0	22
SEROAKR001	Oakford	0	110	.	0	0	.	.	0	0	.	110
SEROAKR002*	Oakford	0	0	0	2	.	.	.	0	0	0	2
SEROAKR003	Oakford	167	0	0	0	0	0	.	.	0	0	167
SEROAKR004	Oakford	45	3	0	0	50	0	26	2	33	.	159
SEROAKR005	Oakford	31	0	.	0	0	0	0	0	0	.	31
SEROAKR007	Oakford	.	.	.	.	.	.	.	2	0	.	2
SERWELR002	Wellard	.	.	.	.	.	.	.	298	75	0	373
SERWHIR001	Whitby	.	.	.	.	.	.	34	.	56	.	90
SOUCOMR001*	Como	408	645	558	301	402	460	242	289	470	563	4338
SOUSALR001*	Salter Point	12	0	0	0	5	0	0	0	2	0	19
SOUSOUR002	South Perth	0	35	0	0	0	0	0	0	0	0	35
STIHAMR001	Hamersley	.	.	.	.	0	.	24	0	0	62	86
STIINNRO01	Innaloo	0	.	0	0	0	0	0	3	0	0	3
STIKARR001	Karrinyup	.	.	.	121	92	2	45	10	0	0	270
STINORR001	North Beach	0	230	0	267	0	6	0	23	19	8	553
SUBSHER001	Shenton Park	0	0	0	9	0	0	0	0	0	0	9
SWABALR001	Ballajura	0	40	0	92	0	35	0	0	0	0	167
SWABALR004	Ballajura	0	.	.	.	0	5	105	0	0	0	110
SWABULR003	Bullsbrook	.	.	.	.	.	.	8	0	0	.	8
SWABULR004	Bullsbrook	.	.	.	.	.	.	0	5	0	.	5
SWAELLR001	Ellenbrook	.	.	.	.	14	.	280	0	0	.	294
SWAHENR002	Henley Brook	.	.	.	.	.	.	.	50	0	0	50
SWALEXR001	Lexia	0	80	0	0	181	0	0	0	34	753	1048
SWALEXR002	Lexia	185	0	.	0	0	0	cleared				185
SWAMELR001*	Melaleuca	500	41	0	20	480	0	.	268	0	0	1309
SWAMILR001	Millendon	.	.	.	.	0	.	250	0	40	0	290
SWAVINR003*	The Vines	.	.	.	.	.	.	21	0	0	3	24
SWAWHIR001*	Whiteman	.	69	13	.	.	0	0	7	15	.	104
VICKENR001*	Kensington	0	.	0	0	0	0	0	0	0	2	2
VICVICR001	Victoria Park	2	0	0	0	0	0	6	0	0	0	8



Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
WANCARR001	Carabooda	.	.	2	.	.	0	0	.	0	.	2
WANCARR004	Carabooda	.	.	.	.	7	.	.	.	.	.	7
WANCRRR001	Carramar	.	.	.	191	0	0	0	0	0	.	191
WANGNAR001	Gngangara	0	.	.	.	0	.	454	316	157	255	1182
WANGNAR003	Gngangara	0	14	0	0	0	0	0	0	0	0	14
WANGNAR004	Gngangara	27	0	0	0	0	0	0	0	0	12	39
WANGNAR005*	Gngangara	.	.	.	100	0	14	0	260	.	.	374
WANGNAR006*	Gngangara	.	.	.	.	40	.	3	6	0	.	49
WANJANR007	Jandabup	.	16	.	0	.	0	cleared				16
WANMARR001	Mariginiup	0	20	.	0	.	71	0	770	0	0	861
WANMARR002*	Mariginiup	0	.	2	3	3	0	0	0	0	0	8
WANMARR003	Mariginiup	542	152	10	16	147	280	4	1260	625	739	3775
WANMARR004	Mariginiup	0	0	0	.	.	.	.	8	0	0	8
WANMARR005	Mariginiup	.	.	.	.	.	.	.	0	350	cleared	350
WANNEER001	Neerabup	.	29	.	.	0	.	0	.	.	.	29
WANNEER002	Neerabup	604	0	0	0	0	0	0	0	0	.	604
WANNOWR001	Nowergup	.	.	35	10	0	0	0	4	.	.	49
WANNOWR005*	Nowergup	0	.	.	.	.	.	3	0	0	.	3
WANPINR001	Pinjar	.	.	853	35	1521	616	1232	900	315	1830	7302
WANPINR002	Pinjar	.	312	276	0	138	101	0	0	0	.	827
WANPINR003	Pinjar	64	0	0	0	0	0	0	0	.	.	64
WANPINR005	Pinjar	275	.	.	.	0	0	cleared				275
WANPINR006	Pinjar	13	0	0	0	2	0	0	0	.	0	15
WANPINR011	Pinjar	0	.	.	800	0	179	0	0	0	12	991
WANTAMR001	Tamala Park	.	.	0	103	20	10	0	0	.	0	133
WANTWOR001	Two Rocks	0	.	7	573	200	30	0	0	18	8	836
WANWANR001	Wanneroo	0	11	6	0	0	0	0	0	0	0	17
WANYANR001	Yanchep	61	.	.	.	450	82	0	.	16	.	609
WANYANR003	Yanchep	.	16	0	564	0	0	0	0	37	.	617
WANYANR004	Yanchep	.	0	0	192	0	0	cleared				192
WANYANR006	Yanchep	342	305	129	0	0	0	0	136	279	0	1191
WANYANR007	Yanchep	.	0	0	.	0	.	173	0	.	60	233
WANYANR008	Yanchep	.	.	.	.	.	.	.	5	0	.	5
WARLAKR001	Lake Clifton	1	0	0	.	.	0	0	.	.	.	1
WARLAKR004	Lake Clifton	.	.	.	.	.	.	.	.	.	5	5
WARPRER001	Preston Beach	.	.	66	330	19	.	158	0	.	.	573
WARPRER002	Preston Beach	100	.	0	.	0	0	0	.	.	.	100
WARWARR002*	Waroona	.	.	.	36	0	0	4	0	11	0	51



**Appendix IIIb:** Great Cocky Count (2010-2019) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page iv) (24) that: (a) are within or immediately adjacent (<1 km) to the **Gnangara pine plantation** (see page v) or (b) have historically been used as a roost by cockatoos feeding within the plantation system. Use of the roosts located in Yanchep National Park (YNP) is documented in Saunders (1980); Shah (2006); Finn *et al.* (2009); and Stock *et al.* (2013). The plantation includes three sections: Gnangara (southern), Pinjar (central), and Yanchep (northern).

Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
GINYEAR001	.	.	387	.	782	.	.	6	0	0	<b>1175</b>
GINYEAR002	49	92	.	.	.	20	.	.	15	369	<b>545</b>
GINYEAR003	.	.	.	.	.	750	4897	3528	6226	5145	<b>20546</b>
GINYEAR004	.	.	.	.	.	.	.	.	.	239	<b>239</b>
SWALEXR001	0	80	0	0	181	0	0	0	34	753	<b>1048</b>
SWALEXR002	185	0	.	0	0	0	cleared				<b>185</b>
SWAMELR001*	500	41	0	20	480	0	.	268	0	0	<b>1309</b>
WANCARR004	.	.	.	.	7	.	.	.	.	.	<b>7</b>
WANGNAR001	0	.	.	.	0	.	454	316	157	255	<b>1182</b>
WANGNAR003	0	14	0	0	0	0	0	0	0	0	<b>14</b>
WANGNAR004	27	0	0	0	0	0	0	0	0	12	<b>39</b>
WANGNAR005*	.	.	.	100	0	14	0	260	.	.	<b>374</b>
WANGNAR006*	.	.	.	.	40	.	3	6	0	.	<b>49</b>
WANJANR007	.	16	.	0	.	0	cleared				<b>16</b>
WANMARR001	0	20	.	0	.	71	0	770	0	0	<b>861</b>
WANMARR002	0	.	2	3	3	0	0	0	0	0	<b>8</b>
WANMARR003	542	152	10	16	147	280	4	1260	625	739	<b>3775</b>
WANMARR004	0	0	0	.	.	.	.	8	0	0	<b>8</b>
WANMARR005	.	.	.	.	.	.	.	0	350	cleared	<b>350</b>
WANNEER001	.	29	.	.	0	.	0	.	.	.	<b>29</b>
WANNEER002	604	0	0	0	0	0	0	0	0	.	<b>604</b>
WANPINR001	.	.	853	35	1521	616	1232	900	315	1830	<b>7302</b>
WANPINR002	.	312	276	0	138	101	0	0	0	.	<b>827</b>
WANPINR003	64	0	0	0	0	0	0	0	.	.	<b>64</b>
WANPINR005	275	.	.	.	0	0	cleared				<b>275</b>
WANPINR006	13	0	0	0	2	0	0	0	.	0	<b>15</b>
WANPINR011	0	.	.	800	0	179	0	0	0	12	<b>991</b>
WANTWOR001	0	.	7	573	200	30	0	0	18	8	<b>836</b>
WANYANR001	61	.	.	.	450	82	0	.	16	.	<b>609</b>
WANYANR003	.	16	0	564	0	0	0	0	37	.	<b>617</b>
WANYANR004	.	0	0	192	0	0	cleared				<b>192</b>
WANYANR006	342	305	129	0	0	0	0	136	279	0	<b>1191</b>
WANYANR007	.	0	0	.	0	.	173	0	.	60	<b>233</b>
<b>Total</b>	<b>2662</b>	<b>1077</b>	<b>1664</b>	<b>2303</b>	<b>3951</b>	<b>2143</b>	<b>6763</b>	<b>7458</b>	<b>8072</b>	<b>9422</b>	<b>45515</b>
<b>% of total Perth-Peel Coastal Plain count</b>	<b>42%</b>	<b>28%</b>	<b>44%</b>	<b>41%</b>	<b>59%</b>	<b>46%</b>	<b>62%</b>	<b>73%</b>	<b>65%</b>	<b>71%</b>	<b>58%</b>
<b>No. of pine-associated sites surveyed</b>	<b>19</b>	<b>19</b>	<b>18</b>	<b>20</b>	<b>26</b>	<b>24</b>	<b>22</b>	<b>24</b>	<b>22</b>	<b>19</b>	<b>33</b>



**Appendix IIIc: Great Cocky Count (2010-2019) roost counts for White-tailed Black-Cockatoos at confirmed roosts** (see page vii) in the Northern Darling Scarp and Plateau. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. The counts are for white-tailed black-cockatoos generally and are not corrected for the relative proportions of Baudin's and Carnaby's Black-Cockatoos. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
ARMBEDR001*	Bedfordale	57	0	.	0	0	0	0	6	0	98	161
ARMBEDR002*	Bedfordale	70	22	.	3	0	.	0	0	0	0	95
ARMBEDR003*	Bedfordale	385	.	.	0	0	60	6	3	12	5	471
ARMBEDR005*	Bedfordale	.	.	.	.	.	.	.	0	36	0	36
ARMKELR002	Kelmscott	0	10	.	0	0	0	0	0	0	.	10
ARMROLR001*	Roleystone	108	13	140	40	0	0	157	70	0	0	528
ARMROLR003*	Roleystone	.	0	0	50	0	0	0	0	0	0	50
ARMROLR004*	Roleystone	.	.	.	.	0	.	28	0	0	0	28
ARMROLR005*	Roleystone	.	.	.	.	.	.	0	0	0	35	35
BEVFLYR002*	Flynn	.	.	.	.	.	.	.	19	0	0	19
BODBODR001	Boddington	.	.	.	.	.	.	9	0	25	.	34
BODBODR002	Boddington	.	.	.	.	.	.	.	0	2	.	2
BODCROR002	Crossman	10	0	.	.	.	3	.	0	.	.	13
BODMARR001*	Marradong	.	.	.	.	.	.	16	0	0	.	16
BODMARR002	Marradong	.	.	.	.	.	.	141	0	11	.	152
KALCANR001*	Canning Mills	.	.	.	.	.	.	.	.	.	1	1
KALCARR002*	Carmel	.	.	.	.	.	.	.	90	.	8	98
KALKALR001	Kalamunda	30	.	25	0	0	0	0	0	.	0	55
KALKALR002	Kalamunda	.	25	23	85	28	10	58	107	48	0	384
KALKALR004	Kalamunda	.	.	.	.	.	.	65	215	0	5	285
KALLESR001	Lesmurdie	.	0	0	0	0	8	0	0	.	.	8
KALMAIR002*	Maida Vale	.	.	.	.	0	.	0	0	0	11	11
KALMAIR003	Maida Vale	.	.	.	.	.	.	0	5	.	0	5
KALPICR001	Pickering Brook	.	.	.	.	.	.	.	5	0	.	5
KALPICR002*	Pickering Brook	.	.	.	.	2	.	0	0	.	.	2
KALPIER001*	Piesse Brook	.	82	46	0	0	0	163	.	210	133	634
KALPIER002*	Piesse Brook	.	.	.	.	.	.	.	6	60	89	155
KALPIER003	Piesse Brook	.	.	.	.	.	.	97	132	163	145	537
KALWALR001*	Walliston	0	5	0	0	0	0	.	0	0	.	5
MUNCHIR001	Chidlow	16	0	.	0	0	cleared					16
MUNDARR001	Darlington	443	7	147	0	0	0	.	0	0	0	597
MUNGLER001	Glen Forrest	.	.	32	51	45	25	65	5	51	0	274
MUNGLER002	Glen Forrest	.	.	13	0	0	0	0	0	0	.	13
MUNGLER003	Glen Forrest	.	.	.	.	45	.	0	335	17	11	408
MUNHEL001*	Helena Valley	.	3	16	42	124	0	44	0	3	0	232
MUNHEL002*	Helena Valley	.	.	.	.	.	.	.	.	0	66	66
MUNHOVR001*	Hovea	.	.	40	0	.	0	0	0	0	0	40
MUNHOVR002	Hovea	243	22	10	0	0	0	18	0	.	.	293
MUNMTHR001*	Mt Helena	.	.	.	8	0	0	0	0	2	.	10
MUNMTHR002	Mt Helena	.	.	.	.	0	.	147	0	0	60	207
MUNMTHR003*	Mt Helena	.	.	.	.	.	.	24	0	0	1	25
MUNMUNR001*	Mundaring	78	.	.	85	45	36	0	0	82	0	326
MUNMUNR003*	Mundaring	.	.	.	.	.	.	0	0	4	0	4
MUNPARR002	Parkerville	.	.	.	.	182	.	66	157	58	145	608
MUNPARR003*	Parkerville	.	.	.	.	.	.	320	70	80	45	515
MUNPARR004*	Parkerville	.	.	.	.	.	.	209	213	309	38	769



Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
MUNPARR005*	Parkerville	.	.	.	.	.	.	.	152	50	62	264
MUNSTOR001*	Stoneville	.	.	.	.	141	0	7	0	0	0	148
MUNSTOR002	Stoneville	.	86	0	.	0	0	0	0	7	0	93
MUNSTOR003*	Stoneville	.	.	.	.	48	.	30	0	0	20	98
MUNSTOR004*	Stoneville	.	.	.	.	.	.	90	0	0	0	90
MUNSTOR005*	Stoneville	.	.	.	.	.	.	19	21	12	0	52
MUNSTOR006	Stoneville	.	.	.	.	.	.	.	.	42	0	42
MURDWER001*	Dwellingup	.	40	.	.	.	0	.	8	.	0	48
MURDWER002*	Dwellingup	.	.	.	.	0	.	.	45	6	5	56
MURDWER003*	Dwellingup	.	.	.	.	.	.	.	.	15	0	15
MURNORR001*	North Dandalup	.	.	.	.	.	.	20	14	33	6	73
MURNORR002*	North Dandalup	.	.	.	.	.	.	.	.	.	50	50
MURTEER001	Teesdale	21	0	0	0	.	0	.	.	.	0	21
NORBAKR001	Bakers Hill	217	.	.	.	.	.	94	52	.	160	523
NORWOOR002	Woottating	.	.	.	.	.	.	.	.	8	0	8
NORWUNR001*	Wundowie	125	.	8	0	.	0	0	0	.	15	148
SERJARR001	Jarrahdale	0	60	0	.	.	0	.	0	0	.	60
SERKEYR002*	Keysbrook	25	.	0	30	.	0	.	0	.	.	55
SERKEYR003*	Keysbrook	.	.	.	.	.	.	.	255	352	211	818
SERKEYR009*	Keysbrook	.	.	.	.	.	.	.	.	.	2	2
SERSERR008*	Serpentine	.	.	.	.	.	.	.	.	.	23	23
SWABULR002*	Bullsbrook	.	18	117	120	328	.	178	0	260	172	1193
SWAGIDR002	Gidgegannup	101	.	23	40	.	217	129	93	0	2	605
SWAGIDR003	Gidgegannup	.	.	3	.	.	.	0	0	0	.	3
SWAGIDR005	Gidgegannup	.	.	.	197	163	169	152	0	113	10	804
SWAGIDR007*	Gidgegannup	.	.	.	.	.	.	0	0	51	0	51
SWAGIDR008*	Gidgegannup	.	.	.	.	.	.	0	3	2	7	12
SWAGIDR009*	Gidgegannup	.	.	.	.	.	.	0	0	7	47	54
TOOMORR001*	Morangup	.	.	183	29	56	12	140	44	99	58	621
TOOMORR003*	Morangup	.	.	.	.	.	.	.	55	32	36	123
WARWAGR001*	Wagerup	.	.	.	236	186	.	.	.	.	.	422
WARWARR003*	Waroona	.	.	.	.	.	.	.	.	4	34	38
WNDNORR001	North Bannister	.	.	.	.	.	.	4	.	.	.	4
WNDWANR003	Wandering	.	.	.	.	.	.	.	.	.	321	321



## APPENDIX IV: Roost counts for white-tailed black-cockatoos in regional areas.

**Appendix IV:** Great Cocky Count (2010-2019) roost counts for White-tailed Black-Cockatoo at **confirmed roosts** (see page vii) in regional areas. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
ALBCHER001	Cheynes	.	.	70	.	.	.	.	.	.	0	70
ALBCHER002	Cheynes	.	.	0	.	60	0	0	.	0	8	68
ALBCHER004	Cheynes	.	.	.	.	.	.	.	.	8	0	8
ALBCHER005	Cheynes	.	.	.	.	.	.	.	.	14	.	14
ALBCHER006	Cheynes	.	.	.	.	.	.	.	.	13	.	13
ALBCHER007	Cheynes	.	.	.	.	.	.	.	.	.	14	14
ALBGOOR001	Goode Beach	.	.	.	84	62	.	0	3	0	0	149
ALBGOOR002	Goode Beach	.	111	.	0	120	0	0	0	0	.	231
ALBGRER002	Green Valley	.	.	.	.	.	.	.	15	0	.	15
ALBKALR001	Kalgan	.	.	213	472	141	73	0	0	.	.	899
ALBKALR004*	Kalgan	.	.	.	.	.	.	.	760	219	498	1477
ALBKOR002*	Kronkup	.	.	.	.	.	.	.	7	0	0	7
ALBLOWR003	Lowlands	.	.	.	.	.	.	.	6	0	0	6
ALBMANR002	Manypeaks	.	.	.	.	.	.	.	.	250	0	250
ALBMCKR001*	McKail	.	.	33	.	18	0	107	110	49	4	321
ALBMETR001	Mettler	.	.	40	145	.	.	.	.	.	.	185
ALBMTCR001	Mt Clarence	.	4	.	.	0	0	0	.	.	.	4
ALBROBR001	Robinson	.	.	0	43	0	.	0	31	0	.	74
ALBSEPR001	Seppings	.	0	0	0	0	2	.	3	0	0	5
ALBTORR002	Torbay	.	.	.	.	.	.	.	.	2	0	2
ALBTORR005	Torbay	.	.	.	.	.	.	.	.	2	0	2
AUGAUGR001	Augusta	.	.	.	.	.	.	.	.	.	21	21
AUGCHAR002*	Chapman Hill	.	.	.	.	.	.	.	23	0	0	23
AUGFORR002*	Forest Grove	.	.	.	.	.	.	6	0	0	.	6
AUGGRAR001	Gracetown	.	.	.	.	1	12	2	12	0	0	27
AUGGRAR002	Gracetown	.	.	.	7	85	4	26	3	54	89	268
AUGGRAR003	Gracetown	.	.	.	.	.	.	.	.	.	7	7
AUGHAMR001	Hamelin Bay	.	.	.	.	.	.	0	2	.	.	2
AUGMARR001	Margaret River	.	.	11	1	47	0	57	0	0	0	116
AUGMARR004	Margaret River	.	.	.	.	.	.	6	0	.	21	27
AUGMARR005*	Margaret River	.	.	.	.	.	.	.	.	.	10	10
AUGMARR006	Margaret River	.	.	.	.	.	.	.	2	0	19	21
AUGMARR007	Margaret River	.	.	.	.	.	.	.	5	0	39	44
AUGMARR008*	Margaret River	.	.	.	.	.	.	.	16	0	0	16
AUGMARR012	Margaret River	.	.	.	.	.	.	.	20	0	4	24
AUGMARR013	Margaret River	.	.	.	.	.	.	.	13	0	0	13
AUGMARR014	Margaret River	.	.	.	.	.	.	.	60	0	.	60
AUGNILR001	Nillup	.	.	.	.	.	.	.	.	.	15	15
AUGROSR001	Rosa Glen	.	.	.	.	.	.	.	46	29	0	75
AUGWITR002	Witchcliffe	.	.	.	.	.	.	.	7	3	2	12
BRIBOYR001	Boyup Brook	.	.	.	.	.	.	.	.	28	0	28
BRIBRIR003	Bridgetown	.	.	.	.	.	.	.	5	0	10	15
BRIBRIR004	Bridgetown	.	.	.	.	.	.	.	.	23	0	23
BRIGLER001	Glenlynn	.	.	70	250	0	.	.	.	614	532	1466
BRIGRER003*	Greenbushes	.	.	.	.	.	.	5	0	2	0	7



Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
BRINORR001	North Greenbushes	.	.	.	.	74	44	2	.	0	0	120
BRINORR002*	North Greenbushes	.	.	.	.	.	.	39	27	45	68	179
BUNCOLR001	College Grove	.	.	0	20	0	7	0	22	0	0	49
BUNCOLR002	College Grove	.	.	.	.	0	.	0	3	0	0	3
BUNGLER001	Glen Iris	.	.	25	0	.	0	0	62	0	9	96
BUNGLER002	Glen Iris	.	.	.	8	4	0	.	41	79	24	156
BUSCARR001	Carbunup	.	.	.	.	.	.	.	121	108	4	233
BUSDUNR001	Dunsborough	.	.	.	32	99	0	0	0	5	87	223
BUSDUNR002	Dunsborough	.	.	.	.	.	.	82	8	10	0	100
BUSJINR001	Jindong	.	.	.	.	.	.	.	.	30	10	40
BUSJINR002*	Jindong	.	.	.	.	0	.	0	1	.	.	1
BUSMEER002	Meelup	.	.	.	.	.	.	.	14	.	67	81
BUSMETR002*	Metricup	.	.	.	.	.	.	.	22	3	150	175
BUSQUIR001	Quindalup	.	.	.	71	107	31	64	30	137	251	691
BUSWILR002	Wilyabrup	.	.	.	.	.	.	.	.	45	10	55
BUSYALR001	Yallingup	.	.	.	0	57	.	.	.	0	.	57
BUSYALR004	Yallingup	.	.	.	.	.	.	8	0	30	0	38
BUSYALR005	Yallingup	.	.	.	.	.	.	.	.	30	0	30
BUSYALR006	Yallingup	.	.	.	.	.	.	.	.	3	.	3
CAPCAPR001	Capel	.	.	.	.	0	.	.	7	0	0	7
CAPCAPR002*	Capel	.	.	.	.	.	.	.	.	64	31	95
CAPGELR001	Gelorup	.	.	38	6	0	0	4	0	0	0	48
CAPGELR002*	Gelorup	.	.	.	.	0	21	2	12	5	89	129
CAPGWIR001	Gwindinup	194	.	14	0	119	175	216	48	193	181	1140
CAPGWIR002	Gwindinup	.	.	.	.	.	.	.	.	123	.	123
CAPNORR001	North Boyanup	.	.	.	4	0	0	26	0	0	0	30
CARENNR001	Eneabba	.	.	.	.	.	.	40	.	.	.	40
CARENNR002	Eneabba	.	.	.	.	.	.	.	.	83	0	83
CARENNR003	Eneabba	.	.	.	.	.	.	.	.	.	39	39
CARWARR001	Warradarge	.	.	.	.	.	.	.	.	404	221	625
CHAHOWR001	Howatharra	.	.	.	.	.	.	.	.	130	0	130
CHANANR001	Nanson	.	.	.	302	262	300	270	0	0	0	1134
CHANANR002	Nanson	.	.	.	0	189	.	0	0	0	0	189
DANBADR001	Badgingarra	.	.	.	.	.	.	.	.	.	205	205
DANDANR001	Dandaragan	.	.	313	228	460	2	0	144	0	357	1504
DANHILR001	Hill River	.	.	160	0	250	0	0	0	0	70	480
DANHILR002	Hill River	.	.	136	.	.	11	.	.	.	.	147
DANHILR003	Hill River	.	.	.	.	131	.	.	0	.	.	131
DANHILR004	Hill River	.	.	.	.	.	.	.	.	16	.	16
DANJURR001	Jurien Bay	.	.	51	225	52	143	436	230	128	400	1665
DANREGR001	Regans Ford	0	22	0	.	.	.	.	.	.	.	22
DARBURR001*	Burekup	.	.	.	.	.	.	.	.	101	4	105
DAREATR001	Eaton	.	4	19	14	0	0	.	20	0	2	59
DENSCOR001	Scotsdale	.	.	.	.	.	.	70	.	.	.	70
DENSCOR003*	Scotsdale	.	.	.	.	.	.	.	.	2	99	101
DONBALR002*	Balingup	.	.	.	.	.	.	.	.	3	0	3





Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
DONCOLR001	Collie	.	.	.	.	.	.	.	.	15	.	15
DONCOLR002*	Collie	.	.	.	.	.	.	.	.	6	0	6
DONDONR001*	Donnybrook	.	.	.	11	0	0	.	0	0	0	11
DONLOWR001*	Lowden	.	.	.	.	.	.	0	0	0	28	28
DONLOWR002*	Lowden	.	.	.	.	.	.	.	.	.	3	3
DONMUMR001	Mumballup	.	29	.	0	.	7	.	.	.	.	36
DONMUMR003	Mumballup	.	.	.	.	.	.	0	20	33	56	109
DONMUNR001*	Mungilup	.	.	.	.	.	.	4	0	0	0	4
DONNOGR001*	Noggerup	.	.	.	.	.	.	0	14	0	0	14
DONRIVR001*	Donnelly River	.	.	.	.	.	.	.	.	0	26	26
DONYABR001*	Yabberup	.	.	.	.	.	.	.	9	1	.	10
ESPCONR002	Condungup	.	.	.	.	.	.	.	.	.	416	416
ESPESPR001	Esperance	.	196	226	230	202	.	665	125	36	107	1787
ESPESPR002	Esperance	.	.	.	.	.	360	.	0	0	0	360
ESPESPR003	Esperance	.	.	.	.	.	60	.	111	163	71	405
ESPESPR004	Esperance	.	.	.	.	.	316	.	205	99	121	741
ESPMYRR001	Myrup	.	.	555	589	791	0	32	0	0	.	1967
ESPMYRR002	Myrup	.	.	1018	0	.	.	.	500	0	0	1518
ESPMYRR003	Myrup	.	.	.	.	.	.	.	559	0	375	934
GINNILR001	Nilgen	.	.	.	583	376	995	500	855	1207	650	5166
GNOSTIR001	Stirling Range National Park	.	.	52	.	38	.	.	187	90	.	367
GOOGOR001	Goomalling	.	9	.	.	.	.	0	.	.	.	9
HARCOOR001	Cookernup	.	.	.	.	.	.	.	.	68	17	85
HARHARR001*	Harvey	.	.	.	.	0	.	10	.	14	0	24
HARLESR001*	Leschenault	.	.	.	.	.	.	14	11	21	0	46
HARMYAR001	Myalup	.	0	0	0	35	0	349	0	0	.	384
HARMYAR002	Myalup	52	155	cleared								207
HARMYAR003	Myalup	.	.	.	.	.	570	33	123	167	.	893
HARMYAR004	Myalup	.	.	.	.	.	.	.	.	.	127	127
HARSUNR001*	Harvey	.	.	.	.	.	24	.	.	83	120	227
HARWELR002	Wellesley	.	.	.	.	.	.	.	.	.	616	616
IRWMILR001	Milo	.	.	1	.	0	.	.	.	.	.	1
JERBOXR001	Boxwood Hill	.	.	11	0	.	0	.	.	.	.	11
KOJKOJR001	Kojonup	.	.	.	.	.	.	.	48	27	8	83
MNJCROR001	Crowea	.	.	.	5	0	.	.	0	.	.	5
MNJMNJR001*	Manjimup	.	.	.	.	.	.	17	0	0	44	61
MNJMNJR002	Manjimup	.	.	.	.	.	.	.	.	27	0	27
MNJMNJR003	Manjimup	.	.	.	.	.	.	.	.	66	0	66
MNJPERR002*	Perup	.	.	.	.	.	.	.	.	.	2	2
NANNANR001	Nannup	.	.	.	.	.	.	.	16	16	0	32
NARNARR002	Narrogin	.	.	16	19	36	.	21	77	17	.	186
NARNARR004	Narrogin	.	.	0	9	.	0	.	.	0	.	9
NARNARR005	Narrogin	.	80	0	0	.	.	0	.	45	.	125



Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Totals
PLAFORR001*	Forest Hill	.	.	.	.	.	.	.	.	.	23	23
PLAMOUR001	Mount Barker	.	.	3	0	0	0	.	.	.	.	3
PLANARR001*	Narrikup	.	.	.	.	.	.	191	0	7	40	238
PLANARR002*	Narrikup	.	.	.	.	45	.	0	.	.	0	45
PLAPORR003*	Porongurup	.	.	.	.	.	.	.	9	137	4	150
PLAPORR006	Porongurup	.	.	.	.	.	.	.	200	0	.	200
PLAPORR007	Porongurup	.	.	.	.	.	.	.	.	67	0	67
PLASTIR001	Stirling Range National Park	.	.	254	316	.	25	.	76	86	.	757
RAVHOPR001	Hopetoun	.	.	.	.	30	.	0	0	0	0	30
RAVHOPR002	Hopetoun	.	.	.	.	150	.	0	.	0	.	150
RAVHOPR003	Hopetoun	.	.	.	.	.	.	.	.	.	640	640
THRARRR002	Arrino	.	.	.	70	.	.	.	.	.	.	70
VCTOLDR001	Old Plains	.	.	.	0	.	0	.	.	.	2	2
WARYARR001	Yarloop	.	.	.	.	.	.	36	.	.	.	36



## APPENDIX V: Roost counts for Forest Red-tailed Black-Cockatoo

**Appendix Va:** Great Cocky Count (2014-2019) roost counts for FRTBC at **confirmed roosts** (see page vii) in the Perth-Peel Coastal Plain. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
ARMARMR002	Armadale	.	.	17	.	15	0	32
ARMARMR004	Armadale	.	.	.	.	6	4	10
ARMCHAR001*	Champion Lakes	.	.	.	11	16	0	27
ARMKELR004	Kelmscott	.	.	.	.	.	6	6
BAYEMBR002	Embleton	.	.	.	.	34	.	34
BAYMAYR001	Maylands	.	.	.	.	.	4	4
BAYMORR001	Morley	0	0	36	130	300	299	765
BAYMORR002	Morley	.	.	.	8	30	2	40
CAMCITR001*	City Beach	0	0	0	0	.	19	19
CAMFLOR002	Floreat	109	.	49	261	360	837	1616
CAMFLOR003	Floreat	.	.	.	.	40	0	40
CAMKAR001	Karrakata	.	.	.	.	3	0	3
CANRIVR001	Riverton	.	.	6	11	7	16	40
CANROSR001	Rossmoyne	.	.	.	.	14	2	16
CANWILR001*	Willetton	4	7	7	5	16	82	121
CHIMUCR001	Muchea	.	.	.	43	26	0	69
COCBANR001*	Banjup	.	0	.	6	17	0	23
COCBANR002*	Banjup	3	.	32	24	109	15	183
COCCOCR001	Cockburn Central	.	.	.	.	15	102	117
COCCOOR001	Coolbellup	.	13	0	0	8	0	21
COCCOOR003	Coolbellup	.	.	57	6	71	33	167
COCMUNR001	Munster	92	.	73	0	365	259	789
COCMUNR003*	Munster	.	.	38	0	108	0	146
COCSPER003	Spearwood	.	.	.	35	12	0	47
FREWHIR001	White Gum Valley	0	.	0	38	29	28	95
GOSCNVR001*	Canning Vale	2	0	0	0	.	0	2
GOSCNVR002*	Canning Vale	0	4	0	0	0	0	4
GOSGOSR004	Gosnells	19	.	31	32	79	0	161
GOSKENR001	Kenwick	.	.	.	51	334	35	420
GOSKENR002	Kenwick	.	.	.	.	72	0	72
GOSMARR001*	Martin	.	.	.	75	37	18	130
GOSSOUR002*	Southern River	.	.	0	36	208	15	259
JOOPADR001*	Padbury	0	0	0	0	0	9	9
KWICASR001*	Casuarina	0	.	.	75	16	0	91
KWIWELR001*	Wellard	0	0	9	0	0	0	9
KWIWELR003	Wellard	.	.	.	.	14	0	14
MANBARR001	Barragup	.	.	.	.	.	46	46
MANBARR002	Barragup	.	.	.	.	.	57	57
MANCOOR002*	Coodanup	0	0	30	0	0	0	30
MANDAWR002*	Dawesville	0	38	0	0	0	0	38
MANDAWR007*	Dawesville	.	0	2	0	0	0	2
MANPARR001	Parklands	0	.	16	0	14	0	30
MANPARR002	Parklands	.	.	.	.	.	13	13
MELLEER001*	Leeming	0	0	11	25	5	0	41
MELMURR001*	Murdoch	199	33	125	209	441	214	1221
MELWINR003*	Winthrop	.	.	.	.	1	0	1
MOSMOSR001	Mosman Park	0	0	0	0	0	3	3



Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
NEDDALR002*	Dalkeith	.	.	.	.	1	0	1
ROCBALR003*	Baldivis	17	25	24	.	45	65	176
ROCKARR002	Karnup	.	.	.	5	37	9	51
SERBYFR002	Byford	.	.	0	2	0	.	2
SERBYFR003	Byford	.	.	6	.	0	.	6
SERBYFR004*	Byford	.	.	88	32	9	0	129
SERDARR001*	Darling Downs	.	.	26	0	24	0	50
SERKEYR001*	Keysbrook	0	0	0	0	0	3	3
SERKEYR004	Keysbrook	.	.	.	14	26	9	49
SERKEYR005	Keysbrook	.	.	.	.	8	0	8
SERKEYR006	Keysbrook	.	.	.	6	3	.	9
SERMUNR002*	Mundijong	.	.	0	4	.	0	4
SEROAKR002*	Oakford	.	.	.	4	15	0	19
SERSERR003	Serpentine	0	0	3	0	9	3	15
SERSERR005	Serpentine	.	.	12	0	4	.	16
SOUCOMR001*	Como	0	0	0	0	0	1	1
SOUSALR001*	Salter Point	2	0	0	0	8	0	10
STIBALR001	Ballajura	.	.	.	.	10	11	21
STIMENR002	Menora	0	.	0	5	0	0	5
STIYOKR002	Yokine	0	1	0	.	83	142	226
STIYOKR003	Yokine	47	28	0	239	276	391	981
SWABALR003	Ballajura	.	.	0	120	151	151	422
SWAHAZR001	Hazelmere	.	.	.	.	.	12	12
SWABULR005	Bullsbrook	.	.	.	.	41	0	41
SWAMELR001*	Melaleuca	0	0	.	129	0	0	129
SWAVINR002	The Vines	.	.	.	.	6	0	6
SWAVINR003*	The Vines	.	.	31	5	0	0	36
SWAWESR001	West Swan	.	.	.	.	36	.	36
SWAWHIR001*	Whiteman	.	0	0	4	0	.	4
VICKENR001*	Kensington	94	121	0	116	108	140	579
VICKENR002	Kensington	.	35	42	0	.	.	77
VICLATR001	Lathlain	0	0	0	0	15	32	47
VICWATR002	Waterford	.	.	0	45	85	51	181
WANGNAR005*	Gnangara	0	0	0	7	.	.	7
WANGNAR006*	Gnangara	3	.	0	4	0	.	7
WANJANR008	Jandabup	.	.	.	102	156	243	501
WANMARR002*	Mariginiup	.	.	.	.	11	20	31
WANNOWR005*	Nowergup	.	.	0	0	2	.	2
WANWANR003	Wanneroo	.	.	.	.	.	3	3
WARLAKR002	Lake Clifton	.	.	.	4	.	.	4
WARLAKR003	Lake Clifton	.	.	.	6	26	29	61
WARWARR001	Waroona	.	.	0	.	0	3	3
WARWARR002*	Waroona	10	0	0	0	20	63	93



**Appendix Vb:** Great Cocky Count (2014-2019) roost counts for FRTBC at **confirmed roosts** (see page vii) in the Northern Darling Scarp and Plateau. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
ARMASHR001	Ashendon	.	.	.	3	.	.	3
ARMBEDR001*	Bedforddale	21	0	0	0	0	13	34
ARMBEDR002*	Bedforddale	0	.	0	22	0	0	22
ARMBEDR003*	Bedforddale	0	0	0	0	3	21	24
ARMBEDR004	Bedforddale	.	.	18	6	0	7	31
ARMBEDR005*	Bedforddale	.	.	.	0	4	18	22
ARMBEDR006	Bedforddale	.	.	.	14	14	15	43
ARMROLR001*	Roleystone	0	0	0	9	0	3	12
ARMROLR003*	Roleystone	0	0	0	4	0	0	4
ARMROLR004*	Roleystone	0	.	35	0	0	50	85
ARMROLR005*	Roleystone	.	.	0	36	40	12	88
BEVFLYR002*	Flynn	.	.	.	83	0	0	83
BEVFLYR003	Flynn	.	.	.	.	.	14	14
BODMARR001*	Marradong	.	.	16	0	0	.	16
BODMARR004	Marradong	.	.	.	18	0	134	152
BODMARR005	Marradong	.	.	.	.	2	.	2
BODMARR006	Marradong	.	.	.	.	.	13	13
CHICHIR001	Chittering	.	.	.	52	71	0	123
CHICHIR002	Chittering	.	.	.	.	.	27	27
KALCANR001*	Canning Mills	.	.	.	.	.	5	5
KALCARR001	Carmel	.	.	0	12	0	.	12
KALCARR002*	Carmel	.	.	.	0	.	24	24
KALCARR003	Carmel	.	.	.	.	.	76	76
KALFORR002	Forrestfield	.	.	.	.	42	65	107
KALFORR003	Forrestfield	.	.	.	.	31	10	41
KALHIGR001	High Wycombe	.	.	.	7	78	5	90
KALHIGR003	High Wycombe	.	.	0	7	0	.	7
KALMAIR002*	Maida Vale	25	.	56	98	137	304	620
KALMAIR005	Maida Vale	.	.	3	0	0	0	3
KALMAIR006	Maida Vale	.	.	.	3	.	.	3
KALPICR002*	Pickering Brook	42	.	0	7	.	.	49
KALPIER001*	Piesse Brook	0	0	25	.	29	6	60
KALPIER002*	Piesse Brook	.	.	.	2	8	0	10
KALWALR001*	Walliston	43	1	.	0	0	.	44
KALWATR002	Wattle Grove	.	.	150	31	150	23	354
MUNCHIR002	Chidlow	12	.	49	65	0	0	126
MUNCHIR003	Chidlow	.	.	4	4	0	.	8
MUNGLER004	Glen Forrest	.	.	33	4	41	.	78
MUNHEL001*	Helena Valley	0	0	4	31	0	13	48
MUNHEL002*	Helena Valley	.	.	.	.	79	0	79
MUNHOVR001*	Hovea	.	14	52	21	78	52	217
MUNHOVR004	Hovea	.	.	.	3	.	4	7



Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
MUNHOVR005	Hovea	.	.	.	.	.	27	27
MUNMTHR001*	Mt Helena	0	0	0	0	2	.	2
MUNMTHR003*	Mt Helena	.	.	41	0	2	2	45
MUNMUNR001*	Mundaring	0	0	0	0	8	0	8
MUNMUNR002	Mundaring	.	20	16	32	7	3	78
MUNMUNR003*	Mundaring	.	.	59	0	0	0	59
MUNPARR003*	Parkerville	.	.	12	8	0	0	20
MUNPARR004*	Parkerville	.	.	0	4	0	0	4
MUNPARR005*	Parkerville	.	.	.	4	2	0	6
MUNSTOR001*	Stoneville	0	24	0	0	0	0	24
MUNSTOR003*	Stoneville	0	.	9	0	0	9	18
MUNSTOR004*	Stoneville	.	.	3	0	0	0	3
MUNSTOR005*	Stoneville	.	.	15	0	0	0	15
MUNWOOR001	Woorlooo	17	.	.	.	0	.	17
MURDWER001*	Dwellingup	.	0	.	0	.	97	97
MURDWER002*	Dwellingup	3	.	.	0	60	120	183
MURDWER003*	Dwellingup	.	.	.	.	0	167	167
MURDWER005	Dwellingup	.	.	.	.	.	32	32
MURNORR001*	North Dandalup	.	.	26	0	3	8	37
MURNORR002*	North Dandalup	.	.	.	.	.	50	50
NORWUNR001*	Wundowie	.	6	0	8	.	0	14
SERJARR002	Jarrahdale	.	.	.	7	0	0	7
SERJARR003	Jarrahdale	.	.	30	59	0	5	94
SERJARR004	Jarrahdale	.	.	.	.	.	45	45
SERKARR001	Karrakup	.	.	.	.	8	.	8
SERKEYR002*	Keysbrook	.	37	.	0	.	.	37
SERKEYR003*	Keysbrook	.	.	.	0	0	5	5
SERKEYR007	Keysbrook	.	.	.	.	.	63	63
SERKEYR009*	Keysbrook	.	.	.	.	.	11	11
SERSERR006	Serpentine	.	.	.	.	.	38	38
SERSERR008*	Serpentine	.	.	.	.	.	41	41
SWABULR002*	Bullsbrook	0	.	0	26	0	0	26
SWAGIDR001	Gidgegannup	.	.	3	0	0	.	3
SWAGIDR007*	Gidgegannup	.	.	86	44	12	3	145
SWAGIDR008*	Gidgegannup	.	.	25	21	27	54	127
SWAGIDR009*	Gidgegannup	.	.	15	0	0	56	71
TOOMORR001*	Morangup	0	5	0	0	0	0	5
TOOMORR002	Morangup	.	.	.	36	11	35	82
TOOMORR003*	Morangup	.	.	.	23	23	23	69
WARWAGR001*	Wagerup	38	.	.	.	.	.	38
WARWARR003*	Waroona	.	.	.	.	35	8	43
WILQUIR001	Quindanning	10	.	0	15	0	0	25
WNDSPRR001	Springs	.	.	74	7	16	.	97



**Appendix Vc: Great Cocky Count (2014-2019) roost counts for FRTBC at confirmed roosts (see page iv) in regional areas. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.**

Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
ALBKALR003	Kalgan	.	.	27	12	.	26	65
ALBKALR004*	Kalgan	.	.	.	0	0	10	10
ALBKRR002*	Kronkup	.	.	.	0	0	5	5
ALBMCKR001*	McKail	0	0	0	10	0	0	10
ALBMETR002	Mettler	.	.	.	7	.	.	7
ALBTORR003	Torbay	.	2	.	0	0	.	2
ALBTORR004	Coffey	.	5	.	.	.	.	5
AUGCHAR001	Chapman Hill	.	.	.	21	0	.	21
AUGCHAR002*	Chapman Hill	.	.	.	35	0	0	35
AUGCOWR004	Cowaramup	.	.	.	.	4	0	4
AUGFORR002*	Forest Grove	.	.	9	0	0	.	9
AUGMARR005*	Margaret River	.	.	.	0	.	4	4
AUGMARR008*	Margaret River	.	.	.	0	0	96	96
AUGMARR015	Margaret River	.	.	.	.	3	49	52
BINBINR002	Bindoon	.	.	.	15	0	.	15
BRIGRER002	Greenbushes	20	0	6	27	31	7	91
BRIGRER003*	Greenbushes	.	.	7	5	26	53	91
BRIGRER004	Greenbushes	.	.	7	0	2	28	37
BRINORR002*	North Greenbushes	.	.	1	0	0	0	1
BRIYORR001	Yornup	.	.	.	.	.	13	13
BUSABBR001	Abba River	.	.	.	.	.	6	6
BUSJINR002*	Jindong	2	.	0	0	.	.	2
BUSMETR002*	Metricup	.	.	.	.	27	0	27
BUSQUIR003	Quindalup	.	.	5	.	.	.	5
BUSQUIR004	Quindalup	.	.	.	.	9	.	9
BUSYELR001	Yelverton	.	.	.	.	.	7	7
CAPBOYR001	Gwindinup	.	15	10	0	17	5	47
CAPCAPR002*	Capel	.	.	.	.	8	6	14
CAPFERR001	Ferguson	.	.	.	2	.	34	36
CAPGELR002*	Gelorup	0	11	4	15	17	0	47
DARBURR001*	Burekup	.	.	.	2	0	0	2
DAREATR002	Eaton	.	.	.	0	22	0	22
DENHAYR001	Hay	.	.	.	.	8	0	8
DENSCOR003*	Scotsdale	.	.	.	.	0	17	17
DONBALR002*	Balingup	.	.	.	13	71	75	159
DONBOWR001	Bowellling	.	.	.	.	.	66	66
DONCOLR002*	Collie	.	.	.	.	27	0	27
DONDONR001*	Donnybrook	14	6	.	0	0	0	20
DONLOWR001*	Lowden	.	.	3	7	0	8	18
DONLOWR002*	Lowden	.	.	.	.	.	33	33
DONMUMR002	Mumballup	.	.	7	.	.	.	7
DONMUNR001*	Mungalup	.	.	84	0	0	0	84
DONNOGR001*	Noggerup	.	.	49	0	21	0	70



Site code	Locality	2014	2015	2016	2017	2018	2019	Totals
DONRIVR001*	Donnelly River	.	.	.	.	70	82	152
DONYABR001*	Yabberup	.	.	.	.	3	.	3
HARBRUR002	Brunswick	.	.	9	29	.	0	38
HARHARR001*	Harvey	6	.	11	.	0	0	17
HARLESR001*	Leschenault	.	.	23	7	5	3	38
HARLESR002	Leschenault	.	.	.	.	16	6	22
HARROER002	Roelands	3	.	29	0	24	0	56
HARROER003	Roelands	.	.	0	2	3	0	5
HARSUNR001*	Harvey	.	0	.	.	0	6	6
MNJMNJR001*	Manjimup	.	.	16	0	0	35	51
MNJPERR002*	Perup	.	.	.	.	.	68	68
NANNANR004	Nannup	.	.	.	.	.	9	9
PLAFORR001*	Forest Hill	.	.	.	.	.	32	32
PLANARR001*	Narrikup	.	.	0	8	0	0	8
PLANARR002*	Narrikup	39	.	29	.	.	0	68
PLAPORR003*	Porongurup	.	.	.	2	0	0	2
WESDARR002	Darkan	.	.	.	.	5	.	5
WESMOOR001	Moodiarrup	.	.	.	.	4	.	4
WILQUIR002	Quindanning	.	.	38	0	14	0	52





**Appendix Vd:** Former white-tailed black-cockatoo roosts which are now solely FRTBC roosts. Definition of a roost where FRTBC have replaced white-tailed black-cockatoos: a roost which had >0 white-tailed Black-Cockatoo roosting in previous years, with solely FRTBC roosting in that year. White-tailed Black-Cockatoos not counted in subsequent years either.

Site	Region	Year replaced
KALWALR001	Northern Darling Scarp and Plateau	2014
GOSCNVR001	Perth Peel Coastal Plain	2014
ROCBALR003	Perth Peel Coastal Plain	2014
DONDONR001	Regional	2014
MUNHOVR001	Northern Darling Scarp and Plateau	2015
NORWUNR001	Northern Darling Scarp and Plateau	2015
CANWILR001	Perth Peel Coastal Plain	2015
SERKEYR002	Perth Peel Coastal Plain	2015
COCBANR002	Perth Peel Coastal Plain	2016
PLANARR002	Regional	2016
ARMBEDR002	Northern Darling Scarp and Plateau	2017
ARMROLR003	Northern Darling Scarp and Plateau	2017
KALPICR002	Northern Darling Scarp and Plateau	2017
SWABULR002	Northern Darling Scarp and Plateau	2017
GOSSOUR002	Perth Peel Coastal Plain	2017
SEROAKR002	Perth Peel Coastal Plain	2017
SWAVINR003	Perth Peel Coastal Plain	2017
MUNMTHR003	Northern Darling Scarp and Plateau	2018
SERBYFR004	Northern Darling Scarp and Plateau	2018
SERDARR001	Northern Darling Scarp and Plateau	2018
WANMARR002	Northern Darling Scarp and Plateau	2018
WANNOWR005	Northern Darling Scarp and Plateau	2018
DONNOGR001	Regional	2018
ARMROLR001	Northern Darling Scarp and Plateau	2019
ARMROLR004	Northern Darling Scarp and Plateau	2019
MURDWER001	Northern Darling Scarp and Plateau	2019
MURDWER003	Northern Darling Scarp and Plateau	2019
CAMCITR001	Perth Peel Coastal Plain	2019
CAMCITR001	Perth Peel Coastal Plain	2019
JOOPADR001	Perth Peel Coastal Plain	2019
SERKEYR001	Perth Peel Coastal Plain	2019
ALBKRO002	Regional	2019
AUGMARR008	Regional	2019



**Appendix Ve:** Comparison of average FRTBC GCC counts (April) 2014-2019 and October 14, 2018 FRTBC counts at 15 sites in the Greater Perth-Peel region. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting.

Site	Locality	Average GCC count 2014-19	October 2018 count
BAYMORR001	Morley	128	0
CAMFLOR002	Floreat	323	0
COCBANR002*	Banjup	37	0
COCMUNR001	Munster	158	0
COCMUNR003	Munster	37	0
GOSKENR001	Kenwick	140	0
GOSSOUR002*	Southern River	65	0
KALMAIR002	Maida Vale	124	0
KALWATR002	Wattle Grove	89	0
MELMURR001*	Murdoch	204	4
MUNHOVR001*	Hovea	43	29
STIYOKR003	Yokine	164	0
SWABALR003	Ballajura	106	0
VICKENR001	Kensington	97	0
WANJANR008	Jandabup	167	10
<b>Average all sites</b>		<b>125</b>	<b>3</b>

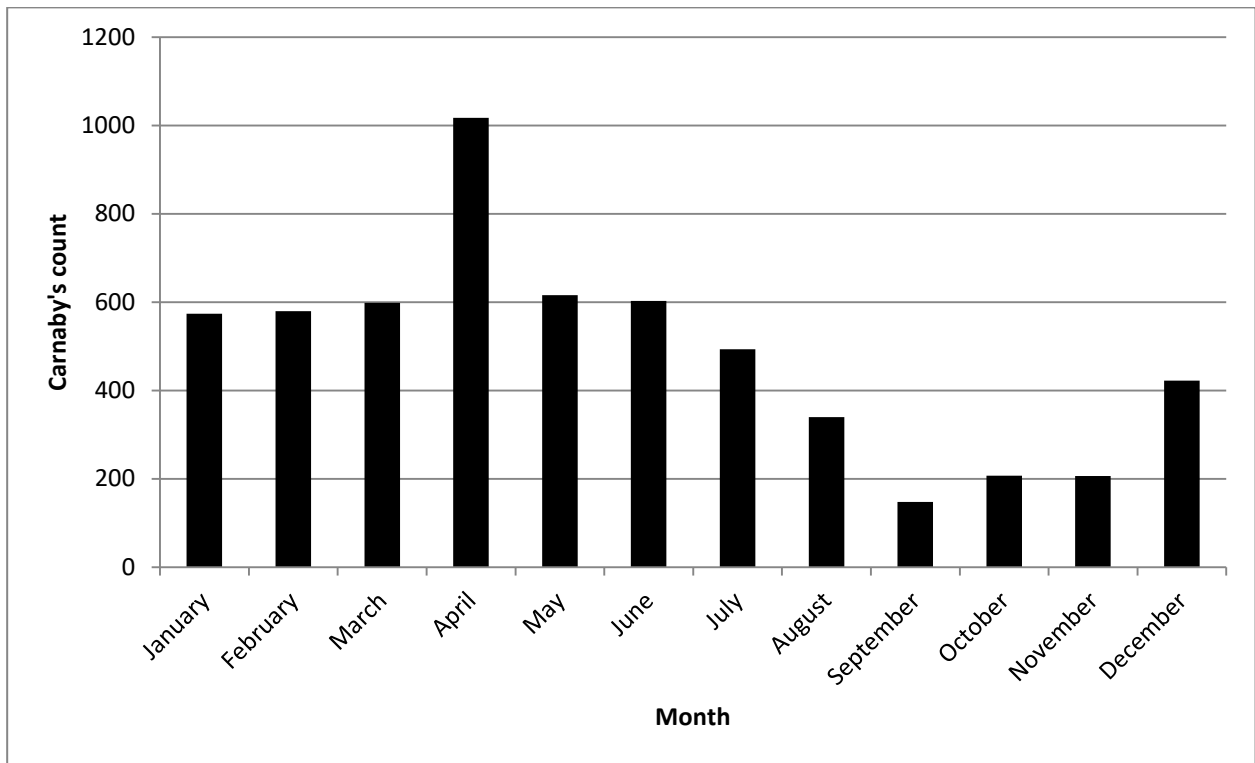


**Appendix VI: Summary of 2019 GCC Survey Monkey results (569 respondents)**

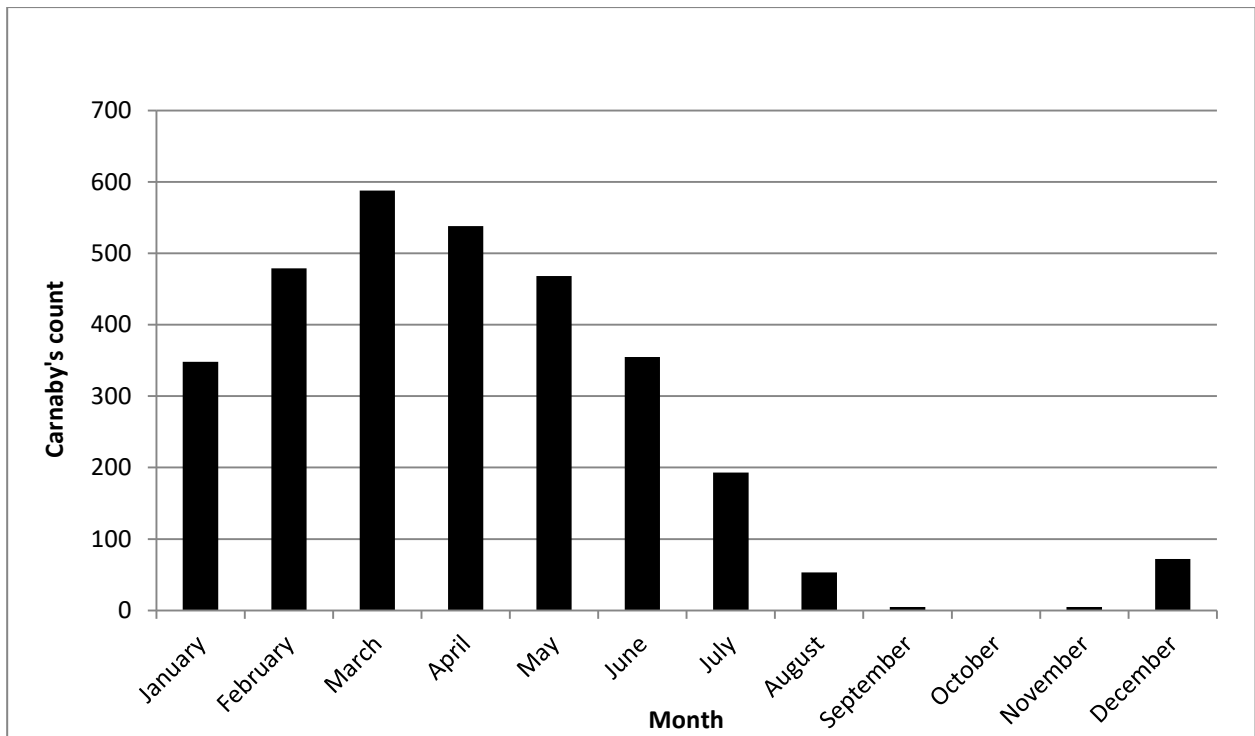
Was 2019 the first time you participated in the GCC?	Yes 39%	No 61%					
Did you attend a GCC workshop prior to the count?	Yes 21%	No 79%					
How would you rate your 2019 GCC experience?	Excellent 59%	Good 30%	Satisfactory 7%	Disappointing 3%	I did not participate in the end 1%		
Do you feel we communicated the information about your roost site and counting instructions clearly?	Yes 95%	No 5%					
Were you allocated a site with other volunteers?	Yes 56%	No 44%					
Did you bring along a friend or relative to help out?	Yes 50%	No 50%					
Are you a BirdLife member?	Yes 27%	No 73%					
If you took part in a GCC campout, how would you rate your experience?	Excellent 13%	Good 3%	Satisfactory 3%	Disappointing 0%	I did not participate in a campout 81%		
Do you intend to participate in the GCC again?	Yes 99%	No 1%					
Age bracket	Under 20 1%	20-30 5%	30-40 9%	40-50 19%	50-60 25%	60-70 25%	Over 70 16%



**Appendix VIIa:** Average monthly counts of Carnaby's Black-Cockatoos at the Gingin roost (GIGGINR001) 2016-2018. Data provided by the Chittering Landcare Group.



**Appendix VIIb:** Maximum counts or average of top three counts of Carnaby's Black-Cockatoos at the Bentley roost (SOUCOMR001), 2009 to 2015. Data provided by Geoff Barrett, DBCA.



**Appendix VIII:** SAS code to analyse the Great Cocky Count results for Carnaby's Black-Cockatoo 2010 – 2019.

```
/* Program to analyse the roost survey data from the annual Great Cocky Counts, 2010-2019 */
/* Matt Williams, Dept of Biodiversity, Conservation & Attractions */
/* July 2019 */
```

```
options ls=78;
```

```
/* Read data */
/* Site is site code name */
/* Pine indicates if roost site is in or adjacent to pine plantation (1) or not (0) */
/* Count is the number of birds counted at the roost site */
/* with . used to indicate no count undertaken ie missing value */
/* and -1 used to indicate a cleared roost site ie no count could be undertaken */
```

```
data a;
length site $10.;
input Site $ pine @@;
do year=2010 to 2019;
input count @@;
output;
end;
cards;
```

GINYEAR003	1	.	.	.	.	.	750	4897	3528	6226	.
GINGINR001	0	392	378	432	686	879	784	1023	880	1148	.
WANPINR001	1	.	.	853	35	1521	616	1232	900	315	.

```
...etc
```

```
;
```

```
/* Make year = 2010 become yr = 1 */
/* remove cleared sites */
/* compute yr squared for quadratic models */
/* and remove 2019 (which may be used for prediction) */
```

```
data a;
set a;
if year = 2019 then delete;
if count = -1 then delete;
yr = year-2009;
yr2=yr*yr;
/* calculate number of surveys conducted each year for potential use as an offset variable */
proc sort data=a;
by year;
```

```
proc means n noprint data=a;
var count;
by year;
output out=nsurveys n=nsurvs;
```



```

* add offset variable to data and log transform;
data xx;set a;
proc sort;by year site;
data a;
merge nsurveys xx;
by year;
* effort is the proportion of sites surveyed (nsurvs) of those available for survey (_FREQ_);
effort = nsurvs/_FREQ_;
lneff = log(effort);
* code dummy variables for individual years ;
if year=2010 then yr2010=1;else yr2010=0;
if year=2011 then yr2011=1;else yr2011=0;
if year=2012 then yr2012=1;else yr2012=0;
if year=2013 then yr2013=1;else yr2013=0;
if year=2014 then yr2014=1;else yr2014=0;
if year=2015 then yr2015=1;else yr2015=0;
if year=2016 then yr2016=1;else yr2016=0;
if year=2017 then yr2017=1;else yr2017=0;
if year=2018 then yr2018=1;else yr2018=0;

proc sort data=a;
by site;

* Select subsets of data (pine sites, non-pine sites or all sites except mega roost);
data pines;
set a;
if pine=1;

data nopines;
set a;
if pine=0;

data nomega;
set a;
* remove mega roost;
if site='GINYEAR003' then delete;

proc freq data=pines;
tables site*pine;
run;

* Initial ZINB model with fixed site effects to provide initial parameter estimates
for random effects models ;
proc genmod data=a;
class site year;
model count = yr site / noint dist=zinb offset=lneff;
zeromodel yr site;
run;

```



```

/* Zero-inflated Generalised Poisson (ZIGP) model incorporating overdispersion */
/* including random site effects in both the count (u) and zero model (v) */
/* with quadratic year effect */
proc nlmixed cov data = a method=gauss qpoints=25;
  parms b0=5.6 b1=-0.11 b2=0 a0=-0.44 a1=0.128 sigma1=0.52 cov12=-0.7 sigma2=1.367 xi=0.949;
  logit0 = a0 + v + a1*yr;
  prob0 = 1 / (1 + exp(-logit0));
  mu = exp(b0 + u + b1*yr + b2*yr2);
  mustar = mu - xi*(mu - count);

  if count = 0 then
    ll = log(prob0 + (1 - prob0)*exp(-mu));
  else
    ll = log(1 - prob0) + log(mu*(1-xi)) + (count-1)*log(mustar) - mustar - lgamma(count + 1);
  model count ~ general(ll);
  random u v ~ normal([0,0],[sigma1,cov12,sigma2]) subject=site;
  predict (1 - prob0)*mu out=ZIGPquad;
run;

/* ZIGP year-by-year model including a random site effect in the zero model and individual year effects for
count */
proc nlmixed data = a method=gauss qpoints=25;
  parms b0=5.6 b21=0 b22=0 b23=0 b24=0 b25=0 b26=0 b27=0 b28=0 a0=-0.44 a1=0.128 sigma1=0.52
cov12=-0.7 sigma2=1.367 xi=0.949; * old parms b0=4.3398 b1=-0.05 a0=-0.18 a1=0.0785 sigma1=1
cov12=-.3 sigma2=1.5 xi=0.05;
  logit0 = a0 + v + a1*yr;
  prob0 = 1 / (1 + exp(-logit0));

  mu = exp(b0 + u + b21*yr2010 + b22*yr2011+ b23*yr2012+ b24*yr2013+ b25*yr2014+ b26*yr2015+
b27*yr2016+ b28*yr2017);
  mustar = mu - xi*(mu - count);
  if count = 0 then
    ll = log(prob0 + (1 - prob0)*exp(-mu));
  else
    ll = log(1 - prob0) + log(mu*(1-xi)) + (count-1)*log(mustar) - mustar - lgamma(count + 1);
  model count ~ general(ll);
  random u v ~ normal([0,0],[sigma1,cov12,sigma2]) subject=site;
  predict (1 - prob0)*mu out=ZIGPyr;
run;

```





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