The 2016 Great Cocky Count:

A community-based survey for

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

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

birdlife
WESTERN AUSTRALIA

Department of
Parks and Wildlife

birds are in our nature

The 2016 Great Cocky Count: A community-based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)

Adam Peck[1], Geoff Barrett[2], Matt Williams[3]

Final Report – October 2016

[1]BirdLife Australia
167 Perry Lakes Drive
Floreat WA 6014
greatcockycount@birdlife.org.au

[2]Department of Parks and Wildlife
Swan Region
2 Australia II Drive
Crawley WA 6009

[3]Department of Parks and Wildlife
Animal Science Program
Locked Bag 104
Bentley Delivery Centre WA 6983

Front cover: A pair of Forest Red-tailed Black-Cockatoos ©Keith Lightbody
Back cover: John Clarke on the morning after the GCC, with the 'mega roost' survey form ©Adam Peck

ACKNOWLEDGEMENTS

We thank the volunteers who surveyed for the 2016 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. One volunteer even got up at the crack of dawn the day after the count to survey a site that had been missed (and counted 454 Carnaby's leaving the roost). 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. Bruce Greatwich was integral to helping out with site allocation, thanks so much for saving me in those days of frantic chaos! Tegan Douglas helped me by answering all my questions, helping with workshops and mainly by catching my many handballs with such grace and flair. Thanks also to Helen Bryant, Robyn Pickering and Sue Mather for supporting me through my baptism of fire. We thank Tony Kirkby and Ron Johnstone from the WA Museum for sharing their knowledge of these birds. Thanks also to Deb Sullivan, Sue Kalab and Jan Checker for coordinating regional roost counts. Special thanks to John and Louise Clarke and Laura Parker; I'm still in awe of your count!

For their support to hold training workshops, we thank: Canning River Eco Education Centre (CREEC), City of Melville, City of Stirling, Blackwood Basin Group, Shire of Kalamunda, Wheatbelt NRM, South West Catchments Council (SWCC), WALGA, Chittering Landcare, Murray Districts Aboriginal Association, Landcare Serpentine-Jarrahdale, Murdoch University, Peel-Harvey Catchment Council, Piney Lakes Environmental Education Centre, Sonia Lamond (WALGA), Leigh Whisson (Wheatbelt NRM), Francis Smit (Landcare Serpentine-Jarrahdale), Jo Garvey and Thelma Crook (Peel-Harvey Catchment Council), Jo Taylor (City of Stirling), Kellie Motteram (City of Melville), Leah Knapp (Murdoch University), Noeleen Edwards and Tracy Lyon (CREEC), Sue Pedrick (Chittering Landcare), Damien Postma (SWCC), Sue Kalab, Basil Schur (Green Skills), BirdLife Albany, Ian Toleman (Shire of Kalamunda) and Ros Thomson.

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 provided the basis for this year's report. The findings of Hugh's report were further refined in this report.

We thank Tegan Douglas, Mike Bamford, Margaret Byrne, Brendan Dooley and Colin Yates for comments on draft versions of this report.

The 2016 Great Cocky Count was supported by DPaW; Peel-Harvey Catchment Council, through funding from the Australian Government; City of Perth; City of Armadale and BirdLife WA.

Citation:
A. Peck, G. Barrett and M. Williams (2016). The 2016 Great Cocky Count: a community-based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*). BirdLife Australia, Floreat, Western Australia.

SUMMARY

Background

- The Great Cocky Count (GCC) is an annual citizen science survey for two of the 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 2016 GCC occurred on Sunday 3 April 2016. This year's GCC was the seventh consecutive count and eighth overall.
- The 2016 GCC surveyed roost sites for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo (FRTBC). Both are endemic to south western WA and both are listed as threatened species under State and Commonwealth legislation.
- This report builds on the substantial contribution made by previous Great Cocky Counts to our knowledge of black-cockatoos in the greater Perth Region and regional Western Australia.

Key Outcomes

- The Great Cocky Count is one of the largest citizen science surveys of its kind in Australia. Community interest is significant – this year over 700 registered volunteers surveyed 398 sites across the southwest of WA. Total volunteer participation likely exceeded 1,000 community members.
- The minimum population count for Carnaby's Black-Cockatoo in the Greater Perth-Peel Region was 11,418 (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 (62%) 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 (6,763) recorded in roosts associated with the pine plantation is consistent with previous surveys. In previous years, the pine plantation has supported 27- 59% 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 4,897 Carnaby's Black-Cockatoos. This accounted for 45% of all of the Carnaby's recorded on the Perth-Peel Coastal Plain, and is the highest single count ever recorded in a Great Cocky Count survey. The site 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 seven Great Cocky Counts (2010-2016). The combined effect of fewer occupied roosts with fewer birds in each roosting flock is an estimated current decline rate of 13.8% 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 ultimate 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-Cockatoo 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 5.5%, 10.8% and 12% decline per year, respectively.
- On the Perth-Peel Coastal Plain, the bulk of the Carnaby's Black-Cockatoos are restricted to few roost sites. For example, 77% of all the birds recorded in the 2010-2016 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 is much greater in pine-associated roosts than non pine-associated roosts (22% and 11% respectively). Provision of adequate roost sites and feeding habitat is needed to ensure the persistence of Carnaby's Black-Cockatoo in this region.
- The 2016 GCC confirmed the presence of FRTBC at various locations throughout the inner metropolitan suburbs of Perth.
- With total populations estimated at 40,000 for Carnaby's Black-Cockatoos, 12,000 for Baudin's Black-Cockatoos and 15,000 for FRTBC, the 2016 GCC recorded approximately 28% of all black-cockatoos in south western WA.
- The Great Cocky Count is well-placed to continue accurate monitoring of Carnaby's Black-Cockatoo and FRTBC on the Perth-Peel Coastal Plain, and potentially across the range of both species, due to continued growth in volunteers and, consequently, survey effort and the integration of statistically rigorous trend analyses.

Regional Results

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

- Volunteers surveyed 231 sites in the Perth-Peel Coastal Plain and counted 10,919 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 pine plantation (notably 4,897 at GINYEAR003, 1,232 at WANPINR001 and 454 at WANGNAR001) and at the Gingin town site (1,023 birds), Dawesville (513 at three sites), Hamilton Hill (295 at two sites), Millendon (250), Kensington (242), Underwood Avenue in Floreat (239), Hollywood Hospital in Nedlands (216) and Bullsbrook (178).
- The population of Carnaby's Black-Cockatoos inhabiting the Perth-Peel Coastal Plain is significant at a species-scale, with three of the five largest roosts and five of the ten largest roosts for the 2016 Great Cocky Count occurring within the Perth-Peel Coastal Plain.

Northern Darling Scarp and Plateau: Carnaby's Black-Cockatoo

- Volunteers surveyed 79 sites in the Northern Darling Scarp and Plateau areas, which encompasses the northern Jarrah-Marri Forest between Bindoon and Waroona, and counted 2,496 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% (499) were estimated to be Carnaby's Black-Cockatoos.
- Significant white-tailed black-cockatoo counts occurred at three sites in the Shire of Mundaring (676 birds) and four sites in the City of Kalamunda (383 birds).

Regional areas: white-tailed black-cockatoos

- Volunteers surveyed 88 sites in regional locations outside of the Greater Perth-Peel Region and recorded 3,340 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 (665 birds), on the northern Swan Coastal Plain (500 at Nilgen and 436 at Jurien Bay), Chapman Valley (270 birds), Gwindinup (216 birds), Narrikup (191) and in the Shire of Albany (107 birds).

Forest Red-tailed Black-Cockatoo (FRTBC)

- Volunteers documented 70 occupied roost sites, a large increase on previous years (28 and 22 occupied roosts in 2014 and 2015 respectively). 24 of these sites had both FRTBC and White-tailed Black-Cockatoos roosting.
- Occupied roosts were located in the Perth-Peel Coastal Plain (24), the Northern Darling Scarp and Plateau (26) and regional areas (20).
- 2,004 FRTBC were counted in 2016: 771 on the Perth-Peel Coastal Plain; 859 in the Northern Darling Scarp and Plateau and 374 in regional areas. The total count was up markedly on previous years (896 and 451 in 2014 and 2015 respectively).
- Significant FRTBC roosts occurred at Mundaring (285 birds at eleven sites), Cockburn (200 birds at four sites), Wattle Grove (150 birds), Murdoch University (125), Byford (88 birds), Gidgegannup (86 birds), Mungalup (84 birds) and Wandering (74).
- FRTBC have replaced white-tailed black-cockatoos at 16 confirmed roost sites in the past three 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 12 April 2015.

Parks and Wildlife/DPaW: Western Australian Department of Parks and Wildlife; formerly known as the Department of 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, DPaW 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). For the 2016 GCC, additional surveys included any surveys completed before or after Sunday 3 April 2016.

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.

Corrected count: For the 2016 GCC the proportion of Carnaby's to Baudin's Black-Cockatoos was set at 2:8. 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, roost counts of white-tailed black-cockatoos were reduced by 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 DPaW.

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 (>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.

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 DPaW Swan Region (a DPAW 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 DPaW Swan Coastal District (a DPAW 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 DPaW Perth Hills District (a DPAW 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 8,000ha.

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

CONTENTS

TABLES and FIGURES

Tables

Figures

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 3 April 2016.

The 2016 GCC is the seventh consecutive GCC and the eighth overall. BirdLife Australia coordinates the count each year with significant support from the Western Australian Department of Parks and Wildlife (DPaW). Funding for the 2016 GCC came from DPaW, Peel-Harvey Catchment Council (PHCC), BirdLife WA, the City of Armadale and the City of Perth.

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).

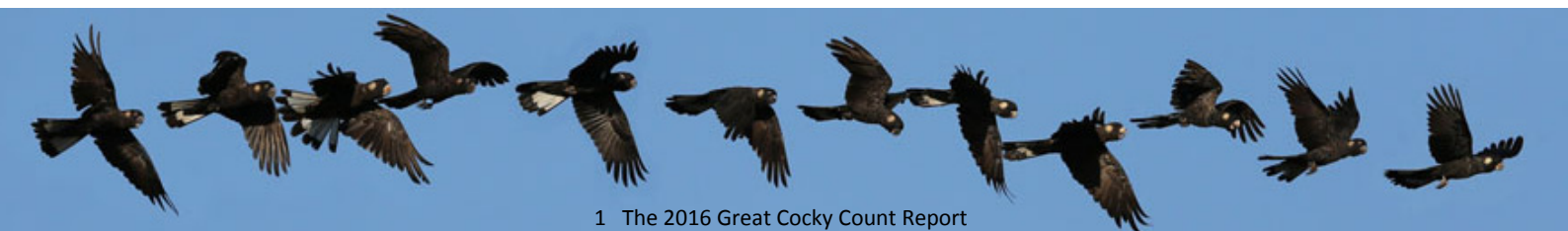
Conservation Status of Carnaby's Black-Cockatoo and FRTBC

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 Black-Cockatoo and Baudin's Black-Cockatoo 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 DPaW 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

Information on the ecology of black-cockatoos on the Swan Coastal Plain is available in Johnstone *et al.* (2010)[3] and Stock *et al.* (2013)[4].

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 method for assessing 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).

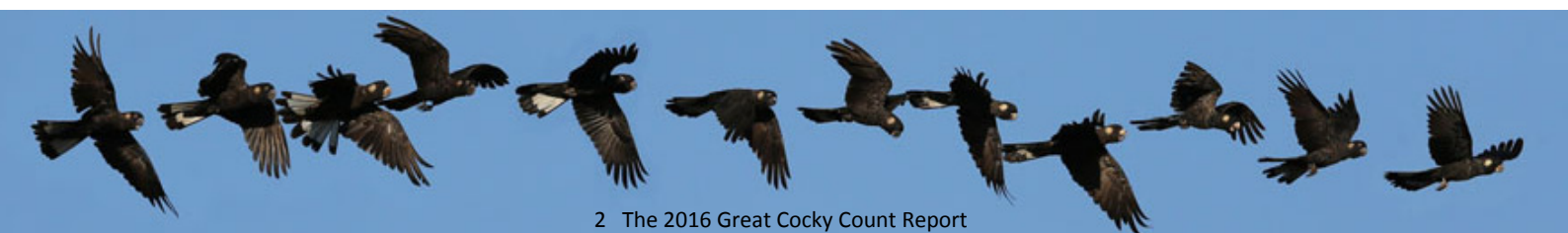
Evolution of the GCC

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 was continued in 2015 and 2016. 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 (*Eucalyptus diversicolor*) forests.

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 and Byrne *et al.* 2015). The 2015 and 2016 reports are available on the Great Cocky Count webpage:

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

[3] Available from: http://www.planningnrm.wa.gov.au/dop_pub_pdfmedia/41434/black_cockatoos_on_swan_coastal_plain.pdf
[4] Available from: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0061145



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

Contribution to Black-Cockatoo Conservation

Recovery plans exist to guide the conservation of Carnaby's Black-Cockatoo and FRTBC and can be accessed at these web pages[5]:

- http://www.environment.gov.au/resource/carnaby%E2%80%99s-cockatoo-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 Red-tailed Black-Cockatoo

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 2016 GCC were to:

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

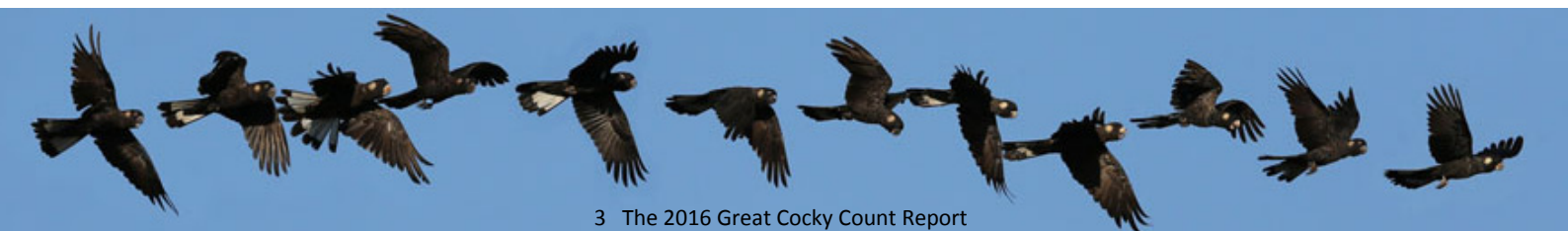
(2) identify roost sites and conduct roost counts for Carnaby's Black-Cockatoo across the species range;

(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 Black-Cockatoo within the Perth-Peel Coastal Plain, across the seven consecutive GCCs (2010-2016) ; 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 2016.



II. METHODS

Survey Timing and Area

Timing

This year's GCC occurred on Sunday 3 April 2016, 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 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.

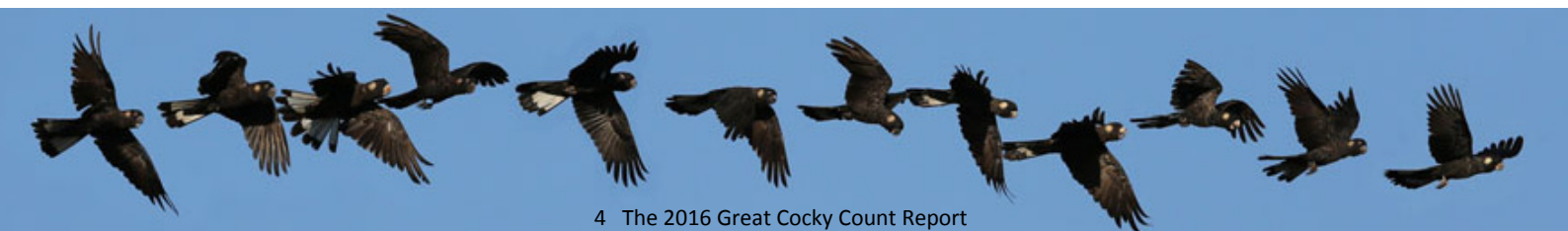
Community Engagement and Training

To recruit volunteers for the 2016 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 2015 GCC counters). We updated the GCC webpage on BirdLife Australia's website[8], which provides information about the GCC, including forms,

[6] A map of the IBRA bioregions is available at: http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-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



protocols and previous reports. This was the first year that we used a Google Form for registrations. Most 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 2016 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 and Byrne *et al.* 2015).

Roost Site Identification

Information about the 2016 GCC also included a request to report roost sites for black-cockatoos. Sites reported to BirdLife Australia prior to the 2016 GCC, which came from community members, Sam Rycken (PhD researcher 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 2016 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.

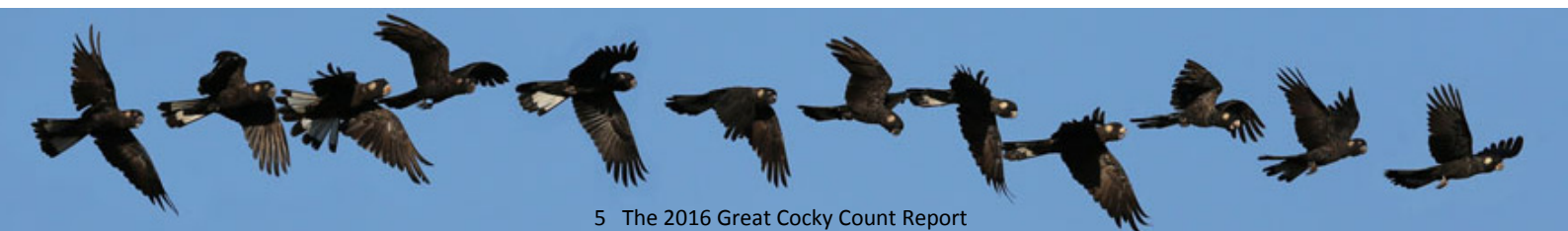
Roost Count Methodology

The 2016 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 and Byrne *et al.* 2015). 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 3 April 2016; (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,

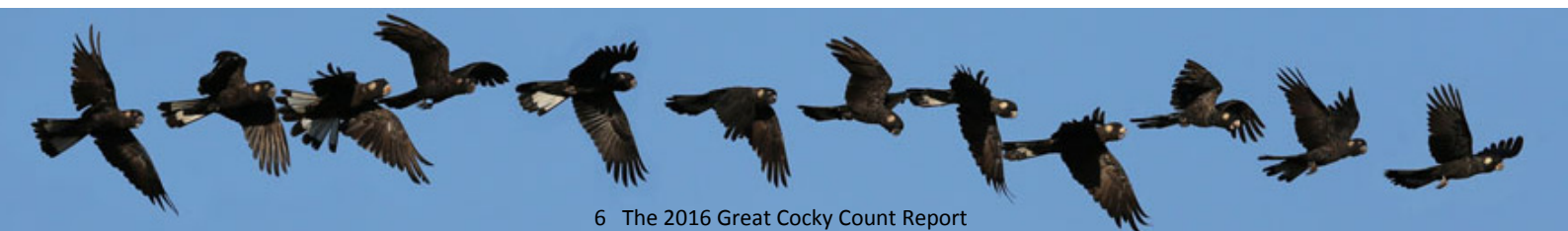
(3) The Greater Perth-Peel Region (i.e., (1)+(2)),

(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 2016.



Total counts for the Greater Perth-Peel Region

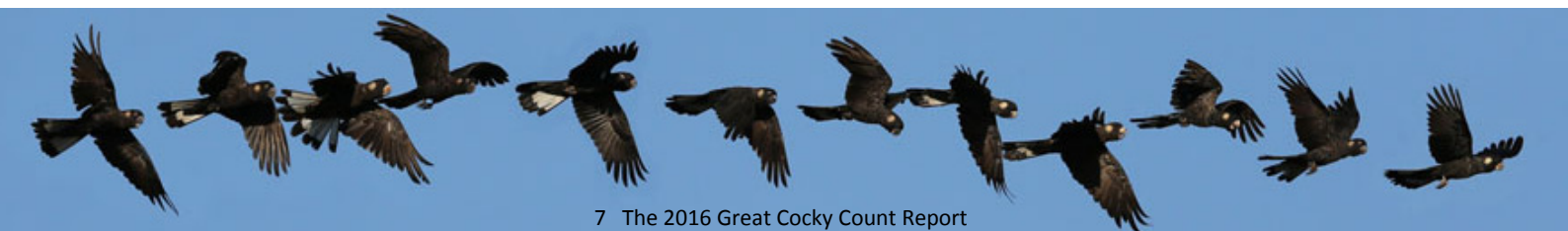
All roosting flocks in the Perth-Peel Coastal Plain were assumed to contain only Carnaby's Black-Cockatoo because the distribution of Baudin's Black-Cockatoos within the Greater Perth-Peel Region is generally confined to the Northern Darling Scarp and Plateau, particularly in early April (Johnstone *et al.* 2010; Tony Kirkby, WA Museum, personal communication). The 2016 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 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 for Perth-Peel Coastal Plain

A key aim for the Great Cocky Count is to assess population trends for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain, which encompasses nearly all of the greater Perth-Peel metropolitan area. 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. 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. Using only the 'raw' total counts, which do not account for any excess zeros or 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 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

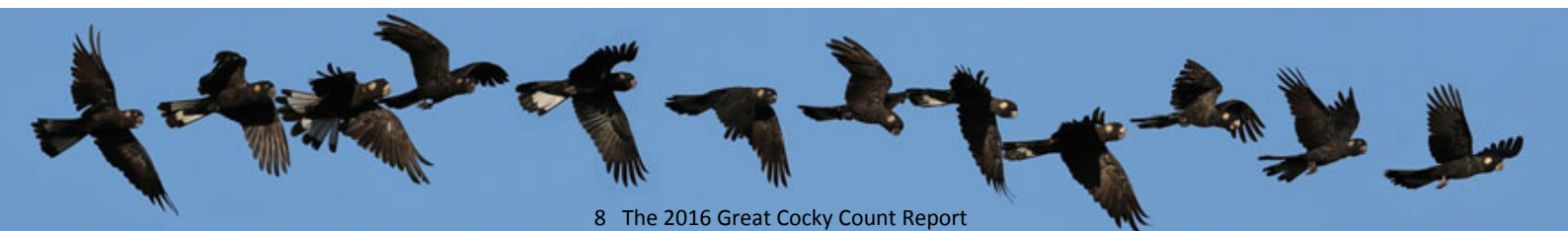
Black-cockatoos are commonly observed in small groups, believed to comprise a mated pair of birds and, often, their offspring ('family units'). For Carnaby's Black-Cockatoo, these family units comprise a triplet – the adult mated pair and a fledgling from the most recent, or a previous, breeding season. 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 2010–2016.

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 400 people attended the 15 Great Cocky Count workshops conducted in March 2016. Workshops were held at locations throughout the Perth-Peel region, including one each at Northam, Mundijong, Bunbury, WALGA (West Leederville), Pinjarra, North Beach, Greenbushes, Northam, Kalamunda, Albany, Melville, Canning, Mandurah, Chittering, and Murdoch University.

Supporters for the workshops included the Canning River Eco Education Centre (CREEC), City of Melville, City of Stirling, Blackwood Basin Group, Shire of Kalamunda, Wheatbelt NRM, South West Catchments Council (SWCC), WALGA, Chittering Landcare, Murray Districts Aboriginal Association, Landcare Serpentine-Jarrahdale, Murdoch University, Peel-Harvey Catchment Council, Piney Lakes Environmental Education Centre, Green Skills Denmark and BirdLife Albany.

Volunteer participation

We assigned 426 survey sites to the 707 registered volunteers (Table 1). Roost counts were conducted at 398 (94%) of these sites. This compares well with previous completion rates for the 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 2016, approximately half were new to the GCC and half had registered previously. Since 2010, more than 2,000 people have participated in at least one GCC as a registered volunteer.

Actual volunteer participation for the 2016 GCC likely exceeded 1,000 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.

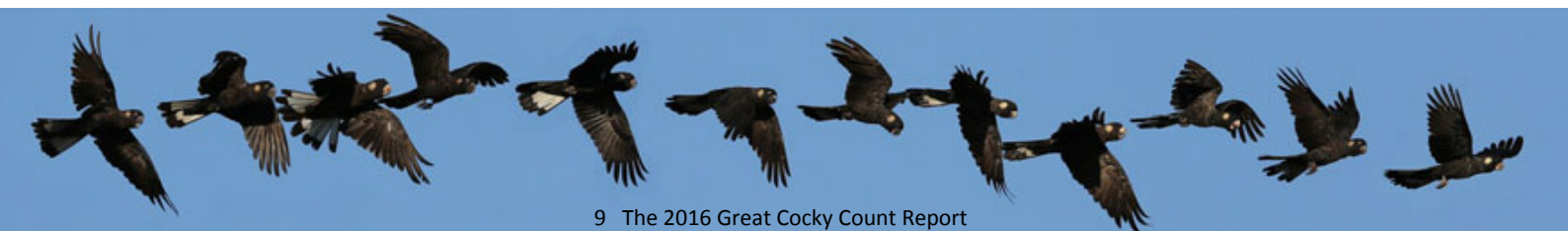


Table 1: Volunteer participation and survey effort for seven Great Cocky Counts (2010-2016). The percentages show the proportion of the sites that were surveyed in each GCC in the Greater Perth-Peel Region (further subdivided into the Perth-Peel Coastal Plain and the Northern Darling Scarp and Plateau), or in Regional areas.

	2010	2011	2012	2013	2014	2015	2016
Registered volunteers	250	263	294	335	592	606	707
Sites assigned for survey	unknown	248	244	262	322	301	426
Sites surveyed	187	165	205	241	290	293	398
In Greater Perth-Peel Region	183 (98%)	150 (91%)	157 (77%)	186 (77%)	230 (79%)	228 (78%)	310 (78%)
(i) Perth-Peel Coastal Plain	157 (84%)	124 (75%)	127 (62%)	144 (60%)	186 (64%)	185 (63%)	231 (58%)
(ii) N. Darling Scarp/Plateau	26 (14%)	26 (16%)	30 (15%)	42 (17%)	44 (15%)	43 (15%)	79 (20%)
– In Regional areas	4 (2%)	15 (9%)	48 (23%)	55 (23%)	60 (21%)	65 (22%)	88 (22%)

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

89 new sites were added to the GCC database this year. This enabled 102 sites which had not previously been surveyed to be surveyed in 2016 (some were already on the database but had never been surveyed). Of these 34 had just white-taileds roosting, 29 had FRTBC roosting, 15 had both roosting and 24 were unoccupied. Of the 638 sites in the database, 84 have still not been surveyed to date. Four confirmed sites were cleared in the last year (SWALEXR002, WANJANR007, WANPINR005 and WANYANR004), all of which were associated with pine plantations.

Table 2: Number of Carnaby's Black-Cockatoo confirmed roosts, unconfirmed roosts, potential sites, cleared sites and FRTBC sites in the GCC site database for the seven Great Cocky Counts (2010-2016). **Cleared roosts** are confirmed roosts that have been cleared of vegetation since 2010.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
No. of confirmed roosts	80	114	151	186	204	217	251
No. of unconfirmed roosts	unknown	29	55	94	108	119	147
No. of potential sites	unknown	155	148	165	184	185	179
No. of cleared roosts	n/a	2	5	7	7	8	12
FRTBC only roosts	n/a	n/a	n/a	n/a	13	20	49
Total no. of sites	**222**	**300**	**359**	**452**	**516**	**549**	**638**

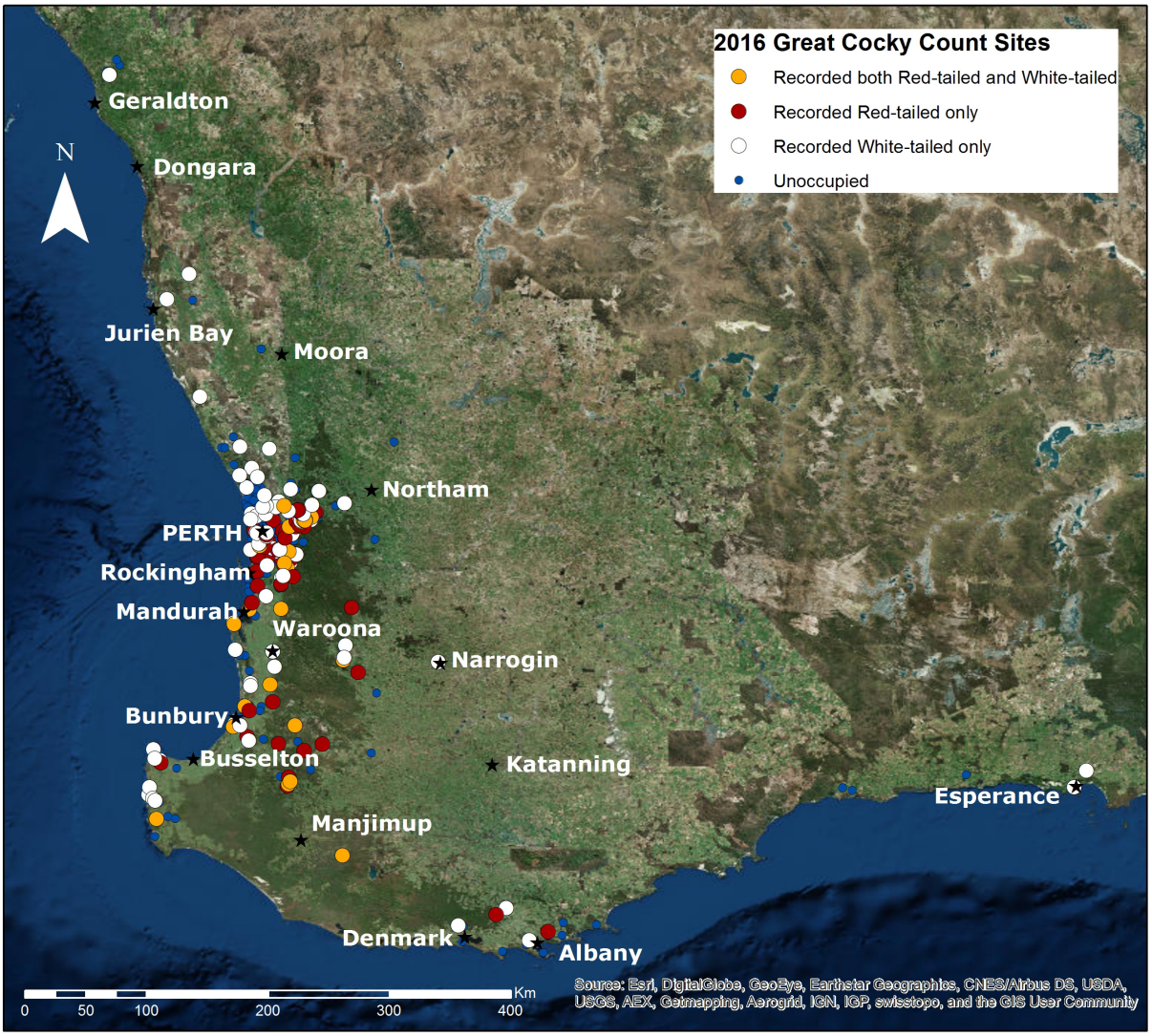


Figure 1: The locations of the 398 sites where surveys were conducted for the 2016 Great Cocky Count. Sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Red-tailed Black-Cockatoo roost sites, or sites where both species roosted in 2016. Figure Credit: Tegan Douglas.

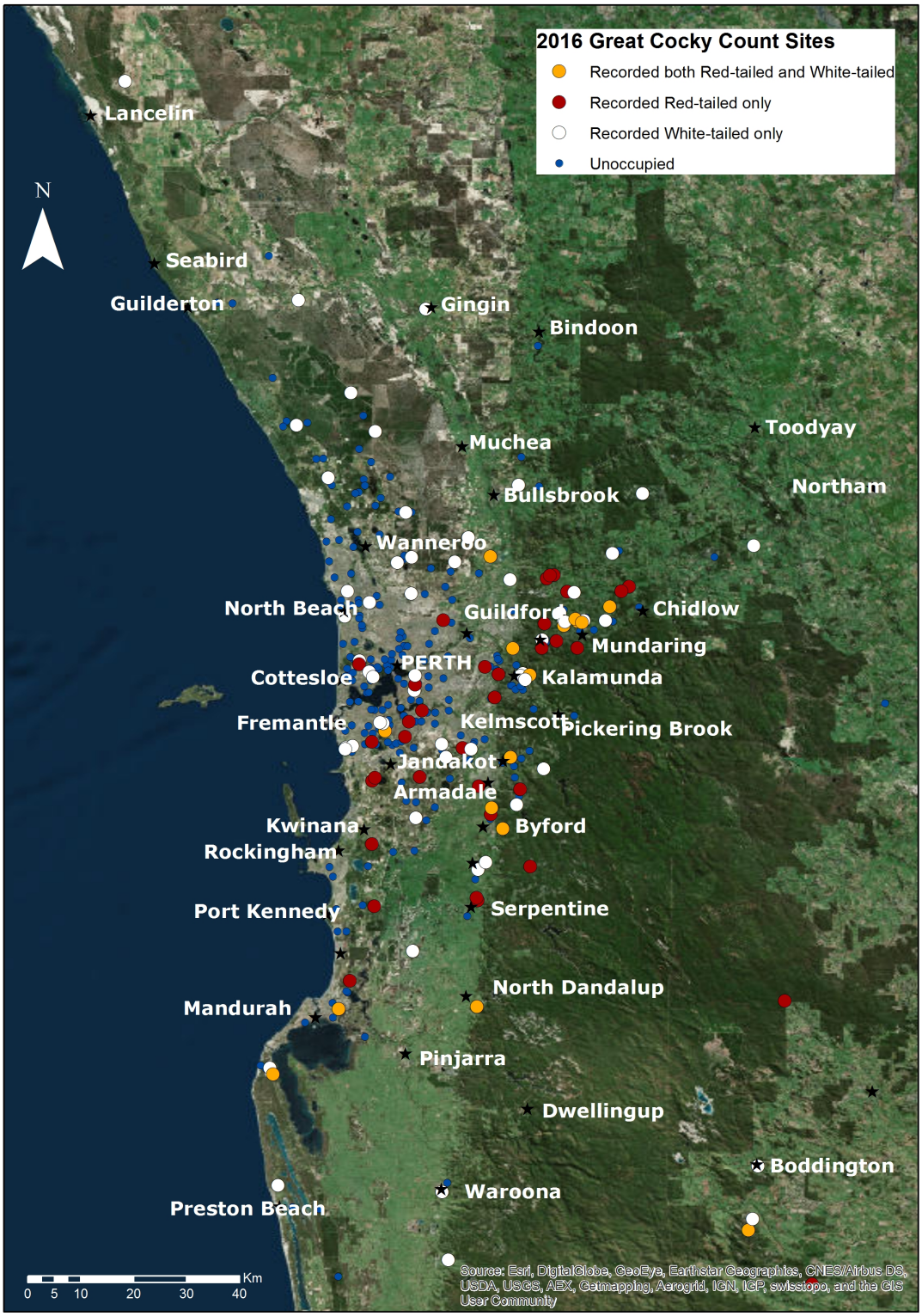


Figure 2: The locations of the 310 sites in the Greater Perth-Peel Region where roost counts were conducted for the 2016 Great Cocky Count. Roosting sites are classified as either unoccupied (no black-cockatoos roosting), white-tailed black-cockatoo roost sites, Red-tailed Black-Cockatoo roost sites, or sites where both species roosted in 2016. 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 310 sites in the Greater Perth-Peel Region. Roost counts occurred in 39 local government areas (LGA), with occupied roosts recorded in 25 (64%) of these (Appendix II). Survey effort was greatest in the Cities of Wanneroo, Mundaring and Swan, with 33, 26 and 25 sites surveyed respectively. Of these, 12 occupied roosts were recorded in the City of Mundaring, eight in the City of Swan and six in the City of Wanneroo.

Regional areas

Volunteers surveyed 88 sites in regional areas (Table 1). Roost counts occurred in 24 LGAs, with occupied (White-tailed Black-Cockatoo) roosts recorded in 17 (71%) of these (Appendix II). The greatest survey effort in regional areas occurred in the Shires of Albany and Busselton, with 10 and 9 sites surveyed and one and three occupied roost recorded respectively.

Across GCCs (2010-2016)

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.

Total counts

Greater Perth-Peel Region

In 2016 the GCC recorded the highest count for Carnaby's in the region. Indeed, the count of 11,418 birds represents over double the average for the years 2010-15 (5,444 birds) (Table 3).

Regional areas

The count for regional areas of 3,340 White-tailed Black Cockatoos shows little change to previous years (average of 3,574 birds between 2012 and 2015) despite more sites being surveyed this year (Table 3).

Across species range

The total count of 16,755 birds is roughly double the average between 2010-15 (8,704 birds) (Table 3).

Roost counts – across species range

At occupied roosts, counts for white-tailed black-cockatoos in the 2016 GCC ranged from 2 to 4,897, with a mean of 161 $\pm$ 49 (standard error) and a median of 47 (104 roost counts). Roost count sizes varied across the three principal survey areas. The lowest was Northern Darling Scarp and Plateau (mean 86 $\pm$ 14); then Regional (mean 104 $\pm$ 29), with the Perth Peel Coastal Plain being significantly the highest (mean 254 $\pm$ 117).

Across the species range, the five largest roost counts accounted for 50% (8,317 of 16,755 birds) of the total number of white-tailed black-cockatoos counted (Appendices III and IV). The ten largest roost counts

accounted for 61% (10,156) of the total number of white-tailed black-cockatoos counted. Three of the five largest roost counts and five of the ten largest roost counts 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 4897, 1232, 1023, 454 and 280 birds) accounted for 72% (7886 of 10,919) 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 42% for the Perth-Peel Coastal Plain (43 occupied roosts of 102 surveyed sites that had at least one positive count for any GCC between 2010-2016) (Table 4).

Gnangara pine plantation

Volunteers recorded 6763 birds at 5 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).

In the 2016 GCC, birds roosting at sites within or associated with the Gnangara pine plantation accounted for 62% (6763 of 10,919 birds) of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain. In previous GCCs (2010-2015), birds roosting in the Gnangara pine plantation have accounted for 27% to 59% of the Carnaby's Black-Cockatoo counted in the Perth-Peel Coastal Plain, with total counts ranging from 1061 to 3951 birds.

Other significant roosts

Significant counts were recorded at Dawesville (513 birds at 3 sites), Hamilton Hill (295 birds at two sites), Millendon (250 birds), Kensington (242 birds), Underwood Avenue in Floreat (239) and Hollywood Hospital in Nedlands (216).

Roost counts – Northern Darling Scarp and Plateau

Within the Northern Darling Scarp and Plateau, the five largest roost counts accounted for 41% (1027 of 2496) of the white-tailed black-cockatoos counted. These counts were recorded at two sites in the Shire of Mundaring (320 and 209 birds), one in Swan (178 birds), one in Kalamunda (163 birds) and one in the City of Armadale (157 birds) (Appendix IIIc). The roost occupancy rate was 74% (29 occupied roosts of 39 surveyed sites that had at least one positive count for any GCC between 2010 and 2016) (Table 4).

White-tailed black-cockatoos were recorded at 12 sites in the Shire of Mundaring (26 sites surveyed and 1039 birds), three sites in Swan (10 sites surveyed and 459 birds), four in the Shire of Kalamunda (22 sites surveyed and 383 birds) and four in the City of Armadale (13 sites surveyed and 194 birds) (Appendix IIIc). Roosts were also recorded at sites in Boddington (166 birds), Toodyay (140 birds), Northam (94 birds) and Wandering (4 birds).

Roost counts – Regional areas

In regional areas, the five largest roost counts (665, 500, 436, 349 and 270 birds) accounted for 66% (2220 of 3340) of the white-tailed black-cockatoos counted (Appendix IV). These sites were located at Esperance, Nilgen, Jurien Bay, Myalup and Nanson.

Areas with significant counts were recorded in the northern Swan Coastal Plain (436 at Jurien Bay and 500 at Nilgen), the Shire of Esperance (697 at two sites), the Shire of Harvey (594 at two sites), the Shire of Harvey (406 birds at 4 sites), at Nanson (270), the Shire of Busselton (154 birds at 3 sites), in the Shire of Capel (248 at four sites), Narrikup (191), in the Shire of Albany (107) and in the Shire of Augusta-Margaret River (97 at 5 sites). (Appendix IV).

Breeding success

The fraction of white-tailed black-cockatoo groups returning to roosts as either pairs or triplets was recorded at 57 sites in 2016. The proportion of groups flying into roosts as triplets (43%) was significantly higher (χ_1 = 395, p <0.001) than the average proportion recorded over previous GCCs (average 38% between 2010-2015, 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 seven Great Cocky Counts (2010-2016). The counts for the **Perth-Peel Coastal Plain** are assumed to include only Carnaby's Black-Cockatoo, whereas the counts for the **Northern Darling Scarp and Plateau** are corrected to account for the mixed flocks of Baudin's and Carnaby's Black-Cockatoos. The counts for the **Greater Perth-Peel Region** are the combined counts for Carnaby's Black-Cockatoo from the two areas. The counts for Regional areas and **across the species range** are the totals for white-tailed black-cockatoos and not corrected for the presence of both white-tailed cockatoo species. The number of roosts is the number of **occupied roosts** (i.e. roosts where at least one white-tailed black-cockatoo roosted).
WT=white-tailed Black-Cockatoo
* Assumption of 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
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)
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)
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)
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)
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)

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 seven Great Cocky Counts 2010 – 2016.

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
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
Northern Darling Scarp and Plateau	18	18	21	28	28	38	39
% 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)
Northern Darling Scarp and Plateau					74% (n=38)	97% (n=39)	74% (n=53)
No. of new roost sites discovered							
Perth-Peel Coastal Plain	60	12	10	6	6	5	14
Northern Darling Scarp and Plateau	18	7	5	4	4	1	14
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%)
Northern Darling Scarp and Plateau	15 (58%)	13 (50%)	15 (50%)	14 (33%)	12 (27%)	9 (21%)	29 (37%)
Roost occupancy rate (% of confirmed sites surveyed)							
Perth-Peel Coastal Plain	60%	65%	44%	49%	48%	40%	42%
Northern Darling Scarp and Plateau	83%	72%	71%	50%	43%	24%	74%

Table 5: The number of white-tailed black-cockatoos arriving at roosts in pairs or triplets, for the six GCCs 2010– 2016, 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-Cockatoo 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

D. Carnaby's Black-Cockatoo: Trend Analysis for the Perth-Peel Coastal Plain (2010-2016)

General survey trends

The number of sites surveyed in the Perth-Peel Coastal Plain varied from 123 to 231 across the seven GCCs (2010-2016; Table 1). The number of occupied roosts varied between 25 and 43, with occupied roosts representing 19-30% of the total number of sites surveyed each year (Table 4). The discovery rate for new roosts declined between 2011-2015, with roughly half discovered in 2010 and relatively few new roosts discovered from 2013 to 2015 (17 in total). This trend was reversed in 2016 with 14 new roosts discovered.

Positive counts (i.e. $\geq$ 1 Carnaby's Black-Cockatoo roosting in at least one GCC) have now been recorded from 115 sites (Table 4). This has risen from 89 sites in 2014 and 99 sites in 2015.

Two confirmed roosts (COCSCCR001 and ROCKARR001) were cleared prior to the 2011 GCC, three more were cleared before the 2012 GCC (COCSCCR002, ROCBALR001 and SWAMELR002), another two were cleared prior to the 2013 GCC (HARMYAR002 and MANDUDR001), one was cleared before the 2015 GCC (MUNCHIR001) and four were cleared before the 2016 count (SWALEXR002, WANJANR007, WANPINR005 and WANYANR004) (Appendix IIIa).

Largest roosts

Within the Perth-Peel Coastal Plain, the ten largest roosts (based on combined counts across years) accounted for over half (59%, or 24,642 of 41,897) of the Carnaby's Black-Cockatoos counted in the 2010-2016 GCCs (Appendix IIIa). Four of these are within the Gnangara pine plantation (GINYEAR001, GINYEAR003, 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 18% (7504 of 41897) of the Carnaby's Black-Cockatoos counted in the seven GCCs. Eight of these are within or associated with the Gnangara pine plantation (SWAMELR001, WANPINR011, WANPINR002, WANTWOR001, WANYANR006, WANNEER002, WANYANR001 and WANYANR003) and the other two are at Manning Lake in Spearwood (COCHAMR001) and Preston Beach (WARPRER001).

Overall, the 40 largest roosts accounted for 91% (38054 of 41897) of the Carnaby's Black-Cockatoos counted in the Perth-Peel Coastal Plain across the seven GCCs.

Occupancy rate

The fraction of occupied roosts within the Perth-Peel Coastal Plain is estimated to be declining at a rate of approximately 2.4% per year (Figure 3). This decline is statistically significant ($p=0.03$), and equates to the loss of about 3 of the 116 known roosts each year. The trends for both pine-associated (n=29, estimated decline of 5% per year) and non-pine-associated roosts (n=87, 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 8.9% per year. This decline is statistically significant (p=0.04), and equates to the loss of about 15 birds per year from the overall average of around 165 birds at each roost. The trends for pine-associated (n=29, estimated decline of 12% per year) and non-pine-associated roosts (n=87, estimated decline of 8% per year) are not significantly different; both are declining.

Total population size

Combining the estimated annual declines in average roost size (8.9%) and roost occupancy (2.4%), at the present roost occupancy rate (43%), the overall estimated rate of decline in the total number of birds is thus 13.8% per year (i.e. an estimated (43.0-2.4)/43.0=94.4% x 91.1% birds are counted each successive year). The overall rate of decline in pine-associated roosts (23% per year) is about twice the rate of decline in non-pine-associated roosts (11%).

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 show less variation in occupancy rates, resulted in estimated rates of decline of 5%, 11% and 12%, 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 small 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 confidently estimated to be around 5% – 15% per year, i.e. an average of 10% per year, slightly lower than the estimates from previous years (e.g. Byrne *et al*. 2015).

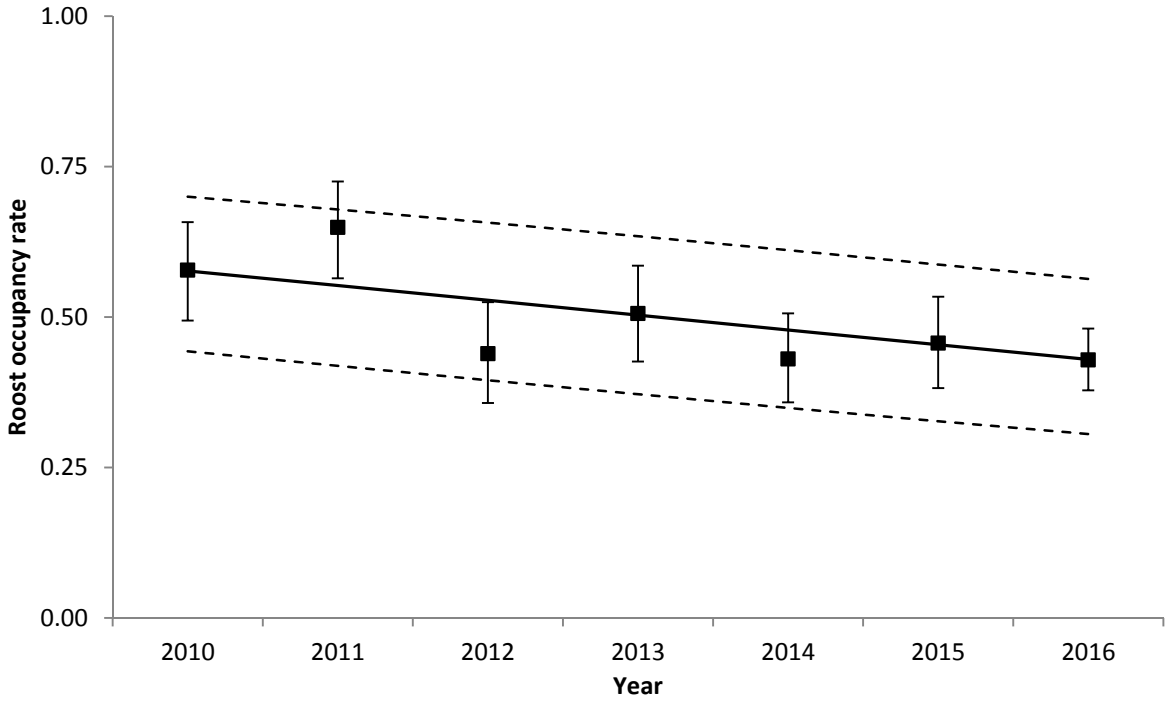


Figure 3: Roost occupancy rate (filled symbols with standard error) for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain for six Great Cocky Counts (2010 – 2016), with 95% confidence interval (dashed line) and trend (solid line), estimated using a log-linear zero-inflated regression model.

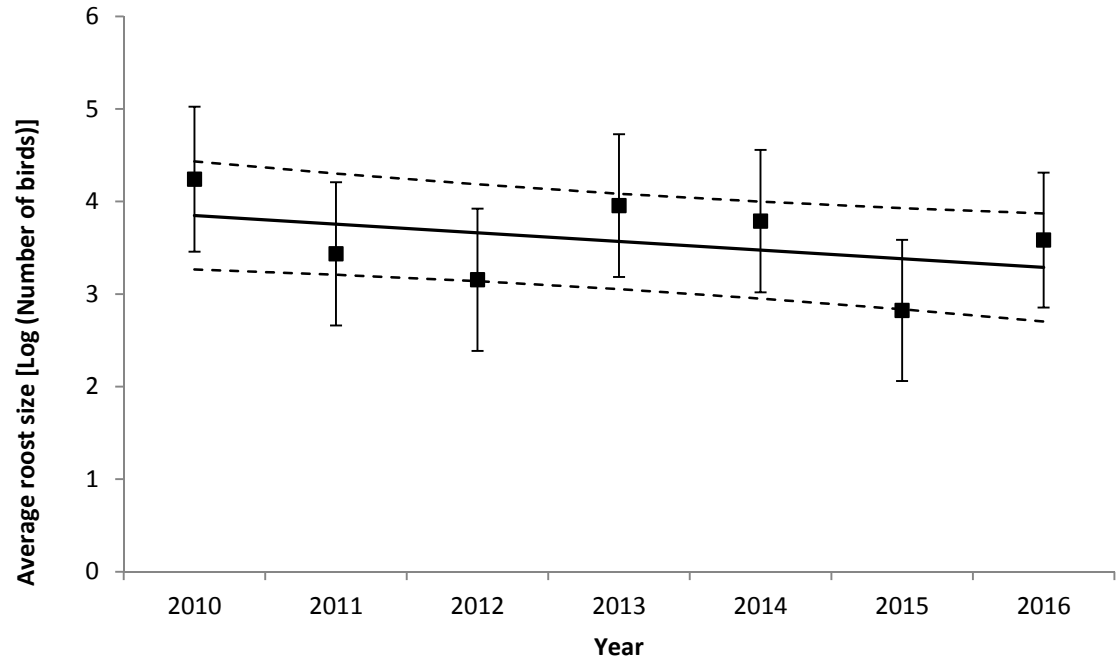


Figure 4: Average roost size (filled symbols with standard errors, log scale) for Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain for six Great Cocky Counts (2010 – 2016), with 95% confidence interval (dashed line) and trend (solid line), estimated using a log-linear zero-inflated regression model.

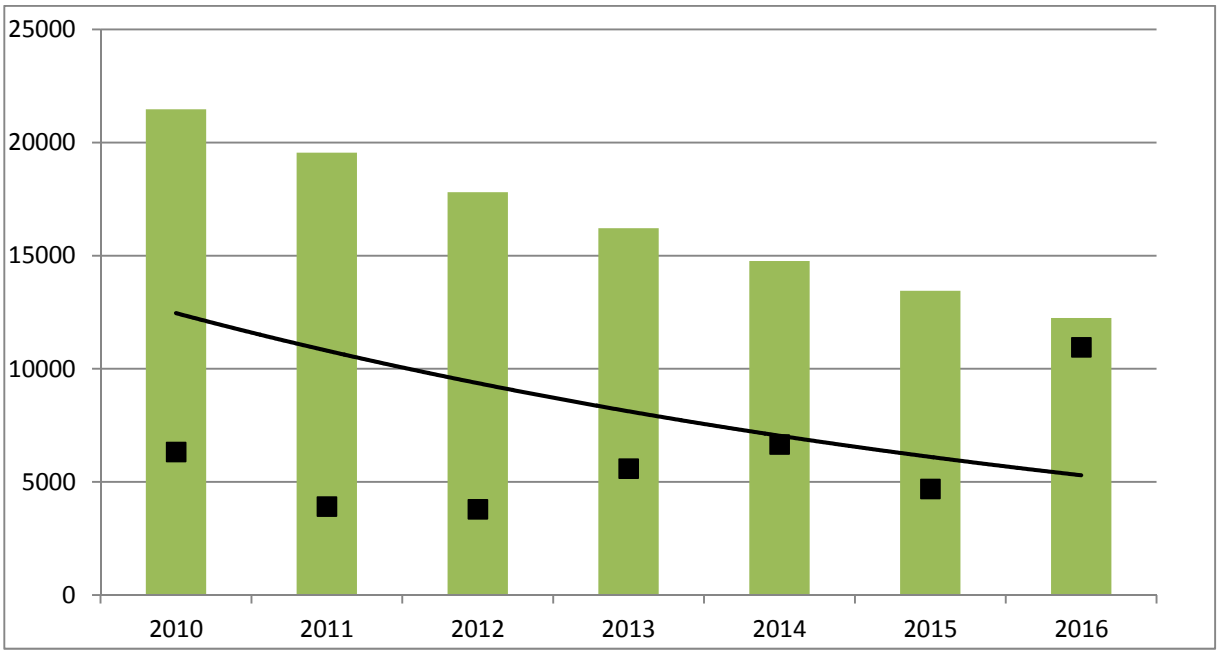


Figure 5: Trends in the abundance of Carnaby's Black-Cockatoo in the Perth-Peel Coastal Plain region 2010-2016: assuming all roosts are occupied (bars), the estimated trend in average roost count, after accounting for roosts that were either not occupied or not surveyed, on the night of the Great Cocky Count (solid line) and actual roost counts for the region (squares).

E. Forest Red-tailed Black-Cockatoo

Roost Site Identification

Perth-Peel Coastal Plain

FRTBC were recorded at roosts in 13 LGAs across the Perth-Peel Coastal Plain: Armadale, Bayswater, Cambridge, Canning, Cockburn, Gosnells, Kwinana, Mandurah, Melville, Rockingham, Serpentine-Jarrahdale, Swan and Victoria Park.

Northern Darling Scarp and Plateau

Volunteers recorded FRTBC at roost sites in eight LGAs within the Northern Darling Scarp and Plateau: Armadale, Boddington, Kalamunda, Mundaring, Murray, Serpentine-Jarrahdale, Swan and Wandering.

Regional areas

FRTBC were recorded at roost sites in ten Regional LGAs: Albany, Augusta-Margaret River, Bridgetown-Greenbushes, Busselton, Capel, Donnybrook-Balingup, Harvey, Manjimup, Plantagenet and Williams.

Overall, occupied roosts have risen from 28 to 70 since 2014 (Table 6).

Roost Counts

FRTBC were recorded roosting at 70 sites across the GCC survey area, with sites fairly evenly spread among the three areas (Table 6; Appendix V). 39 of these (56%) were new sites that had not been surveyed prior to the 2016 GCC. Of the 70 occupied roosts 46 had only FRTBC, while 24 had both FRTBC and white-tailed black-cockatoos.

Roost counts at sites in the Greater Perth-Peel Region accounted for 81% of the total number of FRTBC counted. Of the five largest counts of FRTBC (150, 125, 88, 86 and 84 birds) two were in the Perth-Peel Coastal Plain, two were in the Northern Darling Scarp and Plateau and one was regional. They accounted for 27% of the total number of FRTBC counted across the species range.

FRTBC were recorded at 18% of all sites surveyed across the GCC survey area (70 of 398 sites) and 29% of sites outside of the Greater Perth-Peel Region (20 of 88 sites). Within the Greater Perth-Peel Region, volunteers recorded FRTBC at 11% of sites in the Perth-Peel Coastal Plain (24 of 231 sites) and 30% of sites in the Northern Darling Scarp and Plateau (26 of 79 sites).

Volunteers recorded 24 roosts where both FRTBC and white-tailed black-cockatoos roosted (Appendix V). This is a marked increase on previous years (eight and four joint roosts in 2014 and 2015). FRTBC replaced white-tailed black-cockatoos at five confirmed roosts in 2014, another three in 2015 and a further five in 2016 (Appendix Vd). Of these six were in the Perth-Peel Coastal Plain.

Roost counts for FRTBC ranged from 1 to 150, with a mean of 29 $\pm$ 3.5 (standard error) and a median of 20.5 (70 roosts). This compares to a mean of 32 $\pm$8 with a median of 17 (28 sites) in 2014 and a mean of 20 $\pm$5 and a median of 13.5 (22 sites) in 2015.

The following results are from sites with three or more counts in each of the GCCs (2014-16). Roost sizes were higher on average in the Perth-Peel region (33 ± 4 birds per occupied roost) compared to regional areas (19 ± 5 birds per occupied roost). However, occupancy rate was higher in regional roosts (0.95) than in the Perth-Peel region (0.76). Occupancy rates were higher in 2016 than in previous years with a positive trend overall (Figure 5). Between 2014 and 2016 occupancy rates increased from 0.59 to 0.71 in the Perth-Peel Coastal Plain, from 0.60 to 0.81 in the Northern Darling Scarp and Plateau and from 0.86 to 0.95 in the regions. Average roost size fluctuated little over the last three GCCs (29, 30 and 31 respectively for the southwest of WA).

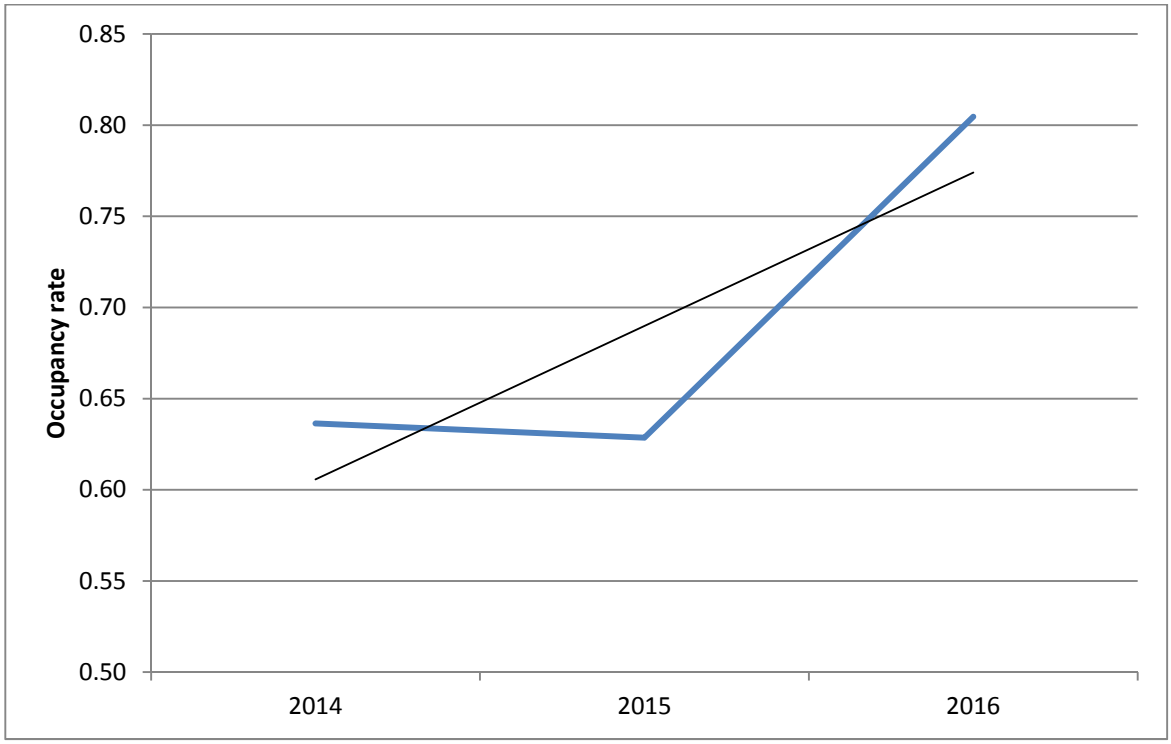


Figure 6. Occupancy rate of FRTBC at confirmed roosts in the southwest of Western Australia between 2014 and 2016 (linear trend line in black). Number of surveyed roosts: 44 in 2014, 35 in 2015 and 87 in 2016.

Table 6: Roost count summary for FRTBC across seven Great Cocky Counts (2014-2016). The number of roosts is the number of **occupied roosts** (i.e. roosts where at least one FRTBC roosted).

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

F. Baudin's Black-Cockatoo

The number of Baudin's Black-Cockatoos has not been reported in previous GCCs, however the data is available and is of value. The estimated number of Baudin's counted has varied between 314 and 1997 over the last seven GCCs, with an average of 927.

Table 7: Roost count summary for Baudin's Black-Cockatoo across seven Great Cocky Counts (2010-2016). 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
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)

IV. DISCUSSION

Community Engagement and Training

Participation in the 2016 count

The 2016 Great Cocky Count included over 700 registered volunteers and is likely to have exceeded 1,000 participants overall, making this year's survey the largest to date and one of the largest citizen science surveys in Australia. Volunteers surveyed 398 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 400 people attended training workshops in 2016. While not all workshop attendees ultimately participated in the 2016 GCC, it is likely that most participants in the 2016 GCC 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 6: Serpentine-Jarrahdale Landcare workshop in Mundijong with Leah Knapp, Jo Garvey, Francis Smit, Adam Peck, Cockatoo Bill and Simon Cherriman. Photo: Landcare SJ.

Volunteer retention

More than 2,000 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 2012-2016 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 has exceeded 50%. This may be because most 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. A survey of volunteers after the count showed that an overwhelming majority (93%) enjoyed participating in the GCC and 98% said they would participate in the future. However, 3% of respondents expressed disappointment and 10% felt instructions on counting and how to locate their site were poor (Appendix VI). This is an issue which needs to be remedied and will be given more attention next year.

Ongoing monitoring

Many volunteers undertake ongoing, systematic monitoring of several sites in the Greater Perth-Peel Region, including the Hollywood Hospital roost in Nedlands, the Underwood Avenue roost in Floreat, roosts in the towns of Gingin and Bullsbrook, and roosts in Yanchep National Park and surrounds.

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 2016 included the delivery of twelve

training workshops across the Perth-Peel region and in regional centres and the further development of a set of observer instructions for each roost site based on previous observer comments. Strategies for improving future GCCs include:

- enhancing volunteer retention through social media engagement and other interactive approaches
- supporting volunteers who regularly monitor local roosts
- online registrations with reply email to confirm registration
- improving volunteer understanding of roost sites and the importance of documenting the absence of black-cockatoos from roosts
- 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 Carnaby's Black-Cockatoo 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 2010 and 2015, but this year saw many new sites confirmed. Many of the confirmed roosts identified since 2012 have been identified through a research program, combining the satellite telemetry tracking of Carnaby's Black-Cockatoo released from rehabilitation centres with field surveys to inspect potential roost sites and conduct roost counts when birds are present (Christine Groom, DPaW, unpublished data; Groom *et al.* 2013). Field surveys by Mark Blythman (DPaW) 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 large 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 district at the time of the survey. In addition, the significant 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 an approach for estimating the proportion of undetected birds become available, it should 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.

However, as the GCC appears to survey a large fraction of the population of the Carnaby's Black-Cockatoo present in the Perth-Peel Coastal Plain, the GCC is closer to a census (i.e. a survey in which all individuals present are counted) than to a smaller, representative sample. As such, estimated trends based on the GCC data should be closer to the true rate of change for the population than to estimates of the rate of change based on smaller, representative samples. Estimates of statistical significance, which apply to smaller, representative samples, are therefore very conservative in the circumstances.

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

Based on the 2016 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.

Significant 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 significant at a species-scale.

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 approximately 27% of the species' population occurred within the Perth-Peel Coastal Plain at the time of the 2016 count.

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

A species population of 40,000 birds means that around 17% of the species occurred within the remaining portions of the Gnangara pine plantation in early April 2016.

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

Significant roosts 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.

(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 consistently occupying a single main roost.

The large count in the Perth-Peel Coastal Plain this year may indicate that previous surveys missed significant roosts and that clearing is concentrating birds in fewer roosts

Each successive GCC has recruited more volunteers and the number of roosts surveyed has risen correspondingly. As more roosting habitat is lost each year 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. Four confirmed pine roosts in the Gnangara plantation were cleared in the last year. This may have contributed to the congregation this year of approximately 5,000 Carnaby's 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 locating roosts increases.

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.

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 an ongoing decline. Trend analysis of roost counts over the last seven GCCs found a current rate of decline of an estimated 14% per year. When the analysis was restricted to the larger, more stable roosts, the decline was still estimated at around 5-12%. 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 5-15% per annum (average 10%), slightly lower than trends estimated in previous years (Byrne *et al.* 2015, Finn *et al*. 2014; Williams *et al*. 2015). Such a rapid decline may manifest in the loss of flocks associated with particular roosts and, 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. 6763 Carnaby's Black-Cockatoos were recorded in roosts within or associated with the Gnangara/Yanchep/Pinjar pine plantations in the 2016 GCC (62% of all Carnaby's in the Perth-Peel Coastal Plain). This abundance is consistent with 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 7000 in Mariginiup in March 2004, 2000 in Ellenbrook in February 2005, 3000 in Gnangara in February 2005, 3000 in Landsdale in March 2005, 5000-7000 in Tamala Park in April 2003, 7000 in Yanchep National Park in July 2006, and 8000-10 000 in the pine plantation along Military Road north of Wanneroo in July 2006. Shah (2006) reported that 2789 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 (~3000 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 2016 GCC, it is likely that at least 2000 – 7000 Carnaby's Black-Cockatoos feed within the Gnangara pine plantation each year.

Previous GCCs are likely to 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 8000 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 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 difficult to determine how 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 significant portion (between 20-30%) 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 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

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

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 three 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 this year (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 likely reflects differences in the timing of the northward migration of Baudin's Black-Cockatoos during their non-breeding season.

Baudin's Black-Cockatoos breed in the Karri Forest and southern Jarrah-Marri Forest 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. One potential approach is to ask volunteers to record black-cockatoo contact calls during roost counts (Tony Kirkby, WA Museum, personal communication).

[13] For information on the Green Growth Plan of the Perth & Peel Regions, see: http://www.environment.gov.au/node/18607 https://www.dpc.wa.gov.au/Consultation/StrategicAssessment/Pages/Default.aspx

Experts could then analyse the recordings and estimate species proportions based on the frequency of contact calls for each species.

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 30 regional sites and the last three consecutive years at 26 sites.

Some initial inferences can therefore be made about the distribution of Carnaby's Black-Cockatoo during the middle of the non-breeding season. Firstly, along the west coast, significant populations 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 (probably 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 significant 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 six very large roosts (>200 birds) accounted for the majority of Carnaby's Black-Cockatoos recorded in regional areas in the 2016 GCC (2436 of 2779 birds or 88%). 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 2016 GCC built on the previous year's GCC as the only broad-scale survey for the Forest Red-tailed Black-Cockatoo, with volunteers documenting 70 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 2016 GCC. This is the result of more focus on this species at BirdLife Australia with the recruitment of a Cockies in Crisis Project Coordinator (Tegan Douglas). It is also the result of roost site information from Sam Rycken at Murdoch University. There are now 95 roost sites with positive FRTBC counts in GCCs.

This year 24 of the 70 FRTBC roosts were also occupied by White-tailed Black-Cockatoos (e.g. Murdoch University and SERBYFR004). Also, significant FRTBC roosts sometimes occur very close to significant Carnaby's Black-Cockatoo roosts. Examples of the latter situation include the FRTBC roost in Kensington (VICKENR001) and the Carnaby's Black-Cockatoo roost site in Dawesville (MANDAWR002).

Distribution of FRTBC in the Perth metropolitan area

Two clear outcomes emerged from the 2016 GCC: (a) FRTBC roosted at sites throughout the Perth metropolitan area, including roosts in the northern, western, and southern suburbs and (b) reasonably large FRTBC roosts (up to 125 birds) occurred at several suburban sites. Observations from the 2014 to 2016 GCCs confirmed roosts in 13 LGAs in the Perth-Peel Coastal Plain, with unconfirmed roosts reported in another five. Volunteers recorded sizable counts at Murdoch University, Floreat, Kensington, and Munster. 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 33 for the Perth-Peel region is much higher than that of regional areas (19) (Figure 5).

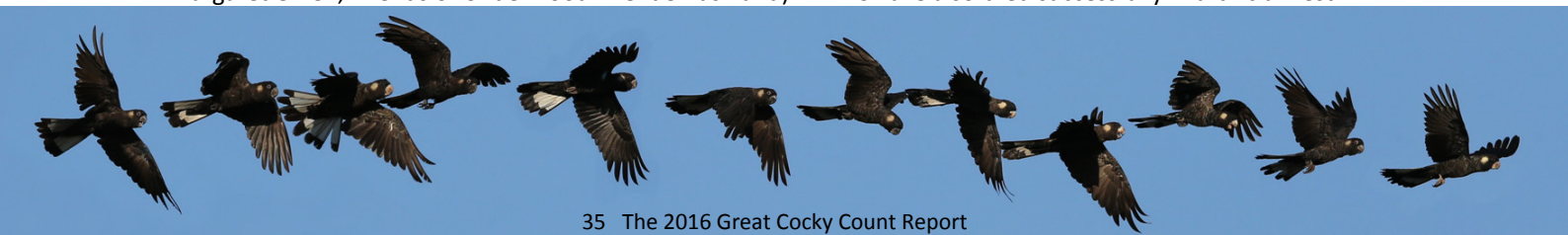
These outcomes are consistent with, and extend, previous observations about recent shifts in the abundance and distribution of FRTBC on the Swan Coastal Plain. In reviewing information about FRTBC on the Swan Coastal Plain, Johnstone *et al.* (2010, p. 24) noted that:

> 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 2016 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 associated 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). Roost occupancy is much higher for FRTBC compared to white-tailed black-cockatoos (Figure 5) but this may be due to them showing more roost fidelity than their population being more stable.

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

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 seven GCCs, involving more than 2000 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 2016 GCC and the trend analyses of the seven GCCs 2010 – 2016 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 by Finn et al. (2014) and Byrne at al. (2015), the Gnangara pine plantation sustains a large proportion (up to 62%) 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 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.

REFERENCES

Abbott, I. 1998. Conservation of the Forest Red-tailed Black Cockatoo, a hollow dependent species, in the eucalypt forests of Western Australia. *Forest Ecology and Management* 109: 175-185.

Berry, P.F. 2008. Counts of Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and records of flock composition at an overnight roosting site in metropolitan Perth. *Western Australian Naturalist* 26: 1-11.

Berry P.F., and M. Owen. 2010. Additional counts and records of flock composition of Carnaby's Cockatoo (*Calyptorhynchus latirostris*) at two overnight roosting sites in metropolitan Perth. *Western Australian Naturalist* 27: 27-38.

BirdLife International. 2012a. *Calyptorhynchus latirostris*. In: 'IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2.' Available from: www.iucnredlist.org. Accessed 27 November 2012.

BirdLife International. 2012b. *Calyptorhynchus baudinii*. In: 'IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2'. Available from: www.iucnredlist.org. Accessed 03 December 2012.

Burnham, Q., G. Barrett, M. Blythman, and R. Scott. 2010. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) identification of nocturnal roost sites and the 2010 Great Cocky Count. Report prepared for the WA Department of Environment and Conservation. Perth, Australia. Available from: http://www.birdlife.org.au/documents/CBC-gccreportaug2010.pdf

Byrne, M., G. Barrett, M. Blythman, H. Finn and M. Williams, 2015. The 2015 Great Cocky Count: a community-based survey for Carnaby's Black-Cockatoos (*Calyptorhynchus latirostris*) and Forest Red-tailed Black-Cockatoos (*Calyptorhynchus banksii naso*). BirdLife Australia, Perth, W.A. Available from: http://www.birdlife.org.au/documents/GCC-report-2015.pdf

Chapman, T. F. 2008. Forest Black Cockatoo (Baudin's cockatoo *Calyptorynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorynchus banksii naso*) Recovery Plan. Department of Conservation and Land Management: Perth Western Australia. Available from: http://www.environment.gov.au/resource/forest-black-cockatoo-baudin%E2%80%99s-cockatoo-calyptorhynchus-baudinii-and-forest-red-tailed

Christidis, L, and W.E. Boles. 2008. Systematics and taxonomy of Australian birds. CSIRO Publishing, Melbourne.

CSIRO, 2009. Water yields and demands in south-west Western Australia, A report to the Australian Government from the CSIRO South-West Western Australia Sustainable Yields Project. CSIRO Water for a Healthy Country Flagship, Australia.

Cunningham, R.B., and B.D. Lindenmayer. 2005. Modeling count data of rare species: some statistical issues. *Ecology* 86: 1135-1142.

Department of the Environment. 2013. Significant Impact Guidelines 1.1 – Matters of National Environmental Significance. Available from: http://www.environment.gov.au/epbc/publications/nes-guidelines.html. Accessed 01 June 2014.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC). 2012. EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, and Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso.* Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59523. Accessed 01 June 2014.

Department of Parks and Wildlife (DPaW). 2013. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia. Western Australian Wildlife Management Program No. 52. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59523

Dobbie, M.J., and A.H. Welsh. 2001. Modelling correlated zero-inflated count data. *Australian and New Zealand Journal of Statistics* 43: 431-444.

Finn, H., W. Stock, and L. Valentine. 2009. Pines and the ecology of Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) in the Gnangara Sustainability Strategy study area. Report for the Forest Products Commission and the Gnangara Sustainability Strategy. Perth, Western Australia. Available from: http://researchrepository.murdoch.edu.au/8182/1/ecology_of_Carnabys_Black-Cockatoos.pdf

Finn, H., G. Barrett, C. Groom, M. Blythman, and M. Williams, M. 2014. The 2014 Great Cocky Count: a community-based survey for Carnaby's Black-Cockatoos (*Calyptorhynchus latirostris*) and Forest Red-tailed Black-Cockatoos (*Calyptorhynchus banksii naso*). BirdLife Australia, Perth, W.A. Available from: http://birdlife.org.au/documents/CBC-2014GCC-Report.pdf

Glossop, B., K. Clarke, D. Mitchell, and G. Barrett. 2011. Methods for mapping of Carnaby's Cockatoo habitat. Department of Environment and Conservation. Perth, Australia.

Groom, C.J., P.R. Mawson, J.D. Roberts, and N.J. Mitchell. 2014. Meeting and expanding human population's needs whilst conserving a threatened parrot species in an urban environment. *WIT Transactions on Ecology and the Environment* 191: 1199-1212.

Groom, C., P. Mawson, K. Warren, J.D. Roberts, and M. Page. 2013. Tracking Carnaby's Cockatoos in Western Australia. *ARGOS Forum* 77: 6-7.

Humbert, J.-Y., L.S. Mills, J.S. Horne, and B. Dennis. 2009. A better way to estimate population trends. *Oikos* 118: 1940-1946.

Johnston, T. 2013. Food resource availability for Carnaby's Cockatoo *Calyptorhynchus latirostris* on the Swan Coastal Plain. MSc thesis, School of Natural Sciences, Edith Cowan University, Joondalup, WA.

Johnstone, R.E., and T. Kirkby. 2008. Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo *(Calyptorhynchus baudinii)* in South-west Western Australia. *Records of the Western Australian Museum* 25:107-118.

Johnstone, R. E., C. Johnstone, and T. Kirkby. 2010. Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin–Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Report for the Department of Planning, Western Australia.

Johnstone, R. E., T. Kirkby, and K. Sarti. 2013 The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. II. Breeding behaviour and diet. *Pacific Conservation Biology* 19: 143-155.

Kabat, A.P., R. Scott, T. J. Kabat, and G. Barrett. 2012a. 2011 Great Cocky Count: Population estimates and identification of roost sites for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*). BirdLife Australia, Perth, Western Australia. Available from: http://birdlife.org.au/documents/SWBC-Great_Cocky_Count_Report-2011.pdf

Kabat, T.J., G. Barrett, and A.P. Kabat. 2012b. 2012 Great Cocky Count: Identification of roost sites for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and population count for the DEC Swan Region. BirdLife Australia, Perth, Western Australia. Available from: http://www.birdsaustralia.com.au/documents/SWBC-Great_Cocky_Count_Report-2012.pdf

Kabat, T.J., G. Barrett, and A.P. Kabat. 2013. 2013 Great Cocky Count: Identification of roost sites for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and population count for the DEC Swan Region. BirdLife Australia, Perth, Western Australia. Available from: http://www.birdsaustralia.com.au/documents/SWBC-Great_Cocky_Count_Report-2013.pdf

Kery, M., and H. Schmid. 2004. Monitoring programs need to take into account imperfect species detectability. *Basic and Applied Ecology* 5: 65-73.

Lee, J., H. Finn, and M.C. Calver. 2013. Ecology of black cockatoos at a mine-site in the eastern jarrah–marri forest, Western Australia. *Pacific Conservation Biology* 19, 76-90.

Link, W.A., and J.R. Sauer. 1997. Estimation of population trajectories from count data. *Biometrics* 53: 63-72.

Perry, D.H. 1948. Black cockatoos and pine plantations. *Western Australian Naturalist* 1: 133–135.

SAS Institute Inc. 2011. SAS/STAT 9.3 User's guide. SAS Institute Inc., Cary, North Carolina, USA.

Sauer, J.R., W.A. Link, and J.A. Royle. 2004. Estimating population trends with a linear model: technical comments. *Condor* 106: 435-440.

Saunders, D.A. 1974. The occurrence of the White-tailed Black Cockatoo, *Calyptorhynchus baudinii*, in *Pinus* plantations in Western Australia. *Wildlife Research* 1: 45–54.

Saunders, D.A. 1980. Food and movements of the short-billed form of the White-tailed Black Cockatoo. *Wildlife Research* 7: 257–69. doi: 10.1071/wr9800257

Saunders, D.A. 1982. The breeding behaviour and biology of the short-billed form of the White-tailed Black Cockatoo *Calyptorhynchus funereus*. *Ibis* 124: 422-455.

Schmeller, D.S., K. Henle, A. Loyau, A. Besnard, and P.-Y. Henry. 2012. Bird-monitoring in Europe – a first overview of practices, motivations and aims. *Nature Conservation* 2: 41-57.

Shah, B. 2006. Conservation of Carnaby's Black-Cockatoo on the Swan Coastal Plain, Western Australia. Report to Birds Australia. Perth, Western Australia. Available from: http://birdlife.org.au/documents/CBC-GCC-Shah2006-Carnabys_SCP_Project_Report.pdf

Stock, W.D., H. Finn, J. Parker, and K. Dods. 2013. Pine as fast food: foraging ecology of an endangered cockatoo in a forestry landscape. *PLoS ONE* 8(4): e61145. Available from: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0061145

Western Australian Planning Commission, and Department of Planning. 2010. Directions 2031 and beyond: metropolitan planning beyond the horizon. Available from: http://www.planning.wa.gov.au/publications/826.asp

Williams, M.R., Yates, C.J., Stock, W.D., Barrett, G.W. & Finn, H.C. (2015) Citizen science monitoring reveals a significant, ongoing decline of the endangered Carnaby's black-cockatoo Calyptorhynchus latirostris. Oryx, http://dx.doi.org/10.1017/S0030605315000320.

Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A. and G.M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer, New York.

APPENDIX I: Example of the 2016 Great Cocky Count survey form

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

Date:	3 April 2016	**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.

**** 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) **Arrive at your allocated roost site at least 45 minutes before sunset** so you are in position and ready to record birds as they arrive. **Start counting from 5:30pm**.

2) **Count all white-tailed black-cockatoos that roost at the site for at least 30 minutes after sunset** (ie. count until at least **6:30pm**).

   - 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).
   - 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 how many you count on your survey form, but do not include them in your count for white-tailed black-cockatoos.
   - **Count ALL white-tailed black-cockatoos** landing at your site – don't worry about telling apart Baudin's and Carnaby's Black-Cockatoos *unless you are certain of the difference*. If you see **red-tailed black-cockatoos at your site**, note this on your survey form as well.
   - If you don't see any cockatoos, don't despair – it is just as important to record that no cockatoos were present at that roost site. Records of presence and absence help us determine patterns of roost occupancy across the GCC survey area.

3) **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.

4) 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 2016 Great Cocky Count please contact Adam Peck, Great Cocky Count Coordinator, at greatcockycount@birdlife.org.au or (08) 9287 2251/ 0401 840 546.

APPENDIX II: Number of sites surveyed across local government areas (2016)

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

Shire	N sites surveyed	N sites occupied	Total count	Shire	N sites surveyed	N sites occupied	Total count
Regional areas							
Albany	10	1	107	**Denmark**	3	1	70
Augusta-Margaret River	9	5	97	**Donnybrook-Balingup**	6	1	4
Bindoon	1	0	0	**Esperance**	3	2	697
Boddington	3	3	166	**Goomalling**	1	0	0
Bridgetown-Greenbushes	6	3	46	**Harvey**	10	4	406
Bunbury	3	0	0	**Manjimup**	1	1	17
Busselton	9	3	154	**Narrogin**	2	1	21
Capel	6	4	248	**Plantagenet**	2	1	191
Carnamah	1	1	40	**Ravensthorpe**	2	0	0
Chapman Valley	5	1	270	**Wandering**	2	1	4
Dandaragan	3	1	436	**West Arthur**	1	0	0
Dardanup	1	0	0	**Williams**	2	0	0
Greater Perth-Peel region							
Armadale	13	4	194	**Mundaring**	26	12	1039
Bayswater	4	0	0	**Murray**	1	1	20
Belmont	2	0	0	**Nedlands**	8	2	249
Cambridge	6	1	239	**Northam**	2	1	94
Canning	9	0	0	**Perth**	1	0	0
Claremont	2	0	0	**Rockingham**	9	0	0
Cockburn	17	3	319	**Serpentine-Jarrahdale**	16	6	242
Fremantle	2	0	0	**South Perth**	4	1	242
Gingin	7	4	6490	**Stirling**	16	2	69
Gosnells	10	2	201	**Subiaco**	5	0	0
Joondalup	10	1	43	**Swan**	25	8	1123
Kalamunda	22	4	383	**Toodyay**	1	1	140
Kings Park	4	0	0	**Victoria Park**	7	1	6
Kwinana	3	0	0	**Vincent**	3	0	0
Mandurah	13	4	515	**Wanneroo**	33	6	1869
Melville	17	3	106	**Waroona**	6	3	198
Mosman Park	1	0	0	**York**	1	0	0

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

Appendix IIIa: Great Cocky Count (2010-2016) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page iv) 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	Totals
ARMFORR001	Forrestdale	.	.	.	0	0	18	0	**18**
ARMHARR001	Harrisdale	.	0	0	.	0	1	3	**4**
ARMKELR001	Kelmscott	14	0	0	0	0	.	.	**14**
CAMCITR001	City Beach	.	.	.	.	2	0	0	**2**
CAMFLOR001	Floreat	237	151	148	157	159	86	239	**1177**
CANFERR001	Ferndale	.	.	.	5	0	0	0	**5**
CANWILR001*	Willetton	0	0	0	0	68	0	0	**68**
CLASWAR001	Swanbourne	.	.	0	0	3	0	0	**3**
COCBANR001	Banjup	.	.	.	.	.	45	.	**45**
COCBANR002*	Banjup	.	.	.	.	53	.	0	**53**
COCBIBR003	Bibra Lake	0	0	.	0	0	0	0	**0**
COCHAMR001	Hamilton Hill	0	169	215	0	168	68	101	**721**
COCHAMR002	Hamilton Hill	.	.	.	.	.	263	194	**457**
COCSCCR001	Success	252	cleared	cleared	cleared	cleared	cleared	cleared	**252**
COCSCCR002	Success	15	3	cleared	cleared	cleared	cleared	cleared	**18**
COCSPER001	Spearwood	0	2	.	323	.	0	0	**325**
COCSPER002	Spearwood	.	5	0	.	.	0	24	**29**
GINGINR001	Gingin	392	378	432	686	879	784	1023	**4574**
GINNEER001	Neergabby	.	.	.	.	.	.	70	**70**
GINWOOR001	Woodridge	113	119	0	30	0	0	0	**262**
GINYEAR001	Yeal	.	.	387	.	782	.	.	**1169**
GINYEAR002	Yeal	49	92	.	.	.	20	.	**161**
GINYEAR003	Yeal	.	.	.	.	.	750	4897	**5647**
GOSCNVR001*	Canning Vale	0	19	.	.	0	0	0	**19**
GOSCNVR002*	Canning Vale	.	.	26	52	0	0	151	**229**
GOSHUNR001	Huntingdale	0	0	.	0	0	0	0	**0**
GOSSOUR002	Southern River	.	.	.	.	.	.	50	**50**
JOODUNR001	Duncraig	.	.	60	0	0	17	43	**120**
JOOEDGR001	Edgewater	0	0	.	0	0	23	0	**23**
JOOPADR001	Padbury	0	.	1	17	7	7	0	**32**
JOOWARR001	Warwick	0	60	.	0	0	0	0	**60**
KWICASR001	Casuarina	2	.	.	0	19	.	.	**21**
KWIWANR001	Wandi	63	0	0	1	0	0	0	**64**
KWIWELR001*	Wellard	.	.	15	50	0	62	0	**127**
MANCOOR002*	Coodanup	.	.	.	21	0	0	2	**23**

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
MANDAWR002*	Dawesville	371	199	11	0	257	135	214	**1187**
MANDAWR004	Dawesville	159	.	.	0	24	22	0	**205**
MANDAWR005	Dawesville	.	30	.	0	0	0	0	**30**
MANDAWR006	Dawesville	.	.	.	.	.	11	132	**143**
MANDAWR007*	Dawesville	.	.	.	.	.	277	167	**444**
MANDUDR001	Dudley Park	.	0	0	cleared	cleared	cleared	cleared	**0**
MELBATR001	Bateman	8	0	0	0	0	0	0	**8**
MELKARR002	Kardinya	0	0	0	.	0	55	0	**55**
MELLEER001*	Leeming	0	0	12	0	70	0	0	**82**
MELMURR001*	Murdoch	700	60	142	127	234	24	78	**1365**
MELWINR001	Winthrop	.	56	81	70	41	0	21	**269**
MELWINR003	Winthrop	117	130	.	.	.	0	7	**254**
MELWINR004	Winthrop	0	0	0	0	2	0	0	**2**
NEDDALR003	Dalkeith	40	90	0	0	0	0	0	**130**
NEDNEDR001	Nedlands	73	103	304	183	114	106	216	**1099**
NEDNEDR002	Nedlands	.	.	.	.	0	11	0	**11**
NEDNEDR003	Nedlands	.	.	.	.	0	2	33	**35**
ROCBALR001	Baldivis	346	.	cleared	cleared	cleared	cleared	cleared	**346**
ROCBALR003*	Baldivis	.	78	0	4	0	0	0	**82**
ROCBALR004	Baldivis	.	40	0	0	0	.	0	**40**
ROCBALR005	Baldivis	.	.	.	0	0	0	0	**0**
ROCKARR001	Karnup	.	cleared	cleared	cleared	cleared	cleared	cleared	**0**
ROCSECR001	Secret Harbour	0	.	0	0	6	0	0	**6**
SERBYFR004	Byford	.	.	.	.	.	.	111	**111**
SERDARR001	Darling Downs	.	.	.	.	.	.	8	**8**
SERKEYR001	Keysbrook	0	.	.	100	3	14	53	**170**
SERMUNR002	Mundijong	.	.	.	.	.	.	10	**10**
SEROAKR001	Oakford	0	110	.	0	0	.	.	**110**
SEROAKR002	Oakford	0	0	0	2	.	.	.	**2**
SEROAKR003	Oakford	167	0	0	0	0	0	.	**167**
SEROAKR004	Oakford	45	3	0	0	50	0	26	**124**
SEROAKR005	Oakford	31	0	.	0	0	0	0	**31**
SERWHIR001	Whitby	.	.	.	.	.	.	34	**34**
SOUCOMR001	Como	408	645	558	301	402	460	242	**3016**
SOUSALR001*	Salter Point	12	0	0	0	5	0	0	**17**
SOUSOUR002	South Perth	0	35	0	0	0	0	0	**35**
STIHAMR001	Hamersley	.	.	.	.	0	.	24	**24**
STIKARR001	Karrinyup	.	.	.	121	92	2	45	**260**
STIMENR001	Menora	.	.	.	0	0	0	0	**0**
STINORR001	North Beach	0	230	0	267	0	6	0	**503**
STIYOKR001	Yokine	.	0	0	0	.	.	0	**0**

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
SUBSHER001	Shenton Park	0	0	0	9	0	0	0	**9**
SWABALR001	Ballajura	0	40	0	92	0	35	0	**167**
SWABALR004	Ballajura	0	.	.	.	0	5	105	**110**
SWABULR003	Bullsbrook	.	.	.	.	.	.	8	**8**
SWAELLR001	Ellenbrook	.	.	.	.	14	.	280	**294**
SWALEXR001	Lexia	0	80	0	0	181	0	0	**261**
SWALEXR002	Lexia	185	0	.	0	0	0	cleared	**185**
SWAMELR001	Melaleuca	500	41	0	20	480	0	.	**1041**
SWAMELR002	Melaleuca	0	.	cleared	cleared	cleared	cleared	cleared	**0**
SWAMILR001	Millendon	.	.	.	.	0	.	250	**250**
SWAVINR003	The Vines	.	.	.	.	.	.	21	**21**
SWAWHIR001	Whiteman	.	69	13	.	.	0	0	**82**
VICVICR001	Victoria Park	2	0	0	0	0	0	6	**8**
WANCARR001	Carabooda	.	.	2	.	.	0	0	**2**
WANCARR004	Carabooda	.	.	.	.	7	.	.	**7**
WANCRRR001	Carramar	.	.	.	191	0	0	0	**191**
WANGNAR001	Gnangara	0	.	.	.	0	.	454	**454**
WANGNAR003	Gnangara	0	14	0	0	0	0	0	**14**
WANGNAR004	Gnangara	27	0	0	0	0	0	0	**27**
WANGNAR005	Gnangara	.	.	.	100	0	14	0	**114**
WANGNAR006*	Gnangara	.	.	.	.	40	.	3	**43**
WANJANR002	Jandabup	.	.	.	.	.	0	.	**0**
WANJANR004	Jandabup	0	.	.	.	.	.	.	**0**
WANJANR005	Jandabup	0	.	0	.	.	.	.	**0**
WANJANR007	Jandabup	.	16	.	0	.	0	cleared	**16**
WANMARR001	Mariginiup	0	20	.	0	.	71	0	**91**
WANMARR002	Mariginiup	0	.	2	3	3	0	0	**8**
WANMARR003	Mariginiup	542	152	10	16	147	280	4	**1151**
WANNEER001	Neerabup	.	29	.	.	0	.	0	**29**
WANNEER002	Neerabup	604	0	0	0	0	0	0	**604**
WANNOWR001	Nowergup	.	.	35	10	0	0	0	**45**
WANNOWR005	Nowergup	0	.	.	.	.	.	3	**3**
WANPINR001	Pinjar	.	.	853	35	1521	616	1232	**4257**
WANPINR002	Pinjar	.	312	276	0	138	101	0	**827**
WANPINR003	Pinjar	64	0	0	0	0	0	0	**64**
WANPINR005	Pinjar	275	.	.	.	0	0	cleared	**275**
WANPINR006	Pinjar	13	0	0	0	2	0	0	**15**
WANPINR007	Pinjar	0	0	0	0	.	.	0	**0**
WANPINR010	Pinjar	.	0	.	.	0	.	.	**0**
WANPINR011	Pinjar	0	.	.	800	0	179	0	**979**
WANTAMR001	Tamala Park	.	.	0	103	20	10	0	**133**

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
WANTWOR001	Two Rocks	0	.	7	573	200	30	0	**810**
WANWANR001	Wanneroo	0	11	6	0	0	0	0	**17**
WANYANR001	Yanchep	61	.	.	.	450	82	0	**593**
WANYANR003	Yanchep	.	16	0	564	0	0	0	**580**
WANYANR004	Yanchep	.	0	0	192	0	0	cleared	**192**
WANYANR006	Yanchep	342	305	129	0	0	0	0	**776**
WANYANR007	Yanchep	.	0	0	.	0	.	173	**173**
WARLAKR001	Lake Clifton	1	0	0	.	.	0	0	**1**
WARPRER001	Preston Beach	.	.	66	330	19	.	158	**573**
WARPRER002	Preston Beach	100	.	0	.	0	0	0	**100**
WARWARR002*	Waroona	.	.	.	36	0	0	4	**40**

Appendix IIIb: Great Cocky Count (2010-2015) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page iv) (24) that: (a) are within or immediately adjacent (<1 km) to the **Gnangara pine plantation** (see page v) or (b) have historically been used as a roost by cockatoos feeding within the plantation system. Use of the roosts located in Yanchep National Park (YNP) is documented in Saunders (1980); Shah (2006); Finn *et al.* (2009); and Stock *et al.* (2013). The plantation includes three sections: Gnangara (southern), Pinjar (central), and Yanchep (northern).
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. A period in a cell means that the site was not surveyed that year. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting.

Site code	2010	2011	2012	2013	2014	2015	2016	Totals
GINYEAR001	.	.	387	.	782	.	.	**1169**
GINYEAR002	49	92	.	.	.	20	.	**161**
GINYEAR003	.	.	.	.	.	750	4897	**5647**
SWALEXR001	0	80	0	0	181	0	0	**261**
SWALEXR002	185	0	.	0	0	0	cleared	**185**
SWAMELR001	500	41	0	20	480	0	.	**1041**
WANCARR004	.	.	.	.	7	.	.	**7**
WANGNAR001	0	.	.	.	0	.	454	**454**
WANGNAR003	0	14	0	0	0	0	0	**14**
WANGNAR004	27	0	0	0	0	0	0	**27**
WANGNAR005	.	.	.	100	0	14	0	**114**
WANGNAR006*	.	.	.	.	40	.	3	**43**
WANJANR007	.	16	.	0	.	0	cleared	**16**
WANMARR001	0	20	.	0	.	71	0	**91**
WANMARR002	0	.	2	3	3	0	0	**8**
WANMARR003	542	152	10	16	147	280	4	**1151**
WANNEER001	.	29	.	.	0	.	0	**29**
WANNEER002	604	0	0	0	0	0	0	**604**
WANPINR001	.	.	853	35	1521	616	1232	**4257**
WANPINR002	.	312	276	0	138	101	0	**827**
WANPINR003	64	0	0	0	0	0	0	**64**
WANPINR005	275	.	.	.	0	0	cleared	**275**
WANPINR006	13	0	0	0	2	0	0	**15**
WANPINR007	0	0	0	0	.	.	0	**0**
WANPINR010	.	0	.	.	0	.	.	**0**
WANPINR011	0	.	.	800	0	179	0	**979**
WANTWOR001	0	.	7	573	200	30	0	**810**
WANYANR001	61	.	.	.	450	82	0	**593**
WANYANR003	.	16	0	564	0	0	0	**580**
WANYANR004	.	0	0	192	0	0	cleared	**192**
WANYANR006	342	305	129	0	0	0	0	**776**
WANYANR007	.	0	0	.	0	.	173	**173**
Total	2662	1077	1664	2303	3951	2143	6763	**20563**
% of total Perth-Peel Coastal Plain count	42%	28%	44%	41%	59%	46%	62%	**49%**
No. of pine-associated sites surveyed	19	20	18	21	27	24	23	**32**

Appendix IIIc: Great Cocky Count (2010-2016) roost counts for Carnaby's Black-Cockatoo at **confirmed roosts** (see page iv) 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	Totals
ARMBEDR001*	Bedfordale	57	0	.	0	0	0	0	**57**
ARMBEDR002	Bedfordale	70	22	.	3	0	.	0	**95**
ARMBEDR003	Bedfordale	385	.	.	0	0	60	6	**451**
ARMKELR002	Kelmscott	0	10	.	0	0	0	0	**10**
ARMROLR001	Roleystone	108	13	140	40	0	0	157	**458**
ARMROLR003	Roleystone	.	0	0	50	0	0	0	**50**
ARMROLR004	Roleystone	.	.	.	.	0	.	28	**28**
BEVFLYR001	Flynn	.	0	0	0	0	0	.	**0**
BODBODR001	Boddington	.	.	.	.	.	.	9	**9**
BODCRORR002	Crossman	10	0	.	.	.	3	.	**13**
BODMARR001	Marradong	.	.	.	.	.	.	16	**16**
BODMARR002	Marradong	.	.	.	.	.	.	141	**141**
KALKALR001	Kalamunda	30	.	25	0	0	0	0	**55**
KALKALR002	Kalamunda	.	25	23	85	28	10	58	**229**
KALKALR004	Kalamunda	.	.	.	.	.	.	65	**65**
KALLESR001	Lesmurdie	.	0	0	0	0	8	0	**8**
KALPICR002*	Pickering Brook	.	.	.	.	2	.	0	**2**
KALPIER001*	Piesse Brook	.	82	46	0	0	0	163	**291**
KALPIER003	Piesse Brook	.	.	.	.	.	.	97	**97**
KALWALR001*	Walliston	0	5	0	0	0	0	.	**5**
MUNCHIR001	Chidlow	16	0	.	0	0	cleared		**16**
MUNDARR001	Darlington	443	7	147	0	0	0	.	**597**
MUNGLER001	Glen Forrest	.	.	32	51	45	25	65	**218**
MUNGLER002	Glen Forrest	.	.	13	0	0	0	0	**13**
MUNGLER003	Glen Forrest	.	.	.	.	45	.	0	**45**
MUNHELR001*	Helena Valley	.	3	16	42	124	0	44	**229**
MUNHOVR001*	Hovea	.	.	40	0	.	0	0	**40**
MUNHOVR002	Hovea	243	22	10	0	0	0	18	**293**
MUNMTHR001	Mt Helena	.	.	.	8	0	0	0	**8**
MUNMTHR002	Mt Helena	.	.	.	.	0	.	147	**147**
MUNMTHR003	Mt Helena	.	.	.	.	.	.	24	**24**
MUNMUNR001	Mundaring	78	.	.	85	45	36	0	**244**
MUNPARR002	Parkerville	.	.	.	.	182	.	66	**248**
MUNPARR003	Parkerville	.	.	.	.	.	.	320	**320**
MUNPARR004	Parkerville	.	.	.	.	.	.	209	**209**
MUNSTOR001*	Stoneville	.	.	.	.	141	0	7	**148**
MUNSTOR002	Stoneville	.	86	0	.	0	0	0	**86**
MUNSTOR003*	Stoneville	.	.	.	.	48	.	30	**78**
MUNSTOR004	Stoneville	.	.	.	.	.	.	90	**90**
MUNSTOR005	Stoneville	.	.	.	.	.	.	19	**19**
MURDWER001	Dwellingup	.	40	.	.	.	0	.	**40**
MURNORR001	North Dandalup	.	.	.	.	.	.	20	**20**

Site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
MURTEER001	Teesdale	21	0	0	0	.	0	.	**21**
NORBAKR001	Bakers Hill	217	.	.	.	.	.	94	**311**
NORWOOR001	Woottating/Copley	0	.	.	0	.	.	.	**0**
NORWUNR001*	Wundowie	125	.	8	0	.	0	0	**133**
SERJARR001	Jarrahdale	0	60	0	.	.	0	.	**60**
SERKEYR002*	Keysbrook	25	.	0	30	.	0	.	**55**
SWABULR002	Bullsbrook	.	18	117	120	328	.	178	**761**
SWAGIDR002	Gidgegannup	101	.	23	40	.	217	129	**510**
SWAGIDR003	Gidgegannup	.	.	3	.	.	.	0	**3**
SWAGIDR004	Gidgegannup	.	.	.	0	.	.	.	**0**
SWAGIDR005	Gidgegannup	.	.	.	197	163	169	152	**681**
TOOMORR001*	Morangup	.	.	183	29	56	12	140	**420**
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 (2010-2016) roost counts for White-tailed Black-Cockatoo at **confirmed roosts** (see page iv) in regional areas. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

2016 site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
ALBCHER001	Cheynes	.	.	70	.	.	.	.	**70**
ALBCHER002	Cheynes	.	.	0	.	60	0	0	**60**
ALBGOOR001	Goode Beach	.	.	.	84	62	.	0	**146**
ALBGOOR002	Goode Beach	.	111	.	0	120	0	0	**231**
ALBKALR001	Kalgan	.	.	213	472	141	73	0	**899**
ALBMCKR001	McKail	.	.	33	.	18	0	107	**158**
ALBMETR001	Mettler	.	.	40	145	.	.	.	**185**
ALBMTCR001	Mt Clarence	.	4	.	.	0	0	0	**4**
ALBROBR001	Robinson	.	.	0	43	0	.	0	**43**
ALBSEPR001	Seppings	.	0	0	0	0	2	.	**2**
AUGFORR002	Forest Grove	.	.	.	.	.	.	6	**6**
AUGGRAR001	Gracetown	.	.	.	.	1	12	2	**15**
AUGGRAR002	Gracetown	.	.	.	7	85	4	26	**122**
AUGMARR001	Margaret River	.	.	11	1	47	0	57	**116**
AUGMARR003	Margaret River	.	.	.	0	0	0	.	**0**
AUGMARR004	Margaret River	.	.	.	.	.	.	6	**6**
BRIGLER001	Glenlynn	.	.	70	250	0	.	.	**320**
BRIGRER003	Greenbushes	.	.	.	.	.	.	5	**5**
BRINORR001	North Greenbushes	.	.	.	.	74	44	2	**120**
BRINORR002	North Greenbushes	.	.	.	.	.	.	39	**39**
BUNCOLR001	College Grove	.	.	0	20	0	7	0	**27**
BUNGLER001	Glen Iris	.	.	25	0	.	0	0	**25**
BUNGLER002	Glen Iris	.	.	.	8	4	0	.	**12**
BUSDUNR001	Dunsborough	.	.	.	32	99	0	0	**131**
BUSDUNR002	Dunsborough	.	.	.	.	.	.	82	**82**
BUSQUIR001	Quindalup	.	.	.	71	107	31	64	**273**
BUSYALR001	Yallingup	.	.	.	0	57	.	.	**57**
BUSYALR004	Yallingup	.	.	.	.	.	.	8	**8**
CAPGELR001	Gelorup	.	.	38	6	0	0	4	**48**
CAPGELR002*	Gelorup	.	.	.	.	0	21	2	**23**
CAPGWIR001	Gwindinup	194	.	14	0	119	175	216	**718**
CAPNORR001	North Boyanup	.	.	.	4	0	0	26	**30**
CARENNR001	Eneabba	.	.	.	.	.	.	40	**40**
CHANANR001	Nanson	.	.	.	302	262	300	270	**1134**
CHANANR002	Nanson	.	.	.	0	189	.	0	**189**
DANDANR001	Dandaragan	.	.	313	228	460	2	0	**1003**
DANHILR001	Hill River	.	.	160	0	250	0	0	**410**
DANHILR002	Hill River	.	.	136	.	.	11	.	**147**
DANHILR003	Hill River	.	.	.	.	131	.	.	**131**
DANJURR001	Jurien Bay	.	.	51	225	52	143	436	**907**
DANREGR001	Regans Ford	0	22	0	.	.	.	.	**22**
DAREATR001	Eaton	.	4	19	14	0	0	.	**37**

2016 site code	Locality	2010	2011	2012	2013	2014	2015	2016	Totals
DENSCOR001	Scotsdale	.	.	.	.	.	.	70	**70**
DONARGR001	Argyle	.	.	.	0	.	0	.	**0**
DONDONR001*	Donnybrook	.	.	.	11	0	0	.	**11**
DONMUMR001	Mumballup	.	29	.	0	.	7	.	**36**
DONMUNR001	Mungalup	.	.	.	.	.	.	4	**4**
ESPESPR001	Esperance	.	196	226	230	202	.	665	**1519**
ESPESPR002	Esperance	.	.	.	.	.	360	.	**360**
ESPESPR003	Esperance	.	.	.	.	.	60	.	**60**
ESPESPR004	Esperance	.	.	.	.	.	316	.	**316**
ESPMYRR001	Myrup	.	.	555	589	791	0	32	**1967**
ESPMYRR002	Myrup	.	.	1018	0	.	.	.	**1018**
GINNILR001	Nilgen	.	.	.	583	376	995	500	**2454**
GNOSTIR001	Stirling Range NP	.	.	52	.	38	.	.	**90**
GOOGOOR001	Goomalling	.	9	.	.	.	.	0	**9**
HARHARR001	Harvey	.	.	.	.	0	.	10	**10**
HARLESR001	Leschenault	.	.	.	.	.	.	14	**14**
HARMYAR001	Myalup	.	0	0	0	35	0	349	**384**
HARMYAR002	Myalup	52	155	cleared					**207**
HARMYAR003	Myalup	.	.	.	.	.	570	33	**603**
HARSUNR001	Harvey	.	.	.	.	.	24	.	**24**
IRWMILR001	Milo	.	.	1	.	0	.	.	**1**
JERBOXR001	Boxwood Hill	.	.	11	0	.	0	.	**11**
MNJCROR001	Crowea	.	.	.	5	0	.	.	**5**
MNJMNJR001	Manjimup	.	.	.	.	.	.	17	**17**
NARNARR002	Narrogin	.	.	16	19	36	.	21	**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	**191**
PLANARR002*	Narrikup	.	.	.	.	45	.	0	**45**
PLASTIR001	Stirling Range NP	.	.	254	316	.	25	.	**595**
RAVHOPR001	Hopetoun	.	.	.	.	30	.	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 (2014-2016) roost counts for FRTBC at **confirmed roosts** (see page iv) 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	Totals
ARMARMR002	Armadale	.	.	17	**17**
BAYMORR001	Morley	0	0	36	**36**
CAMFLOR002	Floreat	109	.	49	**158**
CANRIVR001	Riverton	.	.	6	**6**
CANWILR001*	Willetton	4	7	7	**18**
COCBANR002*	Banjup	3	.	32	**35**
COCCOOR001	Coolbellup	.	13	0	**13**
COCCOOR003	Coolbellup	.	.	57	**57**
COCMUNR001	Munster	92	.	73	**165**
COCMUNR003	Munster	.	.	38	**38**
GOSCNVR001*	Canning Vale	2	0	0	**2**
GOSCNVR002*	Canning Vale	0	4	0	**4**
GOSGOSR004	Gosnells	19	.	31	**50**
KWIWELR001*	Wellard	0	0	9	**9**
MANCOOR002*	Coodanup	0	0	30	**30**
MANDAWR002*	Dawesville	0	38	0	**38**
MANDAWR007*	Dawesville	.	0	2	**2**
MANPARR001	Parklands	0	.	16	**16**
MELLEER001*	Leeming	0	0	11	**11**
MELMURR001*	Murdoch	199	33	125	**357**
ROCBALR003*	Baldivis	17	25	24	**66**
SERBYFR003	Byford	.	.	6	**6**
SERBYFR004	Byford	.	.	88	**88**
SERDARR001	Darling Downs	.	.	26	**26**
SERSERR003	Serpentine	0	0	3	**3**
SERSERR005	Serpentine	.	.	12	**12**
SOUSALR001*	Salter Point	2	0	0	**2**
STIYOKR002	Yokine	0	1	0	**1**
STIYOKR003	Yokine	47	28	0	**75**
SWAVINR003	The Vines	.	.	31	**31**
VICKENR001	Kensington	94	121	0	**215**
VICKENR002	Kensington	.	35	42	**77**
WANGNAR006*	Gnangara	3	.	0	**3**
WARWARR002*	Waroona	10	0	0	**10**

Appendix Vb: Great Cocky Count (2014-2016) roost counts for FRTBC at **confirmed roosts** (see page iv) 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	Totals
ARMBEDR001*	Bedfordale	21	0	0	**21**
ARMBEDR004	Bedfordale	.	.	18	**18**
ARMROLR004	Roleystone	0	.	35	**35**
BODMARR001	Marradong	.	.	16	**16**
KALMAIR002	Maida Vale	25	.	56	**81**
KALMAIR005	Maida Vale	.	.	3	**3**
KALPICR002*	Pickering Brook	42	.	0	**42**
KALPIER001*	Piesse Brook	0	0	25	**25**
KALWALR001*	Walliston	43	1	.	**44**
KALWATR002	Wattle Grove	.	.	150	**150**
MUNCHIR002	Chidlow	12	.	49	**61**
MUNCHIR003	Chidlow	.	.	4	**4**
MUNGLER004	Glen Forrest	.	.	33	**33**
MUNHELR001*	Helena Valley	0	0	4	**4**
MUNHOVR001*	Hovea	.	14	52	**66**
MUNMTHR003	Mt Helena	.	.	41	**41**
MUNMUNR002	Mundaring	.	20	16	**36**
MUNMUNR003	Mundaring	.	.	59	**59**
MUNPARR003	Parkerville	.	.	12	**12**
MUNSTOR001*	Stoneville	0	24	0	**24**
MUNSTOR003*	Stoneville	0	.	9	**9**
MUNSTOR004	Stoneville	.	.	3	**3**
MUNSTOR005	Stoneville	.	.	15	**15**
MUNWOOR001	Wooroloo	17	.	.	**17**
MURDWER002	Dwellingup	3	.	.	**3**
MURNORR001	North Dandalup	.	.	26	**26**
NORWUNR001*	Wundowie	.	6	0	**6**
SERJARR003	Jarrahdale	.	.	30	**30**
SERKEYR002*	Keysbrook	.	37	.	**37**
SWAGIDR001	Gidgegannup	.	.	3	**3**
SWAGIDR007	Gidgegannup	.	.	86	**86**
SWAGIDR008	Gidgegannup	.	.	25	**25**
SWAGIDR009	Gidgegannup	.	.	15	**15**
TOOMORR001*	Morangup	0	5	0	**5**
WARWAGR001*	Wagerup	38	.	.	**38**
WILQUIR001	Quindanning	10	.	0	**10**
WNDSPRR001	Springs	.	.	74	**74**

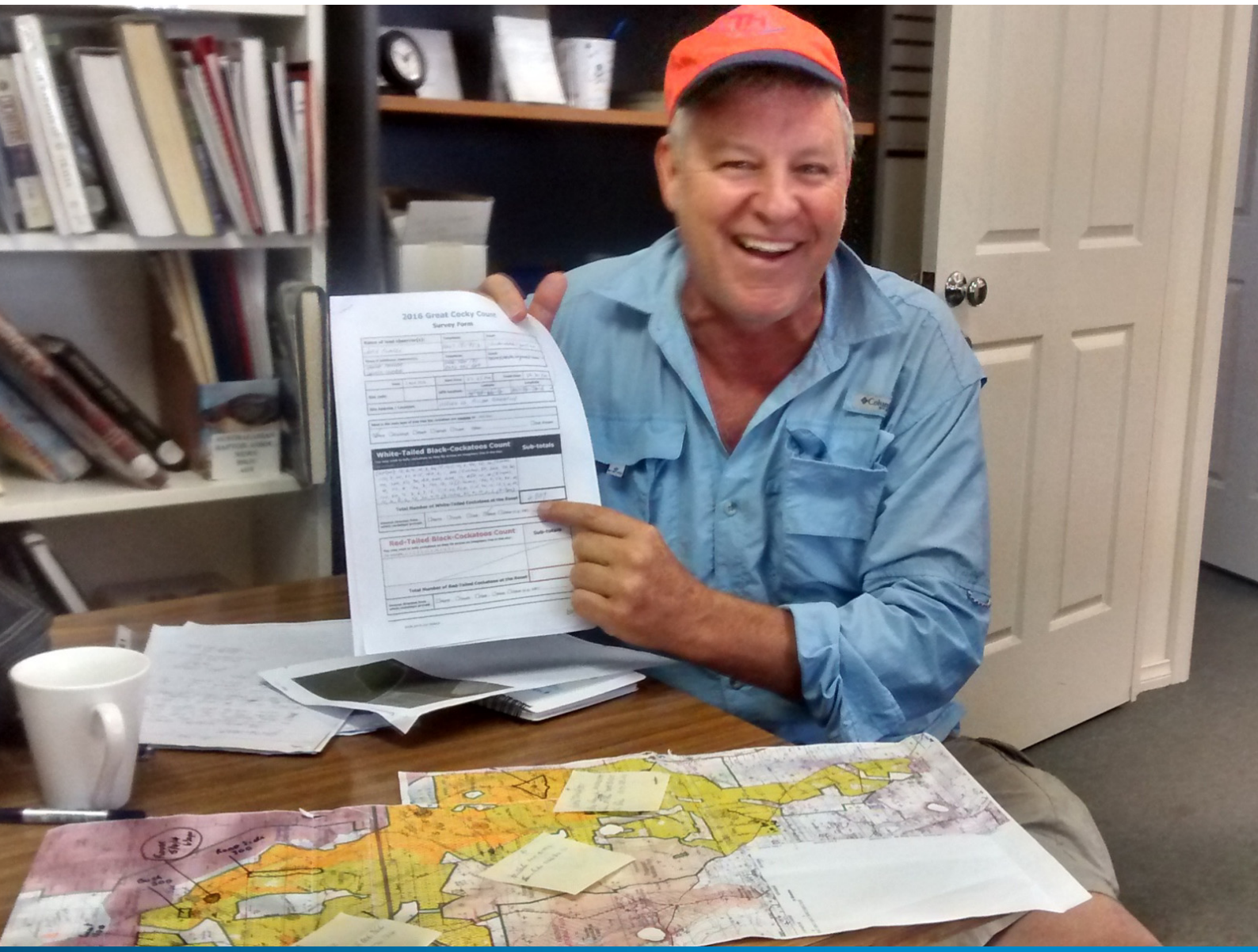
Appendix Vc: Great Cocky Count (20104-2016) roost counts for FRTBC at **confirmed roosts** (see page iv) in regional areas. Sites with an asterisk are or have been recorded as having both White-tailed and FRTBC roosting. A period in a cell means that the site was not surveyed in that year.

Site code	Locality	2014	2015	2016	Totals
ALBKALR003	Kalgan	.	.	27	**27**
ALBTORR003	Torbay	.	2	.	**2**
ALBTORR004	Coffey	.	5	.	**5**
AUGFORR002	Forest Grove	.	.	9	**9**
BRIGRER002	Greenbushes	20	0	6	**26**
BRIGRER003	Greenbushes	.	.	7	**7**
BRIGRER004	Greenbushes	.	.	7	**7**
BRINORR002	North Greenbushes	.	.	1	**1**
BUSJINR002	Jindong	2	.	0	**2**
BUSQUIR003	Quindalup	.	.	5	**5**
CAPBOYR001	Gwindinup	.	15	10	**25**
CAPGELR002*	Gelorup	0	11	4	**15**
DONDONR001*	Donnybrook	14	6	.	**20**
DONLOWR001	Lowden	.	.	3	**3**
DONMUMR002	Mumballup	.	.	7	**7**
DONMUNR001	Mungalup	.	.	84	**84**
DONNOGR001	Noggerup	.	.	49	**49**
HARBRUR002	Brunswick	.	.	9	**9**
HARHARR001	Harvey	6	.	11	**17**
HARLESR001	Leschenault	.	.	23	**23**
HARROER002	Roelands	3	.	29	**32**
MNJMNJR001	Manjimup	.	.	16	**16**
PLANARR002*	Narrikup	39	.	29	**68**
WILQUIR002	Quindanning	.	.	38	**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
ARMBEDR001	Northern Darling Scarp and Plateau	2014
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

Appendix VI: Summary of Survey Monkey results (335 respondents)							
Was 2016 the first time you participated in the GCC?	Yes 49%	No 51%					
Did you attend a GCC workshop prior to the count?	Yes 26%	No 74%					
How would you rate your 2016 GCC experience?	Excellent 50%	Good 33%	Satisfactory 10%	Disappointing 3%	I did not participate in the end 4%		
Do you feel we communicated the information about your roost site and counting instructions clearly?	Yes 90%	No 10%					
Were you allocated a site with other volunteers?	Yes 50%	No 50%					
Do you intend to participate in the GCC again?	Yes 98%	No 2%					
Age bracket	Under 20 2%	20-30 7%	30-40 13%	40-50 20%	50-60 21%	60-70 25%	Over 70 12%



Australia's voice for birds since 1901

BirdLife Australia is dedicated to achieving outstanding conservation results for our native birds and their habitats.

With our specialised knowledge and the commitment of an Australia-wide network of volunteers and supporters, we are creating a bright future for Australia's birds.

birdlife.org.au

Add your voice

join us

Enjoy the rewards of membership, making a real difference for our native birds

volunteer

Contributing your time is one of the most effective ways to help

donate

Help us create positive outcomes for birds and their habitats

PHCC Working Together
Peel-Harvey Catchment Council

City of Perth

City of Armadale