The 2017 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*)

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Final Report – September 2017

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Front cover: Four in flight – Carnaby's Black-Cockatoos in Fitzgerald River National Park. Geoff Hunter.

Back cover: A pair of Carnaby's prospecting for a hollow near Lake Magenta, November 2016. Adam Peck.

The Elizabeth Gabler Charitable Trust and the John and Beryl Henderson Foundation

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We thank the volunteers who surveyed for the 2017 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.

I (Adam Peck) would like to personally thank the following people. Candice Le Roux was integral to helping out with site allocation, thanks so much for your help. Thanks to my colleagues Helen Bryant and Tegan Douglas for helping out and being great to work with. We thank Ron Johnstone and Tony Kirkby from the WA Museum for sharing their knowledge of these birds. Thanks also to Boyd Wykes, Christine Wilder and Jan Checker for coordinating regional roost counts. Thanks again to the mega roost counting crew for your significant survey. Thanks to Sheree Manning for help with data entry.

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Thanks to all past Great Cocky Count coordinators for laying down a template for others to follow. A special thank you to BirdLife's 2014 Great Cocky Count coordinator Hugh Finn, whose 2014 Great Cocky Count report and statistical analyses continues to provide the basis for the GCC report. The findings of Hugh's report were further refined in this report.

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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 2017 GCC occurred on Sunday 9 April 2017. This year's GCC was the eighth consecutive count and ninth overall.
- The 2017 GCC surveyed roost sites for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoo (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 almost 900 registered volunteers surveyed 469 sites across the southwest of WA. Total volunteer participation likely exceeded 1,500 community members.
- The minimum population count for Carnaby's Black-Cockatoo in the Greater Perth-Peel Region was 10,248 (similar to 2016 and around 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 3).
- Most (73%) of the Carnaby's Black-Cockatoos recorded in the Perth-Peel Coastal Plain were associated with the Gnangara-Pinjar pine plantation, north of Perth. The large number of Carnaby's Black-Cockatoos (7,450) recorded in roosts associated with the pine plantation is higher than previous surveys. In previous years, the pine plantation has supported 27- 62% 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 3,528 Carnaby's Black-Cockatoos. This accounted for 34% of all of the Carnaby's 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 a count of 4,897 in 2016 and has come to be known as the 'mega roost'.

- 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 eight Great Cocky Counts (2010-2017). The combined effect of fewer occupied roosts with fewer birds in each roosting flock is an estimated current decline rate of 11% 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.
- Given the potential movement of Carnaby's Black-Cockatoos between roosts, the variation in roost occupancy over time, and the inconsistent survey histories at some sites, the trend at the largest, most consistently-surveyed roosts should provide a more robust indication of trends in the Swan Coastal Plain region. Analysis of the ten-, twenty- and thirty-largest roosts indicate a current trend of 0%, 3% and 5% decline per year, respectively.
- On the Perth-Peel Coastal Plain, the majority of the Carnaby's Black-Cockatoos are restricted to relatively few roost sites. For example, 78% of all the birds recorded in the 2010-2017 Great Cocky Counts were in just 20 roost sites. Many of these sites are associated with pines. Trend analysis shows that the rate of decline in pine-associated roosts is roughly half that of non pine-associated roosts (7% and 13%, respectively). Provision of adequate roost sites and feeding habitat is needed to ensure the persistence of Carnaby's Black-Cockatoo in this region.
- The 2017 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 this year. 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 2017 GCC recorded approximately 30% of all black-cockatoos in south western WA.
- The Great Cocky Count is well-placed to continue monitoring of Black-Cockatoos on the Perth-Peel Coastal Plain, and potentially across the south west, due to continued growth in volunteers 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 240 sites in the Perth-Peel Coastal Plain and counted 10,248 Carnaby's Black-Cockatoos. The Perth-Peel Coastal Plain encompasses most of the Swan Coastal Plain between Lancelin and Waroona.
- Significant counts in the Perth-Peel Coastal Plain occurred in the Gnangara-Pinjar pine plantation (notably 3,528 in Yeal, 2,030 across two sites in Mariginiup, 900 in Pinjar and 576 across two sites in Gnangara; the total of 7,034 birds at these six sites was 70% of the total count) and at the Gingin town site (880 birds), 338 across two sites in Nedlands, 298 at Wellard, 289 in Como, 281 in Floreat, 268 in Melaleuca, 156 across 3 sites in Dawesville, 136 in Yanchep and 110 in Duncraig.
- 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 known roosts and six of the ten largest.

Northern Darling Scarp and Plateau

- Volunteers surveyed 105 sites in the Northern Darling Scarp and Plateau areas, which encompasses the northern Jarrah-Marri Forest between Bindoon and Waroona, and counted 2,180 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 20% (436) were estimated to be Carnaby's Black-Cockatoos.
- Significant white-tailed black-cockatoo counts occurred at five sites in the Shire of Mundaring (927 birds) and four sites in the City of Kalamunda (544 birds) and one site in Keysbrook (255 birds, known to be Baudin's Black-Cockatoos).

Regional areas

- Volunteers surveyed 124 sites in regional locations outside of the Greater Perth-Peel Region and recorded 5,029 white-tailed black-cockatoos. Counts of white-tailed black-cockatoos in forested areas may include Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo.
- 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 in the Shire of Esperance (1,500 birds across five sites), in the Shire of Albany (935 birds across eight sites), on the northern Swan Coastal Plain (855 at Nilgen, 230 at Jurien Bay and 144 in Dandaragan), in the Shire of Plantagenet (285 across three sites), 263 across two sites in the Stirling Ranges, 209 across two sites in the Porongorups and 121 at Carbunup (known to be Baudin's Black-Cockatoos).

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

- Volunteers documented 95 occupied roost sites, a large increase on previous years (29, 23 and 71 occupied roosts in 2014, 2015 and 2016 respectively). 19 of these sites had both FRTBC and White-tailed Black-Cockatoos roosting.
- Occupied roosts were located in the Perth-Peel Coastal Plain (39), the Northern Darling Scarp and Plateau (38) and regional areas (18).
- 2,989 FRTBC were counted in 2017: 1,934 on the Perth-Peel Coastal Plain; 836 in the Northern Darling Scarp and Plateau, and 219 in regional areas. The total count was up markedly on previous years (896, 451 and 2,004 in 2014, 2015 and 2016 respectively). 2017 recorded a large increase in the numbers of FRTBCs on the Perth-Peel Coastal Plain, up 60% on 2016.
- Significant FRTBC roosts occurred at Floreat (261 birds), Yokine (239 birds), Murdoch (209 birds), Morley (130 birds), Melaleuca (129 birds), Baldivis (120 birds), Kensington (116 birds) and Jandabup (102 birds).
- FRTBC have replaced white-tailed black-cockatoos at 23 confirmed roost sites in the past four GCCs.

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 9 April 2017.

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: 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 2017 GCC the proportion of Carnaby's was set at 0.2 of white-tailed black-cockatoos (the same as 2016). This is based on advice from Tony Kirkby at the WA Museum and a count by experienced ornithologist Simon Cherriman at Parkerville. For the 2014 and 2015 GCCs, roost counts of white-tailed black-cockatoos within the Northern Darling Scarp and Plateau were reduced to 0.4 of the recorded count to derive a corrected count of the Carnaby's Black-Cockatoo population in the Greater Perth-Peel Region. This correction is based on field observations by Tony Kirkby (WA Museum) during April 2014 indicating flocks in the Mundaring/Kalamunda/Armadale region consisted of 40% Carnaby's Black-Cockatoos and 60% Baudin's Black-Cockatoos. In 2010-2013 GCCs, the proportion of Carnaby's was set at 0.2 based on field observations by Ron Johnstone and Tony Kirkby from the WA Museum.

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 triplet) represents a mated pair with the fledgling from the current or previous breeding season, and (3) the number of triplets 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* or *potential site*.

Confirmed roost: Any site where black-cockatoos were recorded roosting as part of a *formal roost survey*.

Occupied roost: A *confirmed roost* that had a positive count (i.e. ≥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 (≥1 bird) during any *formal roost survey*.

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

FRTBC only roost: Any site where a positive count (i.e. ≥1 bird roosting for the night) of FRTBC has been recorded as part of a formal roost survey and no white-tailed black-cockatoos have been recorded.

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 (Eg 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 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 7,000ha.

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 9 April 2017.

The 2017 GCC is the eighth consecutive GCC and the ninth overall. BirdLife Australia coordinates the count each year with significant support from the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA). Funding for the 2017 GCC came from the Elizabeth Gabler Charitable Trust, the John and Beryl Henderson Foundation, State NRM, Peel-Harvey Catchment Council (PHCC), the City of Perth and the Shire of Augusta-Margaret River.

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).[1]

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 Black-Cockatoo is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, while Baudin's Black-Cockatoos and 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 *Wildlife Conservation Act 1950*. The Western Australian Threatened Species Scientific Committee has classified the Forest Red-tailed Black-Cockatoo as vulnerable, and Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo as endangered.[2]

[1] 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'.
[2] Baudin's Black-Cockatoo is a declared pest under s 22 of the Western Australia *Biosecurity and Agriculture Management Act 2007*. It appears in the Western Australia Organism List (WAOL): https://www.agric.wa.gov.au/organisms

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

http://birdlife.org.au/documents/SWBC-SouthwestBlackCockatooID.pdf. Further information on the ecology of black-cockatoos on the Swan Coastal Plain is available in Johnstone *et al.* (2010)[3] , Stock *et al.* (2013)[4] 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. BirdLife WA has appointed Tegan Douglas as "Cockies in Crisis" 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 3 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). The most recent (2015, 2016 and 2017) 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).

[3] Available from: http://www.nrm.wa.gov.au/media/41434/black_cockatoos_on_swan_coastal_plain.pdf
[4] 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[5]:

- http://www.environment.gov.au/biodiversity/threatened/publications/recovery/calyptorhynchus-latirostris-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 Cockatoo Recovery Plan (DPaW 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 2017 GCC were to:

(1) train and engage community members in the monitoring of black-cockatoos;

(2) identify roost sites and conduct roost counts for Carnaby's 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 Carnaby's and Forest Red-tailed Black-Cockatoos within the Greater Perth-Peel region, across the eight consecutive GCCs (2010-2017) ; and

(5) identify roost sites and conduct roost counts for the Forest Red-tailed and Baudin's Black-Cockatoo across the species range.

[5] Webpages are current as at July 2017.

II. METHODS

Survey Timing and Area

Timing

This year's GCC occurred on Sunday 9 April 2017, consistent with the timing of previous GCCs.

Survey area

The GCC survey area encompasses the geographic range of Carnaby's Black-Cockatoo and FRTBC 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.[6]

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*.[7] 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 2017 GCC, we distributed information and invitations to participate to various community groups, NRM networks and their publications, to the Community Newspaper Group newspapers and emailed a BirdLife Australia contact list (this included all of the 2016 GCC counters). We updated the GCC webpage on BirdLife Australia's website[8], which provides information about the GCC, including forms, protocols and previous reports. This was the second year that we used a Google Form for registrations. Most

[6] A map of the IBRA bioregions is available at: http://www.environment.gov.au/land/nrs/science/ibra
[7] 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
[8] http://www.birdlife.org.au/projects/southwest-black-cockatoo-recovery/great-cocky-count-swbc

people registered this way and it made updating the volunteer list much easier than in previous years. We also promoted the event on BirdLife WA's social media sites, including Twitter 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 that registered to undertake a survey for the 2017 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). These forms and supporting material were also made available on the GCC webpage.[9]

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).

Roost Site Identification

Information about the 2017 GCC also included a request to report roost sites for black-cockatoos. Sites reported to BirdLife Australia prior to the 2017 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 a database. Sites in this database were assigned to one of three categories (confirmed roost, unconfirmed roost, or potential site) based on any prior roost count records for the site (see Key Terms and Abbreviations). For the 2017 GCC, we prioritised the allocation of observers to confirmed roosts, and then to unconfirmed roosts; potential sites received the lowest priority. Not all of the sites in the database were assigned for survey.

Roost Count Methodology

The 2017 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). Roost count instructions were included on the roost count survey form and in other written materials provided to each volunteer.

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 9 April 2017; (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

[9] http://www.birdlife.org.au/projects/southwest-black-cockatoo-recovery/great-cocky-count-swbc

number of cockatoos that arrived at the site within each of several sub-groups (i.e. whether the birds arrived in triplets, pairs, as single individuals, or other multiples).

Species identification protocol

The distributions of Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo overlap in portions of the southwest, particularly in forested areas. Distinguishing between Carnaby's Black-Cockatoo 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 calculate 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 these counts because the distributions of Carnaby's Black-Cockatoo overlap with the distribution of Baudin's Black-Cockatoos in this area and the difficultly 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 Black-Cockatoos 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 (± 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 2017.

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). The 2017 GCC assumed percentages of Carnaby's at 20% and Baudin's at 80% from advice by Tony Kirkby (WA Museum) and Simon Cherriman (Insight Ornithology). This is the same as 2016 and varies slightly to the 2014-15 counts. In April 2014, Tony Kirkby (WA Museum) conducted field surveys of black-cockatoos at roosts in Kalamunda, Armadale and Mundaring, and estimated that flocks of white-tailed black-cockatoos consisted of 40% Carnaby's and 60% Baudin's Black-Cockatoos. As for the previous GCCs, we assumed that the species proportions observed for sites in these locations would apply generally to all sites in the Northern Darling Scarp and Plateau, and applied this same ratio to the 2015 analysis. We therefore multiplied the total white-tailed black-cockatoo count by 0.4 to derive a 'corrected' count of the numbers of Carnaby's Black-Cockatoo for the Northern Darling Scarp and Plateau area. The estimated species proportions for the 2014 and 2015 GCCs differed slightly from those for the 2010-2013 GCCs, in which white-tailed flocks in the Northern Darling Scarp and Plateau were estimated (based on field observations) to comprise 20% Carnaby's Black-Cockatoo and 80% Baudin's Black-Cockatoos.

Trend analysis

A key aim for the Great Cocky Count is to assess population trends for Black-Cockatoos The fact that many surveys recorded counts of zero birds and the many instances where surveys of known roosts were not conducted, however, presented certain challenges for statistical analysis.

Counts of zero at a surveyed site may reflect normal, expected variation in the use of roost sites (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 problems with the study design (birds do not roost at the site because it is unsuitable). Zero counts, particularly those of the last kind, are problematic because they affect estimates of average roost size and therefore any trends (Zuur *et al.* 2009), and may create 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 a trend estimate and total counts that are comparable between years. A further complication arises from roost sites that have been cleared, which are no longer available to the birds and must be excluded from any analysis. Using only the 'raw' total counts, which do not account for cleared sites, any excess zeros and variable sampling effort resulting in missing surveys, and which reflect only those sites where surveys were done, will 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. This model uses a zero-inflated, negative binomial distribution to account for the excess zeros, and for the likely over-dispersion in the counts due to the many unexplained sources of variation, such as differences between observers (Link and Sauer 1997; Dobbie and Welsh 2001; Sauer *et al.* 2004). The model for the occupied roosts assumed a negative binomial distribution for the count data (with the mean being determined by an annual trend in average roost size), and fitted individual site effects to allow for any correlation in the repeated surveys at each site. A negative binomial distribution was appropriate, because it allows for the potentially excess variation that may arise through any unmodelled sources of variation in the

roost counts. We treated the site effects as fixed, rather than random, because the GCC surveys sample a large proportion of the population of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain and were restricted to a relatively small set of sites. This statistical approach models variation in counts more realistically than simple linear regression models of counts or log-transformed counts (Cunningham and Lindenmayer 2005). 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). Thus, the roost count data were modelled in two stages. First, we used a logistic regression model to estimate the fraction of roost sites occupied each year and any trend in roost occupancy rate. Then we used a log-linear regression model to estimate the average number of birds in each occupied roost each year and any trend in average roost size.

This analysis of the population trend in Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain is the subject of a separate scientific paper that has been published in the International Journal of Conservation, Oryx.[10]

We also assessed trends separately for roost sites within or associated with the Gnangara 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) the plantation system, or have been documented as roost sites for Carnaby's Black-Cockatoo feeding in the Gnangara 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 triplet – the adult mated pair and a fledgling from the most recent, or a previous, breeding season. As such, the number of triplets 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 triplets 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 triplets 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 triplets to pairs differed across the years 2010–2017.

Statistical analysis

We used Microsoft Office Excel 2010 and SPSS Statistics Version 22 for basic statistical analyses. The trend analyses were performed using the generalised linear model (GENMOD) procedure of the SAS software (SAS Institute Inc., 2011).

[10] 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.

III. RESULTS

A. Community Engagement and Training

Workshops

Approximately 350 people attended the 12 Great Cocky Count workshops conducted in February and March 2017. Workshops were held at locations throughout the south west, including one each at Williams, Byford, Busselton, Margaret River, Perth, Kwinana, North Dandalup, Waroona, Kalamunda, Wanneroo, Mandurah and Murdoch University.

Supporters for the workshops included the Shire of Kalamunda, South West Catchments Council (SWCC), Landcare Serpentine-Jarrahdale, Murdoch University, Peel-Harvey Catchment Council, Geocatch, the Shire of Augusta-Margaret River, the Cape to Cape Catchments Group, Kwinana Council, Greenfields Primary School, North Dandalup Primary School, Waroona District High School and Wanneroo Council.

Volunteer participation

We assigned 504 survey sites to the 895 registered volunteers (Table 1). Roost counts were conducted at 469 (93%) of these sites. This compares well with previous completion rates for the 2016 (93%), 2015 (97%), 2013 (92%), 2014 (90%), and 2012 (84%) GCCs, and is much higher than for the 2011 GCC (67%). Of the volunteers that registered in 2017, approximately half were new to the GCC and half had registered previously. Since 2010, more than 2,500 people have participated in at least one GCC as a registered volunteer.

Actual volunteer participation for the 2017 GCC likely exceeded 1,500 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 100 volunteers participated in total in these two surveys.

Many sites were surveyed using teams of volunteers. The largest multi-observer roost count was at Murdoch University, where more than 60 volunteers (including Murdoch students and staff and local residents) worked together to conduct a comprehensive survey of the University's South Street campus.

Table 1: Volunteer participation and survey effort for eight Great Cocky Counts (2010-2017). 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
Registered volunteers	250	263	294	335	592	606	707	895
Sites assigned for survey	unknown	248	244	262	322	301	426	504
Sites surveyed	187	165	205	241	290	293	398	469
– In Greater Perth-Peel Region	183 (98%)	150 (91%)	157 (77%)	186 (77%)	230 (79%)	228 (78%)	310 (78%)	345 (74%)
(i) Perth-Peel Coastal Plain	157 (84%)	124 (75%)	127 (62%)	144 (60%)	186 (64%)	185 (63%)	231 (58%)	240 (51%)
(ii) N. Darling Scarp/Plateau	26 (14%)	26 (16%)	30 (15%)	42 (17%)	44 (15%)	43 (15%)	79 (20%)	105 (22%)
– In Regional areas	4 (2%)	15 (9%)	48 (23%)	55 (23%)	60 (21%)	65 (22%)	88 (22%)	124 (26%)

B. Carnaby's Black-Cockatoo: Roost Site Identification

97 new sites were added to the GCC database this year. This enabled 107 sites which had not previously been surveyed to be surveyed in 2017 (some were already on the database but had never been surveyed). Of these 38 had just white-taileds roosting, 33 had FRTBC roosting, 6 had both roosting and 30 were unoccupied. Of the 735 sites in the database, 77 have still not been surveyed to date. One confirmed site was cleared in the last year (WANPINR010), which was associated with pine plantations.

Table 2: Number of Carnaby's Black-Cockatoo confirmed roosts, unconfirmed roosts, potential sites, and cleared sites in the GCC site database for the eight Great Cocky Counts (2010-2017). Cleared roosts are confirmed roosts that have been cleared of vegetation since 2010.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
No. of confirmed roosts	80	114	151	186	204	217	251	296
No. of unconfirmed roosts	unknown	29	55	94	108	119	147	146
No. of potential sites	unknown	155	148	165	184	185	179	196
No. of cleared roosts	n/a	2	5	7	7	8	13	14
No. of FRTBC only roosts	n/a	n/a	n/a	n/a	13	20	49	83
Total no. of sites	**222**	**300**	**359**	**452**	**516**	**549**	**638**	**735**

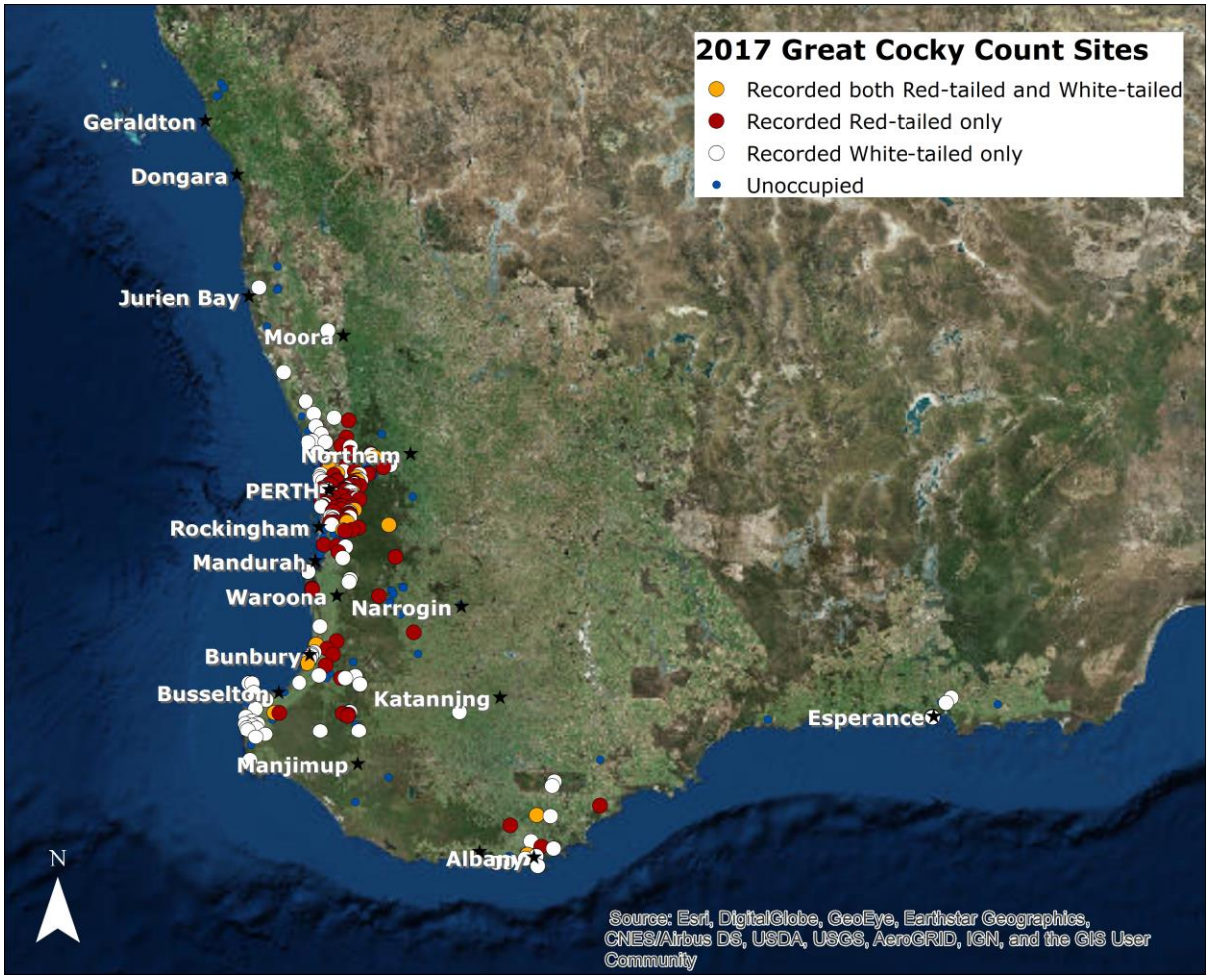

Figure 1: The locations of the 469 sites where surveys were conducted for the 2017 Great Cocky Count. Sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Forest Red-tailed Black-Cockatoo roost sites, or sites where both red- and white-tailed black-cockatoos roosted. Figure credit: Tegan Douglas.

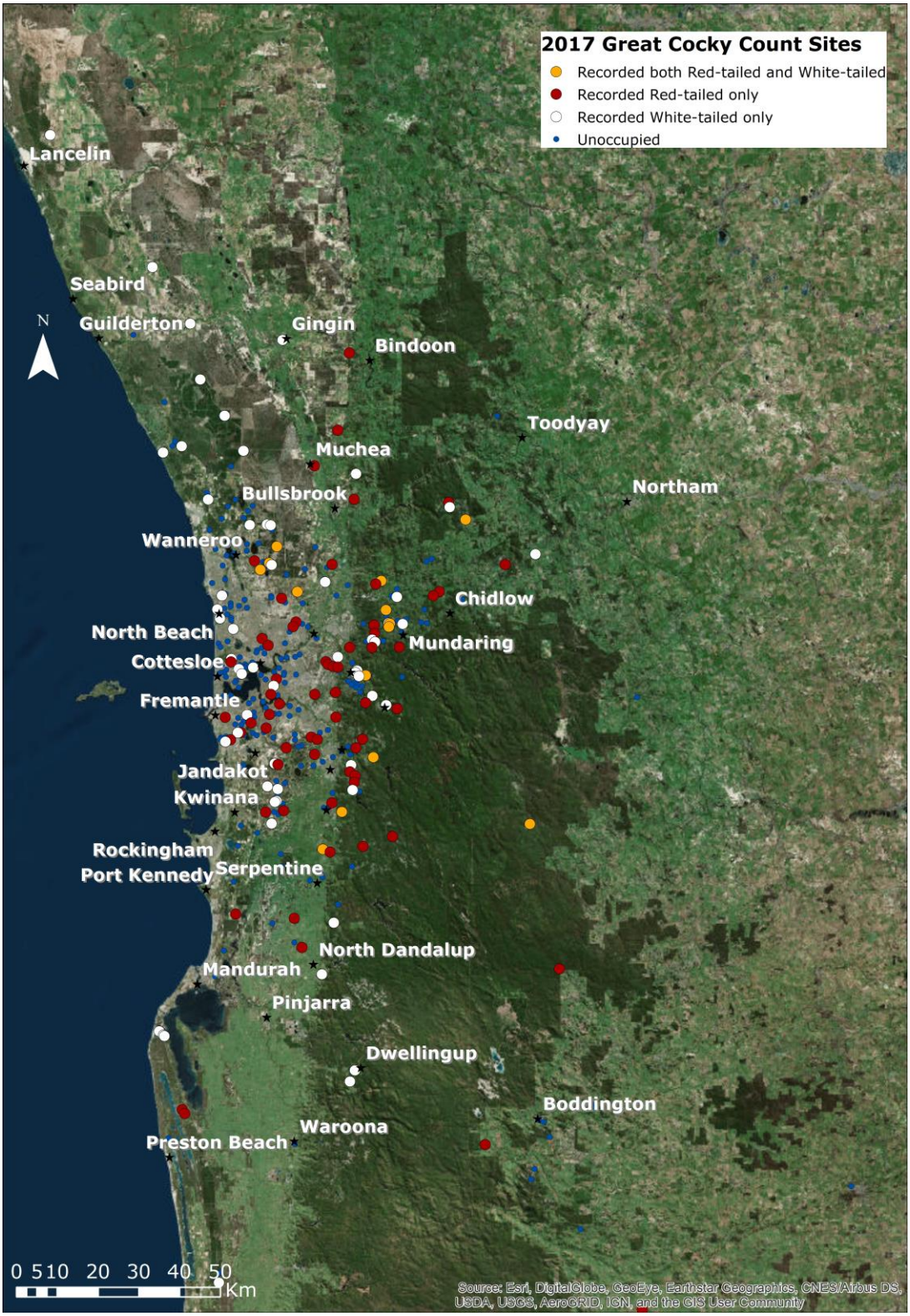

Figure 2: The locations of the 345 sites in the Greater Perth-Peel Region where roost counts were conducted for the 2017 Great Cocky Count. Roosting sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Forest Red-tailed Black-Cockatoo roost sites, or sites where both red- and white-tailed black-cockatoos roosted in 2017. 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 345 sites in the Greater Perth-Peel Region. Roost counts occurred in 37 local government areas (LGA), with occupied roosts recorded in 21 (57%) of these (Appendix II). Survey effort was greatest in the Cities of Wanneroo, Kalamunda, Swan, Mundaring and Serpentine-Jarrahdale, with 32, 30, 29, 28 and 27 sites surveyed respectively. Of these, 10 occupied roosts were recorded in the City of Wanneroo, seven in the Cities of Kalamunda and Mundaring, and six in the Cities of Swan and Serpentine-Jarrahdale.

Regional areas

Volunteers surveyed 124 sites in regional areas (Table 1). Roost counts occurred in 25 LGAs, with occupied (White-tailed Black-Cockatoo) roosts recorded in 16 (64%) of these (Appendix II). The greatest survey effort in regional areas occurred in the Shires of Augusta-Margaret River (22), Albany and Busselton, with 15 sites each. Of these, 12 occupied roosts were recorded in Augusta-Margaret River, eight in Albany and six in Busselton.

Across GCCs (2010-2017)

The number of sites surveyed has increased each year since 2010, both in the Greater Perth-Peel Region and in regional areas (Table 1), although most have been in the Perth-Peel metropolitan area. Since 2012 approximately 80% of sites are within the Greater Perth-Peel region and 20% are in regional areas. This year the regional count increased to 26% of all sites surveyed.

Total counts

Greater Perth-Peel Region

In 2017 the GCC recorded 10,684 Carnaby's in the region. This is similar to last year (11,418 birds) and is roughly double the average for the years 2010-15 (5,444 birds) (Table 3).

Regional areas

The count for regional areas of 5,029 white-tailed black-cockatoos is a marked increase on previous years (average of 3,527 birds between 2012 and 2016), with more sites being surveyed this year (Table 3).

Across species range

The total count of 17,457 birds is similar to 2016 and is roughly double the average of the years 2010-15 (8,705 birds) (Table 3).

Roost counts – across species range

At occupied roosts, counts for white-tailed black-cockatoos in the 2017 GCC ranged from 1 to 3,528, with a mean of 141 $\pm$ 33 (standard error) and a median of 30 (124 roost counts). Roost count sizes varied across the three principal survey areas. The lowest was for the Northern Darling Scarp and Plateau (mean 81 $\pm$ 17); then Regional areas (mean 91 $\pm$ 24), with the Perth Peel Coastal Plain being the highest (mean 244 $\pm$ 91).

Across the species range, the five largest roosts accounted for 42% (7,338 of 17,457 birds) of the total number of white-tailed black-cockatoos counted (Appendices III and IV). The ten largest roosts accounted for 50% (8,752) of the total number of white-tailed black-cockatoos counted. Four of the five largest roosts, and six 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 3528, 1260, 900, 880 and 770 birds) accounted for 72% (7,338 of 10,248) of the Carnaby's Black-Cockatoo counted (Appendix IIIa). Three of these were within the Gnangara pine plantation north of Perth (Appendix IIIb).The roost occupancy rate was 39% for the Perth-Peel Coastal Plain (42 occupied roosts of the 108 previously occupied roosts that were surveyed) (Table 4).

Gnangara pine plantation

Volunteers recorded 7450 birds at 10 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 73% (7,450 of 10,248) of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain. In previous GCCs (2010-2016), birds roosting in the Gnangara pine plantation have accounted for 27% to 62% of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain, with total counts ranging from 1077 to 6763 birds.

Other large roosts

Large counts were recorded at Gingin (880), Wellard (298), Kensington (289), Floreat (281), Nedlands (242) and Duncraig (110).

Roost counts – Northern Darling Scarp and Plateau

Within the Northern Darling Scarp and Plateau, the five largest roosts accounted for 54% (1175 of 2180) of the white-tailed black-cockatoos counted. These counts were recorded at three sites in the Shire of Mundaring (335, 213 and 157), one in Serpentine-Jarrahdale (255 Baudin's) and one in Kalamunda (215) (Appendix IIIc). The roost occupancy rate was 47% (27 occupied roosts of the 58 previously occupied roosts that were surveyed) (Table 4).

White-tailed black-cockatoos were recorded at seven sites in the Shire of Mundaring (28 sites surveyed and 953 birds), seven sites in Kalamunda (30 sites surveyed and 560 birds) and three in the City of Armadale (20 sites surveyed and 79 birds) (Appendix IIIc). Roosts were also recorded at sites in Toodyay (99 birds), Gidgegannup (93 birds) and Northam (52 birds).

Roost counts – Regional areas

In regional areas, the five largest roosts (855, 760, 559, 500 and 230 birds) accounted for 58% (2904 of 5029) of the white-tailed black-cockatoos counted (Appendix IV). These sites were located at Nilgen, Kalgan, Myrup and Jurien Bay.

Sites with large counts were recorded in the Shire of Esperance (1500 at five sites), in the Shire of Albany (935 at eight sites), northern Swan Coastal Plain (230 at Jurien Bay and 855 at Nilgen), the Stirling Ranges and Porongurups (472 birds at 4 sites), the Shire of Dandaragan (374 birds at two sites), the Shire of Augusta-Margaret River (209 at 12 sites), the Shire of Busselton (196 birds at six sites), the Shire of Harvey (132 birds at two sites), and at Bunbury (128 birds at four sites) (Appendix IV).

Breeding success

The fraction of white-tailed black-cockatoo groups returning to roosts as either pairs or triplets was recorded at 56 sites in 2017. The proportion of groups flying into roosts as triplets (37%) was not significantly different ($\chi^2 = 0.5$, $p = 0.92$) than the average proportion recorded over previous GCCs (average 39% between 2010-2016, range 31% – 46%) (Table 5). Further analysis and a comparison of the fraction of triplets 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: Roost count summary for Carnaby's Black-Cockatoo across eight Great Cocky Counts (2010-2017). 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 black-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 20% Carnaby's and 80% Baudin's. # Assumption of 40% Carnaby's and 60% Baudin's.represents a total count for white-tailed black-cockatoos**

	2010	2011	2012	2013	2014	2015	2016	2017
Greater Perth-Peel Region								
No. of Carnaby's Black-Cockatoo counted in **Perth-Peel Coastal Plain**	6330 (35 roosts)	3912 (37 roosts)	3791 (25 roosts)	5591 (35 roosts)	6662 (37 roosts)	4692 (37 roosts)	10919 (43 roosts)	10248 (42 roosts)
No. of Carnaby's Black-Cockatoo counted in **Northern Darling Scarp and Plateau** (corrected)	386* (total WT count = 1929; 15 roosts)	79* (total WT count = 393; 13 roosts)	165* (total WT count = 826; 15 roosts)	203* (total WT count = 1016; 14 roosts)	557# (total WT count = 1393; 13 roosts)	216# (total WT count = 540; 9 roosts)	499* (total WT count = 2496; 29 roosts)	436* (total WT count = 2180; 27 roosts)
No. of Carnaby's Black-Cockatoo counted in **Greater Perth-Peel Region**	6716 (50 roosts)	3991 (50 roosts)	4036 (40 roosts)	5794 (49 roosts)	7219 (50 roosts)	4908 (46 roosts)	11418 (72 roosts)	10684 (69 roosts)
Regional areas								
No. of white-tailed black-cockatoos counted **in Regional areas****	246 (2 roosts)	610 (9 roosts)	3329 (23 roosts)	3744 (26 roosts)	4041 (29 roosts)	3182 (21 roosts)	3340 (32 roosts)	5029 (55 roosts)
Across Species Range								
No. of white-tailed black-cockatoos counted **across species range****	8505 (52 roosts)	4915 (59 roosts)	7946 (63 roosts)	10351 (75 roosts)	12096 (79 roosts)	8414 (67 roosts)	16755 (104 roosts)	17457 (124 roosts)

Table 4: The numbers 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, for each of the eight Great Cocky Counts 2010 – 2017.

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
No. of sites surveyed, of those that had a positive count in a GCC up to that year								
Perth-Peel Coastal Plain	58	57	59	70	79	89	102	108
Northern Darling Scarp and Plateau	18	18	21	28	28	38	39	58
% of sites surveyed, of those that had a positive count in a GCC up to that year								
Perth-Peel Coastal Plain	Not defined	81% (n=93)	76% (n=105)	77% (n=128)	89% (n=89)	90% (n=99)	89% (n=115)	92% (n=117)
Northern Darling Scarp and Plateau					74% (n=38)	97% (n=39)	74% (n=53)	94% (n=62)
No. of new roost sites discovered								
Perth-Peel Coastal Plain	60	12	10	6	6	5	14	14
Northern Darling Scarp and Plateau	18	7	5	4	4	1	14	10
No. of occupied roosts (% of all sites surveyed)								
Perth-Peel Coastal Plain	35 (22%)	37 (30%)	26 (20%)	34 (23%)	38 (21%)	36 (21%)	43 (19%)	42 (18%)
Northern Darling Scarp and Plateau	15 (58%)	13 (50%)	15 (50%)	14 (33%)	12 (27%)	9 (21%)	29 (37%)	27 (26%)
Roost occupancy rate (% of confirmed sites surveyed)								
Perth-Peel Coastal Plain	60%	65%	44%	49%	48%	40%	42%	39%
Northern Darling Scarp and Plateau	83%	72%	71%	50%	43%	24%	74%	47%

Table 5: The number of white-tailed black-cockatoos arriving at roosts in pairs or triplets, for the eight GCCs 2010– 2017, with percentages in parentheses. N 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	Triplets	N 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 (63%)	158 (37%)	56

D. Carnaby's Black-Cockatoo: Trend Analysis for the Perth-Peel Coastal Plain and Darling Scarp and Plateau (2010-2017)

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 eight GCCs (2010-2017; 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 and has remained fairly steady since then.

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 117 sites (Table 4).

Fourteen confirmed roosts have been cleared since the 2010 GCC: Two (COCSCCR001 and ROCKARR001) were cleared prior to the 2011 GCC; three more before the 2012 GCC (COCSCCR002, ROCBALR001 and SWAMELR002); another two prior to the 2013 GCC (HARMYAR002 and MANDUDR001); one before the 2015 GCC (MUNCHIR001); five before the 2016 count (SWALEXR002, WANJANR005,WANJANR007, WANPINR005 and WANYANR004); and one before the 2017 count (WANPINR010) (Appendix IIIa).

Largest roosts

Within the Perth-Peel Coastal Plain, the ten largest roosts (based on combined counts across years) accounted for over half (62%, or 32,248 of 52,145) of the Carnaby's Black-Cockatoos counted in the 2010-2017 GCCs (Appendix IIIa). Four of these are within the Gnangara pine plantation (GINYEAR003, SWAMELR001, WANMARR003 and WANPINR001), another two are within smaller suburban pine plantings (SOUCOMR001 in Kensington and MELMURR001 at Murdoch University). The other four are at Gingin (GINGINR001), Dawesville (MANDAWR002), Underwood Avenue in Floreat (CAMFLOR001) and Hollywood Hospital in Nedlands (NEDNEDR001).

The next ten largest roosts accounted for a further 16% (8,252 of 52,145) of the Carnaby's Black-Cockatoos counted in the eight GCCs. Nine of these are within or associated with the Gnangara pine plantation (GINYEAR001, WANPINR011, WANPINR002, WANTWOR001, WANYANR006, WANGNAR001, WANNEER002, WANYANR001 and WANMARR001) and the other one is at Manning Lake in Spearwood (COCHAMR001).

Overall, the 40 largest roosts accounted for 91% (38,054 of 41,897) of the Carnaby's Black-Cockatoos counted in the Perth-Peel Coastal Plain across the eight GCCs.

Occupancy rate

The fraction of occupied roosts within the Perth-Peel Coastal Plain is estimated to be declining at a rate of approximately 2.2% per year (Figure 3). This decline is statistically significant (p=0.02), and equates to the loss of about 3 of the 129 known roosts each year. The trends for both pine-associated (n=30, estimated decline of 3% per year) and non-pine-associated roosts (n=89, estimated decline of 2% 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 at approximately 6.1% per year (Figure 4). This decline is marginally statistically significant (p=0.055). The trends for pine-associated (n=30, estimated increase of 1% per year) and non-pine-associated roosts (n=89, estimated decline of 9% per year) are significantly different; flock sizes in pine-associated roosts are currently steady, but are declining at non-pine roosts.

Estimated trend in the Perth-Peel Region

To determine the overall trend in the number of birds in the region, the estimated annual declines in average roost size (6.1%) and roost occupancy (2.2%) must be combined. At the present roost occupancy rate (41%), the rate of decline in the total number of birds is a 5.4% decline due to fewer occupied roosts (100 – (41-2.2)/41), combined with a 6.1% decline due to smaller flock sizes – a total decline of 11% per year (Figure 5). The estimated overall rate of decline in pine-associated roosts (7% per year) is about half that for non-pine-associated roosts (13%).

As indicated above, a relatively small number of roost sites account for the bulk of birds recorded within the Perth-Peel Coastal Plain region. Analysis of the trends in subsets of the largest 10, 20 and 30 roosts, which have been surveyed consistently and show less variation in occupancy rates, resulted in estimated rates of decline of 0%, 3% and 5%, respectively. Removal of the 'mega' roost (which could be seen as an outlier) had no effect on these results. Thus, the low occupancy rate of smaller roosts may be inflating the estimated rate of decline, and the true rate may be less than that resulting from analysis of the entire dataset. While closer examination of the roost count data should provide a more accurate estimate of the trend (Williams *et al*. 2015), the current rate of decline can be estimated to be around 5% – 11% per year, and slightly lower than the estimates from previous years (e.g. Byrne *et al*. 2015; Peck et al. 2016).

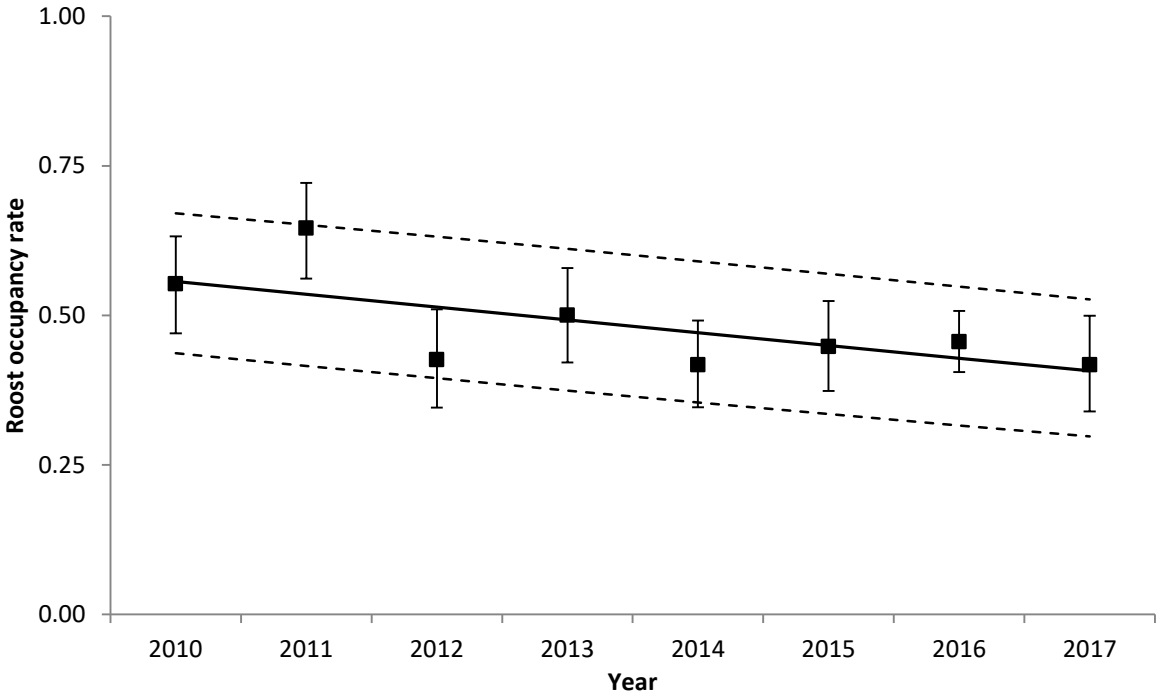

Figure 3: Roost occupancy rate (filled symbols with standard error) for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain (2010 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

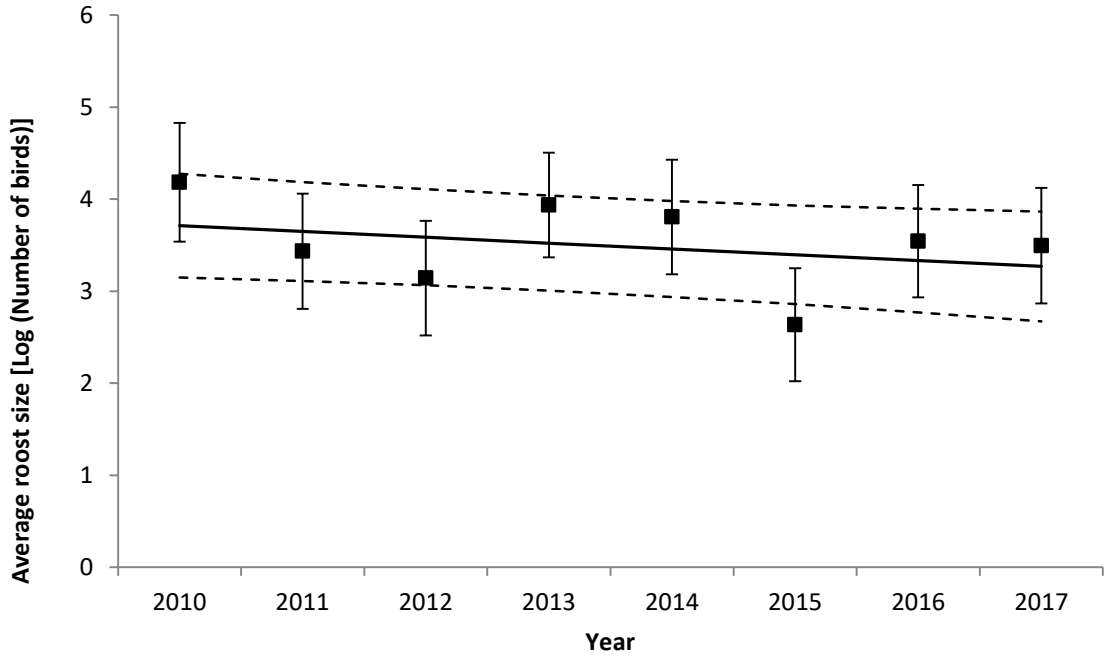

Figure 4: Average roost size (filled symbols with standard errors, log scale) for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain (2010 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

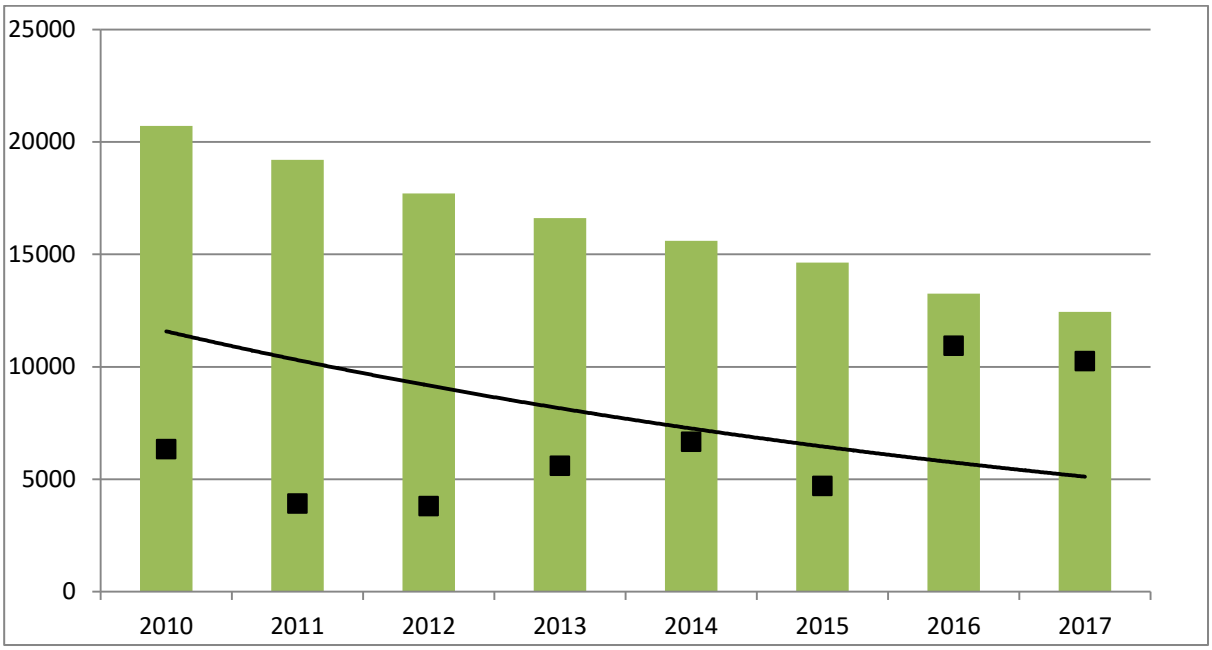

Figure 5: Trends in the abundance of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain region 2010-2017: the estimated total count if all roosts were occupied on the night of the Great Cocky Count (bars), the estimated trend in abundance after accounting for roosts that were not occupied or not surveyed (solid line), and the actual roost counts for the region (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 eight GCCs (2010-2017; Table 1). The number of occupied roosts varied between 9 and 30, with occupied roosts representing 22-58% of the total number of sites surveyed each year (Table 4). The discovery rate for new roosts was high in 2010 and 2011 but declined to 2015. This trend has been reversed in the last two years with 24 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 62 sites (Table 4). 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 half (5,337 of 10,773) of the white-tailed black-cockatoos counted in the 2010-2017 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 3.5% per year (Figure 6). This decline is statistically significant ($p = 0.020$), and equates to the loss of about 2 of the 66 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 11.9% per year (Figure 7). This decline is statistically significant ($p = 0.0038$), and equates to the loss of about 9 birds per year from the overall average of around 78 birds at each roost.

Estimated trend in the Northern Darling Scarp and Plateau

Combining the estimated annual declines in average roost size (11.9%) and roost occupancy (3.5%), at the present estimated roost occupancy rate (47%), the overall estimated rate of decline in the total number of birds is thus 18% per year (Figure 8).

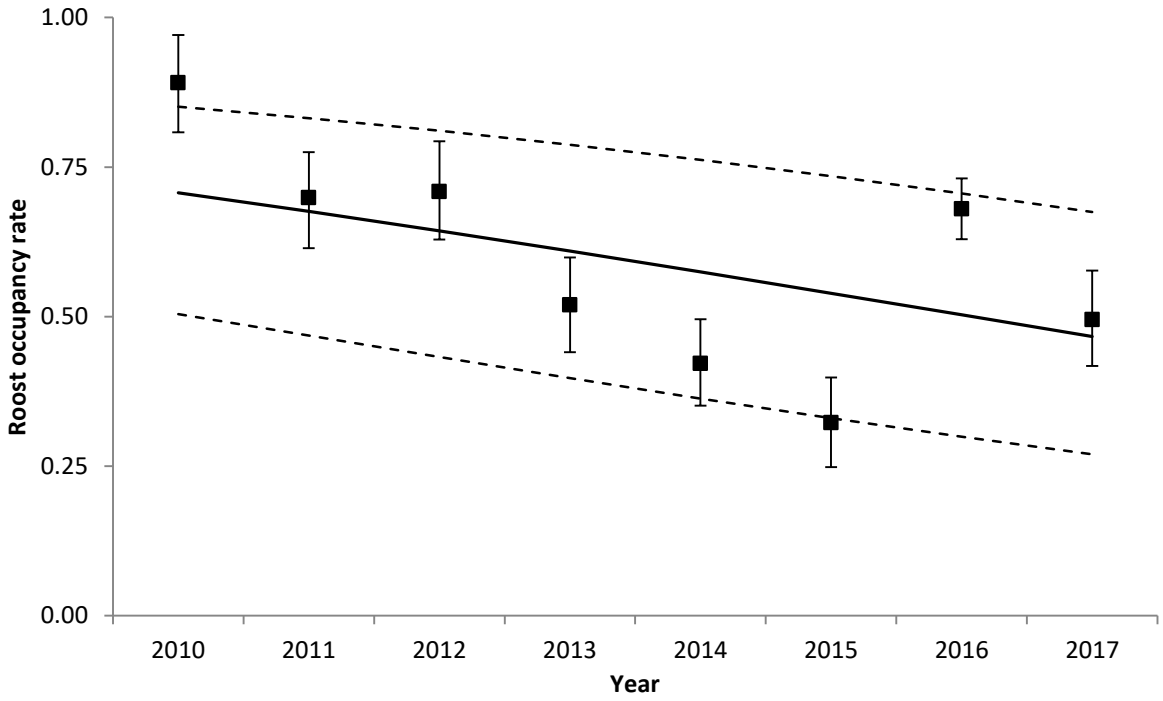

Figure 6: Roost occupancy rate (filled symbols with standard error) for white-tailed black-cockatoos in the Northern Darling Scarp and Plateau (2010 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

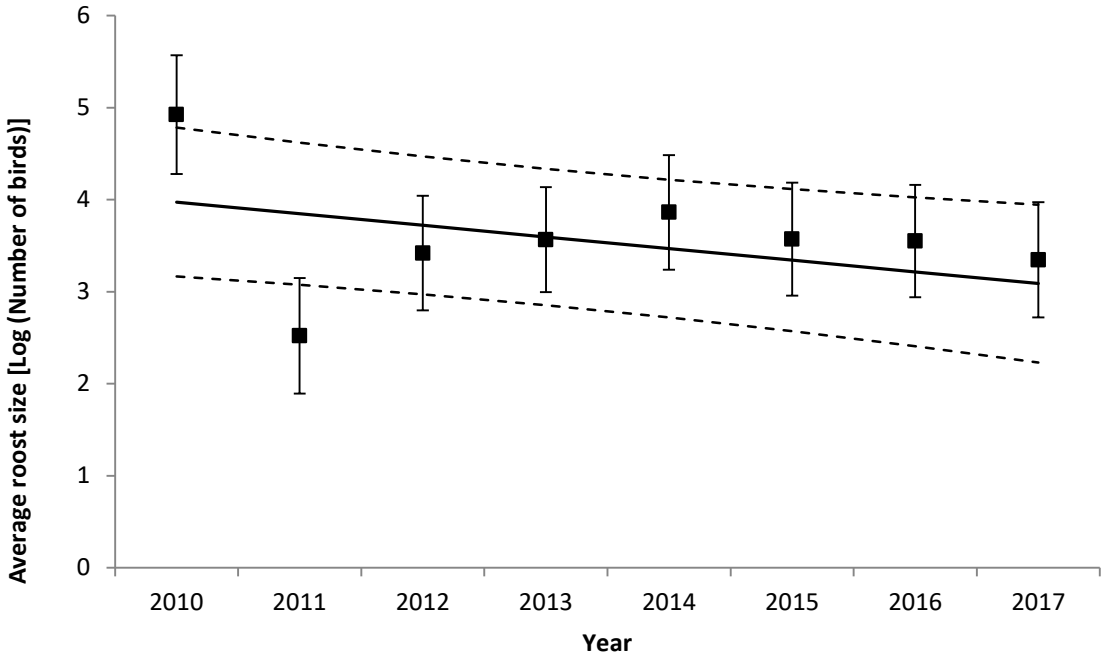

Figure 7: Average roost size (filled symbols with standard errors, log scale) for white-tailed black-cockatoo in the Northern Darling Scarp and Plateau (2010 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

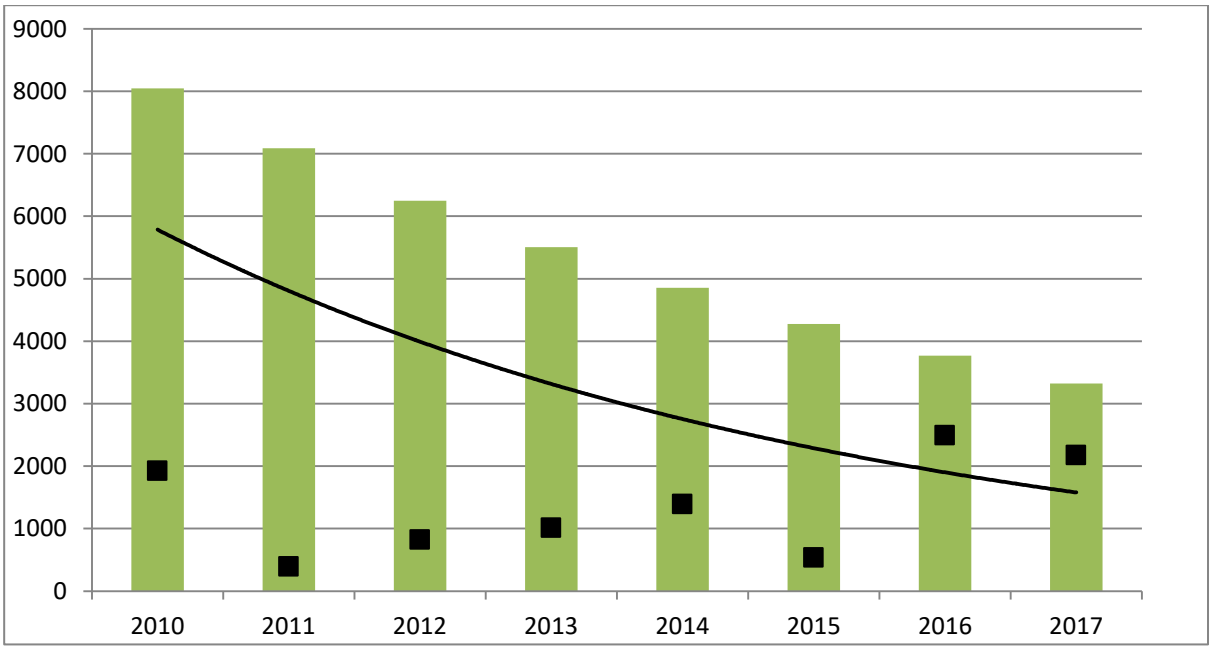

Figure 8: Trends in the abundance of white-tailed black-cockatoo in the Northern Darling Scarp and Plateau region 2010-2017: the estimated total count if all roosts were occupied on the night of the Great Cocky Count (bars), the estimated trend in abundance after accounting for roosts that were not occupied or not surveyed (solid line), and the actual roost counts for the region (squares).

E. Forest Red-tailed Black-Cockatoo

Roost Site Identification

Perth-Peel Coastal Plain

FRTBC were recorded at roosts in 18 LGAs across the Perth-Peel Coastal Plain: Armadale, Bayswater, Cambridge, Canning, Chittering, Cockburn, Fremantle, Gosnells, Kwinana, Mandurah, Melville, Rockingham, Serpentine-Jarrahdale, Stirling, Swan, Victoria Park, Wanneroo and Waroona.

Northern Darling Scarp and Plateau

Volunteers recorded FRTBC at roost sites in 12 LGAs within the Northern Darling Scarp and Plateau: Armadale, Beverley, Boddington, Chittering, Kalamunda, Mundaring, Northam, Serpentine-Jarrahdale, Swan, Toodyay, Williams and Wandering.

Regional areas

FRTBC were recorded at roost sites in nine Regional LGAs: Albany, Augusta-Margaret River, Bindoon, Bridgetown-Greenbushes, Capel, Dardanup, Donnybrook-Balingup, Harvey and Plantagenet.

Overall, occupied roosts have risen dramatically from 28 in 2014, to 95 in 2017 (Table 6). This increase has been greatest in the Greater Perth-Peel region.

Roost Counts

FRTBC were recorded roosting at 95 sites across the GCC survey area, with relatively few sites in regional areas (Table 6; Appendix V). 33 of these (35%) were new sites that had not been surveyed prior to the 2017 GCC. Of the 95 occupied roosts 76 had only FRTBC, while 19 had both FRTBC and white-tailed black-cockatoos.

Roost counts at sites in the Greater Perth-Peel Region accounted for 93% of the total number of FRTBC counted. The five largest counts of FRTBC (261, 239, 209, 130, and 129 birds) were in the Perth-Peel Coastal Plain. They accounted for 32% of the total number of FRTBC counted across the species range.

FRTBC were recorded at 20% of all sites surveyed across the GCC survey area (95 of 469 sites) and 15% of sites outside of the Greater Perth-Peel Region (18 of 124 sites). Within the Greater Perth-Peel Region, volunteers recorded FRTBC at 16% of sites in the Perth-Peel Coastal Plain (39 of 240 sites) and 36% of sites in the Northern Darling Scarp and Plateau (38 of 105 sites).

Volunteers recorded 19 roosts where both FRTBC and white-tailed black-cockatoos roosted (Appendix V). This is similar to last year (24 joint roosts) and a marked increase on previous years (eight and four joint roosts in 2014 and 2015, respectively). FRTBC replaced white-tailed black-cockatoos at 23 sites: four confirmed roosts in 2014, another three in 2015, a further five in 2016, and 11 in 2017 (Appendix Vd). Of these 13 were in the Perth-Peel Coastal Plain region.

Roost counts for FRTBC ranged from 1 to 261, with a mean of 31 $\pm$ 4.9 (standard error) and a median of 12. This compares to a mean of 32 $\pm$8 with a median of 17 in 2014, a mean of 20 $\pm$5 and a median of 13.5 in 2015 and a mean of 29 $\pm$ 3.5 and a median of 20.5 in 2016.

Table 6: Roost count summary for FRTBC across four Great Cocky Counts (2014-2017). The number of roosts is the number of **occupied roosts** (i.e. roosts where at least one FRTBC roosted).

	2014	2015	2016	2017
Greater Perth-Peel Region				
No. of FRTBC counted in **Perth-Peel Coastal Plain**	601 (13 roosts)	305 (10 roosts)	771 (24 roosts)	1934 (39 roosts)
No. of FRTBC counted in **Northern Darling Scarp and Plateau**	211 (9 roosts)	107 (7 roosts)	859 (26 roosts)	836 (38 roosts)
No. of FRTBC counted in **Greater Perth-Peel Region**	812 (22 roosts)	412 (17 roosts)	1630 (50 roosts)	2770 (77 roosts)
Regional areas				
No. of FRTBC counted **in Regional areas**	84 (6 roosts)	39 (5 roosts)	374 (20 roosts)	219 (18 roosts)
Across Species Range				
No. of FRTBC counted **across species range**	896 (28 roosts)	451 (22 roosts)	2004 (70 roosts)	2989 (95 roosts)

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 (2014-2017; Table 1). The number of occupied roosts varied between 10 and 39, with occupied roosts representing 5-16% of the total number of sites surveyed each year. The discovery rate was of new roosts was fairly low in 2014 and 2015 but has increased since then.

Positive counts (i.e. $\geq$ 1 FRTBC roosting in at least one GCC, not including cleared sites) have now been recorded from 59 sites. No confirmed FRTBC roosts have been cleared since 2014.

Largest roosts

Within the Perth-Peel Coastal Plain, the ten largest roosts (based on combined counts across years) accounted for two thirds (67%, or 2,432 of 3,611) of the FRTBCs counted in the 2014-2017 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 8.5% per year (Figure 9). This decline is statistically significant (p=0.032), and equates to an increase of about 5 of the 59 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 20% per year (Figure 10). This increase is statistically significant (p=0.0046), and equates to an increase of about 8 birds per year to the overall average of around 40 birds at each roost.

Estimated trend in the Perth-Peel region

Combining the estimated annual increase in average roost size (20%) and roost occupancy (8.5%), at the present estimated roost occupancy rate (72%), the overall estimated rate of increase in the total number of birds is thus 34.5% per year (Figure 11).

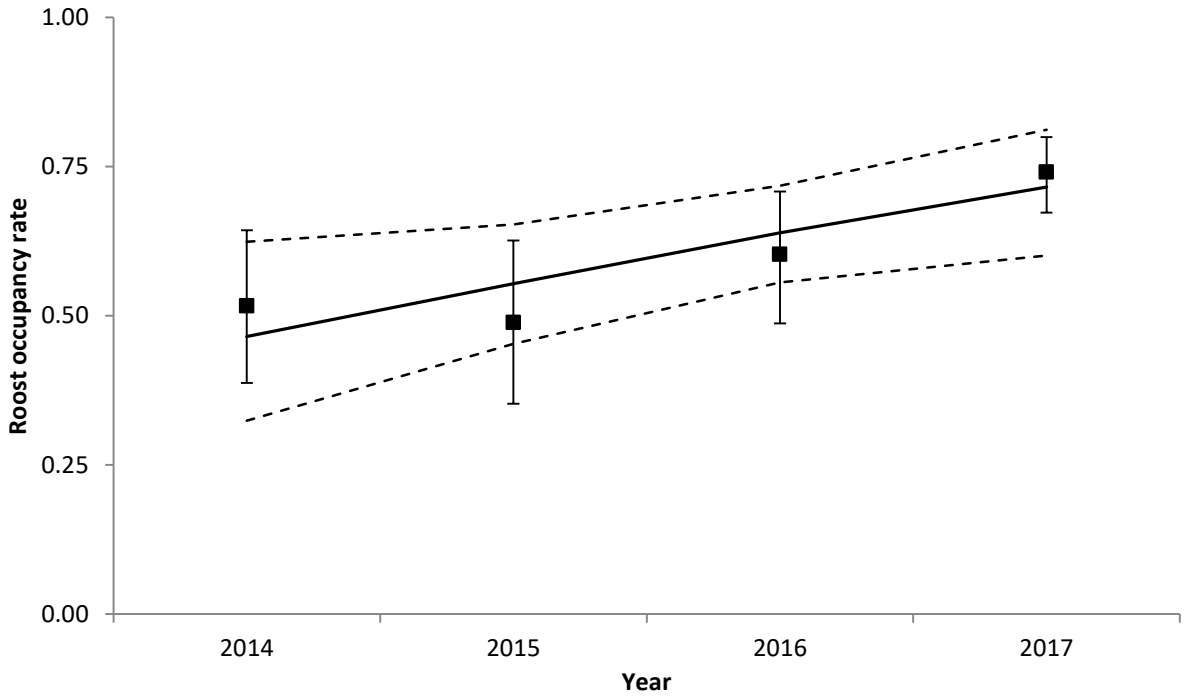

Figure 9: Roost occupancy rate (filled symbols with standard error) for FRTBCs in the Perth-Peel Coastal Plain (2014 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

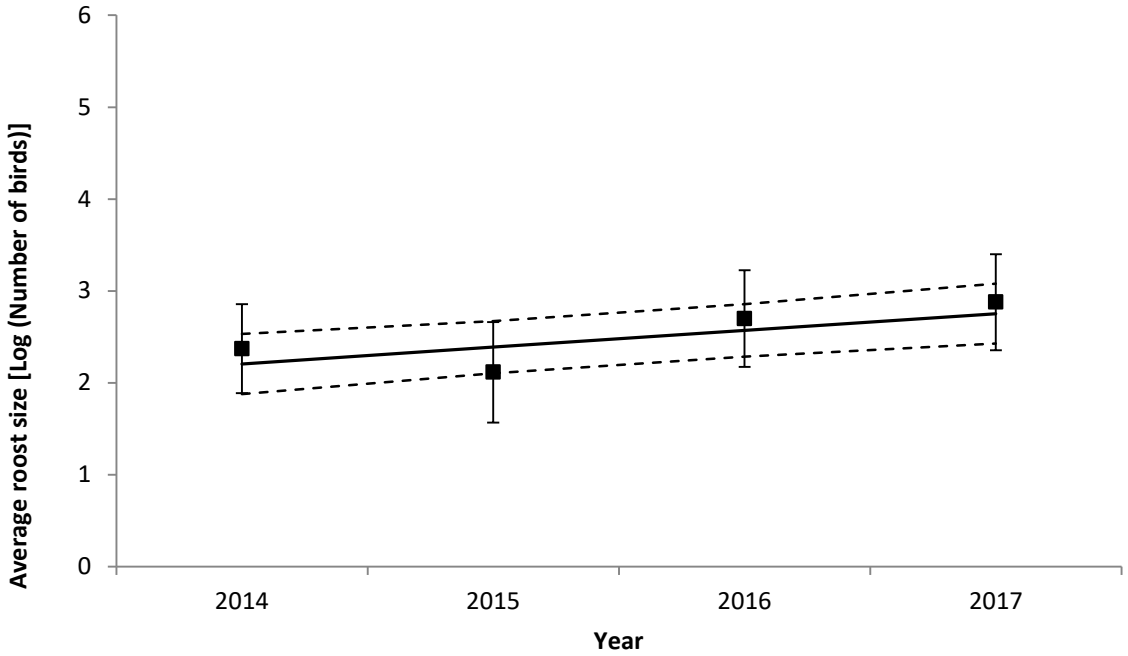

Figure 10: Average roost size (filled symbols with standard errors, log scale) for FRTBCs in the Perth-Peel Coastal Plain (2014 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

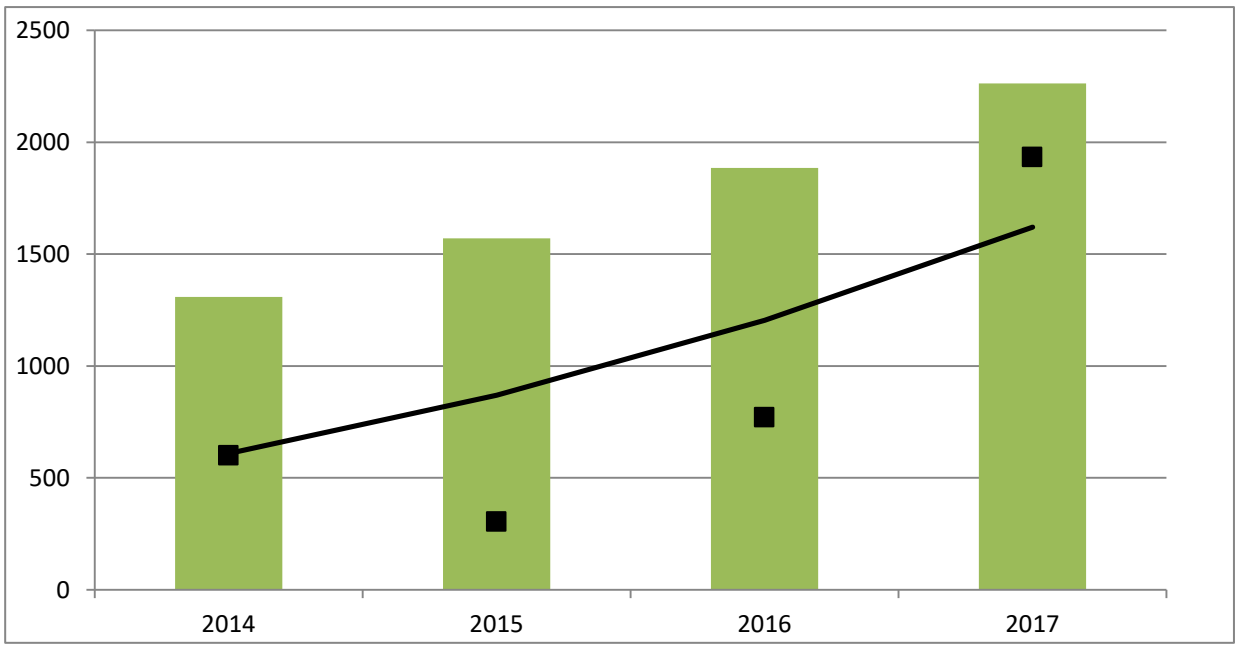

Figure 11: Trends in the abundance of Forest Red-tailed Black-Cockatoo in the Perth-Peel Coastal Plain (2014 – 2017): the estimated total count if all roosts were occupied on the night of the Great Cocky Count (bars), the estimated trend in abundance after accounting for roosts that were not occupied or not surveyed (solid line), and the actual roost counts for the region (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 (2014-2017; Table 1). The number of occupied roosts varied between 9 and 30, with occupied roosts representing 19-36% of the total number of sites surveyed each year. The discovery rate of new roosts was fairly low in 2014 and 2015 but has increased since then.

Positive counts (i.e. $\geq$ 1 FRTBC roosting in at least one GCC, not including cleared sites) have now been recorded from 58 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 over half (54%, or 1,083 of 2,013) of the FRTBCs counted in the 2014-2017 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 7.6% per year (Figure 12). This increase equates to an increase of about 4 of the 58 known roosts each year but is not statistically significant.

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 0.7% per year (Figure 13). This decline is not statistically significant and equates to no loss of birds per year to the overall average of around 23 birds at each roost.

Estimated trend in the Northern Darling Scarp and Plateau

Combining the estimated annual decline in average roost size (0.7%) and increase in roost occupancy (7.6%), at the present estimated roost occupancy rate (72%), the overall estimated rate of increase in the total number of birds is thus 9.8% per year (Figure 14).

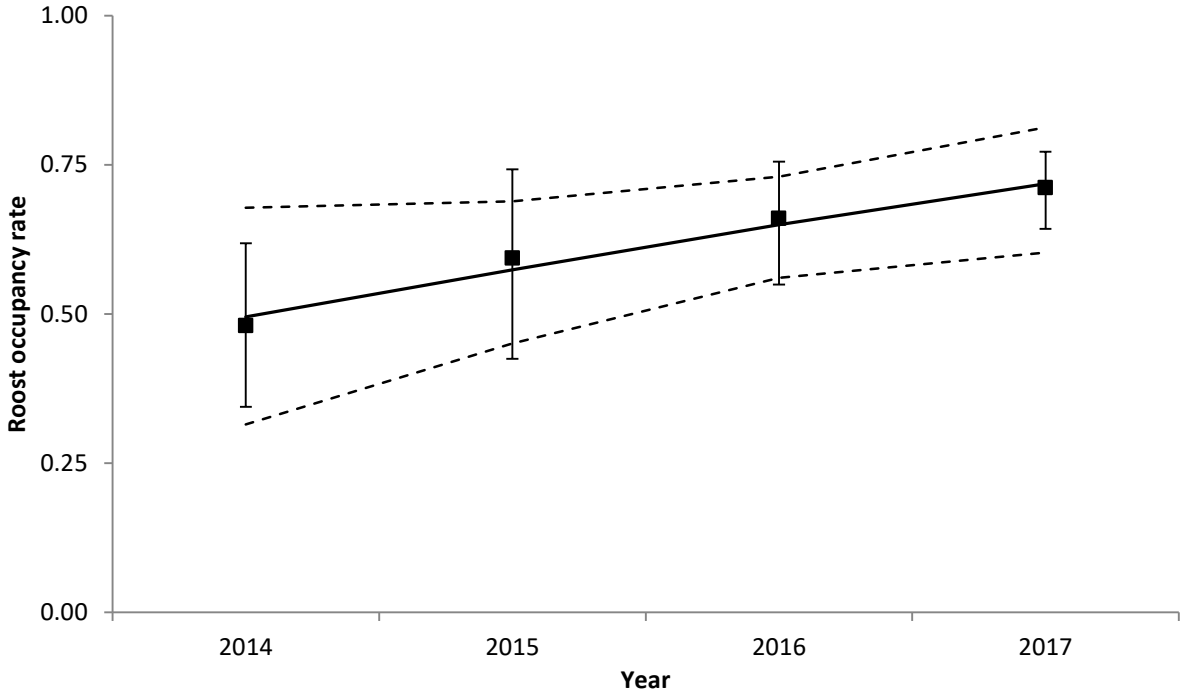

Figure 12: Roost occupancy rate (filled symbols with standard error) for FRTBCs in the Northern Darling Scarp and Plateau (2014 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

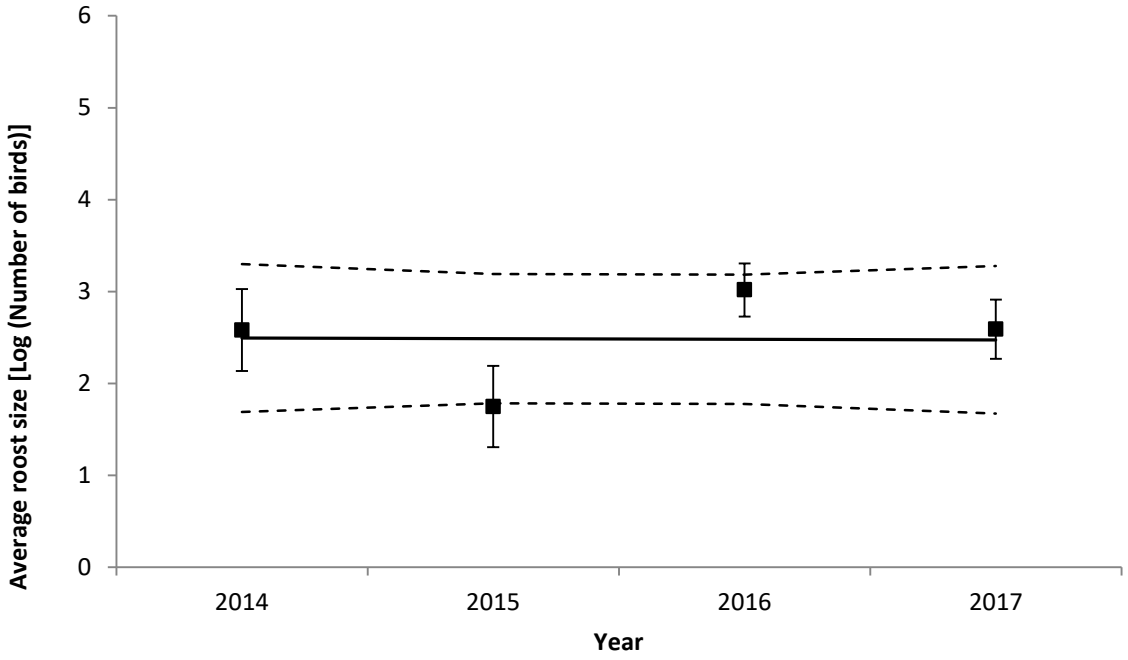

Figure 13: Average roost size (filled symbols with standard errors, log scale) for FRTBCs in the Northern Darling Scarp and Plateau (2014 – 2017), with trend (solid line) and 95% confidence interval (dashed line), estimated using a log-linear zero-inflated regression model.

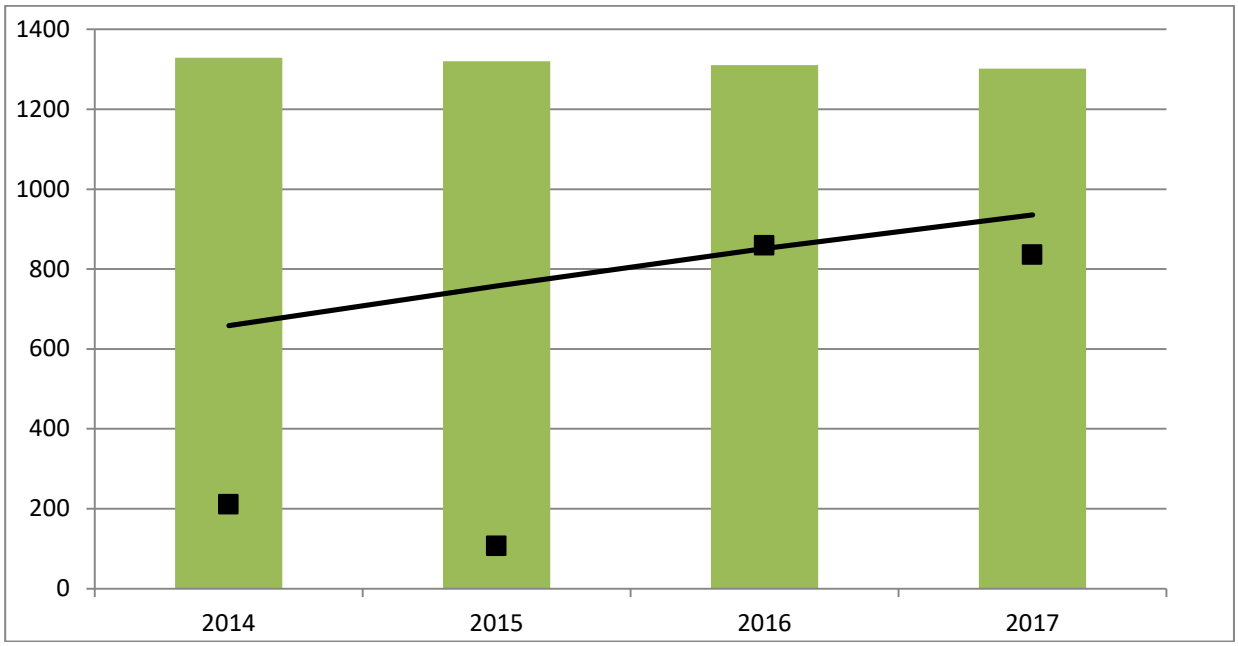

Figure 14: Trends in the abundance of FRTBCs in the Northern Darling Scarp and Plateau region 2014-2017: assuming all roosts are occupied (bars), the estimated trend in average roost count, after accounting for roosts that were either not occupied or not surveyed, on the night of the Great Cocky Count (solid line) and actual roost counts for the region (squares).

F. Baudin's Black-Cockatoo

The estimated number of Baudin's counted has varied between 314 and 1,997 over the last eight GCCs, with an average of 1,029.

Table 7: Roost count summary for Baudin's Black-Cockatoo across eight Great Cocky Counts (2010-2017). The counts are corrected to account for the mixed flocks of Baudin's and Carnaby's Black-Cockatoos. 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

*** Assumption of 20% Carnaby's and 80% Baudin's**

 # Assumption of 40% Carnaby's and 60% Baudin's

	2010	2011	2012	2013	2014	2015	2016	2017
No. of Baudin's Black-Cockatoo counted in **Northern Darling Scarp and Plateau** (corrected)	1543* (total WT count = 1929; 15 roosts)	314* (total WT count = 393; 13 roosts)	661* (total WT count = 826; 15 roosts)	813* (total WT count = 1016; 14 roosts)	836# (total WT count = 1393; 13 roosts)	324# (total WT count = 540; 9 roosts)	1997* (total WT count = 2496; 29 roosts)	1744* (total WT count = 2180; 27 roosts)

IV. DISCUSSION

Community Engagement and Training

Participation in the 2017 count

The 2017 Great Cocky Count included almost 900 registered volunteers and is likely to have exceeded 1,500 participants overall, making this year's survey the largest to date and one of the largest citizen science surveys in Australia. Volunteers surveyed 469 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 (>40 participants) groups at Murdoch University and Salter Point (Aquinas College).

Workshops

About 350 people attended training workshops in 2017. While not all workshop attendees participated in the 2017 GCC, most had either participated in a previous GCC or had attended a training workshop. Informal feedback from GCC participants and NRM staff indicated strong support for holding workshops 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.

Figure 15: North Dandalup Primary School workshop. 130 enthusiastic students attended! Photo: A. Peck.

Volunteer retention

More than 2,500 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 2012-2017 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 survey 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 fallen in the last two years and we expect this trend to continue in future years (Table 8). A survey of volunteers after the count showed that an overwhelming majority (94%) enjoyed participating in the GCC and 99% said they would participate in the future. However, 3% of respondents expressed disappointment and 4% felt instructions on counting and how to locate their site were poor (Appendix VI). This is an issue which needs to be remedied and each year we endeavour to do this.

Table 8: Nil results as a percentage of all sites surveyed

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

Figure 16: Part of the mega roost counting team. Photo: John Clarke

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 2017 included an online registration form with confirmation email and the further development of a set of observer instructions for each roost site based on previous observer comments. Strategies under consideration for improving future GCCs include:

- GCC campouts where city volunteers will be able to travel to regional sites to survey
- development of a GCC FAQ sheet to answer people's questions
- online booking of some survey sites to be trialled
- more information on land tenure and land owner contact details to be given to counters
- more details given to counters on other nearby roost sites being surveyed
- improving volunteer understanding of roost sites and the importance of zero counts
- 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 contrast, 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 had declined steadily between 2013 and 2015, but the last two years have seen many new sites confirmed. 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) have also identified previously unknown sites within the Perth-Peel Coastal Plain and Northern Darling Scarp and Plateau over the last three years. Current research at Murdoch University led by Dr Kris Warren has identified many new roosts by radio tracking of 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. This will be an ongoing source of new roosts into the future.

It is likely that important 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. Additional roosts also continue to be identified within the northern portions of the Northern Darling Scarp and Plateau, particularly between Gidgegannup and Bindoon. 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).

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 roost sites discovered has declined steadily, suggesting that the GCC surveys a substantial fraction of the occupied roosting sites for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain and, thus, of the birds present in the region at the time of the survey. 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 Gnangara 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

In the past some people have expressed the view that the timing of the GCC should be moved. This is because in some areas of WA black-cockatoos are not present or are present in low numbers in April. 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 this area. The charts in Appendix VII show monthly counts for the Gingin town site roost (GINGINR001) in 2016 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 115 in early September and a high of 1023 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 move to the Wheatbelt to breed between June and December). The data show that April is a good time to do a survey of the population, as they are present in high numbers at this time of year. The timing may be less appropriate for other areas and may change from year to year depending on availability of food and water. For example, in the Capes region there is anecdotal evidence of Black-Cockatoos leaving coastal areas earlier than in previous years due to unusually high rainfall in the summer of 2016/17. This may account for lower roost counts in the area in the 2017 GCC (pers comm. Boyd Wykes). The availability of food and water may also be affected by climate change, since rainfall and temperature 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 requires data to be collected at a consistent time every year.

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

Based on the 2017 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 suggests that the total population size of Carnaby's Black-Cockatoo is around 40,000 individuals (DPaW 2013, p. 7), meaning that at least 27% of the species' population occurred within the Perth-Peel Coastal Plain at the time of the 2017 count.

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

A species population of 40,000 birds means that at least 19% of the species occurred within the remaining portions of the Gnangara pine plantation in early April 2017.

(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 (>90 birds) include the Gingin townsite; 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; Gosnells Golf Club in Canning Vale; Preston Beach; Star Swamp in North Beach and the City of Stirling Nursery in Karrinyup. Some of these sites were unoccupied in 2017 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 frequently between roosts, rather than occupying them consistently .

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

Each successive GCC has recruited more volunteers 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 utilising the Gnangara pine plantation, which is currently being cleared at 1,000ha per year, with five confirmed roosts in the Gnangara plantation cleared in the last two years. This clearing may have contributed to the congregation of birds at the 'mega roost' (GINYEAR003). This roost is in one the few remaining large contiguous areas of uncleared pines. In summary, as more habitat is lost and more volunteers are surveying, the likelihood of overlooking large roosts is decreasing.

Another theory is that extensive bush fires in the South West of WA have contributed to the concentration of birds to remaining unburnt sites. Recent fires in Yarloop and Moore River may have caused birds to move to the Gnangara 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 is experiencing ongoing decline. Trend analysis of roost counts over the last eight GCCs found a current rate of decline of an estimated 11% per year. When restricted to the larger, more stable roosts, the decline was still estimated at 0-5%. From these results, we conclude that the population of Carnaby's Black-Cockatoo on the Perth-Peel Coastal Plain continues to decline at a rate of around 5-11% per annum, slightly lower than trends estimated in previous years (e.g. Byrne *et al*. 2015; Peck *et al*. 2016). Should this trend continue, it is of serious concern for the future viability of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain.

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 Perth-Peel Coastal Plain region, or the displacement of birds from existing to new roost sites. 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 all of these factors, until a better understanding of the demographics of Carnaby's Black-Cockatoo emerges.

The significance of the Gnangara 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 are 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. 7,450 Carnaby's Black-Cockatoos (73%) were recorded in roosts within or associated with the Gnangara/Yanchep/Pinjar pine plantations in the 2017 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 Gnangara pine plantation, including flocks of 7,000 in Mariginiup in March 2004, 2,000 in Ellenbrook in February 2005, 3,000 in Gnangara 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 Gnangara pine plantation in April 2006, as part of the 2006 GCC.[11] 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. Given these records, and their consistency with the count recorded for the Gnangara plantation system in the 2017 GCC, it is clear that several thousand Carnaby's Black-Cockatoos feed within the Gnangara pine plantation each year.

GCCs prior to 2016 may have underestimated the number of birds present in the Gnangara pine plantation as it is problematic to survey, for several reasons. Firstly, the plantation currently covers an area of 6,000 ha and extends for over 50 km from north to south. Secondly, the density of the pine stands makes it difficult to obtain clear sightlines for 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, creating issues of access and volunteer safety. Finally, Carnaby's Black-Cockatoos may shift between roosting locations, both from day to day and from year to year, making it problematic to select survey sites and allocate observers. 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.

Harvesting without replacement of the remaining pines in the Gnangara plantation will remove a food source that currently supports a substantial portion (at least 19%) of the Carnaby's Black-Cockatoo population between January-April each year. The impact of this loss should not be underestimated, particularly given that extensive

[11] Another 574 Carnaby's Black-Cockatoo roosted in the Karnup pine plantation in Baldivis which is now cleared.

areas of Banksia woodland are also scheduled for removal, and the species is already listed as endangered. The loss of the pine food resource is readily described as an impact that is "important, notable or of consequence, having regard to its context or intensity"[12] and easily meets several of the significant impact criteria proposed for species listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in the most recent guidelines (DSEWPAC 2012, Department of the Environment 2013). The main reason for removing the pines is to replenish the ground water in the Gnangara aquifer, which has decreased alarmingly over recent years (CSIRO 2009). Also, State timber agreements for the Gnangara area are binding. The State Government is currently undertaking a strategic assessment of the impacts of proposed development in the Perth and Peel regions[13], with the intention of avoiding, mitigating and offsetting the impacts of habitat removal on Carnaby's Black-Cockatoos.

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

Based on data from the last four 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). 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.

[12] This is the interpretation of 'significant impact' stated by Branson J in *Booth v Bosworth* [2001] FCA 1453 and which appears in the significant impact guidelines for the *Environment Protection and Biodiversity Conservation Act 1999* prepared by the Commonwealth Department of the Environment (Department of the Environment 2013).

[13] For information on the Green Growth Plan of the Perth & Peel Regions, see: http://www.environment.gov.au/node/18607

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 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. This has accounted for the varying proportions used to estimate the number of Carnaby's and Baudin's in the Northern Darling Scarp and Plateau. Further work is required to clarify the variation in the proportions of Baudin's and Carnaby's Black-Cockatoos at roosts in the Northern Darling Scarp and Plateau. A few volunteers recorded audio of calls at roosts on GCC day this year, but the results were not of sufficient quality or quantity to analyse. Next year a more accurate analysis of this issue will be developed.

(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 18%, 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 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 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 the last two consecutive years at 56 regional sites, for the last three consecutive years at 24 sites and for the last four years at 21 sites.

Some initial inferences can therefore 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 lower abundances, along the southern Swan Coastal Plain south of Lake Preston with roosts occurring near pine plantations (e.g. Myalup) 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 were recorded in the Stirling Range National Park.

Counts at seven large roosts (>200 birds) accounted for two thirds of white-tailed black-cockatoos recorded in regional areas in the 2017 GCC (3309 of 5029 birds or 66%). 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 would provide valuable information about population trends in regional areas.

Forest Red-tailed Black-Cockatoo

Identification of roost sites for FRTBC

The 2017 GCC built on the previous year's GCC as the only broad-scale survey for the Forest Red-tailed Black-Cockatoo, with volunteers documenting 95 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 2017 GCC. This is the result of an increased focus on this species by BirdLife Australia, with the recruitment of a "Cockies in Crisis" Project Coordinator. It is also the result of roost site information from Sam Rycken and Karen Riley at Murdoch University. There are now 152 known roost sites for FRTBC.

This year, 19 of the 95 FRTBC roosts were also occupied by White-tailed Black-Cockatoos (e.g. SWAMELR001 and SERBYFR004). Also, FRTBC roosts sometimes occur very close to Carnaby's Black-Cockatoo roosts. Examples of the latter situation include the FRTBC roost in Kensington (VICKENR002) and the Carnaby's Black-Cockatoo roost site in Dawesville (MANDAWR002).

Distribution of FRTBC in the Perth metropolitan area

The 2017 GCC showed a large increase in numbers of FRTBC roosting in the Perth-Peel region (1,934 birds compared to an average of 559 between 2014 and 2016). Observations from the 2014 to 2017 GCCs confirmed roosts in 19 LGAs in the Perth-Peel Coastal Plain, with unconfirmed roosts reported in another five. Volunteers recorded sizable counts at Murdoch University, Floreat, Morley, Yokine, Ballajura, Melaleuca, Kensington and Jandabup. These counts are much larger than flock sizes reported for FRTBC in forested regions (Abbott 1998, Lee *et al.* 2013). Indeed, the average roost size of 50 for the Perth-Peel region is much higher than that of regional areas (12).

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 2017 GCC demonstrate the extent of this expansion onto the Swan Coastal Plain and suggest 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). 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 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.

There is evidence that FRTBC may be replacing white-tailed black-cockatoos at some roost sites. 23 former confirmed white-tailed black-cockatoo roost sites are now only used by FRTBC (Appendix Vd). 13 of these are in the Perth-Peel Coastal Plain and this reflects the trend of FRTBC frequenting this area more over the last decade.

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. Breeding data from 2016 show a decline in breeding success (Johnstone *et al*, 2017). This suggests that the increase in numbers is more likely to be due to a redistribution of birds from other areas.

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 eight GCCs, involving more than 2500 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 on 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 roosts and feeding habitat. These are tangible successes and reflect the contributions of hundreds 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 2017 GCC and the trend analyses of the eight GCCs 2010 – 2017 identified several issues that have important implications for black-cockatoo conservation efforts. Firstly, there are indications that the population of Carnaby's Black-Cockatoo inhabiting the Perth-Peel Coastal Plain continues to decline. 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 roosting Carnaby's Black-Cockatoo will be partly due to the removal of these pine plantations. Finally, Forest Red-tailed Black-Cockatoos now occur through the urban portions of the Perth-Peel metropolitan area, with significant roosts in several urban locations. These findings provide an important focus for decision-making about the future of the Gnangara pine plantation, the conservation of urban and peri-urban Banksia woodland, and the protection of roosts and food resources throughout the region.

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APPENDIX I: The 2017 Great Cocky Count survey form

Name of lead observer(s):	**Telephone:**	**Email:**
Name of additional observer(s):	**Telephone:**	**Email:**

Date:	9 April 2017	**Start time:**		**Finish time:**	
Site code:		**GPS location:**	**Latitude**		**Longitude**
Site Address / Location:					

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

☐Pine ☐Eucalypt ☐Marri ☐Jarrah ☐Tuart Other: _____ ☐Not Known

White-Tailed Black-Cockatoos Count **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, ...)*	**Sub-totals**
Total Number of White-Tailed Cockatoos at the Roost	
General direction from which cockatoos arrived:	☐North ☐South ☐East ☐West ☐Other (e.g. SW): _____

Red-Tailed Black-Cockatoos Count **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, ...)*	**Sub-totals**
Total Number of Red-Tailed Cockatoos at the Roost	
General direction from which cockatoos arrived:	☐North ☐South ☐East ☐West ☐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

via post:

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

How to Do a Roost Count

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 <u>at least</u> 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 <u>ALL</u> 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:

via email: greatcockycount@birdlife.org.au

via post: Adam Peck, Great Cocky Count Coordinator
BirdLife Australia, Peregrine House, 167 Perry Lakes Drive,
Floreat, WA 6014

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 when 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, beware of traffic.

For inquiries about the 2017 Great Cocky Count please contact Adam Peck, Great Cocky Count Coordinator, at greatcockycount@birdlife.org.au or (08) 9287 2251.

APPENDIX II: Number of sites surveyed across local government areas (2017)

Appendix IIa: Number of roost sites surveyed, occupied roosts and total counts of White-tailed Black-Cockatoos in the 2017 GCC.

Shire	N sites surveyed	N sites occupied	Total count	Shire	N sites surveyed	N sites occupied	Total count
Regional areas							
Albany	15	8	935	**Gingin**	1	1	855
Augusta-Margaret River	22	12	209	**Gnowangerup**	2	1	187
Bindoon	1	0	0	**Harvey**	6	2	134
Bridgetown-Greenbushes	6	2	32	**Kojonup**	1	1	48
Bunbury	4	4	128	**Manjimup**	2	0	0
Busselton	15	6	196	**Nannup**	1	1	16
Capel	9	3	67	**Narrogin**	1	0	0
Carnamah	1	0	0	**Plantagenet**	4	3	285
Chapman Valley	4	0	0	**Ravensthorpe**	1	0	0
Dandaragan	5	2	374	**Toodyay**	1	0	0
Dardanup	3	1	20	**West Arthur**	1	0	0
Donnybrook-Balingup	9	3	43	**Williams**	1	0	0
Esperance	8	5	1500				
Greater Perth-Peel region							
Armadale	20	3	79	**Mosman Park**	1	0	0
Bayswater	6	0	0	**Mundaring**	28	7	953
Belmont	3	0	0	**Murray**	3	3	67
Beverley	1	1	19	**Nedlands**	8	2	338
Boddington	8	0	0	**Northam**	2	1	52
Cambridge	6	1	281	**Rockingham**	4	0	0
Canning	7	0	0	**Serpentine-Jarrahdale**	27	6	576
Chittering	2	0	0	**South Perth**	4	1	289
Claremont	2	0	0	**Stirling**	16	3	36
Cockburn	21	3	84	**Subiaco**	4	0	0
Fremantle	1	0	0	**Swan**	29	6	426
Gingin	6	5	4498	**Toodyay**	3	2	99
Gosnells	9	0	0	**Victoria Park**	9	0	0
Joondalup	10	1	110	**Vincent**	4	0	0
Kalamunda	30	7	560	**Wandering**	1	0	0
Kings Park	5	1	8	**Wanneroo**	32	10	3665
Kwinana	6	2	78	**Waroona**	4	0	0
Mandurah	6	3	156	**Williams**	1	0	0
Melville	15	1	54	**York**	1	0	0

Appendix IIb: Number of roost sites surveyed, occupied roosts and total counts of Forest Red-tailed Black-Cockatoos in the 2017 GCC.

Shire	N sites surveyed	N sites occupied	Total count	Shire	N sites surveyed	N sites occupied	Total count
Regional areas							
Albany	15	3	29	**Gingin**	1	0	0
Augusta-Margaret River	22	2	56	**Gnowangerup**	2	0	0
Bindoon	1	1	15	**Harvey**	6	3	38
Bridgetown-Greenbushes	6	2	32	**Kojonup**	1	0	0
Bunbury	4	0	0	**Manjimup**	2	0	0
Busselton	15	0	0	**Nannup**	1	0	0
Capel	9	2	17	**Narrogin**	1	0	0
Chapman Valley	4	0	0	**Plantagenet**	4	2	10
Dandaragan	5	0	0	**Ravensthorpe**	1	0	0
Dardanup	3	1	2	**Toodyay**	1	0	0
Donnybrook-Balingup	9	2	20	**West Arthur**	1	0	0
Esperance	8	0	0	**Williams**	1	0	0
Greater Perth-Peel region							
Armadale	20	8	105	**Mosman Park**	1	0	0
Bayswater	6	2	138	**Mundaring**	28	10	176
Belmont	3	0	0	**Murray**	3	0	0
Beverley	1	1	83	**Nedlands**	8	0	0
Boddington	8	1	18	**Northam**	2	1	8
Cambridge	6	1	261	**Rockingham**	4	1	5
Canning	7	2	16	**Serpentine-Jarrahdale**	27	8	128
Chittering	2	2	95	**South Perth**	4	0	0
Claremont	2	0	0	**Stirling**	16	2	244
Cockburn	21	4	71	**Subiaco**	4	0	0
Fremantle	1	1	38	**Swan**	29	7	349
Gingin	6	0	0	**Toodyay**	3	2	59
Gosnells	9	4	194	**Victoria Park**	9	2	161
Joondalup	10	0	0	**Vincent**	4	0	0
Kalamunda	30	8	167	**Wandering**	1	1	7
Kings Park	5	0	0	**Wanneroo**	32	3	113
Kwinana	6	1	75	**Waroona**	4	2	10
Mandurah	6	0	0	**Williams**	1	1	15
Melville	15	2	234	**York**	1	0	0

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

Appendix IIIa: Great Cocky Count (2010-2017) 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	Totals
ARMFORR001	Forrestdale	.	.	.	0	0	18	0	0	18
ARMHARR001	Harrisdale	.	0	0	.	0	1	3	0	4
ARMKELR001	Kelmscott	14	0	0	0	0	.	.	.	14
CAMCITR001	City Beach	.	.	.	.	2	0	0	0	2
CAMFLOR001	Floreat	237	151	148	157	159	86	239	281	1458
CANFERR001	Ferndale	.	.	.	5	0	0	0	0	5
CANWILR001*	Willetton	0	0	0	0	68	0	0	0	68
CLASWAR001	Swanbourne	.	.	0	0	3	0	0	0	3
COCBANR001*	Banjup	.	.	.	.	.	45	.	0	45
COCBANR002*	Banjup	.	.	.	.	53	.	0	0	53
COCBANR003	Banjup	.	.	.	.	.	.	.	6	6
COCCOOR005	Coolbellup	.	.	.	.	.	.	.	38	38
COCHAMR001	Hamilton Hill	0	169	215	0	168	68	101	0	721
COCHAMR002	Hamilton Hill	.	.	.	.	.	263	194	0	457
COCSCCR001	Success	252	cleared	cleared	cleared	cleared	cleared	cleared	cleared	252
COCSCCR002	Success	15	3	cleared	cleared	cleared	cleared	cleared	cleared	18
COCSPER001	Spearwood	0	2	.	323	.	0	0	40	365
COCSPER002	Spearwood	.	5	0	.	.	0	24	0	29
GINGINR001	Gingin	392	378	432	686	879	784	1023	880	5454
GINNEER001	Neergabby	.	.	.	.	.	.	70	.	70
GINNEER002	Neergabby	.	.	.	.	.	.	.	34	34
GINWANR001	Wanerie	0	0	.	.	0	.	.	50	50
GINWOOR001	Woodridge	113	119	0	30	0	0	0	0	262
GINYEAR001	Yeal	.	.	387	.	782	.	.	6	1175
GINYEAR002	Yeal	49	92	.	.	.	20	.	.	161
GINYEAR003	Yeal	.	.	.	.	.	750	4897	3528	9175
GOSCNVR001*	Canning Vale	0	19	.	.	0	0	0	0	19
GOSCNVR002*	Canning Vale	.	.	26	52	0	0	151	0	229
GOSHUNR001	Huntingdale	0	0	.	0	0	0	0	.	0
GOSSOUR002*	Southern River	.	.	.	.	.	.	50	0	50
JOODUNR001	Duncraig	.	.	60	0	0	17	43	110	230
JOOEDGR001	Edgewater	0	0	.	0	0	23	0	0	23
JOOPADR001	Padbury	0	.	1	17	7	7	0	0	32
JOOWARR001	Warwick	0	60	.	0	0	0	0	0	60
KINPERR001	Perth	0	.	0	.	0	0	0	8	8
KWICASR001*	Casuarina	2	.	.	0	19	.	.	0	21
KWIWANR001	Wandi	63	0	0	1	0	0	0	0	64
KWIWANR002	Wandi	.	.	.	0	0	0	0	5	5
KWIWANR004	Wandi	.	.	.	.	.	.	.	73	73
KWIWELR001*	Wellard	.	.	15	50	0	62	0	0	127
MANCOOR002*	Coodanup	.	.	.	21	0	0	2	0	23
MANDAWR002*	Dawesville	371	199	11	0	257	135	214	86	1273
MANDAWR004	Dawesville	159	.	.	0	24	22	0	61	266

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
MANDAWR005	Dawesville	.	30	.	0	0	0	0	.	30
MANDAWR006	Dawesville	.	.	.	.	.	11	132	0	143
MANDAWR007*	Dawesville	.	.	.	.	.	277	167	9	453
MANDUDR001	Dudley Park	.	0	0	cleared	cleared	cleared	cleared	cleared	0
MELBATR001	Bateman	8	0	0	0	0	0	0	0	8
MELKARR002	Kardinya	0	0	0	.	0	55	0	0	55
MELLEER001*	Leeming	0	0	12	0	70	0	0	0	82
MELMURR001*	Murdoch	700	60	142	127	234	24	78	0	1365
MELWINR001	Winthrop	.	56	81	70	41	0	21	0	269
MELWINR003	Winthrop	117	130	.	.	.	0	7	54	308
MELWINR004	Winthrop	0	0	0	0	2	0	0	0	2
NEDDALR003	Dalkeith	40	90	0	0	0	0	0	0	130
NEDNEDR001	Nedlands	73	103	304	183	114	106	216	242	1341
NEDNEDR002	Nedlands	.	.	.	.	0	11	0	0	11
NEDNEDR003	Nedlands	.	.	.	.	0	2	33	96	131
ROCBALR001	Baldivis	346	.	cleared	cleared	cleared	cleared	cleared	cleared	346
ROCBALR003*	Baldivis	.	78	0	4	0	0	0	.	82
ROCBALR004	Baldivis	.	40	0	0	0	.	0	0	40
ROCBALR005	Baldivis	.	.	.	0	0	0	0	0	0
ROCKARR001	Karnup	.	cleared	cleared	cleared	cleared	cleared	cleared	cleared	0
ROCSECR001	Secret Harbour	0	.	0	0	6	0	0	.	6
SERBYFR004*	Byford	.	.	.	.	.	.	111	7	118
SERDARR001*	Darling Downs	.	.	.	.	.	.	8	0	8
SERKEYR001	Keysbrook	0	.	.	100	3	14	53	0	170
SERMUNR002*	Mundijong	.	.	.	.	.	.	10	12	22
SEROAKR001	Oakford	0	110	.	0	0	.	.	0	110
SEROAKR002*	Oakford	0	0	0	2	.	.	.	0	2
SEROAKR003	Oakford	167	0	0	0	0	0	.	.	167
SEROAKR004	Oakford	45	3	0	0	50	0	26	2	126
SEROAKR005	Oakford	31	0	.	0	0	0	0	0	31
SEROAKR007	Oakford	.	.	.	.	.	.	.	2	2
SERWELR002	Wellard	.	.	.	.	.	.	.	298	298
SERWHIR001	Whitby	.	.	.	.	.	.	34	.	34
SOUCOMR001	Como	408	645	558	301	402	460	242	289	3305
SOUSALR001*	Salter Point	12	0	0	0	5	0	0	0	17
SOUSOUR002	South Perth	0	35	0	0	0	0	0	0	35
STIHAMR001	Hamersley	.	.	.	.	0	.	24	0	24
STIINNR001	Innaloo	0	.	0	0	0	0	0	3	3
STIKARR001	Karrinyup	.	.	.	121	92	2	45	10	270
STIMENR001	Menora	.	.	.	0	0	0	0	0	0
STINORR001	North Beach	0	230	0	267	0	6	0	23	526
STIYOKR001	Yokine	.	0	0	0	.	.	0	0	0
SUBSHER001	Shenton Park	0	0	0	9	0	0	0	0	9

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
SWABALR001	Ballajura	0	40	0	92	0	35	0	0	167
SWABALR004	Ballajura	0	.	.	.	0	5	105	0	110
SWABULR003	Bullsbrook	.	.	.	.	.	.	8	0	8
SWABULR004	Bullsbrook	.	.	.	.	.	.	0	5	5
SWAELLR001	Ellenbrook	.	.	.	.	14	.	280	0	294
SWAHENR002	Henley Brook	.	.	.	.	.	.	.	50	50
SWALEXR001	Lexia	0	80	0	0	181	0	0	0	261
SWALEXR002	Lexia	185	0	.	0	0	0	cleared	cleared	185
SWAMELR001*	Melaleuca	500	41	0	20	480	0	.	268	1309
SWAMELR002	Melaleuca	0	.	cleared	cleared	cleared	cleared	cleared	cleared	0
SWAMILR001	Millendon	.	.	.	.	0	.	250	0	250
SWAVINR003*	The Vines	.	.	.	.	.	.	21	0	21
SWAWHIR001*	Whiteman	.	69	13	.	.	0	0	7	89
VICVICR001	Victoria Park	2	0	0	0	0	0	6	0	8
WANCARR001	Carabooda	.	.	2	.	.	0	0	.	2
WANCARR004	Carabooda	.	.	.	.	7	.	.	.	7
WANCRRR001	Carramar	.	.	.	191	0	0	0	0	191
WANGNAR001	Gnangara	0	.	.	.	0	.	454	316	770
WANGNAR003	Gnangara	0	14	0	0	0	0	0	0	14
WANGNAR004	Gnangara	27	0	0	0	0	0	0	0	27
WANGNAR005*	Gnangara	.	.	.	100	0	14	0	260	374
WANGNAR006*	Gnangara	.	.	.	.	40	.	3	6	49
WANJANR002	Jandabup	.	.	.	.	.	0	.	.	0
WANJANR004	Jandabup	0	.	.	.	.	.	.	0	0
WANJANR005	Jandabup	0	.	0	.	.	.	cleared	cleared	0
WANJANR007	Jandabup	.	16	.	0	.	0	cleared	cleared	16
WANMARR001	Mariginiup	0	20	.	0	.	71	0	770	861
WANMARR002	Mariginiup	0	.	2	3	3	0	0	0	8
WANMARR003	Mariginiup	542	152	10	16	147	280	4	1260	2411
WANMARR004	Mariginiup	0	0	0	.	.	.	.	8	8
WANNEER001	Neerabup	.	29	.	.	0	.	0	.	29
WANNEER002	Neerabup	604	0	0	0	0	0	0	0	604
WANNOWR001	Nowergup	.	.	35	10	0	0	0	4	49
WANNOWR005	Nowergup	0	.	.	.	.	.	3	0	3
WANPINR001	Pinjar	.	.	853	35	1521	616	1232	900	5157
WANPINR002	Pinjar	.	312	276	0	138	101	0	0	827
WANPINR003	Pinjar	64	0	0	0	0	0	0	0	64
WANPINR005	Pinjar	275	.	.	.	0	0	cleared	cleared	275
WANPINR006	Pinjar	13	0	0	0	2	0	0	0	15
WANPINR007	Pinjar	0	0	0	0	.	.	0	.	0
WANPINR010	Pinjar	.	0	.	.	0	.	.	cleared	0

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
WANPINR011	Pinjar	0	.	.	800	0	179	0	0	979
WANTAMR001	Tamala Park	.	.	0	103	20	10	0	0	133
WANTWOR001	Two Rocks	0	.	7	573	200	30	0	0	810
WANWANR001	Wanneroo	0	11	6	0	0	0	0	0	17
WANYANR001	Yanchep	61	.	.	.	450	82	0	.	593
WANYANR003	Yanchep	.	16	0	564	0	0	0	0	580
WANYANR004	Yanchep	.	0	0	192	0	0	cleared	cleared	192
WANYANR006	Yanchep	342	305	129	0	0	0	0	136	912
WANYANR007	Yanchep	.	0	0	.	0	.	173	0	173
WANYANR008	Yanchep	.	.	.	.	.	.	.	5	5
WARLAKR001	Lake Clifton	1	0	0	.	.	0	0	.	1
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	40

Appendix IIIb: Great Cocky Count (2010-2017) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page vii) that: (a) are within or immediately adjacent (<1 km) to the **Gnangara pine plantation** (see page vii) 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).

Pine-associated sites: All roost sites in the GCC roost site database (including confirmed roosts, unconfirmed roosts, and potential sites) that are within or immediately adjacent (<1 km) to the Gnangara pine plantation. 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 that year.

Site code	2010	2011	2012	2013	2014	2015	2016	2017	Totals
GINYEAR001	.	.	387	.	782	.	.	6	1175
GINYEAR002	49	92	.	.	.	20	.	.	161
GINYEAR003	.	.	.	.	.	750	4897	3528	9175
SWALEXR001	0	80	0	0	181	0	0	0	261
SWALEXR002	185	0	.	0	0	0	cleared	cleared	185
SWAMELR001*	500	41	0	20	480	0	.	268	1309
WANCARR004	.	.	.	.	7	.	.	.	7
WANGNAR001	0	.	.	.	0	.	454	316	770
WANGNAR003	0	14	0	0	0	0	0	0	14
WANGNAR004	27	0	0	0	0	0	0	0	27
WANGNAR005*	.	.	.	100	0	14	0	260	374
WANGNAR006*	.	.	.	.	40	.	3	6	49
WANJANR007	.	16	.	0	.	0	cleared	cleared	16
WANMARR001	0	20	.	0	.	71	0	770	861
WANMARR002	0	.	2	3	3	0	0	0	8
WANMARR003	542	152	10	16	147	280	4	1260	2411
WANNEER001	.	29	.	.	0	.	0	.	29
WANNEER002	604	0	0	0	0	0	0	0	604
WANPINR001	.	.	853	35	1521	616	1232	900	5157
WANPINR002	.	312	276	0	138	101	0	0	827
WANPINR003	64	0	0	0	0	0	0	0	64
WANPINR005	275	.	.	.	0	0	cleared	cleared	275
WANPINR006	13	0	0	0	2	0	0	0	15
WANPINR007	0	0	0	0	.	.	0	.	0
WANPINR010	.	0	.	.	0	.	.	cleared	0
WANPINR011	0	.	.	800	0	179	0	0	979
WANTWOR001	0	.	7	573	200	30	0	0	810
WANYANR001	61	.	.	.	450	82	0	.	593
WANYANR003	.	16	0	564	0	0	0	0	580
WANYANR004	.	0	0	192	0	0	cleared	cleared	192
WANYANR006	342	305	129	0	0	0	0	136	912
WANYANR007	.	0	0	.	0	.	173	0	173
Total	2662	1077	1664	2303	3951	2143	6763	7450	28013
% of total Perth-Peel Coastal Plain count	42%	28%	44%	41%	59%	46%	62%	73%	67%
No. of pine-associated sites surveyed	19	20	18	21	27	24	23	22	32

Appendix IIIc: Great Cocky Count (2010-2017) roost counts for Carnaby's Black-Cockatoo 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 Black-Cockatoos and Carnaby's Black-Cockatoo. 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	Totals
ARMBEDR001*	Bedfordale	57	0	.	0	0	0	0	6	63
ARMBEDR002*	Bedfordale	70	22	.	3	0	.	0	0	95
ARMBEDR003	Bedfordale	385	.	.	0	0	60	6	3	454
ARMKELR002	Kelmscott	0	10	.	0	0	0	0	0	10
ARMROLR001*	Roleystone	108	13	140	40	0	0	157	70	528
ARMROLR003	Roleystone	.	0	0	50	0	0	0	0	50
ARMROLR004*	Roleystone	.	.	.	.	0	.	28	0	28
BEVFLYR001	Flynn	.	0	0	0	0	0	.	.	0
BEVFLYR002*	Flynn	.	.	.	.	.	.	.	19	19
BODBODR001	Boddington	.	.	.	.	.	.	9	0	9
BODCROR002	Crossman	10	0	.	.	.	3	.	0	13
BODMARR001*	Marradong	.	.	.	.	.	.	16	0	16
BODMARR002	Marradong	.	.	.	.	.	.	141	0	141
KALCARR002	Carmel	.	.	.	.	.	.	.	90	90
KALKALR001	Kalamunda	30	.	25	0	0	0	0	0	55
KALKALR002	Kalamunda	.	25	23	85	28	10	58	107	336
KALKALR004	Kalamunda	.	.	.	.	.	.	65	215	280
KALLESR001	Lesmurdie	.	0	0	0	0	8	0	0	8
KALMAIR003	Maida Vale	.	.	.	.	.	.	0	5	5
KALPICR001	Pickering Brook	.	.	.	.	.	.	.	5	5
KALPICR002*	Pickering Brook	.	.	.	.	2	.	0	0	2
KALPIER001*	Piesse Brook	.	82	46	0	0	0	163	.	291
KALPIER002*	Piesse Brook	.	.	.	.	.	.	.	6	6
KALPIER003	Piesse Brook	.	.	.	.	.	.	97	132	229
KALWALR001*	Walliston	0	5	0	0	0	0	.	0	5
MUNCHIR001	Chidlow	16	0	.	0	0	cleared	cleared	cleared	16
MUNDARR001	Darlington	443	7	147	0	0	0	.	0	597
MUNGLER001	Glen Forrest	.	.	32	51	45	25	65	5	223
MUNGLER002	Glen Forrest	.	.	13	0	0	0	0	0	13
MUNGLER003	Glen Forrest	.	.	.	.	45	.	0	335	380
MUNHELR001*	Helena Valley	.	3	16	42	124	0	44	0	229
MUNHOVR001*	Hovea	.	.	40	0	.	0	0	0	40
MUNHOVR002	Hovea	243	22	10	0	0	0	18	0	293
MUNMTHR001	Mt Helena	.	.	.	8	0	0	0	0	8
MUNMTHR002	Mt Helena	.	.	.	.	0	.	147	0	147
MUNMTHR003*	Mt Helena	.	.	.	.	.	.	24	0	24
MUNMUNR001	Mundaring	78	.	.	85	45	36	0	0	244
MUNPARR002	Parkerville	.	.	.	.	182	.	66	157	405
MUNPARR003*	Parkerville	.	.	.	.	.	.	320	70	390
MUNPARR004*	Parkerville	.	.	.	.	.	.	209	213	422
MUNPARR005*	Parkerville	.	.	.	.	.	.	.	152	152
MUNSTOR001*	Stoneville	.	.	.	.	141	0	7	0	148
MUNSTOR002	Stoneville	.	86	0	.	0	0	0	0	86

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
MUNSTOR003*	Stoneville	.	.	.	.	48	.	30	0	78
MUNSTOR004*	Stoneville	.	.	.	.	.	.	90	0	90
MUNSTOR005*	Stoneville	.	.	.	.	.	.	19	21	40
MURDWER001	Dwellingup	.	40	.	.	.	0	.	8	48
MURDWER002*	Dwellingup	.	.	.	.	0	.	.	45	45
MURNORR001*	North Dandalup	.	.	.	.	.	.	20	14	34
MURTEER001	Teesdale	21	0	0	0	.	0	.	.	21
NORBAKR001	Bakers Hill	217	.	.	.	.	.	94	52	363
NORWOOR001	Woottating/Copley	0	.	.	0	.	.	.	.	0
NORWUNR001*	Wundowie	125	.	8	0	.	0	0	0	133
SERJARR001	Jarrahdale	0	60	0	.	.	0	.	0	60
SERKEYR002*	Keysbrook	25	.	0	30	.	0	.	0	55
SERKEYR003	Keysbrook	.	.	.	.	.	.	.	255	255
SWABULR002*	Bullsbrook	.	18	117	120	328	.	178	0	761
SWAGIDR002	Gidgegannup	101	.	23	40	.	217	129	93	603
SWAGIDR003	Gidgegannup	.	.	3	.	.	.	0	0	3
SWAGIDR004	Gidgegannup	.	.	.	0	.	.	.	.	0
SWAGIDR005	Gidgegannup	.	.	.	197	163	169	152	0	681
SWAGIDR008*	Gidgegannup	.	.	.	.	.	.	0	3	3
TOOMORR001*	Morangup	.	.	183	29	56	12	140	44	464
TOOMORR003*	Morangup	.	.	.	.	.	.	.	55	55
WARWAGR001*	Wagerup	.	.	.	236	186	.	.	.	422
WNDNORR001	North Bannister	.	.	.	.	.	.	4	.	4
YORTALR001	Talbot	.	.	0	0	.	0	0	.	0

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

Appendix IV: Great Cocky Count (2010-2017) 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	Totals
ALBCHER001	Cheynes	.	.	70	.	.	.	.	.	70
ALBCHER002	Cheynes	.	.	0	.	60	0	0	.	60
ALBGOOR001	Goode Beach	.	.	.	84	62	.	0	3	149
ALBGOOR002	Goode Beach	.	111	.	0	120	0	0	0	231
ALBGRER002	Green Valley	.	.	.	.	.	.	.	15	15
ALBKALR001	Kalgan	.	.	213	472	141	73	0	0	899
ALBKALR004	Kalgan	.	.	.	.	.	.	.	760	760
ALBKROR002	Kronkup	.	.	.	.	.	.	.	7	7
ALBLOWR003	Lowlands	.	.	.	.	.	.	.	6	6
ALBMCKR001*	McKail	.	.	33	.	18	0	107	110	268
ALBMETR001	Mettler	.	.	40	145	.	.	.	.	185
ALBMTCR001	Mt Clarence	.	4	.	.	0	0	0	.	4
ALBROBR001	Robinson	.	.	0	43	0	.	0	31	74
ALBSEPR001	Seppings	.	0	0	0	0	2	.	3	5
AUGCHAR002*	Chapman Hill	.	.	.	.	.	.	.	23	23
AUGFORR002*	Forest Grove	.	.	.	.	.	.	6	0	6
AUGGRAR001	Gracetown	.	.	.	.	1	12	2	12	27
AUGGRAR002	Gracetown	.	.	.	7	85	4	26	3	125
AUGHAMR001	Hamelin Bay	.	.	.	.	.	.	0	2	2
AUGMARR001	Margaret River	.	.	11	1	47	0	57	0	116
AUGMARR003	Margaret River	.	.	.	0	0	0	.	0	0
AUGMARR004	Margaret River	.	.	.	.	.	.	6	0	6
AUGMARR006	Margaret River	.	.	.	.	.	.	.	2	2
AUGMARR007	Margaret River	.	.	.	.	.	.	.	5	5
AUGMARR008	Margaret River	.	.	.	.	.	.	.	16	16
AUGMARR012	Margaret River	.	.	.	.	.	.	.	20	20
AUGMARR013	Margaret River	.	.	.	.	.	.	.	13	13
AUGMARR014	Margaret River	.	.	.	.	.	.	.	60	60
AUGROSR001	Rosa Glen	.	.	.	.	.	.	.	46	46
AUGWITR002	Witchcliffe	.	.	.	.	.	.	.	7	7
BRIBRIR003	Bridgetown	.	.	.	.	.	.	.	5	5
BRIGLER001	Glenlynn	.	.	70	250	0	.	.	.	320
BRIGRER003*	Greenbushes	.	.	.	.	.	.	5	0	5
BRINORR001	North Greenbushes	.	.	.	.	74	44	2	.	120
BRINORR002*	North Greenbushes	.	.	.	.	.	.	39	27	66
BUNCOLR001	College Grove	.	.	0	20	0	7	0	22	49
BUNCOLR002	College Grove	.	.	.	.	0	.	0	3	3
BUNGLER001	Glen Iris	.	.	25	0	.	0	0	62	87
BUNGLER002	Glen Iris	.	.	.	8	4	0	.	41	53
BUSCARR001	Carbunup	.	.	.	.	.	.	.	121	121
BUSDUNR001	Dunsborough	.	.	.	32	99	0	0	0	131
BUSDUNR002	Dunsborough	.	.	.	.	.	.	82	8	90

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
BUSJINR002*	Jindong	.	.	.	.	0	.	0	1	1
BUSMEER002	Meelup	.	.	.	.	.	.	.	14	14
BUSMETR002	Metricup	.	.	.	.	.	.	.	22	22
BUSQUIR001	Quindalup	.	.	.	71	107	31	64	30	303
BUSYALR001	Yallingup	.	.	.	0	57	.	.	.	57
BUSYALR004	Yallingup	.	.	.	.	.	.	8	0	8
CAPCAPR001	Capel	.	.	.	.	0	.	.	7	7
CAPGELR001	Gelorup	.	.	38	6	0	0	4	0	48
CAPGELR002*	Gelorup	.	.	.	.	0	21	2	12	35
CAPGWIR001	Gwindinup	194	.	14	0	119	175	216	48	766
CAPNORR001	North Boyanup	.	.	.	4	0	0	26	0	30
CARENNR001	Eneabba	.	.	.	.	.	.	40	.	40
CHANANR001	Nanson	.	.	.	302	262	300	270	0	1134
CHANANR002	Nanson	.	.	.	0	189	.	0	0	189
DANDANR001	Dandaragan	.	.	313	228	460	2	0	144	1147
DANHILR001	Hill River	.	.	160	0	250	0	0	0	410
DANHILR002	Hill River	.	.	136	.	.	11	.	.	147
DANHILR003	Hill River	.	.	.	.	131	.	.	0	131
DANJURR001	Jurien Bay	.	.	51	225	52	143	436	230	1137
DANREGR001	Regans Ford	0	22	0	.	.	.	.	.	22
DAREATR001	Eaton	.	4	19	14	0	0	.	20	57
DENSCOR001	Scotsdale	.	.	.	.	.	.	70	.	70
DONARGR001	Argyle	.	.	.	0	.	0	.	0	0
DONDONR001*	Donnybrook	.	.	.	11	0	0	.	0	11
DONMUMR001	Mumballup	.	29	.	0	.	7	.	.	36
DONMUMR003	Mumballup	.	.	.	.	.	.	0	20	20
DONMUNR001*	Mungalup	.	.	.	.	.	.	4	0	4
DONNOGR001*	Noggerup	.	.	.	.	.	.	0	14	14
DONYABR001	Yabberup	.	.	.	.	.	.	.	9	9
ESPESPR001	Esperance	.	196	226	230	202	.	665	125	1644
ESPESPR002	Esperance	.	.	.	.	.	360	.	0	360
ESPESPR003	Esperance	.	.	.	.	.	60	.	111	171
ESPESPR004	Esperance	.	.	.	.	.	316	.	205	521
ESPMYRR001	Myrup	.	.	555	589	791	0	32	0	1967
ESPMYRR002	Myrup	.	.	1018	0	.	.	.	500	1518
ESPMYRR003	Myrup	.	.	.	.	.	.	.	559	559
GINNILR001	Nilgen	.	.	.	583	376	995	500	855	3309
GNOSTIR001	Stirling Range National Park	.	.	52	.	38	.	.	187	277
GOOGOOR001	Goomalling	.	9	.	.	.	.	0	.	9
HARHARR001*	Harvey	.	.	.	.	0	.	10	.	10
HARLESR001*	Leschenault	.	.	.	.	.	.	14	11	25
HARMYAR001	Myalup	.	0	0	0	35	0	349	0	384
HARMYAR002	Myalup	52	155	cleared	cleared	cleared	cleared	cleared	cleared	207

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	2017	Totals
HARMYAR003	Myalup	.	.	.	.	.	570	33	123	726
HARSUNR001	Harvey	.	.	.	.	.	24	.	.	24
IRWMILR001	Milo	.	.	1	.	0	.	.	.	1
JERBOXR001	Boxwood Hill	.	.	11	0	.	0	.	.	11
KOJKOJR001	Kojonup	.	.	.	.	.	.	.	48	48
MNJCROR001	Crowea	.	.	.	5	0	.	.	0	5
MNJMNJR001*	Manjimup	.	.	.	.	.	.	17	0	17
NANNANR001	Nannup	.	.	.	.	.	.	.	16	16
NARNARR002	Narrogin	.	.	16	19	36	.	21	0	92
NARNARR004	Narrogin	.	.	0	9	.	0	.	.	9
NARNARR005	Narrogin	.	80	0	0	.	.	0	.	80
PLAMOUR001	Mount Barker	.	.	3	0	0	0	.	.	3
PLANARR001*	Narrikup	.	.	.	.	.	.	191	0	191
PLANARR002*	Narrikup	.	.	.	.	45	.	0	.	45
PLAPORR003*	Porongurup	.	.	.	.	.	.	.	9	9
PLAPORR006	Porongurup	.	.	.	.	.	.	.	200	200
PLASTIR001	Stirling Range National Park	.	.	254	316	.	25	.	76	671
RAVHOPR001	Hopetoun	.	.	.	.	30	.	0	0	30
RAVHOPR002	Hopetoun	.	.	.	.	150	.	0	.	150
THRARRR002	Arrino	.	.	.	70	.	.	.	.	70
WARYARR001	Yarloop	.	.	.	.	.	.	36	.	36
WNDWANR001	Wandering	.	.	.	0	.	.	.	.	0

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

Appendix Va: Great Cocky Count (2014-2017) 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	Totals
ARMARMR002	Armadale	.	.	17	.	17
ARMCHAR001	Champion Lakes	.	.	.	11	11
BAYMORR001	Morley	0	0	36	130	166
BAYMORR002	Morley	.	.	.	8	8
CAMFLOR002	Floreat	109	.	49	261	419
CANRIVR001	Riverton	.	.	6	11	17
CANWILR001*	Willetton	4	7	7	5	23
CHIMUCR001	Muchea	.	.	.	43	43
COCBANR001*	Banjup	.	0	.	6	6
COCBANR002*	Banjup	3	.	32	24	59
COCCOOR001	Coolbellup	.	13	0	0	13
COCCOOR003	Coolbellup	.	.	57	6	63
COCMUNR001	Munster	92	.	73	0	165
COCMUNR003	Munster	.	.	38	0	38
COCSPER003	Spearwood	.	.	.	35	35
FREWHIR001	White Gum Valley	0	.	0	38	38
GOSCNVR001*	Canning Vale	2	0	0	0	2
GOSCNVR002*	Canning Vale	0	4	0	0	4
GOSGOSR004	Gosnells	19	.	31	32	82
GOSKENR001	Kenwick	.	.	.	51	51
GOSMARR001	Martin	.	.	.	75	75
GOSSOUR002*	Southern River	.	.	0	36	36
KWICASR001*	Casuarina	0	.	.	75	75
KWIWELR001*	Wellard	0	0	9	0	9
MANCOOR002*	Coodanup	0	0	30	0	30
MANDAWR002*	Dawesville	0	38	0	0	38
MANDAWR007*	Dawesville	.	0	2	0	2
MANPARR001	Parklands	0	.	16	0	16
MELLEER001*	Leeming	0	0	11	25	36
MELMURR001*	Murdoch	199	33	125	209	566
ROCBALR003*	Baldivis	17	25	24	.	66
ROCKARR002	Karnup	.	.	.	5	5
SERBYFR002	Byford	.	.	0	2	2
SERBYFR003	Byford	.	.	6	.	6
SERBYFR004*	Byford	.	.	88	32	120

Site code	Locality	2014	2015	2016	2017	Totals
SERDARR001*	Darling Downs	.	.	26	0	26
SERKEYR004	Keysbrook	.	.	.	14	14
SERKEYR006	Keysbrook	.	.	.	6	6
SERMUNR002*	Mundijong	.	.	0	4	4
SEROAKR002*	Oakford	.	.	.	4	4
SERSERR003	Serpentine	0	0	3	0	3
SERSERR005	Serpentine	.	.	12	0	12
SOUSALR001*	Salter Point	2	0	0	0	2
STIMENR002	Menora	0	.	0	5	5
STIYOKR002	Yokine	0	1	0	.	1
STIYOKR003	Yokine	47	28	0	239	314
SWABALR003	Ballajura	.	.	0	120	120
SWAMELR001*	Melaleuca	0	0	.	129	129
SWAVINR003*	The Vines	.	.	31	5	36
SWAWHIR001*	Whiteman	.	0	0	4	4
VICKENR001	Kensington	94	121	0	116	331
VICKENR002	Kensington	.	35	42	0	77
VICLATR001**	Lathlain	0	0	0	0	0
VICWATR002	Waterford	.	.	0	45	45
WANGNAR005*	Gnangara	0	0	0	7	7
WANGNAR006*	Gnangara	3	.	0	4	7
WANJANR008	Jandabup	.	.	.	102	102
WARLAKR002	Lake Clifton	.	.	.	4	4
WARLAKR003	Lake Clifton	.	.	.	6	6
WARWARR002*	Waroona	10	0	0	0	10

** This roost is a confirmed FRTBC roost due to consistent counts of up to 80 birds outside GCC day.

Appendix Vb: Great Cocky Count (2014-2017) 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	Totals
ARMASHR001	Ashendon	.	.	.	3	3
ARMBEDR001*	Bedfordale	21	0	0	0	21
ARMBEDR002*	Bedfordale	0	.	0	22	22
ARMBEDR004	Bedfordale	.	.	18	6	24
ARMBEDR006	Bedfordale	.	.	.	14	14
ARMROLR001*	Roleystone	0	0	0	9	9
ARMROLR003*	Roleystone	0	0	0	4	4
ARMROLR004*	Roleystone	0	.	35	0	35
ARMROLR005	Roleystone	.	.	0	36	36
BEVFLYR002*	Flynn	.	.	.	83	83
BODMARR001*	Marradong	.	.	16	0	16
BODMARR004	Marradong	.	.	.	18	18
CHICHIR001	Chittering	.	.	.	52	52
KALCARR001	Carmel	.	.	0	12	12
KALHIGR001	High Wycombe	.	.	.	7	7
KALHIGR003	High Wycombe	.	.	0	7	7
KALMAIR002	Maida Vale	25	.	56	98	179
KALMAIR005	Maida Vale	.	.	3	0	3
KALMAIR006	Maida Vale	.	.	.	3	3
KALPICR002*	Pickering Brook	42	.	0	7	49
KALPIER001*	Piesse Brook	0	0	25	.	25
KALPIER002*	Piesse Brook	.	.	.	2	2
KALWALR001*	Walliston	43	1	.	0	44
KALWATR002	Wattle Grove	.	.	150	31	181
MUNCHIR002	Chidlow	12	.	49	65	126
MUNCHIR003	Chidlow	.	.	4	4	8
MUNGLER004	Glen Forrest	.	.	33	4	37
MUNHELR001*	Helena Valley	0	0	4	31	35
MUNHOVR001*	Hovea	.	14	52	21	87
MUNHOVR004	Hovea	.	.	.	3	3
MUNMTHR003*	Mt Helena	.	.	41	0	41
MUNMUNR002	Mundaring	.	20	16	32	68
MUNMUNR003	Mundaring	.	.	59	0	59
MUNPARR003*	Parkerville	.	.	12	8	20
MUNPARR004*	Parkerville	.	.	0	4	4
MUNPARR005*	Parkerville	.	.	.	4	4

Site code	Locality	2014	2015	2016	2017	Totals
MUNSTOR001*	Stoneville	0	24	0	0	24
MUNSTOR003*	Stoneville	0	.	9	0	9
MUNSTOR004*	Stoneville	.	.	3	0	3
MUNSTOR005*	Stoneville	.	.	15	0	15
MUNWOOR001	Wooroloo	17	.	.	.	17
MURDWER002*	Dwellingup	3	.	.	0	3
MURNORR001*	North Dandalup	.	.	26	0	26
NORWUNR001*	Wundowie	.	6	0	8	14
SERJARR002	Jarrahdale	.	.	.	7	7
SERJARR003	Jarrahdale	.	.	30	59	89
SERKEYR002*	Keysbrook	.	37	.	0	37
SWABULR002*	Bullsbrook	0	.	0	26	26
SWAGIDR001	Gidgegannup	.	.	3	0	3
SWAGIDR007	Gidgegannup	.	.	86	44	130
SWAGIDR008*	Gidgegannup	.	.	25	21	46
SWAGIDR009	Gidgegannup	.	.	15	0	15
TOOMORR001*	Morangup	0	5	0	0	5
TOOMORR002	Morangup	.	.	.	36	36
TOOMORR003*	Morangup	.	.	.	23	23
WARWAGR001*	Wagerup	38	.	.	.	38
WILQUIR001	Quindanning	10	.	0	15	25
WNDSPRR001	Springs	.	.	74	7	81

Appendix Vc: Great Cocky Count (2014-2017) roost counts for FRTBC 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.

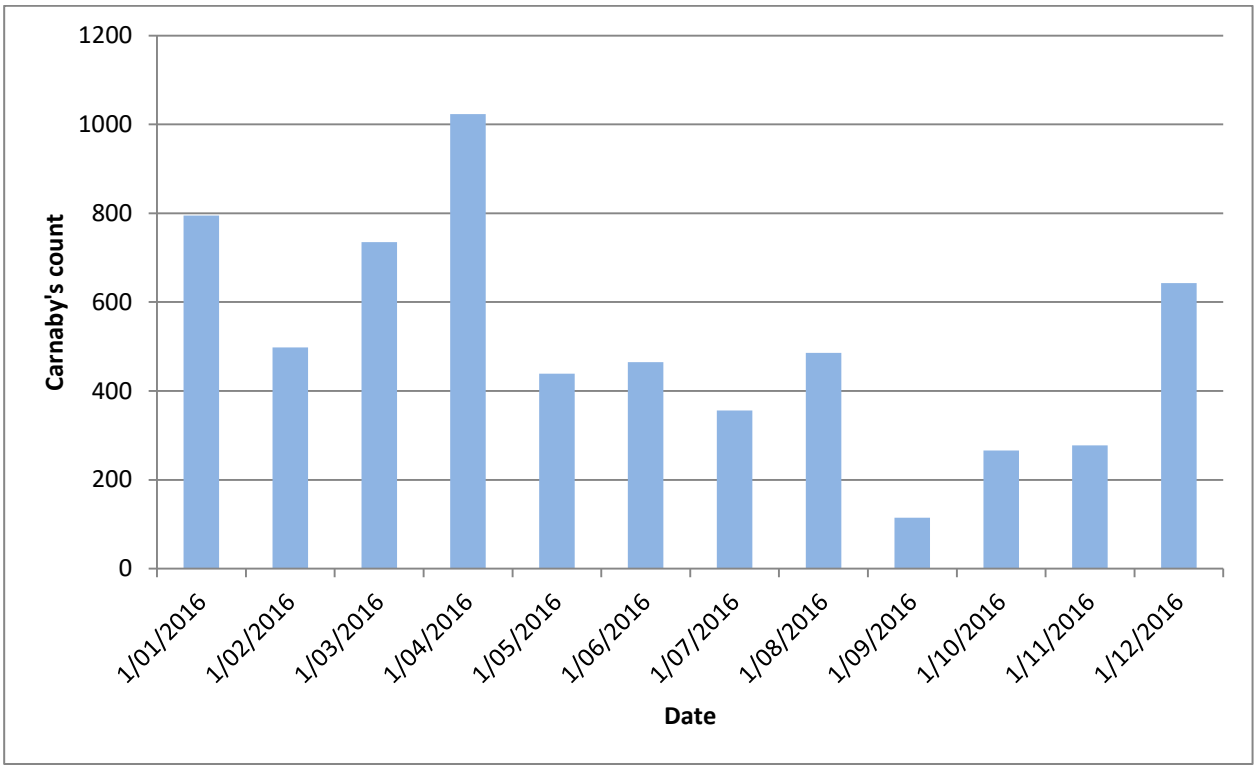
Site code	Locality	2014	2015	2016	2017	Totals
ALBKALR003	Kalgan	.	.	27	12	39
ALBMCKR001*	McKail	0	0	0	10	10
ALBMETR002	Mettler	.	.	.	7	7
ALBTORR003	Torbay	.	2	.	0	2
ALBTORR004	Coffey	.	5	.	.	5
AUGCHAR001	Chapman Hill	.	.	.	21	21
AUGCHAR002*	Chapman Hill	.	.	.	35	35
AUGFORR002*	Forest Grove	.	.	9	0	9
BINBINR002	Bindoon	.	.	.	15	15
BRIGRER002	Greenbushes	20	0	6	27	53
BRIGRER003*	Greenbushes	.	.	7	5	12
BRIGRER004	Greenbushes	.	.	7	0	7
BRINORR002*	North Greenbushes	.	.	1	0	1
BUSJINR002*	Jindong	2	.	0	0	2
BUSQUIR003	Quindalup	.	.	5	.	5
CAPBOYR001	Gwindinup	.	15	10	0	25
CAPFERR001	Ferguson	.	.	.	2	2
CAPGELR002*	Gelorup	0	11	4	15	30
DARBURR001	Burekup	.	.	.	2	2
DONBALR002	Balingup	.	.	.	13	13
DONDONR001*	Donnybrook	14	6	.	0	20
DONLOWR001	Lowden	.	.	3	7	10
DONMUMR002	Mumballup	.	.	7	.	7
DONMUNR001*	Mungalup	.	.	84	0	84
DONNOGR001*	Noggerup	.	.	49	0	49
HARBRUR002	Brunswick	.	.	9	29	38
HARHARR001*	Harvey	6	.	11	.	17
HARLESR001*	Leschenault	.	.	23	7	30
HARROER002	Roelands	3	.	29	0	32
HARROER003	Roelands	.	.	0	2	2
MNJMNJR001*	Manjimup	.	.	16	0	16
PLANARR001*	Narrikup	.	.	0	8	8
PLANARR002*	Narrikup	39	.	29	.	68
PLAPORR003*	Porongurup	.	.	.	2	2
WILQUIR002	Quindanning	.	.	38	0	38

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 >1 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.

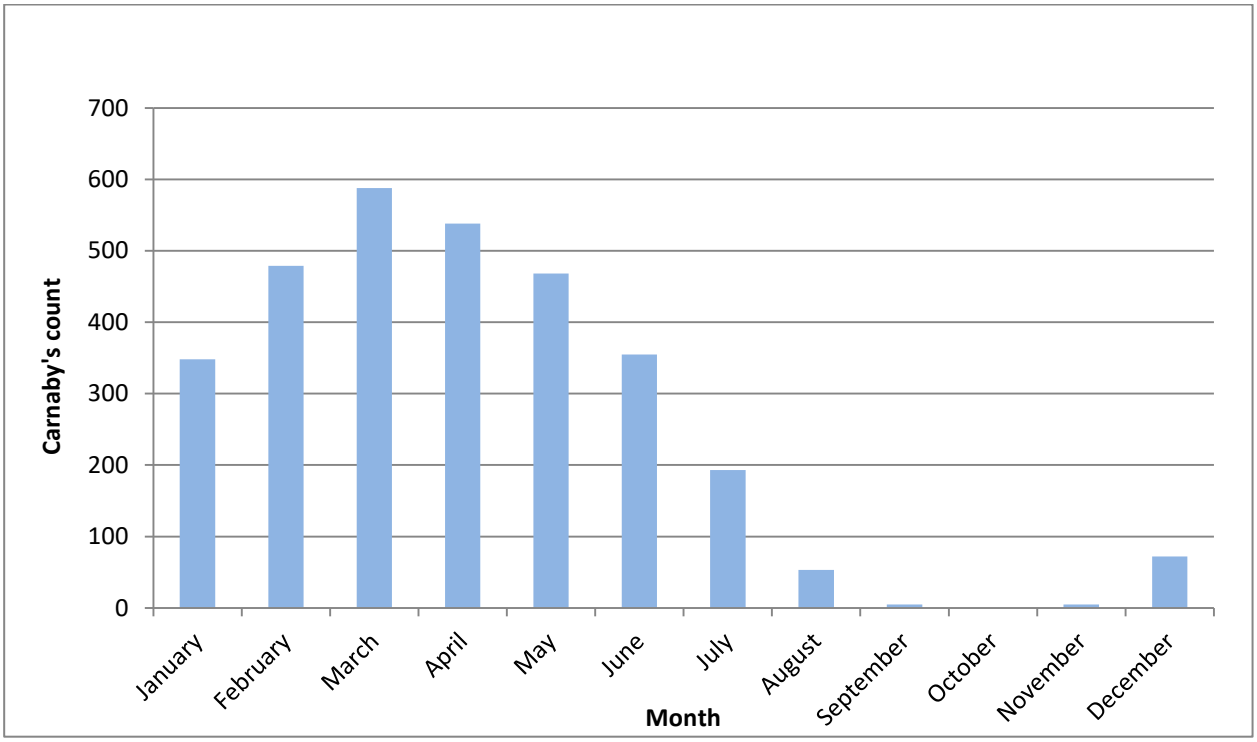
Site	Region	Year replaced
KALWALR001	Northern Darling Scarp and Plateau	2014
GOSCNVR001	Perth Peel Coastal Plain	2014
ROCBALR003	Perth Peel Coastal Plain	2014
DONDONR001	Regional	2014
CANWILR001	Perth Peel Coastal Plain	2015
MUNHOVR001	Northern Darling Scarp and Plateau	2015
NORWUNR001	Northern Darling Scarp and Plateau	2015
COCBANR002	Perth Peel Coastal Plain	2016
KALPICR002	Northern Darling Scarp and Plateau	2016
KWIWELR001	Perth Peel Coastal Plain	2016
MELLEER001	Perth Peel Coastal Plain	2016
PLANARR002	Regional	2016
ARMBEDR002	Northern Darling Scarp and Plateau	2017
BRIGRER003	Regional	2017
COCBANR001	Perth Peel Coastal Plain	2017
GOSSOUR002	Perth Peel Coastal Plain	2017
KWICASR001	Perth Peel Coastal Plain	2017
MELMURR001	Perth Peel Coastal Plain	2017
MUNHELR001	Northern Darling Scarp and Plateau	2017
PLANARR001	Regional	2017
SEROAKR002	Perth Peel Coastal Plain	2017
SWABULR002	Perth Peel Coastal Plain	2017
SWAVINR003	Perth Peel Coastal Plain	2017

Appendix VI: Summary of Survey Monkey results (381 respondents, 42% of registered volunteers)							
Was 2017 the first time you participated in the GCC?	Yes 48%	No 52%					
Did you attend a GCC workshop prior to the count?	Yes 20%	No 80%					
How would you rate your 2017 GCC experience?	Excellent 56%	Good 30%	Satisfactory 8%	Disappointing 3%	I did not participate in the end 3%		
Do you feel we communicated the information about your roost site and counting instructions clearly?	Yes 96%	No 4%					
Were you allocated a site with other volunteers?	Yes 59%	No 41%					
Did you bring along a friend or relative to help out?	Yes 54%	No 46%					
Are you a BirdLife member?	Yes 27%	No 73%					
Do you intend to participate in the GCC again?	Yes 99%	No 1%					
Age bracket	Under 20 2%	20-30 7%	30-40 14%	40-50 21%	50-60 21%	60-70 23%	Over 70 12%

Appendix VIIa: Monthly counts of Carnaby's Black-Cockatoos at the Gingin roost (GIGGINR001) in 2016. 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.



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