



SHIRE OF SERPENTINE
JARRAHDALE
WESTERN AUSTRALIA

BLACK COCKATOO CONSERVATION ACTION PLAN



Acknowledgment of Country

We acknowledge the Traditional Custodians of the boodjar (lands) on which this plan was prepared, the Whadjuk and Bindjareb Noongar¹ people, including Elders past and present.

We respect the enduring connections of Noongar people to the southwest of Western Australia, which includes the last remaining habitat for southwest Western Australia's threatened black cockatoos.

Please note: this document may contain the words and names of people who have passed away.

¹ There are several ways to spell Noongar; as is common for oral, non-written languages. This plan uses 'Noongar', and acknowledges the diversity of spellings.

Suggested citation

Murdoch University Black Cockatoo Conservation Management Project (2023) *Shire of Serpentine Jarrahdale Black Cockatoo Conservation Action Plan, Keep Carnaby's Flying – Ngoolarks Forever* project, Murdoch University.

Partners

This plan was developed for the Shire of Serpentine Jarrahdale by Murdoch University as part of the Shire's participation in the *Keep Carnaby's Flying – Ngoolarks² Forever* project, a community activation initiative to help safeguard black cockatoos in the Perth-Peel region, made possible with support from Lotterywest and the following partner organisations:



COVER PHOTO Rick Dawson

PHOTO CREDITS Karen Riley, Sam Rycken, Molly Spaulding, Zoe Kissane (p18, 45)
(Murdoch University black cockatoo researchers)

² There are several ways to spell and say the Noongar name for Carnaby's cockatoo. This plan uses 'ngoolark', and acknowledges the name diversity.

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A note on referencing:

The information in this Plan about specific threats to black cockatoos and effective conservation actions comes from peer-reviewed scientific publications, and from guidelines and advice prepared by government and organisations with specific black cockatoo expertise. The Plan incorporates information from ongoing research by Murdoch University and Birdlife Australia, and includes data specific to the Shire of Serpentine Jarrahdale. For readability, referencing has been confined to footnotes supporting selected statements. A list of selected references and resources is provided at the end of the document. For general advice about black cockatoos, please contact Birdlife Australia.

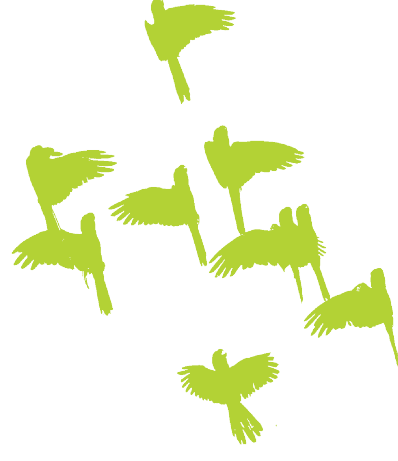


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BLACK COCKATOO CONSERVATION

Introduction

Black cockatoos are iconic wildlife in the Western Australian landscape. They are charismatic species that generate high levels of public attention and concern, and consistently poll amongst Australia's favourite birds.

All three of southwest Western Australia's endemic black cockatoo species – Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed cockatoo – are experiencing severe population declines due to habitat loss and other threatening processes, and face extinction within decades unless threats are addressed³. In the Perth-Peel region in particular, they are under great pressure.

As land managers and decision-makers, local governments play a critical role in protecting black cockatoos in their suburbs. Benefits of retaining black cockatoos in urban environments are numerous and include social, cultural, environmental and biodiversity benefits. In the Perth-Peel region, poor planning and management have already led to the loss of black cockatoos entirely from some areas.

The Shire of Serpentine Jarrahdale is an important area for black cockatoos, with roost sites and food resources that support flocks of Carnaby's cockatoos and forest red-tailed cockatoos. Unlike most of the Perth-Peel region, the Shire is also a home and breeding area for the

rarest of Australia's black cockatoos: Baudin's cockatoo.⁴ To safeguard the Shire's black cockatoos, there are some key evidence-informed actions that it will be important for the Shire to undertake, when managing its built and natural environments. This plan presents those actions.

Purpose

This plan outlines the actions the Shire of Serpentine Jarrahdale can undertake to manage the key threatening processes affecting black cockatoos within the Shire. The plan has been designed as a practical guide to help the Shire of Serpentine Jarrahdale safeguard its black cockatoos.

Background

In 2022, in recognition of the Shire's importance for black cockatoos, the Shire was one of four local governments invited to participate in the inaugural year of Keep Carnaby's Flying – Ngoolarks Forever⁵, with project activities commencing in 2023.⁶

The *Keep Carnaby's Flying – Ngoolarks Forever* project is a collaboration between universities, Aboriginal organisations and natural resource management and wildlife NGOs, with support from Lotterywest. The project's goal is to activate

the community to 'keep Carnaby's flying' in the Perth-Peel region, through a range of on-ground activities underpinned by science and cultural engagement. Key activities include outreach to community groups and schools, and funds and support to participating LGAs to plant black cockatoo food trees and install bird water drinking stations in targeted locations, informed by research, to help black cockatoos in the short term. Each participating LGA also receives an LGA-specific Black Cockatoo Conservation Action Plan (this document) to guide longer-term actions.

This Conservation Action Plan was developed by one of the lead organisations in *Keep Carnaby's Flying – Ngoolarks Forever*; Murdoch University. The university has been researching southwest WA's three black cockatoo species since 2007, with a focus on health, habitat use and flock movements, including GPS and ARGOS satellite tracking of flocks in the Perth-Peel region and across the species' ranges (see blackcockatooconservationwa.com). This research, along with locality-specific black cockatoo data from Birdlife Australia, has enabled the development of a targeted plan for the Shire of Serpentine Jarrahdale.

The plan covers:

- 1 The importance of the Shire of Serpentine Jarrahdale for black cockatoos.
- 2 Threats faced by black cockatoos in the Shire of Serpentine Jarrahdale.
- 3 Actions for the Shire to take to protect its black cockatoos.⁷

3 As the International Union for Conservation of Nature (IUCN) notes in its 'Justification of Red List category' for Baudin's cockatoo: "This species is experiencing very rapid declines exceeding a rate of 90% over the past three generations... There is no reason to suggest these declines will cease with nest hollow shortages continuing to afflict the species with low productivity, and fire and drought impacts [on habitat] projected to worsen with ongoing anthropogenic climate change. With a relatively small population (likely comprising fewer than 4,000 mature individuals), future declines of this magnitude place Baudin's Black-cockatoo at considerable extinction risk; it is therefore listed as *Critically Endangered*." Critically Endangered is the last step before extinction.

4 As black cockatoos are found only in Australia, this means the Shire of Serpentine Jarrahdale is home to the rarest black cockatoo in the world.

5 keepcarnabysflying.org.au

6 Shire of Serpentine Jarrahdale Letter of Participation, Natural Reserves Coordinator, 18 November 2022.

7 While the overall *Keep Carnaby's Flying – Ngoolarks Forever* project focused on Carnaby's cockatoos, this Plan has been designed to support all the Shire's black cockatoos, irrespective of species.

Murdoch University's black cockatoo research team – Who we are

This plan was prepared by Murdoch University, a partner organisation in *Keep Carnaby's Flying – Ngoolarks Forever*, with contributions from the university's black cockatoo conservation management research team⁸. Our team is undertaking one of the largest and longest studies of wild cockatoos in the world.

Our research focuses on the health, demographics and ecology of Western Australia's threatened black cockatoos. We have collaborations with the Department of Biodiversity, Conservation and Attractions (DBCA), Perth Zoo, Kaarakin Black Cockatoo Conservation Centre, WA Museum, World Wildlife Fund, Birdlife Australia and industry partners. Our research addresses most of the key Actions and Objectives in the [national Recovery Plans](#) for all three of southwest Western Australian's black cockatoo species.

Since 2007 we have undertaken disease screening of injured black cockatoos treated at Perth Zoo for rehabilitation back to the wild, and health monitoring of Carnaby's cockatoo nestlings throughout the species' breeding range.

In an exciting first for Australian cockatoos, we have developed the methodology to attach GPS and ARGOS satellite tags to rehabilitated black cockatoos prior to release back into wild flocks. This allows us to track flocks and identify key areas and habitat for foraging, roosting and breeding, as well as migratory movements, about which much remains unknown. We also attach telemetry tags to black cockatoos at key breeding sites to investigate habitat use at these sites.

Our tracking of flocks in the Perth-Peel region helps to identify important habitat and address threatening processes in different localities. Working with local governments, natural resource management and urban land-care NGOs and Birdlife Australia, we can identify important foraging habitat and roost trees to retain, priority locations for planting black cockatoo food species and providing bird water drinking stations, and hotspots for threats such as vehicle strikes, so that these can be managed.



8 blackcockatooconservationwa.com



Carnaby's cockatoos



Baudin's cockatoos



Forest red-tailed cockatoos

Southwest Western Australia's black cockatoos at a glance

Distinguishing features

- » **Carnaby's cockatoos (*Zanda latirostris*), Baudin's cockatoos (*Zanda baudinii*):** white panels on tail, Carnaby's have a shorter upper bill (beak) than Baudin's cockatoos, and are more prevalent in urban areas
- » **Forest red-tailed cockatoos (*Calyptorhynchus naso*)⁹:** red panels on tail for male, red, orange and yellow on tail for females and juveniles

Public image

- » Highly visible, charismatic wildlife, including in urban landscapes
- » Intelligent, curious, social
- » Strong cultural connections for Noongar people and wider community
- » Attract community and media attention and concern

Life history

- » Long-lived, slow-breeding
- » Flocks of generally <100 birds; may be larger, especially for Carnaby's cockatoos
- » Pairs likely mate for life; breed once per year (if breeding resources are available); raise one fledgling

Threat status

- » **Current population trends:** decreasing
- » All three species receive special protection as Matters of National Environmental Significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- » All three species remain in grave danger of ongoing and catastrophic population decline
- » **Carnaby's cockatoo:** Listed as Endangered under *Biodiversity Conservation Act 2016* (BC Act), EPBC Act (1999) and IUCN Red List for Threatened Species (IUCN Red List); (rapid population decline of >50%–79% in 45 years¹⁰)
- » **Baudin's cockatoo:** Endangered under BC Act and EPBC Act; Critically Endangered IUCN Red List (very rapid population decline of >90% in 45 years¹¹)
- » **Forest red-tailed cockatoo:** Vulnerable⁸ under BC Act and EPBC Act
- » **Major threats:** ongoing habitat loss and degradation; urban and industrial expansion; fires; disease; vehicle strike; displacement from hollows by competing species. Most threats now exacerbated by harmful climate changes.

Diet

- » Preferences vary by species; predominantly seeds (also flowers, nectar, grubs) from native trees, especially banksia, hakea, marri and jarrah; some introduced plants e.g. plantation pines (Carnaby's cockatoos). Food resources must be supported by roosts and water in close proximity.

9 As of August 2023, taxonomic research has discovered that forest red-tailed cockatoos, which had previously been considered a sub-species, are in fact a new species (Saunders & Pickup 2023). Their status as a separate species will have conservation implications, and may mean that their conservation risk status is raised from 'vulnerable' to 'endangered'; given that there are fewer forest red-tailed black cockatoos left than Carnaby's cockatoos, and the latter is already recognised as endangered.

10 BirdLife International (2022). *Zanda latirostris*. The IUCN Red List of Threatened Species 2022: e.T22684733A212974328. <https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T22684733A212974328.en>

11 BirdLife International (2023). Species factsheet: *Zanda baudinii*. <http://datazone.birdlife.org/species/factsheet/baudins-black-cockatoo-zanda-baudinii>



Figure 1. Southwest WA distribution of a: Carnaby's cockatoos; b: Baudin's cockatoos; c: forest red-tailed cockatoos
Source: Department of Sustainability, Environment, Water, Population and Communities

Distribution, movements and habitat

- » **Distribution:** Occur only in southwest WA (see **Figure 1**)
- » **Breeding seasons vary by species:** Carnaby's cockatoo and Baudin's cockatoo generally undertake breeding activities from August to February; FRTC around October-November, and sometimes in autumn if rains and food are sufficient.
- » **Breeding movements:** Most Carnaby's cockatoo flocks spend the non-breeding season foraging in coastal areas, including the Swan Coastal Plain, to build body condition for breeding, and then migrate inland to semi-arid Wheatbelt breeding areas. Some breeding occurs closer to the coast. Baudin's cockatoos and FRTCs breed in forests in humid and sub-humid zones; some flocks undertake seasonal movements for breeding, while others breed locally.

- » **Nesting:** All species nest in large hollows in large old eucalypts, living and dead, in forests and woodlands as well as remnant patches. Trees with suitable hollows are typically >200 years old. Breeding habitat requires sufficient foraging habitat and water within close proximity.
- » **Night roost habitat:** preferred roost trees are tall (often >25m), native or non-native, with medium foliage density¹². Several stands of roost trees within a few hundred metres may form a single roost site; different flocks may share a roost. Roosts must be supported by proximity to water and food; number of birds at a roost correlates with nearby food availability.
- » **Daily foraging movements:** While resident¹³ at a roost, flocks generally forage within 4–6km from that roost.



The points about night roosts and daily foraging movements are particularly relevant for land managers in the Perth-Peel region, given that all three species have been recorded roosting and foraging in Perth-Peel, and given it is a major foraging region for Carnaby's cockatoos.

¹² Le Roux, C. 2017. Nocturnal roost tree, roost site and landscape characteristics of Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) on the Swan Coastal Plain.

¹³ Here, 'resident' at a roost means returning to the same roost on consecutive nights. When black cockatoos are not 'resident' at a roost, they may use other roosts in the same area or undertake seasonal shifts, likely in response to local depletion of food resources.

Cultural significance of black cockatoos

Background

To gather perspectives of Noongar people from the Perth–Peel region on the cultural significance of black cockatoos, the *Keep Carnaby's Flying – Ngoolarks Forever* project held cultural engagement workshops in 2022–23 with Elders and senior Noongar people from the Perth–Peel region. Workshop participants included delegates from Ngangk Yira Institute for Change Elders Council (Murdoch University) and Winjan Aboriginal Corporation, a not-for-profit community organization and Aboriginal rangers program that undertakes land care in the Shire of Serpentine Jarrahdale.

Themes that emerged in the workshops are presented here to facilitate local government cultural engagement for black cockatoo conservation. Quotes from participants are presented in their own words, as collated by the project's Cultural Engagement Lead Barb Hostalek with support from the Ngangk Yira Institute for Change. It is acknowledged that there is diversity of culture, knowledge and perspectives within Noongar Nations.



Themes from the workshops

1. Desire for Noongar people to work with local governments on black cockatoo conservation

The Carnaby's project is important. Winjan Aboriginal Corporation's involvement in supporting the project is very important, and a serious matter for our community. We grew-up with the birdlife, the birds, and once you see them go, you miss it. And this project is a collaboration involving revegetation, put in...water stations, looking at important revegetation opportunities, working across the metro area on Noongar Country.

We all, as a collective and full community, need to take full responsibility. To us as Noongar People, this is a bird that is part of life. And seeing the destruction of that as part of clearing of land is a concern. Being part of a community [we] take responsibility through education awareness with the shires we will be working with, and the wider community.

Collaborating with councils is a model to change the way things are done. It's an opportunity to work together to save the Ngoolarks.

Brett Hill¹⁴

We are all responsible for boodjar – for planet earth, sky land and water [including] the protection of these birds.

Jade Maddox¹⁵

We all want to be part of the solution.

Millie Penny¹⁶

- ¹⁴ Noongar Elder and Winjan Board Director, Elders Yarning Circle, 2023
- ¹⁵ Senior Bindjareb woman, Elders Yarning Circle 2023
- ¹⁶ Noongar Elder and Middar Yoga Dance Troupe
- ¹⁷ Senior Bindjareb woman, Elders Yarning Circle 2023
- ¹⁸ Noongar Elder and Winjan Aboriginal Corporation Director, Elders Yarning Circle, 2023
- ¹⁹ Noongar Elder and Winjan Aboriginal Corporation Director, Elders Yarning Circle, 2023
- ²⁰ Senior Noongar man (DBCA Education Officer Yanchep National Park), Elders Yarning Circle, 2023
- ²¹ Whadjuk/Ballardong Elder, Elders Yarning Circle, 2023

2. Cultural significance

Families had them as a totem – they were messengers of the changing of the seasons and the coming of the rains.

Jade Maddox¹⁷

When you first hear them, it's around Easter time. It used to tell me, the salmon are coming around to where I am in Mandurah. They tell me that.

Franklyn Nannup¹⁸

You know, you know years ago, years ago, I was told that when black cockatoos flew south they brought rains, and when they moved went flew back north they took the rain away.

Franklyn Nannup¹⁹

The "tail of two cockies": Karrak the red-tailed black cockatoo acquired its red tail markings on the tail from Ngo-lak, the white tailed Carnaby's cockatoo. Mulal the swamp hen was feeding...on a sedge, the roots of which ooze red sap, and he cut a reed and struck Ngo-lak across his back. When Ngo-lak spread his tail to defend his back, Mulal threw lumps of red sap at his tail. Ngo-lak...turned into Karrak, the red-tailed black cockatoo.

Derek Nannup²⁰

[The] spirituality of the bird has been lost and we need to revive that...who are sharing these stories.

Marie Taylor²¹

3. Concern about black cockatoo declines and the importance of protecting boodjar (country)

Noongar Country is kwobidak boodjar (beautiful country). It is an internationally-recognised Global Biodiversity Hotspot, and the only home of the Ngoolark (Carnaby's cockatoos).

Barb Hostalek²²

The Black cockatoo, one with a red tail, one with a white tail. Seeing them fly around is a normal part of life growing up as a kid and now as an adult. Their welfare is a grave concern, their lifestyle being impacted on by the destruction of the land whether it's through development for housing, suburbia. The Southwest is a precious place on the planet, with animals and plant life and we as Noongar people have been here 50,000 years.

George Walley²³

Everything is interconnected, the birds are dying, the food is dying, their waters are going...land is flattened without a care. It all interconnects. We used to see mobs of them....It's very sad.

Jade Maddox²⁴

Once they're gone, you can't get them back.

Franklyn Nannup²⁵

²² Aboriginal woman and Cultural Lead, Keep Carnaby's Flying – Ngoolarks Forever, 2023

²³ Bindjareb Noongar Elder and Winjan Board Director, Elder Yarning Circle 2023

²⁴ Senior Bindjareb woman, Elders Yarning Circle 2023

²⁵ Noongar Elder and Winjan Aboriginal Corporation Director, Elders Yarning Circle, 2023

²⁶ Aboriginal woman and Cultural Lead, Keep Carnaby's Flying – Ngoolarks Forever, 2023

²⁷ Noongar man and DBCA Officer Yanchep National Park, Elders Yarning Circle, 2023

²⁸ Whadjuk woman, Elders Yarning Circle 2023

²⁹ Noongar Elder and Winjan Board Director, Elders Yarning Circle, 2023

³⁰ Noongar Elder and Winjan Aboriginal Corporation Director, Elders Yarning Circle, 2023

³¹ Noongar Elder, Elders Yarning Circle 2023

Conversation between Brett Hill²⁹ and Franklyn Nannup³⁰

Brett Hill: The challenge to all families, households... We all go camping, go bush... How do we first connect, what do we hear, if we listen? And if some of that natural environment is gone...?

Franklyn Nannup: [then] you hear nothing.

So the challenge is to look at all development, [even at] schools, home, before you cut down a tree. Think about the significance of that tree...to the Carnaby's, to our birds. If they're gone, it's all gone...the challenge is to plant a tree.

I went out, me and my wife was out there with the Activate the Wheatbelt [community revegetation] mob, and then in one week we planted over 200,000 trees.

Mort Hansen³¹

[At the workshops] Elders expressed support for saving black cockatoos by protecting remaining bushland, and planting more trees as homes and food sources. They expressed concern that land clearing should not include ongoing clearing of places for Ngoolarks to live.

Barb Hostalek²⁶

How do we get [land-owners] to appreciate a native garden.

Derek Nannup²⁷

I've got the yard ready to go [to plant food for Ngoolarks]. The council should step in...if you're willing to put in a native garden...give us the plants we want...there's bush medicine, there's bush tucker.

Chelsey Thomson²⁸



Importance of the Shire of Serpentine Jarrahdale for black cockatoos

The Shire of Serpentine Jarrahdale is one of the most important areas in the Perth-Peel region for black cockatoos. The Shire hosts many roost sites for both Carnaby's cockatoos and forest red-tailed cockatoos. Unlike most of Perth and Peel, the Shire also has flocks of critically endangered Baudin's cockatoos. The presence of all three of these threatened species is due to the presence of important food resources for black cockatoos in the Shire of Serpentine Jarrahdale, including in the Shire's reserves and green spaces.

The Shire of Serpentine Jarrahdale has valuable roosting and breeding habitat to support all three species of black cockatoos, and key food resources around roosts and breeding sites to ensure they remain viable. **Figure 2** shows the known black cockatoo roost sites in the Shire, as well as known roosts just outside the Shire's boundary, as some of the Shire of Serpentine Jarrahdale's foraging flocks may roost just outside the Shire's boundary at night.

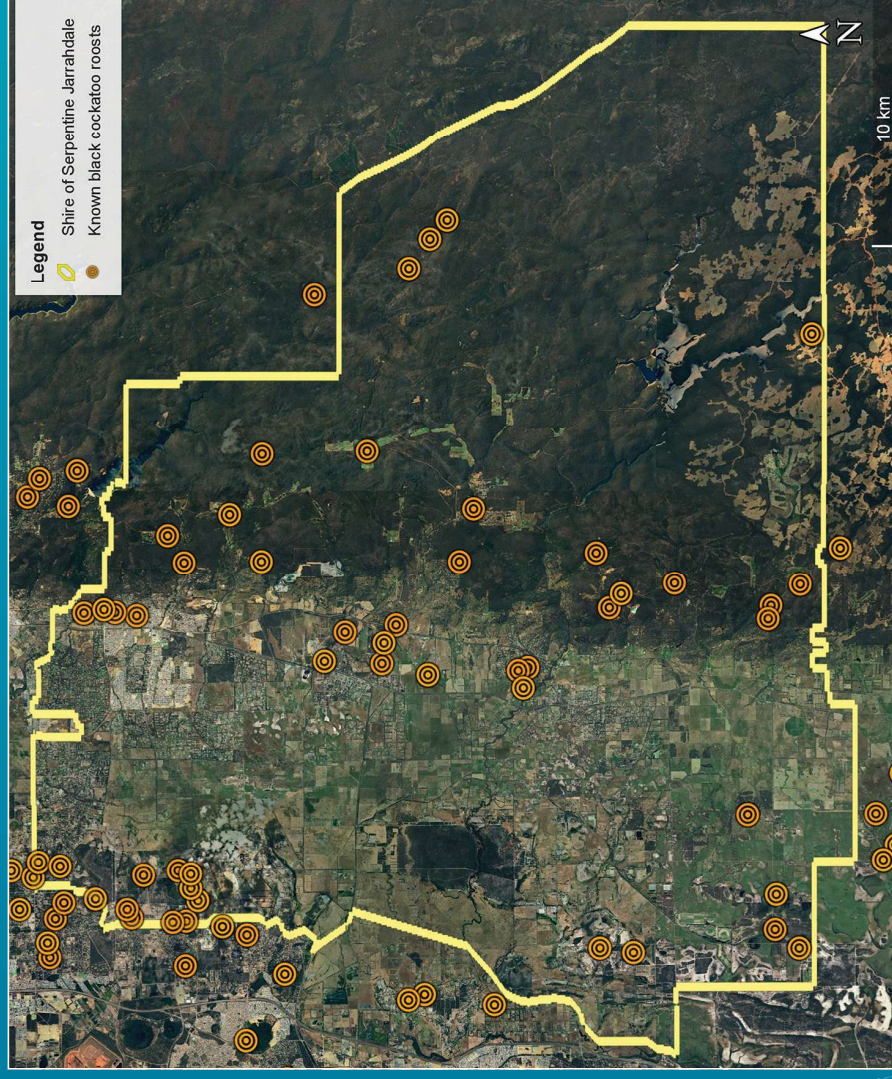


Figure 2. Known black cockatoo roost sites within the Shire of Serpentine Jarrahdale

Of the 49 known night roosts, 36 have recorded use by white-tailed black cockatoos (either Carnaby's cockatoos or Baudin's cockatoos), and 24 by forest red-tailed cockatoos (some roosts are used by two or three species). Roost locations are identified through Birdlife Australia's Great Cocky Count (early April) and Murdoch University flock tracking data; however not all flocks have been tracked, and while most roost sites in urban areas of Perth and Peel have been identified, it is possible that some have not, or that new sites may be used in the future.

Note: roosts located just outside the Shire are included in the map because some of the black cockatoos that forage within the Shire of Serpentine Jarrahdale may use a night roost just outside the Shire.

Source: Data from Birdlife Australia's annual Great Cocky Count and flock tracking data from Murdoch University's Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).



Legislative requirements and policy implementation

This Plan will also support the Shire of Serpentine Jarrahdale to meet its legislative requirements regarding black cockatoos, and to implement the environmental and natural resource management policies of state and Commonwealth government.

Opportunities to leverage black cockatoo actions to meet Native Vegetation Policy outcomes

The Native Vegetation Policy (NVP) for Western Australia includes the policy outcome of 'net gain of native vegetation' and the strategic action of 'protection and enhancement of urban forests and bushland'. This Black Cockatoo Conservation Action Plan can assist the Shire of Serpentine Jarrahdale to implement the NVP in a way that directly supports black cockatoos. For example, this Plan can ensure that the Shire's actions towards 'gain of native vegetation' and 'protection and enhancement of urban forests and bushland' (from the NVP) involve planting and protecting the specific native trees that are key foods for black cockatoos, and that these actions occur in locations that will be of value to black cockatoos, based on Shire-specific data.

The importance of the Shire of Serpentine Jarrahdale for black cockatoos presents the Shire with opportunities and responsibilities. Local governments have considerable capacity to ensure that their communities continue to enjoy wild black cockatoos in their local area, given the powers of local government as land managers and environmental decision-makers at the local level. As black cockatoos continue to decline across their ranges, it becomes more critical to support the flocks that roost and forage in the Perth-Peel region.

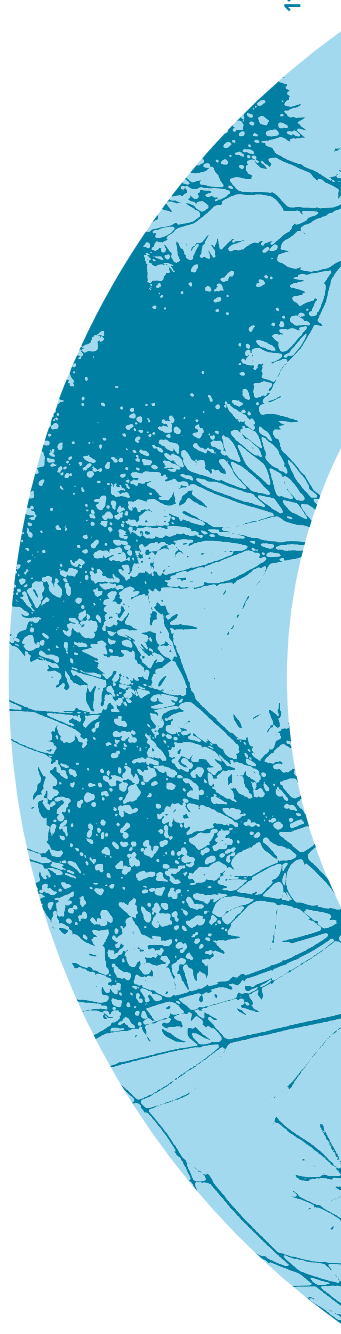
The plight of black cockatoos is of increasing public interest, with community expectations that local governments will make decisions and take actions that align with scientific knowledge about the threats to black cockatoos and about what is required to retain them in the region and in specific local areas. This Black Cockatoo Conservation Action Plan will support the Shire of Serpentine Jarrahdale to take an evidence-informed approach to the sustainable management of its black cockatoo flocks.

Alignment with the Shire's existing strategies, policies and plans

Some information in this Plan will be familiar to Shire of Serpentine Jarrahdale officers and elected representatives, and may already be incorporated in the Shire's strategies, policies, plans and guidelines. This Plan also includes new Shire-specific data and information from analyses undertaken as part of developing this Plan, specific to the Shire of Serpentine Jarrahdale. This information is provided to inform and, where required, update existing strategies, policies and plans.

SMART goals: The actions in this plan will also allow the Shire of Serpentine Jarrahdale to develop and implement SMART goals specific to its requirements.

The Shire of Serpentine Jarrahdale's black cockatoos are a significant environmental and cultural asset for the Shire. Undertaking the actions in this Plan to protect and manage the Shire's flocks of black cockatoos will help the Shire of Serpentine Jarrahdale to be a truly sustainable Shire for black cockatoos, while simultaneously enhancing urban forest, native vegetation, urban cooling, climate mitigation and local biodiversity.

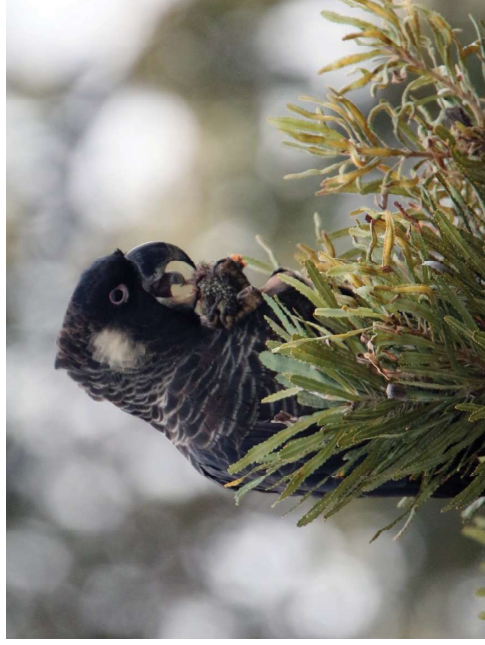
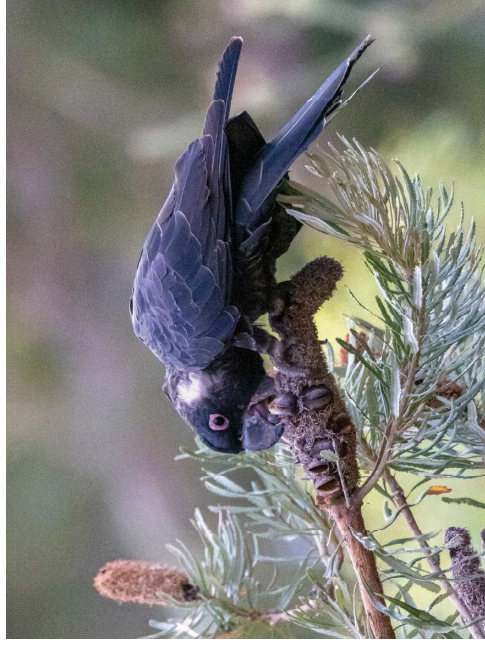


Threat 1. Loss of habitat

Loss of habitat is the main direct cause of the declines of black cockatoos in southwest Western Australia. Clearing of native vegetation has stripped away too much of the birds' foraging, roosting and breeding habitat, and has fragmented and degraded much of what is left.

The formal conservation status for Carnaby's cockatoos, Baudin's cockatoos and forest red-tailed cockatoos indicates that if net habitat loss continues, all three species will become extinct (within decades, for at least the first two species). Despite this, clearing of their remaining habitat continues; perpetuating their declines.

In Perth and Peel, local governments have unique powers and capacity to help black cockatoos in the region, due to their roles and responsibilities as land managers and decision-makers at the local level, and their roles in the sustainable management of biodiversity and native vegetation in their local area. To help the Shire of Serpentine Jarrahdale to safeguard its black cockatoo flocks, this part of the Conservation Action Plan outlines the key habitat-related threats that are relevant for the area, and specific actions for the Shire to take to address these threats.

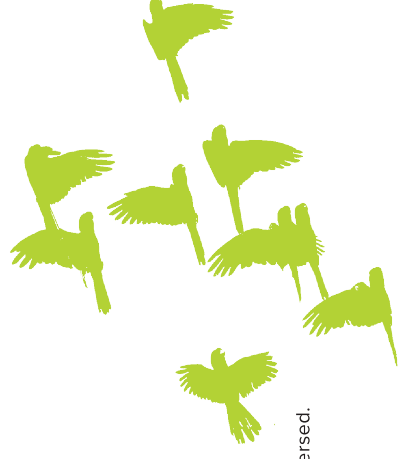


1.1 Lack of food resources

Lack of food is driving black cockatoo declines;³² In Perth and Peel, flocks are under particular pressure.³³ Their main food resources, including jarrah, marri, banksia and hakea, have been extensively cleared. The threat of food scarcity in the Perth-Peel region has been exacerbated further by the clearing of the majority of the pine plantations, which had become a critical resource for Carnaby's cockatoos. In some areas of Perth, a lack of food has meant that black cockatoo flocks are already gone.

Areas without enough food resources lose their black cockatoos

Two Perth suburbs are shown in **Figure 3** and **Figure 4**, with black cockatoo flock movement data for each area. In **Figure 3**, development within a suburb has been poorly designed and managed with respect to retention of green spaces and native vegetation; and without enough food, black cockatoos have been lost from the area. In **Figure 4**, retention of native vegetation, green spaces and 'vegetation corridors' (vegetation patches within several hundred metres of each other, which act as stepping stones between larger areas of foraging habitat), and larger suburban blocks with gardens, have allowed black cockatoos to continue to forage. This area has kept its black cockatoos.



³² The national recovery plans for southwest Western Australia's black cockatoos identify the need to plant more foraging habitat, if declines are to be reversed.

³³ Williams et al. (2017); Birdlife Australia (2023)



Figure 3. GPS data showing foraging movements for a tagged Carnaby's cockatoo and its flock
The birds use the retained green spaces and vegetation patches for foraging. Note also the use of a horizontal belt of retained Tuart trees running through adjacent residential plots, which the flock used as corridor habitat to allow access to foraging habitat on the western side of the suburb. The densely built-up areas, where vegetation has been removed and not replanted, are devoid of flock movement. Black cockatoos have been lost from these areas.

Source: Data from Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).

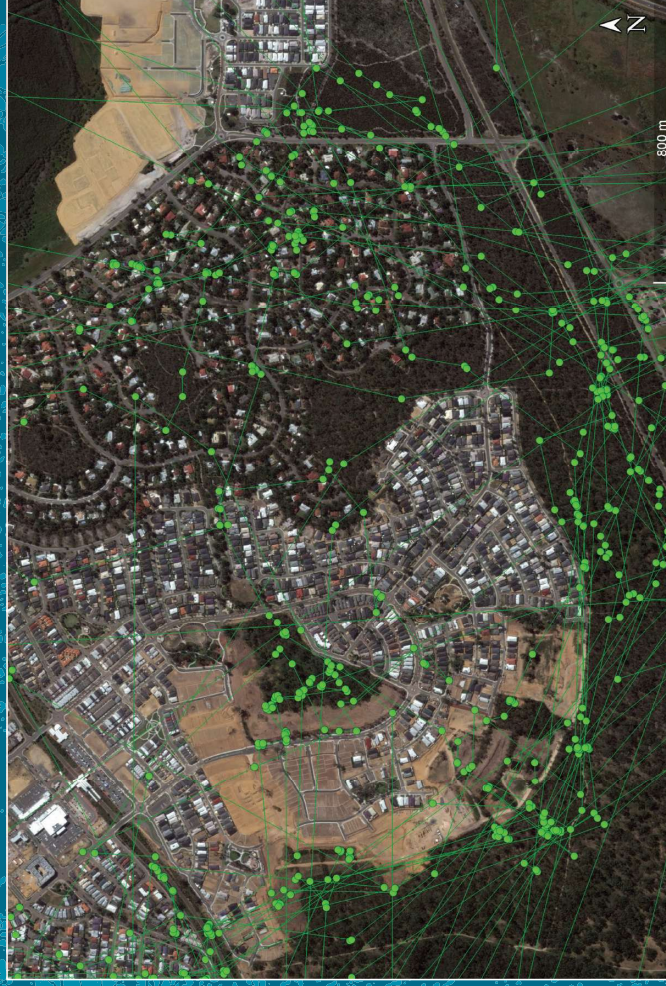


Figure 4. GPS data showing foraging movements for a tagged Carnaby's cockatoo and its flock
This figure shows a continued high presence of black cockatoos in the suburban areas with larger blocks and retained vegetation (east side of map). In contrast, the newer housing development in the centre of the map has been poorly planned and designed with respect to native vegetation (as well as urban canopy, urban cooling and public open spaces), and involved the removal of all vegetation. This area provides no foraging or movement opportunities for black cockatoos, and is largely devoid of black cockatoo activity and presence.

Source: data from Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).



Black cockatoos need food in close proximity to their roosts

Flock tracking data show that outside of breeding migrations, black cockatoo flocks in the Perth-Peel region typically spend weeks to months roosting in a particular area, during which time the birds forage in close proximity to that roost.³⁴ In general, the *maximum* daily distance that flocks will forage from their resident roost is around 6km³⁵. This highlights the need for local governments to ensure that black cockatoos have enough food resources in close proximity to their roosts. If there is ongoing net loss of foraging habitat within 6km of a roost, eventually flocks will be lost from that area.

Black cockatoos need food security during times of low food yield

It is critical to recognise that much of the foraging habitat in an area may not produce food for black cockatoos at certain times of year, due to seasonal restrictions in fruiting and flowering. Patches that contain a range of food species with different fruiting months will mitigate this risk, however there can also be large variations in food production between years. In some years, banksia woodland on the Swan Coastal Plain produces only half the fruit yield of other years³⁶, greatly reducing the total food available for black cockatoos; and individual marri trees only have a high

fruit yield every 3–5 years³⁷. Flocks need enough foraging habitat close to their roosts (within 6km) to ensure they still have food available during months and years of lower food productivity.

If seasonal and interannual differences in food availability are not planned for and managed effectively by natural resource managers, then during low-yield periods, black cockatoos are at risk of depleting all available food resources within daily foraging range of their roosts.

The value of small patches is often ignored

In the Perth-Peel region, where larger areas of bushland are scarce, black cockatoos can only survive by making extensive use of small patches of food resources. Murdoch University's flock tracking research shows that no patch is too small to be used as a food resource by black cockatoos³⁸. Small patches of foraging habitat and single food trees include those in parks and other green spaces, around ovals, along road verges and in private backyards. These small patches are often undervalued and at risk of being cleared; which can lead to large cumulative losses of food resources. All are important, to retain black cockatoos in urban areas.

³⁴ Murdoch University's flock tracking data show that flocks show seasonal residence patterns across years. For example, a particular flock of Carnaby's cockatoos that returns from its breeding grounds to the Shire of Serpentine Jarrahdale in late summer, with dependent young in tow, to spend all or part of the non-breeding season foraging in the Shire, will likely use the same roost sites that they used the previous year; in anticipation that specific patches of food resources which were available in the Shire of Serpentine Jarrahdale the previous year will still be available in the same locations in subsequent years.

³⁵ Murdoch University data for the Perth-Peel region and Swan Coastal Plain show that when a Carnaby's cockatoo flock is 'resident' at a roost (returning to the same roost each night), the flock forages at a mean distance of 4.26 +/- 2.24km from the roost (Murdoch University unpubl. data 2023). These findings support previously reported daily maximum foraging distances of around 6km from roosts (e.g. Kabat et al. 2012; Rycken et al. 2021). State and Commonwealth government conservation agencies including DBCA and DCEEW also use this figure of <6km as a maximum daily foraging distance from roosts for black cockatoo flocks during the non-breeding season; the time when black cockatoos on the Swan Coastal Plain need to find enough food to build their energy reserves for the next breeding season.

³⁶ See Appendix A of Williams et al. (2017) for discussion of recurring low-yield years for banksia.

³⁷ See, for example, Robinson 1960; Mawson 1995; Johnstone & Kirkby 1999.

³⁸ Riley et al. (2023) unpubl. data

Quality of foraging habitat can be misjudged

Quality of native vegetation as a food resource for black cockatoos should not be assessed using general 'vegetation quality' ratings. Food trees remain valuable for black cockatoos even if the understorey is 'degraded'. Likewise, Murdoch University flock tracking research shows that in urban areas, black cockatoos often feed on small patches of banksia that have relatively 'sparse' canopy cover. These vegetation conditions, which may be rated 'low' quality in other contexts, often represent high value food resources in the Perth-Peel region. Failure to recognise this can lead to the clearing of important food resources which should have been either retained, or replaced – by planting new food sources nearby before clearing occurs – to avoid net loss for flocks in the local area.

Plant diseases, fire and climate-related risks

Plant diseases such as dieback and marri canker, and risks from fire and climate impacts all threaten the viability of black cockatoo foraging habitat. The risk increases when areas of habitat become small and more exposed to external risks; as is the case in the Perth-Peel region. Plant diseases, fire and climate changes threaten not only foraging habitat but also roosting and breeding habitat, and as such, each of these threats is covered separately, later in this Plan.

Cumulative impacts

The numerous small and larger clearing actions in the Perth-Peel region, on both public and private land, represent 'death by a thousand cuts' for black cockatoos. Many small net losses of food will eventually mean an area becomes unviable for black cockatoo flocks. Yet the impacts of a clearing action are still often assessed from the point of view of the 'individual' impact, without appropriate consideration of cumulative impacts. This occurs despite regulatory requirements to consider cumulative impacts.

Nor are the impacts of clearing a patch of foraging habitat typically considered at the level of the individual flock. This reduces the likelihood that actions will be implemented which aim to mitigate impacts to the specific flocks that were using the patch as a food resource, and which will require alternative food resources to ensure no net loss of food. The species declines of Western Australia's black cockatoos are being led by declines of individual flocks, and managing natural resources to ensure no net loss of food for individual flocks will help to halt these declines.

Inadequacy of planning laws

Perth has the lowest retention of urban canopy of any capital city in Australia, and government has recognised that planning laws have been inadequate to enable tree retention³⁹. The WALGA recognises the need for net gain of canopy and particularly native vegetation in urban areas. In 2023, the WALGA asked state government to increase funding for the Urban Forest Grant Program, to help local governments plant more trees in their local areas. This aligns strongly with the need to plant more food trees for black cockatoos.

Use of eDNA to investigate temporal food resource risks

In addition to tracking black cockatoo flocks using GPS and Argos satellite telemetry and observing birds directly to see what they are feeding on, another option for investigating what birds are eating at a specific time of year and area is to use environmental DNA (eDNA) analysis, which examines which plants are present or absent in the birds' diet at time of sampling.

In 2023, eDNA samples (in the form of scats) were collected from under Carnaby's cockatoo roosts in the Shire of Serpentine Jarrahdale, and results are presented in **Appendix 3**. Once larger numbers of samples are collected across different flocks, months and locations in urban areas, this approach may help to clarify temporal food resource threats, such as times of year when preferred foods are not available (for example, months when Carnaby's cockatoos in a particular area are lacking banksia in their diet; which may indicate that the area is lacking the species of banksia that fruit at that time of year).

While this research is new and ongoing, **Appendix 3** is included in this Plan to show its potential as a tool for investigating food-related issues for black cockatoos in specific local government areas.

³⁹ Minister for Planning, Hon Rita Saffioti MP (2023), as quoted in www.ac.net.au/news/2023-03-11/perth-housing-developments-that-could-improve-tree-canopy/102060214

Actions »

In Perth and Peel, it will not be possible for local governments to retain black cockatoos unless the ongoing 'net loss' of food resources is halted and reversed. For flocks that roost and forage in the Shire of Serpentine Jarrahdale, this means *retaining and improving* their remaining food resources, and *creating* additional food for them.

These are the most important direct actions that the Shire of Serpentine Jarrahdale can take to safeguard its black cockatoos.

Retain and improve existing food resources

- » Retain black cockatoo foraging habitat on council managed and regulated land.
- » While creating new habitat is critical, retention of existing habitat is the highest priority, because:
 1. When new food resources are planted to offset the clearing of existing food resources, there is a 'food gap' of at least 5–10 years before the new plants begin providing food. Given that food insufficiency is already causing black cockatoo declines, any additional food shortage will increase the risks to flocks in the local area, and the species⁴⁰ overall.
 2. Revegetated areas of foraging habitat such as banksia woodland are often of lower foraging value than the original cleared vegetation, leading to net loss of quantity and quality of food for flocks in the local area⁴¹. Retention of existing resources avoids this problem.

3. Success of revegetation is not guaranteed, and all efforts require long-term management. Retention of existing habitat avoids these issues and risks.⁴²
 - » Improve the condition and quality of existing foraging habitat, through infill planting, weed and disease control (dieback, marri canker), and fire risk management.
 - » Recognise that the quality of foraging habitat for black cockatoos should not be assessed by general 'vegetation quality' ratings. Food trees remain valuable for black cockatoos even if the understorey is 'degraded'; and in urban areas, black cockatoos often forage on small patches of banksia that have relatively 'sparse' canopy cover. These are still high value food resources in the Perth-Peel region.
 - » Retain small remnants of native vegetation. Even small patches may contain a diversity of food trees that will provide food at different times of year. In Perth and Peel, remnant patches of food are valuable however small.
 - » Retain individual large food trees (e.g. jarrah, marri). Their value as food (and roosts) is difficult to replace.

⁴⁰ To avoid impact on flocks from clearing of food resources, some clearing proponents proactively plant new foraging habitat in the area of the proposed clearing action (within 6km), several years before clearing is proposed to occur. This is often an appropriate mitigation, as it aims to safeguard flocks from additional food shortages that could have arisen from the clearing action. Six kilometres aligns with the approximate upper limit of a flock's daily foraging distance from their roost (see details in earlier sections).

This mitigation also aligns with the EPA's technical advice regarding Carnaby's cockatoo foraging habitat in Perth and Peel (EPA 2019). The EPA advice states that any clearing should be offset by undertaking revegetation, or rehabilitation of degraded areas, within "close proximity of the impacted area", to provide alternative food resources for the flocks affected by the action. The EPA advice acknowledges that such actions will take time to provide new food resources; highlighting the need to commence planting 5–8 years before clearing, to allow time for replacement food to become available.

⁴¹ Although this risk can be mitigated by replanting over a larger area than the original cleared area and planting for species diversity, it is challenging to find enough space for additional revegetation in urban areas, particularly given that flocks affected by a clearing action need replacement habitat within their daily foraging range (4–6km from their roosts).

⁴² Occasionally there will be no option but to clear food resources. In such cases, local governments should require, as a condition of clearing, that the proponent ensures no net loss (and preferably net gain) of foraging resources for flocks in the local area. For simplicity, 'local area' is within 6km of the clearing action (this aligns with research regarding daily foraging distances for flocks on the Swan Coastal Plain).

This approach was adopted by the City of Canning in a recent clearing referral. The City submitted a referral to clear 2.4ha of black cockatoo foraging habitat, but ensured it had already created an 'advanced offset'. Prior to submitting the referral, the City had created 6ha of new foraging habitat on degraded land at a Bush Forever site within 6km of the proposed clearing area. The City recognised that three points are essential to mitigate clearing of black cockatoo food resources:

- new foraging habitat must be created to offset what is lost (rather than only acquiring existing bushland, which perpetuates net loss).
- the new habitat must be created within the daily foraging range of affected flocks, to ensure no impact to those flocks.
- the new habitat should be established several years prior to clearing, so that it is mature enough to be providing food before any food is removed, thereby avoiding years of 'net loss' which could impact flocks.

In this example, the City recognised that if ongoing net habitat loss led to insufficient food for flocks within foraging range of their roosts, the roosts would become unviable and black cockatoos would be lost from the area. The City took effective action to prevent this.

- » Retain pine trees and Cape Lilac until alternative food sources become available. In the Perth-Peel region, where native food sources are scarce, pine is a high-energy food resource for Carnaby's cockatoos, and Cape Lilac is important for forest red-tailed cockatoos⁴³.
- » Retain food resources on private land
 - Large losses of native vegetation and tree canopy are due to clearing on private land⁴⁴. Importantly, local government regulators and decision-makers have influence over much of this clearing, such as through rezoning decisions. Local governments can support black cockatoos by making decisions which retain local food resources.
 - At time of writing, many local governments in Perth are advocating for legislation to help them identify and protect 'important trees' on private property, for the trees' aesthetic value as well as for urban cooling and local biodiversity. Support for this legislation is support for black cockatoos.



- » Apply formal measures and mechanisms to enable the Shire of Serpentine Jarrahdale to better retain black cockatoo food resources on government and private land, including land management agreements and strategies as required. This will support legislative responsibilities (e.g. BC Act, EPBC Act), and complement the Shire's roles, responsibilities and strategies in related areas (e.g. urban biodiversity; urban forest/canopy; urban cooling; climate mitigation).

- » Undertake community awareness-raising about the value and necessity of retaining food resources on government and private property, if suburbs are to retain their black cockatoos. Black cockatoos are charismatic flagship species for community engagement efforts.
 - Important community messages include that black cockatoos in the Shire of Serpentine Jarrahdale make extensive use of smaller areas of green space and private gardens when feeding.

⁴³ Taking pine as an example, this is important in areas where there may be food shortages, due to the high energy content of pine seed and the large number of cones per tree. The 'carrying capacity' of pine forest is 9x greater than banksia woodlands, i.e. for the same sized area of vegetation, pine supports 9x as many Carnaby's cockatoos as banksia woodland (Williams et al. 2017). However, native foods like banksia provide essential proteins and micronutrients, and tracking studies show that Carnaby's cockatoo flocks that feed in pine plantations still spend part of each day feeding on native foods (Murdoch University unpubl. data 2023).

⁴⁴ Western Australian Department of Parks and Wildlife, (2013). *Carnaby's cockatoo Recovery Plan*.

Create additional food resources

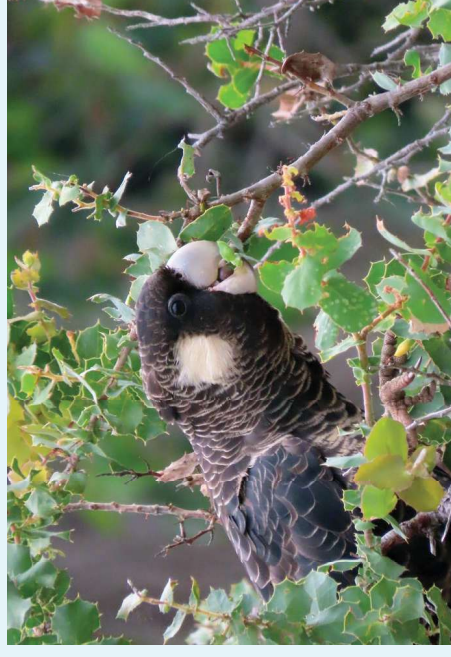
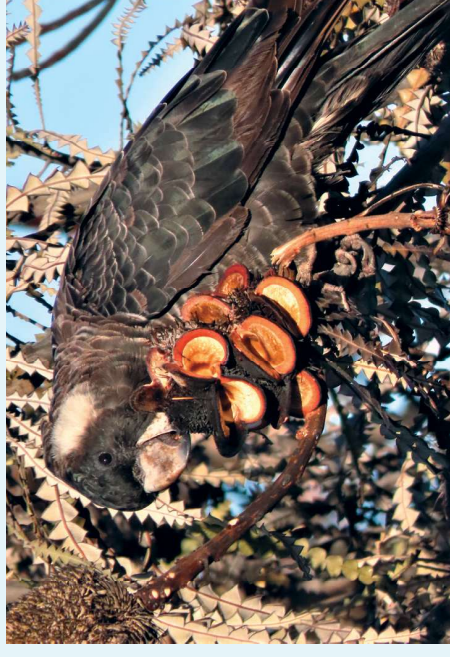
On the Swan Coastal Plain, where food is already insufficient, black cockatoo declines will not be reversed without shifting to 'net gain' of food resources. This Plan provides information about *what* to plant, and *where* to plant, for the Shire of Serpentine Jarrahdale's black cockatoo flocks.

What to plant

- » Plant species from the Proteaceae family, particularly banksia and hakea, to provide food in 5–10 years and address current foot shortages. Plant seedlings rather than seeds.
- » Plant jarrah and marri, as established trees where possible, for longer-term food resources (and roosts).
- » In urban areas where food resources are scarce, black cockatoos also benefit from introduced pine and macadamia (Carnaby's cockatoos) and Cape Lilac (forest red-tailed cockatoos). Plant macadamia for a fast-growing food resource⁴⁵.
- » Ensure all planting and plant maintenance are planned and resourced for optimal plant survival. Plan for infill planting to replace losses.

» Plant a variety of species (Table 1).

- Different plants provide food for black cockatoos at different times of year. Access to a variety of food species will support flocks in the Shire of Serpentine Jarrahdale during times of year when some plants are not providing food.
- Different plants provide different important nutrients⁴⁶.
- » Plant many of the same species (with the same fruiting times) in the same area, so that sufficient food becomes available at the same time of year to feed an entire flock⁴⁷.
- » Where possible, avoid herbicides and pesticides on black cockatoo food plants, particularly when the plants are producing food resources (i.e. flowers, fruits).
- » Assess whether dieback is present at the proposed planting site. This will influence what to plant, given that some plants, particularly Proteaceae, are susceptible to this disease⁴⁸.
- » Plant banksia species in well-drained areas to minimise losses from dieback.
- » Use Table 1 to update the Shire's relevant strategies and plans to prioritise retention and planting of black cockatoo food species where possible. The data and information in this Plan present the Shire with an opportunity to transform its environmental and urban forest strategies and plans into documents that strongly safeguard the Shire's black cockatoos.



⁴⁵ Macadamia is recommended as a fast-growing, high-energy food source for Carnaby's cockatoos, given that there is not enough native foraging habitat left on the Swan Coastal Plain to halt their declines. Other common nut trees in the Perth-Peel region are not useful to plant for black cockatoos, because they have nuts which can be eaten by smaller cockatoo species such as corellas, which outnumber black cockatoos and may take the majority of the food. Macadamia nuts have hard shells which only black cockatoos can break.

⁴⁶ As an example, Murdoch University's tracking of Carnaby's cockatoo flocks in the Perth-Peel region has found that the birds may feed heavily on plantation pines at times of year when cones are available, but will always also spend some time each day foraging on banksia and other native species. While pine is a high-energy food for Carnaby's cockatoos, banksia provides them with important proteins and micro-nutrients.

⁴⁷ When a flock does not have sufficient food available to feed in a single area, the birds are forced to expend additional energy flying between numerous patches, which reduces their energy reserves and may impact breeding success.

⁴⁸ The Dieback Working Group has resources and publications available on their website regarding the relative resilience of various local native plants to dieback, as well as about how best to manage dieback in bushland, and other useful information: www.dwg.org.au

Table 1. High priority food plants to plant for black cockatoos in the Shire of Serpentine Jarrahdale^a

Tree type	Name	Height (m)	Flower colour; flowering season	Important for which of the Shire of Serpentine Jarrahdale's black cockatoo species
Banksias	Slender banksia (<i>Banksia attenuata</i>)	Medium tree; 1–10m	Yellow; Oct–Feb	• Carnaby's cockatoo
	Swamp banksia (<i>Banksia littoralis</i>)	Medium shrub; 1–2m	Yellow; Mar–July	• Carnaby's cockatoo
	Firewood banksia (<i>Banksia menziesii</i>)	Medium tree; 8–10m	Red/yellow or pink/yellow; Feb–Oct	• Carnaby's cockatoo
	Acorn banksia (<i>Banksia prionotes</i>)	Medium tree; 8–10m	Bright orange; Feb–Aug	• Carnaby's cockatoo
	Oak-leaved banksia (<i>Banksia quercifolia</i>)	Large shrub; 1.5–3m	Orange/yellow; Mar–Nov	• Carnaby's cockatoo
Hakeas	Showy banksia (<i>Banksia speciosa</i>)	Small to medium tree; 1–6m	Cream or lemon yellow; year-round	• Carnaby's cockatoo
	Parrot bush (<i>Banksia sessilis</i>)	Large shrub; 0.5–5m	Yellow-cream; Apr–Nov	• Carnaby's cockatoo
	Two-leaved hakea (<i>Hakea trifurcata</i>)	Large shrub; 1.5–3m	Pink or white-cream; Apr–Oct	• Carnaby's cockatoo
	Wavy-leaved hakea (<i>Hakea undulata</i>)	Medium shrub; 1–2m	White; July–Oct	• Carnaby's cockatoo
	Marri (<i>Cornelia calophylla</i>)	Large tree; 40m	Pink or white; Dec–May	• Baudin's cockatoo ^c • Forest red-tailed cockatoo • Carnaby's cockatoo
Larger trees	Jarrah (<i>Eucalyptus marginata</i>)	Large tree; 40m	White-cream or pink; June–Jan	• Forest red-tailed cockatoo • Carnaby's cockatoo
	Coastal blackbutt or Pricklybark (<i>Eucalyptus tottiana</i>)	Medium tree; up to 15m	White, Jan–April	• Carnaby's cockatoo
	Macadamia (<i>Macadamia integrifolia</i>)	Medium tree; 2–12m depending on species	Varies by species (purple, pink or white); flowering and fruiting times vary by species	• Carnaby's cockatoo
	Pine ^b (<i>Pinus</i> sp.)	Large tree; varies by species	Varies by species; flowering and fruiting times vary by species	• Carnaby's cockatoo

Notes: (a) For additional suitable black cockatoo food species and information on plant selection and the design of plantings, see resources on the website of Birdlife Australia.
(b) P. pinaster is the preference; a Carnaby's cockatoo can meet daily energy requirements from 11 cones of P. pinaster, or 18 cones of P. radiata (Stock et al. 2013). They will feed on all pine species, including native pine. (c) Baudin's cockatoo is a marri specialist. Although they may less commonly feed on some other species on this list, including jarrah, B. menziesii, B. littoralis, H. undulata and H. trifurcata, marri is the only native plant that Baudin's cockatoos commonly consume. This makes marri of utmost importance for this species.

Where to plant

Council-managed green spaces

- » Provide additional food resources in council-managed green spaces.
- » Undertake revegetation activities using black cockatoo food species, to extend existing patches of native vegetation or create new patches.
- » Creating new habitat is valuable even in small areas. Patches of 0.1–0.5ha are used by black cockatoos for feeding, as are single trees.
- » Undertake infill planting with black cockatoo food species, where existing native vegetation could benefit from this.
- » Consider creating small patches of banksia and hakea around parks and other open spaces.
- » Undertake advanced tree planting of jarrah, marri and macadamia around parks and open spaces.
- » Improve the condition and connectivity of existing habitat.
- » These actions align with WALGA's stated priorities for Public Open Space.⁴⁹

To support these actions, the locations of council-managed green spaces in the Shire of Serpentine Jarrahdale in relation to known black cockatoo roost sites are shown in **Figure 5**. Provision of additional food within daily foraging distance of roosts (not more than 4–6km) is a critical action to support the Shire's flocks.

Street trees and road verges

In addition to planting food trees in the council-managed green spaces identified in **Figure 5**, the Shire of Serpentine Jarrahdale can support local black cockatoo flocks by planting food tree species as street trees and on road verges. These are valuable areas for food resources for black cockatoos in urban landscapes.

Safe set-backs from roads

All planting of black cockatoo food trees near roads should include appropriate set-back distances, so birds can access the trees safely:

- » In quiet suburban streets (speed limit <50km/hr), plant food trees at least 3–5m back from road edges. Planting along a single side of the road will reduce the risk of birds flying across the road when moving between trees.
- » For busy roads (speed limit >50km/hr), plant food trees at least 10m from road edges.
- » Maintain existing large food trees (jarrah, marri) on verges by pruning low branches.
- » Never plant black cockatoo food plants on median strips; this is a death trap for the birds.

Bush Forever areas and DBCA land

Bush Forever areas and DBCA land contain remnant native vegetation and food resources that are critical for retaining black cockatoos in local areas.

- » Working with DBCA as required, undertake revegetation activities and infill planting with black cockatoo food species in Bush Forever areas and DBCA land.
- » Small patches are important.
- » Improve the condition and connectivity of existing habitat.

To support these actions, the locations of Bush Forever areas and DBCA land in the Shire in relation to known black cockatoo roost sites are shown in **Figure 6 on page 22** (Bush Forever) and **Figure 7 on page 23** (DBCA land). (Please note, due to the scarcity of Bush Forever areas in one area of the Shire, that area is not included in **Figure 6**, and instead the same area in **Figure 7** includes the locations of both DBCA land and Bush Forever areas together in relation to roosts). Planting and retaining food resources within daily foraging distance of roosts (not more than 4–6km) is a critical action to support the Shire's black cockatoo flocks.



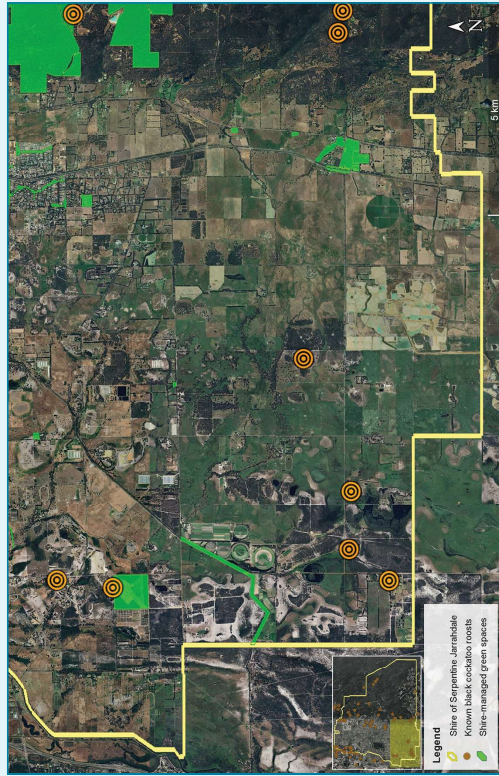
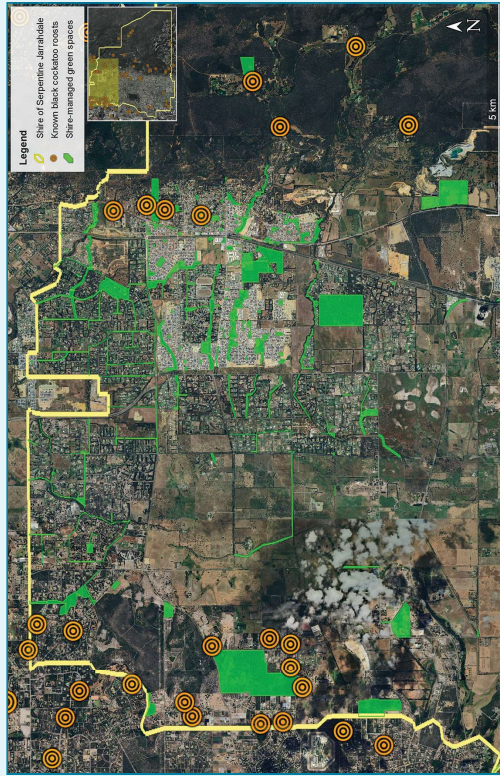
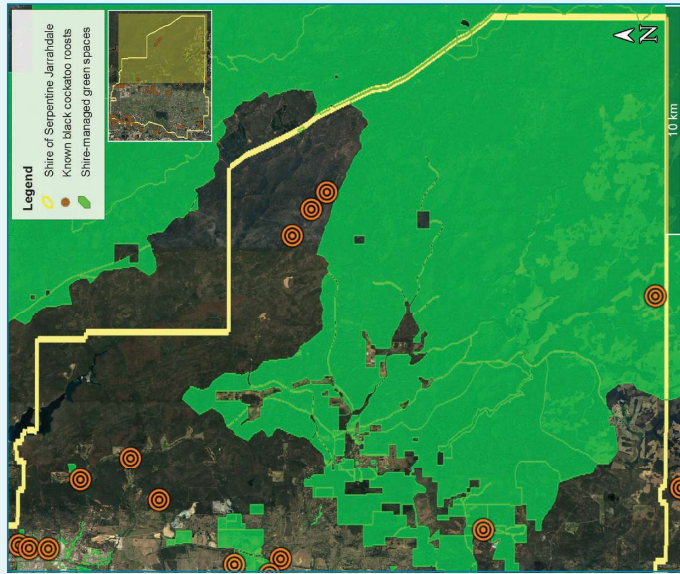
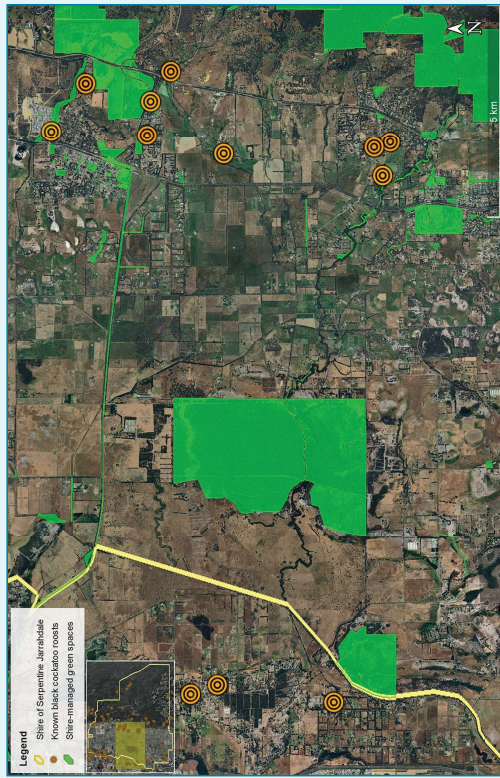
⁴⁹ WALGA Advocacy Position Manual 2023 lists the creation of new 'natural bushland' in POS as a priority for Western Australia's local governments.

Figure 5. Shire of Serpentine Jarrahdale: showing council-managed green spaces in relation to known roost sites for black cockatoo flocks

Roosts just outside the Shire are included in the maps, because the black cockatoos that forage within the Shire may use night roosts just outside the Shire. Green spaces near roosts are of value for the Shire to investigate for revegetation activities, infill planting, or advanced tree planting with black cockatoo food species.

Note: Each map includes a small inset-map, to show which part of the Shire that map represents.

Source: Shire-managed green space data were obtained using spatial layers provided by the Shire ('SJS_ReserveRegister_May2023.shp'; obtained 02/05/2023 and 'SJ_Managed_Lands_V2.shp'; obtained 27/07/23). Black cockatoo data are from Birdlife Australia and Murdoch University. Figure produced using Google Earth Pro (<https://earth.google.com>).



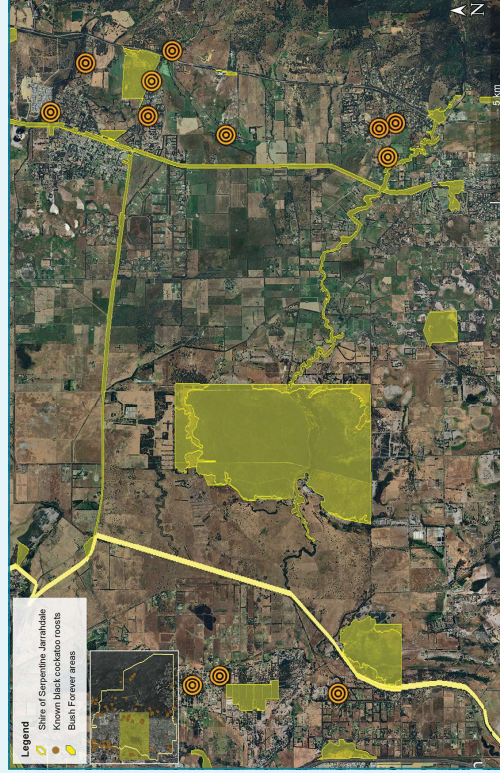
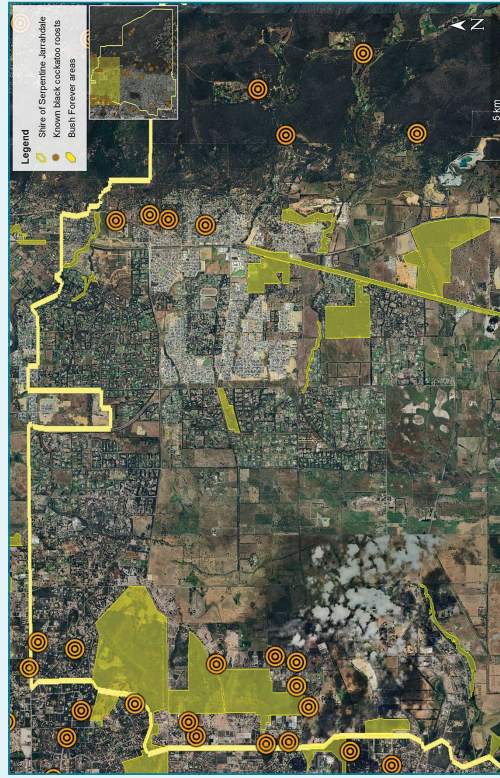


Figure 6. Shire of Serpentine Jarrahdale: Bush Forever areas in relation to known roost sites for black cockatoo flocks, showing areas of value for the Shire to investigate for revegetation activities and infill planting with black cockatoo food species

(Note: One area of the Shire contained very little Bush Forever land, and has therefore been excluded from **Figure 6**. This area is instead represented in **Figure 7**). Roosts located just outside the Shire are included on the maps, because the black cockatoos that forage within the Shire may use night roosts just outside.

Source: Bush Forever areas were obtained from the Department of Planning, Lands and Heritage data layer 'Region Scheme – Special Areas (DPLH-022)' ([wa.gov.au/dataset/region-schemes-special-areas-dop-073](https://catalogue.data.wa.gov.au/dataset/region-schemes-special-areas-dop-073); accessed 26/04/2023). Black cockatoo data are from Birdlife Australia and Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).

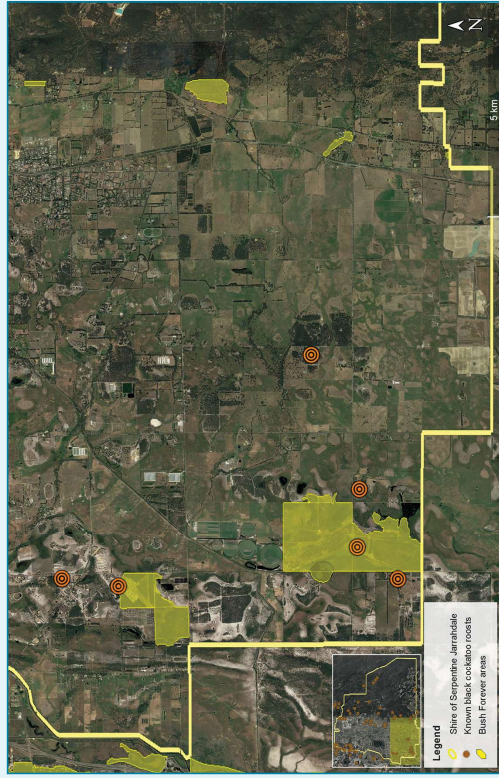
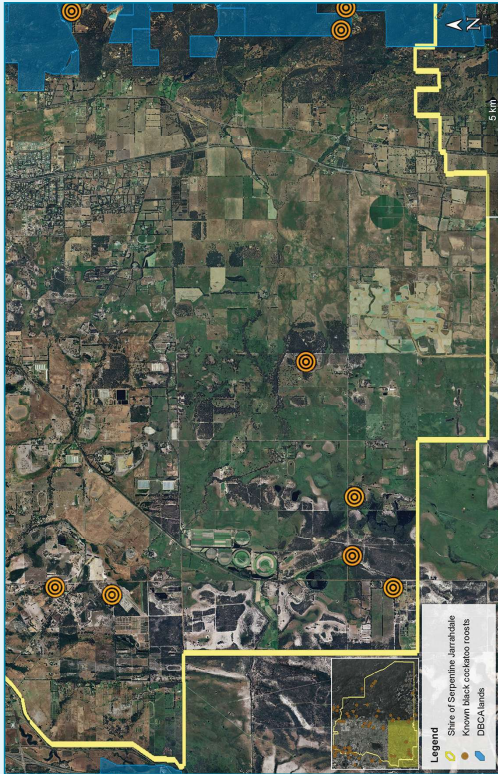
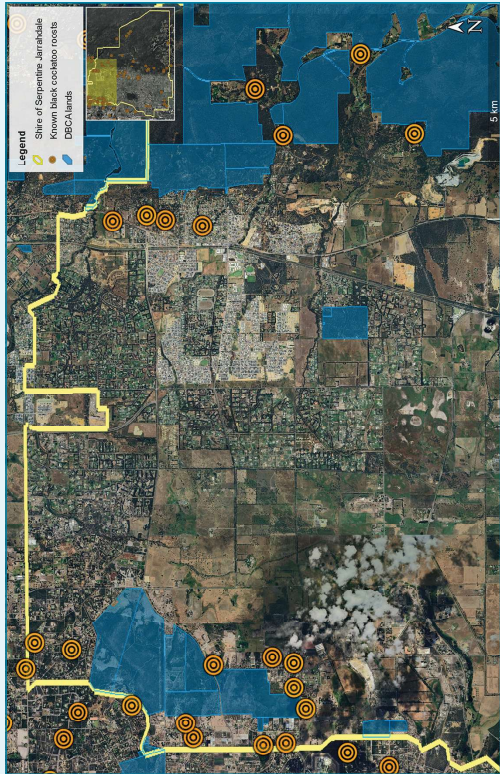
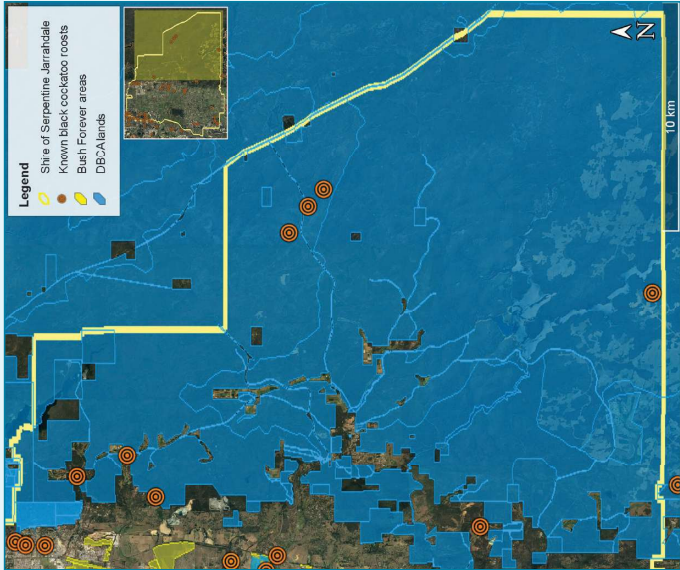
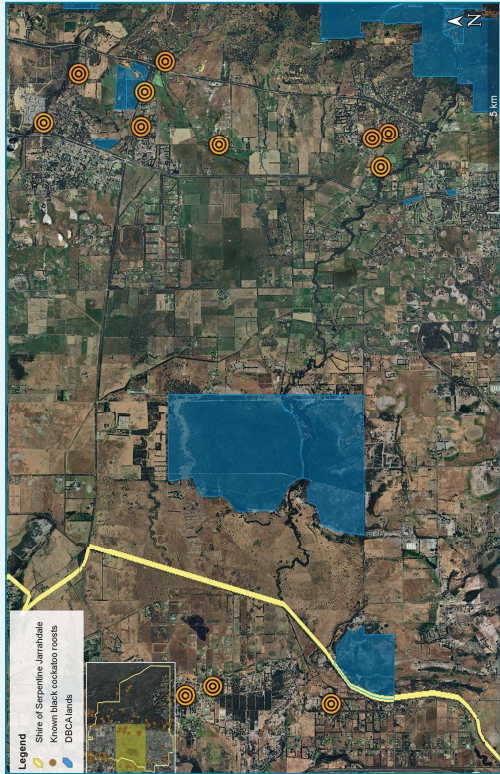


Figure 7. Shire of Serpentine Jarrahdale: DBCA reserves and legislated lands in relation to known roost sites for black cockatoo flock*

Showing areas of value to investigate for local government to work with DBCA on revegetation activities and infill planting with black cockatoo food species (Please note, the map of the eastern part of the Shire also includes the location of the small area of Bush Forever land in that part of the Shire). Roost sites just outside the Shire are included, because the black cockatoos that forage within the Shire may use night roosts just outside.

*Note: * While many night roost sites in the Shire are likely to have been located, it is probable that some roosts remain unidentified, or that new sites are used in the future.*

Source: DBCA lands were obtained from the Department of Biodiversity, Conservation and Attractions data layers 'DBCA - Legislated Lands and Waters (DBCA-011)' (data.wa.gov.au/dataset/dbca-legislatedlands-and-waters; accessed 26/04/2023) and 'Regional Parks (DBCA-026)' ([catalogue](https://data.wa.gov.au/dataset/regional-parks); accessed 26/04/2023). Bush Forever areas were obtained as per **Figure 6** caption. Black cockatoo data are from Birdlife Australia and Murdoch University. Figure produced using Google Earth Pro (<https://earth.google.com>).



**BLACK
COCKATOO
CONSERVATION**



School land

Plant additional food resources on school land. GPS and Argos satellite telemetry tracking of black cockatoo flocks in the Shire of Serpentine Jarrahdale by Murdoch University has revealed that remnant native vegetation on school land is an important food resource for these flocks. **Figure 8** is provided as an example.

- » Engage with schools and state government to undertake revegetation activities and infill planting on school land, using black cockatoo food species.
- » Even small patches are valuable.
- » Shire of Serpentine Jarrahdale community engagement teams can use black cockatoos as flagship species, and hooks such as ‘create a Carnaby’s café’⁵⁰ to activate school communities.

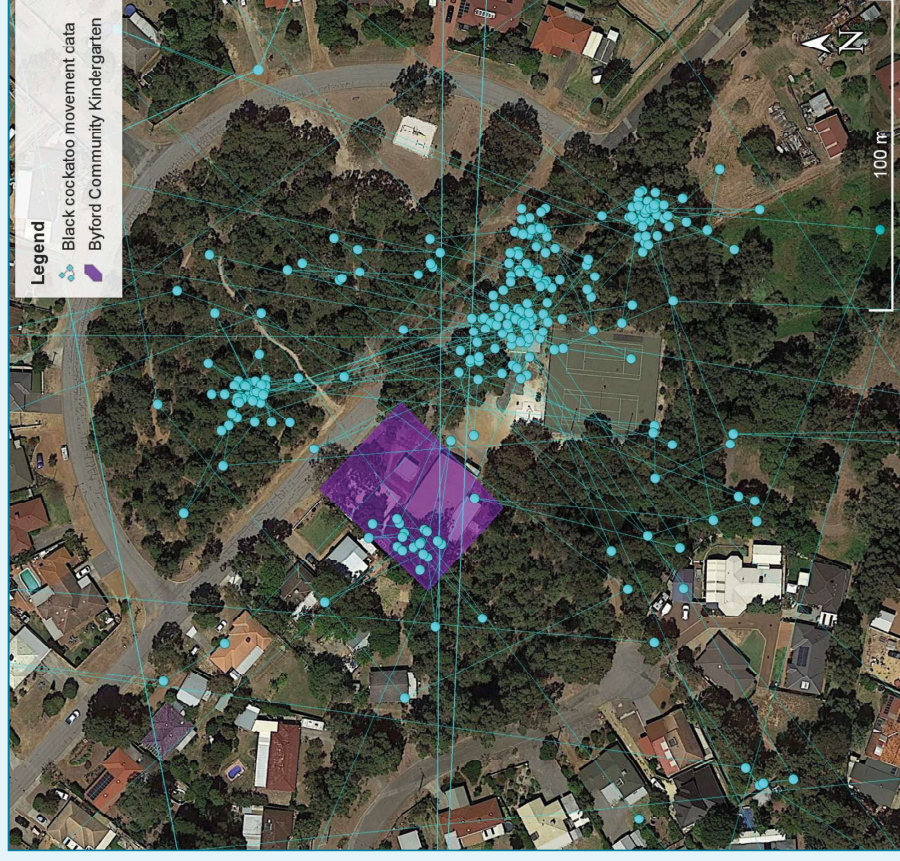


Figure 8. Schools and their ovals often provide valuable foraging and roosting habitat for black cockatoos

In this example, Murdoch University flock tracking data show how Byford Community Kindergarten provides abundant foraging habitat for a forest red-tailed cockatoo and its flock.

Source: GPS tracking data are from Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).

Priority areas for revegetation

To help prioritise where to plant additional food resources in the Shire of Serpentine Jarrahdale, the following four maps show the 10 largest known black cockatoo roosts (by number of birds) for flocks that forage in the Shire, with a 2km buffer around each of these roosts (**Figure 9**). Areas within these buffers that may be suitable for planting additional food are identified as ‘priority areas’; to focus expenditure of limited resources in the short term. They should be considered as a guide only: while flocks prefer to forage close to roosts, they will forage up to around 4–6km from their roost, and all revegetation and restoration activities within the Shire will benefit local flocks. For the same reason, all foraging habitat that remains within the Shire is critical to retain.

- » Create vegetation corridors to help flocks access food. Black cockatoos prefer to make short ‘step’ flights between habitat patches when moving through fragmented landscapes (see vegetation corridors in this Plan). If inspection of maps in this Plan reveals gaps between roosts and foraging habitat where native vegetation is absent, consider adding a small patch of foraging habitat as a stepping stone.

50 For planting a Carnaby’s café, see www.murdoch.edu.au/research/hbi/carnabys/how-you-can-help/help-by-planting-food

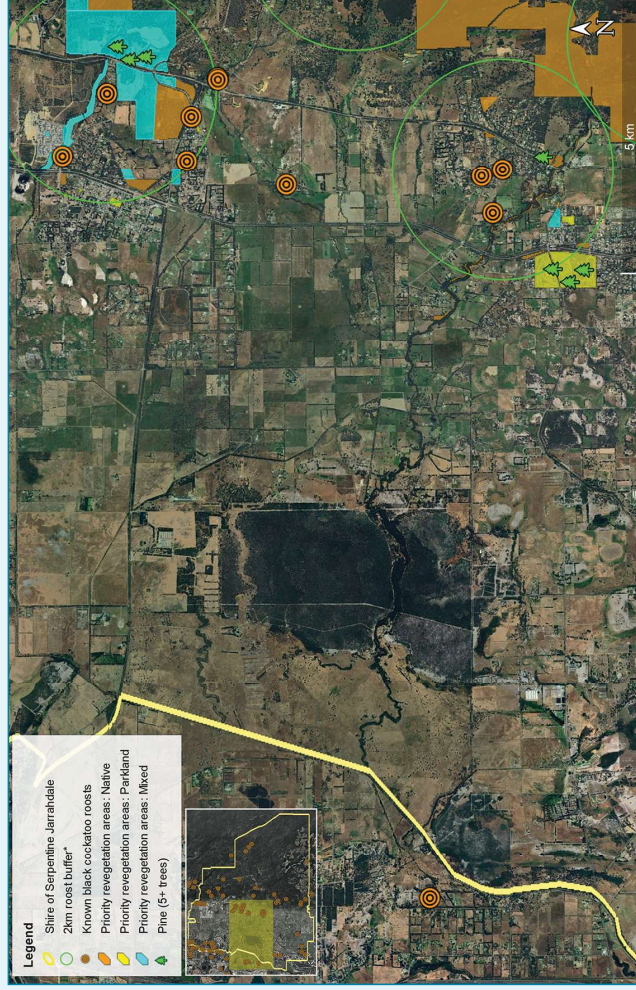
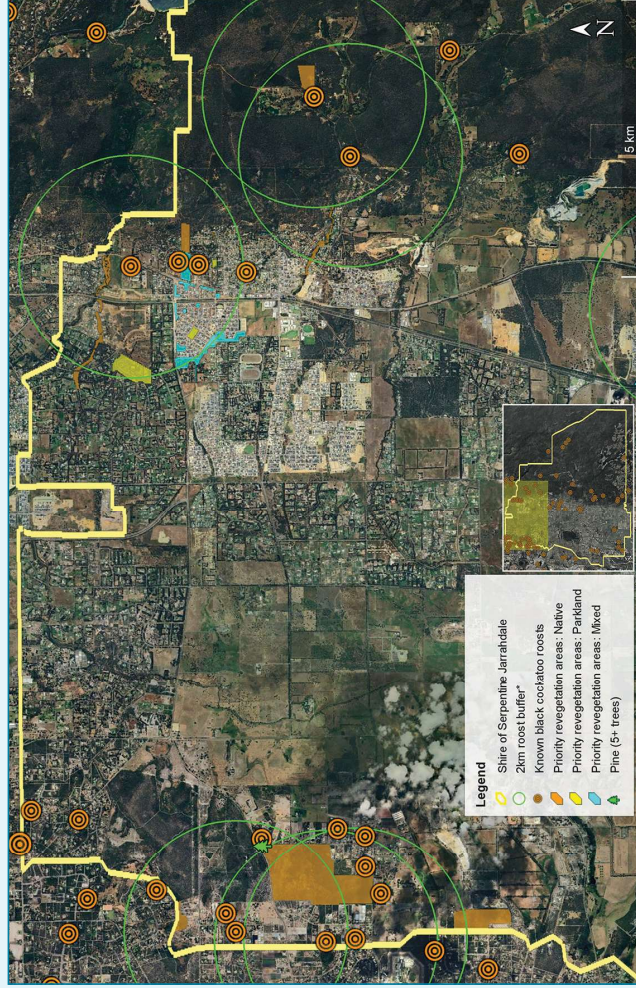


Figure 9. Recommended priority areas for habitat retention and revegetation in the Shire of Serpentine Jarrahdale (figure cont. next page)

Priority areas were identified using 2km buffers (lime rings) around the largest known roosts (by number of birds) for flocks that forage in the Shire of Serpentine Jarrahdale.

Native revegetation areas: include areas of bushland potentially suitable for infill planting with native tube stock. **Parkland revegetation areas:** include playgrounds, parks, ovals or other open spaces potentially suitable for parkland tree planting with either native or exotic tree species.

Mixed revegetation areas: include a mixture of either remnant bushland/cultivated garden beds potentially suitable for native tube stock planting, and public open space potentially suitable for parkland tree planting with either native or exotic tree species. **Pine:** provides important foraging opportunities for Carnaby's cockatoos, therefore the locations of pine stands with 5+ trees are identified on the map (excluding stands on private property, as far as could be established).

Note: While these priority areas have been provided to focus expenditure of limited resources, flocks will forage up to around 4–6km from their roosts, and all habitat within the Shire should be considered critical for the retention of flocks, alongside a policy of 'no net loss' of foraging habitat within the Shire's boundaries.

Source: Black cockatoo data are from Birdlife Australia and Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).

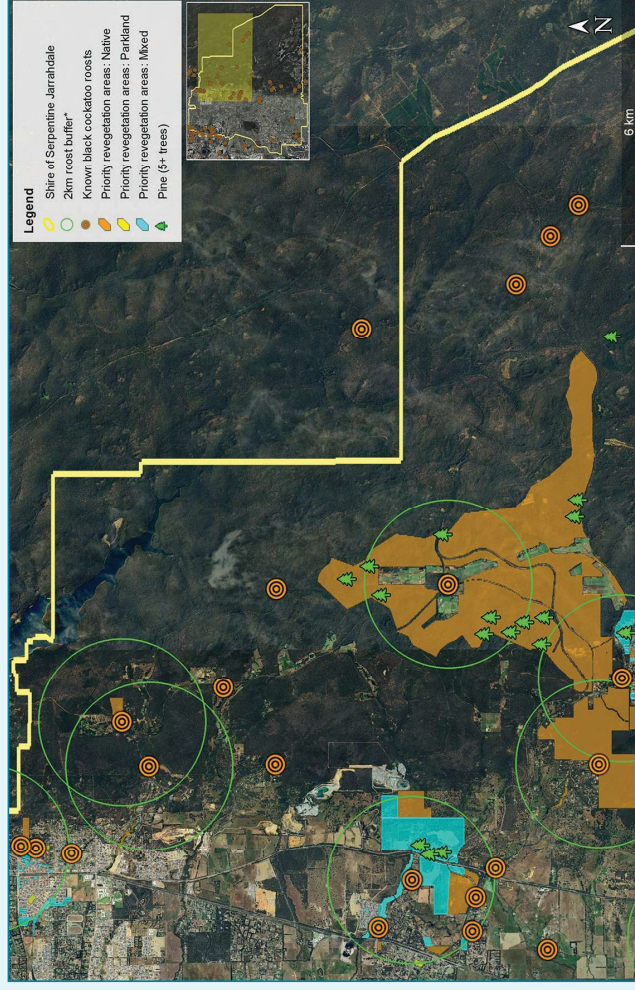
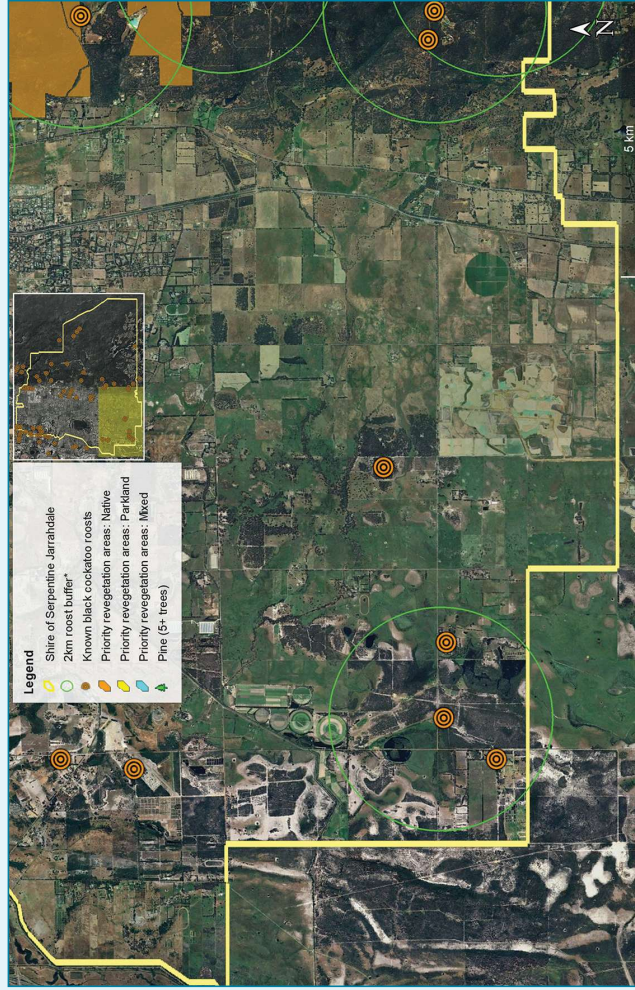


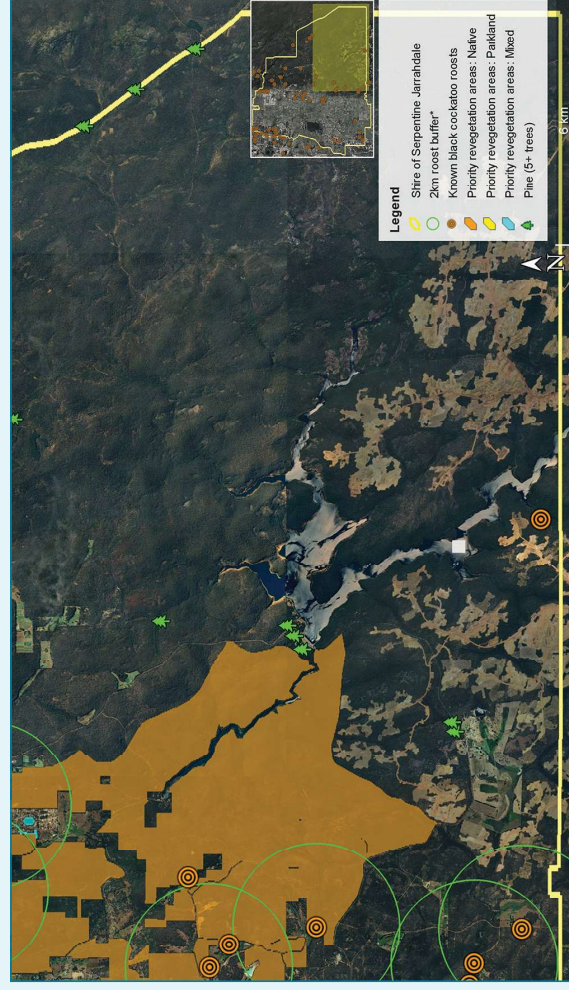
Figure 9. Recommended priority areas for habitat retention and revegetation in the Shire of Serpentine Jarrahdale cont.

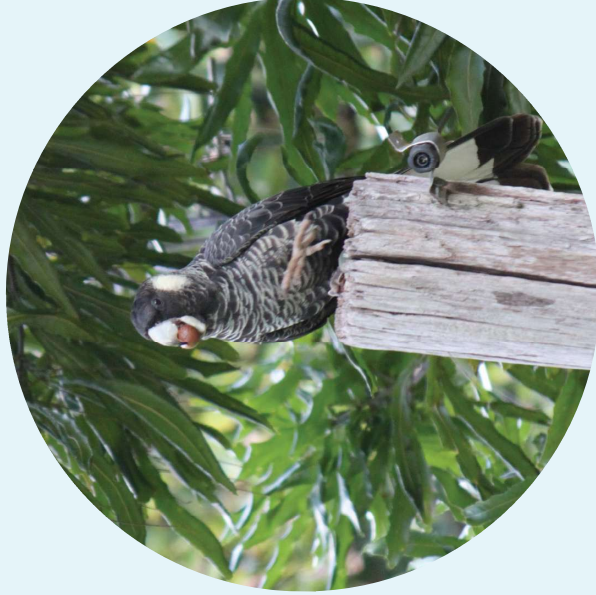
Priority areas were identified using 2km buffers (lime rings) around the largest known roosts (by number of birds) for flocks that forage in the Shire of Serpentine Jarrahdale.

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Note: While these priority areas have been provided to focus expenditure of limited resources, flocks will forage up to around 4–6km from their roosts, and all habitat within the Shire should be considered critical for the retention of flocks, alongside a policy of 'no net loss' of foraging habitat within the Shire's boundaries.

Source: Black cockatoo data are from Birdlife Australia and Murdoch University Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).





Plant macadamia for a fast-growing food resource.

- » Build these actions regarding black cockatoo food resources into existing strategies, policies and plans:
 - Integrating these actions into existing strategies, policies and plans will enable a whole-of-Shire approach towards ensuring enough food for black cockatoo flocks in the Shire of Serpentine Jarrahdale.
 - Relevant strategies, policies and plans to align with these actions include those related to clearing proposals; urban forest/ canopy; urban cooling and climate mitigation; biodiversity; street trees and road verge management; trees on private property; and public open space.

- Set and maintain a formal target of **net gain** of foraging habitat in the Shire of Serpentine Jarrahdale (public and private land), recognising that ongoing net loss will lead to loss of black cockatoos. Net gain will also benefit other threatened native birds and pollinator insects, and will contribute to urban canopy, water sensitive urban design, beautification of streets and public open spaces, climate mitigation and urban cooling.
- » Activate the community to plant black cockatoo food:
 - Provide the community with information about the value of giving black cockatoos more food, including planting suitable food in gardens and other private property (see Birdlife Australia's website for details).
 - Use key dates such as National Tree Day (July), International Day for Biodiversity (May), World Bird Day (January), and Clean-up Australia Day (March) to create awareness and on-ground action. Dates in autumn and winter (planting season) can be leveraged to offer native plant and seedling giveaway and subsidy schemes to residents and Friends of Bushland groups, and to hold planting and rehabilitation days.
 - Organise and promote community planting days, including in collaboration with land care NGOs⁵¹, Friends groups and DBCA. Liaise with these organisations about events they are organising which the Shire could help promote and support.
 - Provide information about land care NGOs, Friends groups, Birdlife Australia and Kaarakin Black Cockatoo Conservation Centre, to activate the community to volunteer with these groups and assist in black cockatoo conservation actions.

- Engage with businesses and utility providers to identify new areas for revegetation, such as on golf courses, school grounds and power easements.

Key points

- » Urban and peri-urban areas lose their black cockatoos when too much of their food is lost.
- » When resident at a roost, flocks need enough food within 4–6km of the roost.
- » Numerous flocks of all three black cockatoo species forage and roost in the Shire.
- » Adopt a policy of 'net gain' of food resources. Without this, black cockatoo declines cannot be reversed.
- » Both habitat retention and creation of new habitat are important to safeguard the Shire's black cockatoos.
- » Engage the community to help.
- » Use this black cockatoo plan to feed into the Shire's existing strategies, plans and guidelines, to ensure that they directly support planting of black cockatoo food species wherever possible, and thereby become documents that can support the Shire to safeguard its black cockatoo flocks.

⁵¹ Recommended organisations include the partner organisations on the *Keep Carnaby's Flying* – Ngoolarks Forever project; see logos at the start of this document

1.2 Lack of roosts

Black cockatoo roost habitat is under threat across Perth and Peel, where most habitat suitable for roosting has been cleared. In some urban areas, no roost habitat remains.

What is suitable night roost habitat?

Black cockatoos roost communally at night in one or more tall, large trees; often the tallest trees in the area. Key night roost sites can support more than one flock together, and different species may share a roost. Trees can be native or non-native; key requirements include that the trees must be tall (research shows a preference for >25m⁵²) with medium density foliage (around 50%). In areas where insufficient roost habitat remains at a single location, the flock may divide to roost in two or three locations that are within a few hundred metres of each other. Together, the locations are then considered a single roost.

During the time that a flock is resident in an area – for example, when a Carnaby's cockatoo flock is roosting and foraging in the Shire of Serpentine Jarrahdale during the non-breeding season – the flock may use a few different night roosts within the area depending on food availability and weather conditions. Flock tracking data show flocks have preferred roosts, and revisit the same roost or network of roosts at a particular time of year each year, coinciding with seasonal patterns in food availability⁵³. This highlights the need for flocks to have several suitable roost locations in a particular area.



⁵² Le Roux, C. (2017). Nocturnal roost tree, roost site and landscape characteristics of Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) on the Swan Coastal Plain.

⁵³ 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), 1. Groom, C. (2015). *Roost site fidelity and resource use by Carnaby's cockatoo, Calyptorhynchus latirostris, on the Swan coastal plain, Western Australia* (Doctoral dissertation, University of Western Australia).

Roost viability

Night roosts must be supported by close proximity to enough food resources to feed the flock (see previous section) and by close proximity to safe drinking water (see next section). If either food or water becomes too scarce to support the flock, the roost becomes unviable.

Threats to roost habitat include:

- » Ongoing clearing of suitable tall trees on government and private land:
 - Few roost sites remain in each local government area in the Perth–Peel region.
 - Although just under two-thirds of known roosts in the Perth–Peel region are in parks and reserves, the remaining roosts are located on private land, highlighting the challenges of protecting roosts in urban areas.
 - Roosts are large trees. If removed, they cannot be replaced within decades.
- » Lack of enough food resources within daily foraging range of a roost (6km) to allow the roost to remain viable:
 - See previous section for the details of the research showing that black cockatoos need enough food within 6km of their roost to support all members of the flock.
 - See previous section for threats to food resources in the Shire, and actions to undertake.
- » Lack of reliable safe drinking water in close proximity to the roost (see next section).
- » Lack of succession planning for new roost habitat.
- » Disturbance at night.

Note: the risk to roost viability from continual loud noises or bright lighting overnight at roosts is not clear. Research is required to clarify whether noise and bright light at night roosts is a risk.

Value of the Shire's roosts for black cockatoos

- » The Shire of Serpentine Jarrahdale has night roosts for all three black cockatoo species, including (unlike most Perth–Peel local government areas) the rarest species: Baudin's cockatoo.
- » Some of the roosts comprise enough trees to support larger flocks (many urban roosts do not have enough trees for large flocks).
- » The roosts include food resources within the birds' daily foraging range (up to 6km from roosts).

Day roost habitat and crèche trees

As well as night roosts, black cockatoos need day roost habitat. Once daytime temperatures become too warm, black cockatoos must stop their foraging activity and take shelter in trees with shady canopies, where they rest until temperatures fall.

Flocks need enough trees with dense canopies near their foraging areas, to allow them to rest and avoid heat stress on hot days. Likewise, black cockatoos need access to a few trees with dense canopies near their roosts, to act as 'nursery' or 'crèche' trees when the flocks have new young with them. For example, when Carnaby's cockatoos return from their breeding sites to the Shire of Serpentine Jarrahdale in summer and early autumn each year, they bring new dependent young with them, which are crèched in one or more nursery trees near the roost each morning as the adults head out to forage. The young birds retreat into the canopy to hide and rest, and wait to be collected and fed by their parents at the end of the day. They then return together to the night roost.



Actions »

Retain existing night roosts

1. **Identify** and protect all night roosts within the Shire of Serpentine Jarrahdale. DBCA and Birdlife Australia have roost locations; Birdlife will have the latest data if DBCA databases have not been updated.
2. **Work** with the WALGA and state government to enable local governments to protect important trees on private property.
3. **Recognise** that a roost may not be in use year-round but may be critical at particular times of year, related to seasonal availability of food nearby. Given the scarcity of food for black cockatoos in some areas and at some times of year, whenever a patch of foraging habitat is producing food, the roosts nearby will become critical. Without them, black cockatoos cannot access that food.

Create new roost habitat

1. **Plan** for roost habitat succession by planting new roost habitat.
2. **Recommended** roost trees in the Perth-Peel region include marri, jarrah and tuart. Over time, these will provide both roost habitat and food or corridor habitat. For Carnaby's cockatoos in the Perth-Peel region, pine also provides important roost habitat and food.
3. **Plant** and maintain several trees together where possible, to create a roost with enough trees to support larger flocks. Parks and schools are often appropriate locations to plant larger trees.
4. **Ensure** new roost trees are supported by enough food resources within 6km; preferably closer.
5. **Consider** planting new roost trees at or near an existing roost, to enable that roost to remain viable over several generations of trees.

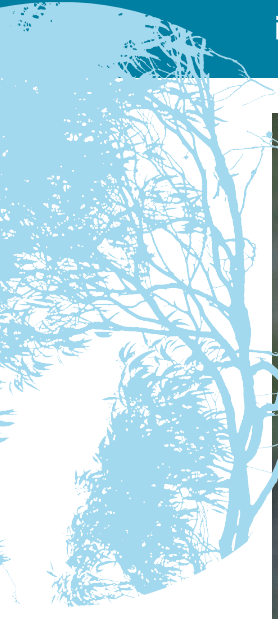
6. **Ensure** that roost succession planning is supported by updating the Shire's relevant strategies, policies and plans where required.
7. **Check** roost datasets (DBCA, Birdlife Australia) every 1–2 years, to ensure any new roosts are identified.
8. **Notify** Birdlife Australia if new roosts are reported to the Shire of Serpentine Jarrahdale, so they can update their database (greatcockcount@birdlife.org.au).

Community engagement

1. **Liaise** with Birdlife Australia to organise flock counts at roosts in the Shire of Serpentine Jarrahdale through the annual citizen-science Great Cocky Count. Host and promote workshops about the Great Cocky Count, and the ongoing Cockywatch surveys (Birdlife Australia), to enable Shire of Serpentine Jarrahdale community volunteers to become trained as citizen scientists. Direct funds towards Friends groups or other community groups to create new foraging habitat near roosts or enhance existing habitat (through infill planting; weeding).
2. **Provide** information through the Shire's online networks about the importance of retaining the Shire of Serpentine Jarrahdale's black cockatoo roosts, and of providing enough food resources near roosts to ensure they remain viable.

Key points

- » Protect all remaining night roosts for black cockatoos in the Shire.
- » Support roosts by providing food resources and water nearby.
- » Create new roosts (succession planning) by planting marri, jarrah and tuart around ovals or in other public open spaces.



1.3 Lack of vegetation corridors

- » In the Perth-Peel region, urbanisation has removed most black cockatoo habitat, and the habitat that remains has been fragmented into many smaller, unconnected patches.
- » The urban landscape includes large expanses without trees, including some suburban blocks, housing estates and industrial areas. These present a threat to urban wildlife because they act as 'roadblocks' which prevent wildlife movement between natural areas, such as between one foraging area and the next.
- » Contrary to popular belief, when black cockatoos are resident in the Perth-Peel region, they do not just 'fly wherever they want'. Tracking data by Murdoch University show that the birds avoid larger cleared

- urban areas without trees. Instead, they move through the landscape by relying on vegetation corridors, such as a row of street trees or a network of neighbouring habitat patches.
- » Patches and strips of vegetation offer black cockatoos protection, shelter, and places to land, forage and rest. They act as 'stepping stones', allowing the birds to move through built-up areas by making short 'step' flights between vegetation patches.
- » Without a vegetation corridor, food resources may not be accessible to black cockatoos.
- » Risks to vegetation corridors include the possibility that many trees and vegetation patches which form part of a corridor may be on private land, and not protected from clearing.

The value of street trees

Along with their aesthetic value and urban cooling effects, mature street trees are valuable wildlife corridors. Murdoch University's flock tracking data show that one Carnaby's cockatoo flock in Perth's northern suburbs was able to access a patch of fruiting banksia on the far side of a dense new housing development by moving along a row of large tuart trees in the backyards of adjacent private properties, which had been protected by local government. No other vegetation had been retained in the vicinity, on either government or private land. Without the row of street trees, the black cockatoos may not have been able to access the important food resource on the other side of the development. In urban areas where food resources are already scarce, vegetation corridors are critical to allow black cockatoos to access all remaining foraging habitat.



Pink-flowering banksia: Decisions regarding street trees should prioritise black cockatoo food trees and shrubs where possible. They have attractive flowers and help feed black cockatoos in urban landscapes.

A special kind of corridor: The breeding season movement corridor in the Shire

Murdoch University's flock tracking data show that the vegetation corridors in the Shire of Serpentine Jarrahdale are important not only to allow black cockatoos to move daily between their roosts and food resources, but because the Shire forms part of an important, landscape-scale movement corridor which supports the birds on their way to and from breeding sites. While some black cockatoos breed locally within the Shire (see later in this Plan), many Carnaby's cockatoo and Baudin's cockatoo flocks undertake breeding migrations, and some forest red-tailed cockatoos undergo seasonal movements to breeding sites as well.

Figure 10 shows the use of the Shire as a seasonal movement corridor for five Baudin's cockatoo and forest red-tailed black cockatoo flocks that contained tagged birds. There will be many other flocks using the corridor, which were not tracked. The Shire is one of just a few Perth-Peel areas that provides this landscape-scale corridor. At the start of the breeding season, many black cockatoos that spend the non-breeding season feeding in the Perth-Peel region undertake long flights to breeding grounds. At the end of the breeding season they will return to their Perth-Peel roosts, bringing with them their dependent young.

The select few local governments whose areas comprise this breeding movement corridor have a critical role to play, in ensuring that the birds have enough food along their route to maintain their energy. The Shire can best support its black cockatoos by ensuring no net loss of food and roosts in the Shire and by creating new patches of native vegetation to enhance the corridor.

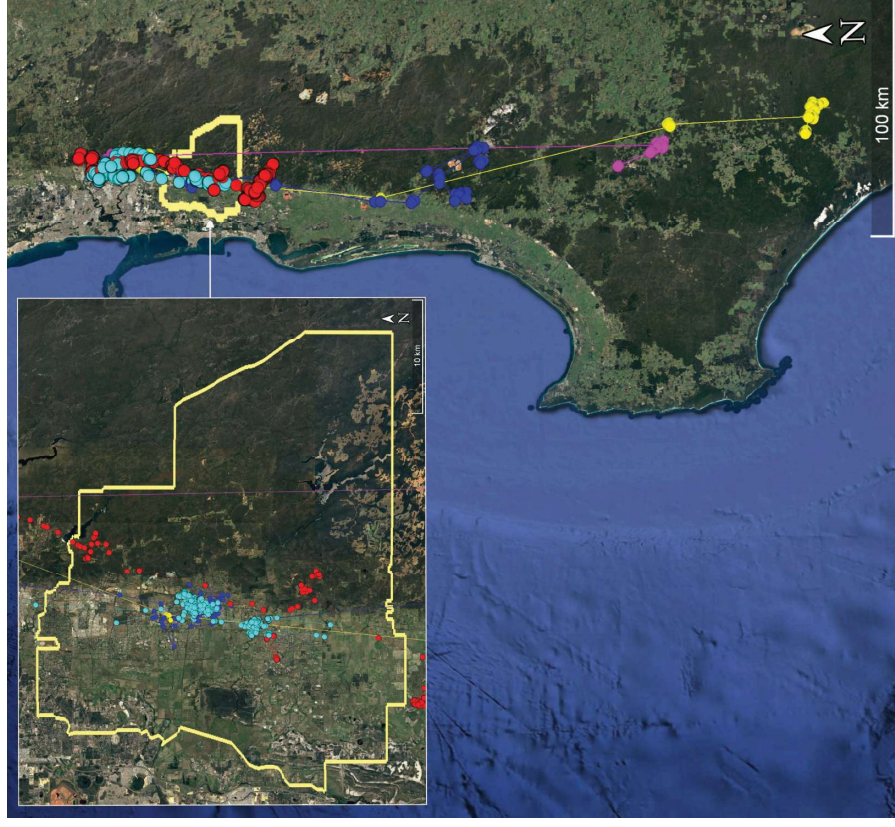


Figure 10. Breeding season movement corridor: Movement paths of five black cockatoo flocks, each with a tagged 'marker bird', highlighting the importance of the Shire as a seasonal movement corridor

Four Baudin's cockatoo flocks (blue, purple, yellow, aqua) undertook southerly movements through the Shire coinciding with the start of the breeding season (Aug to Nov). A tracked forest red-tailed cockatoo flock followed a similar pathway, moving through the Shire in August. The ARGOS satellite telemetry tags only give intermittent flock location fixes, sometimes with several days between data points, which meant that for the purple flock, the exact movement path through the Shire was not captured, however the flock is expected to have used the same pathway as the other flocks, following the foothills. These data demonstrate the importance of the Shire's foothills as a seasonal movement corridor, with southerly movement following the scarp, passing through Byford and Serpentine. While no data were captured for the return journey, it is expected that flocks follow a similar pathway when returning north at the end of the breeding season.

Source: Black cockatoo tracking data are from Murdoch University's Black Cockatoo Conservation Management Project. Figure produced using Google Earth Pro (<https://earth.google.com>).

Actions »

- 1. Retain** vegetation corridors, to allow black cockatoos to access roosts and food resources.
- 2. Recognise** that patches of vegetation are valuable as part of a corridor even when each patch is small; including trees around ovals and parks and on private property. These are important to retain.
- 3. Undertake** succession planning for vegetation corridors. Where existing corridors comprise older trees, plan for retention of this resource for black cockatoos by planting new trees sufficiently far in advance to allow them to replace the older trees over time, enabling the corridor to remain. This will require long-term planning, and may require updates to relevant Shire strategies and plans.
- 4. Enhance** existing vegetation corridors and create new corridors, particularly where larger gaps exist between patches of foraging habitat.
- 5. Plant** patches of black cockatoo food trees (e.g. marri, jarrah, banksia, hakea) in spaces where there is little or no vegetation, and within 6km of roosts and food resources. New patches which can act as 'stepping stones' between larger areas of foraging habitat are particularly important.



Policy implementation

Creating and enhancing vegetation corridors for urban wildlife in the Shire is an effective way to implement the state Native Vegetation Policy, which includes a Strategic Goal of increasing the connectivity of native vegetation. It will also support local biodiversity and climate mitigation.

- 6. Ensure adequate set-back distances when planting black cockatoo food trees on road verges. In quiet streets (speed limits <50km) plant at least 3–5m from road edges; on busier roads (speed limits >50km/hr) plant >10m from the road. Never plant black cockatoo food plants on median strips.**

- 7. Engage** the community to create vegetation corridors through the Shire that will also provide food for the birds, including by planting food trees around school ovals, golf courses and in backyards. Assist NRM land care groups, Friends groups and Winjan Aboriginal Corporation to enhance vegetation corridors, and promote community involvement in native vegetation planting days.

Key points

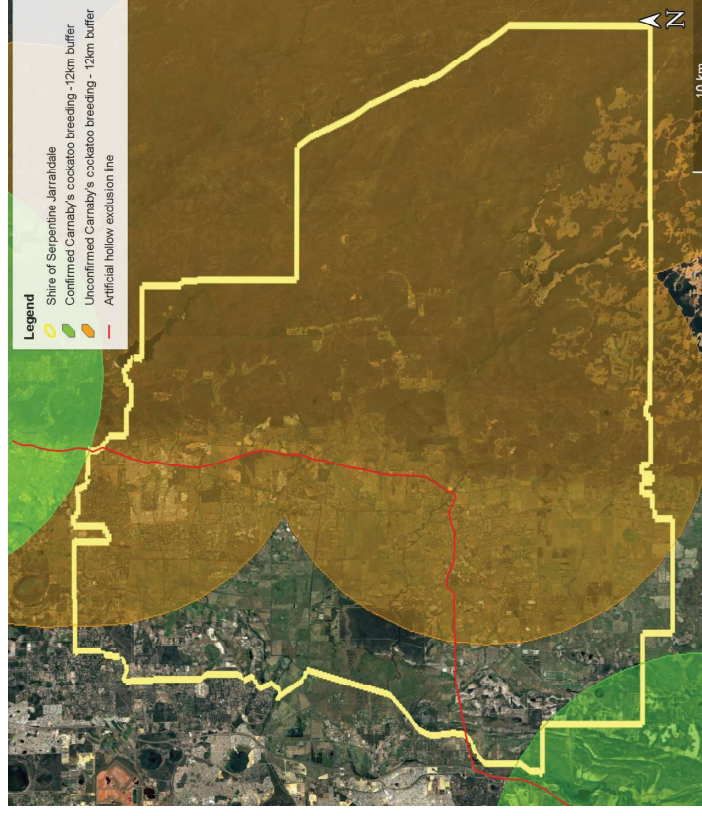
- » Black cockatoos need vegetation corridors to allow them to move through urban landscapes.
- » Planting new food resources can also increase vegetation corridors across the Shire of Serpentine Jarrahdale.
- » The Shire's native vegetation corridors are not only useful to enable daily flock movements: the Shire is part of a seasonal breeding movement corridor for black cockatoos.

1.4 Lack of breeding habitat

Black cockatoos nest in large hollows in old eucalypts, living or dead. To develop suitable hollows, the trees typically need to be at least 200 years old. Breeding habitat must also be supported by enough food resources within 12km or preferably 6km⁵⁴, and by access to reliable fresh drinking water (preferably within 1km).

Very little black cockatoo breeding habitat remains in the Perth-Peel region. In breeding areas that have lost most or all of their natural hollows, artificial hollows have shown some success, mainly for Carnaby's cockatoos (reported uptake by forest red-tailed cockatoos is around 8%).⁵⁵ Artificial hollows need regular monitoring and maintenance over many decades to remain viable and safe; hollows in poor repair have been linked to bird deaths (Carnaby's Cockatoo Recovery Team pers. comm). In urban areas, artificial hollows are often taken over by smaller parrots such as corellas and galahs, which can become pests. Urban environments are also high-risk for black cockatoo fledglings, which are inexperienced fliers and vulnerable to vehicle strike and raven attack. For these reasons, DBCA advises against installation of artificial hollows in urbanised areas of metropolitan Perth and Peel. This Plan supports that advice.

Some black cockatoos that roost and forage in the Shire of Serpentine Jarrahdale will travel to breeding sites outside the Shire at the start of the breeding season, and then bring their fledglings back to the Shire. However, **Baudin's cockatoos are known to breed in the Shire** (confirmed locations in the Serpentine hills area; other sites possible).⁵⁶



The Shire also provides important food resources for breeding Carnaby's cockatoos that have found a nest just outside the Shire (**Figure 11**) and there are reports of activity indicative of breeding by Carnaby's cockatoos within the Shire itself. Breeding within the Shire is also likely for some or many of the Shire's forest red-tailed cockatoos, given this species often breeds locally.

Figure 11. Locations of confirmed and unconfirmed (i.e. potential) Carnaby's cockatoo breeding activity (12km buffers)

'Unconfirmed breeding' refers to observations of behaviour indicative of breeding, such as birds moving in pairs to inspect hollows at the start of the breeding season (indicative of 'prospecting' for suitable nests), where checks of hollows to confirm breeding (e.g. female on nest; feeding of young) did not occur. Breeding records are only publicly available for Carnaby's cockatoos, however there is also confirmed breeding for Baudin's cockatoos, and possibly forest-red-tailed cockatoos, in the Serpentine hills area; contact DBCA for further information. The 12km buffer indicates the area within the Shire where food resources are supporting these breeding sites (breeding birds require sufficient food within 12km or ideally 6km of their nest).⁵⁴ The red line on the map indicates the boundary of DBCA's recommended exclusion zone for artificial hollows, to ensure artificial hollows are not installed in built-up areas that are high-risk for fledglings. **Installation of artificial hollows is not recommended west of the red line.**

Source: Birdlife Australia and DBCA data. Exclusion zone line is adapted from the map included in DBCA's Fauna Note Artificial Hollows for All Black Cockatoos: www.dbca.wa.gov.au/management/threatened-species-and-communities/threatened-and-priority-fauna-resources. Figure produced using Google Earth Pro (<https://earth.google.com>).

⁵⁴ Murdoch University data show that Carnaby's cockatoos will fly 12km or, more rarely, up to 15km from their nests to find food; however Saunders (1980; 1982; cited in EPA 2019) found that when the parent birds had to fly 12km to find food, their chicks had significantly lower growth rates and likelihood of survival than chicks whose parents had enough food available within 6–7km of their nest.

⁵⁵ Pers. comm. Tony Kirby, Western Australian Museum, September 2023.

⁵⁶ Baudin's cockatoos are the most endangered black cockatoo; already listed as 'Critically Endangered' and still declining. A scarcity of breeding habitat (shortage of mature eucalypts with suitable hollows) is listed in their national Recovery Plan as one of the main threats to the species' survival. This makes the Shire's breeding habitat critically important to protect.

Actions »

Protect and enhance food resources near breeding sites

The Shire can support the black cockatoos that are breeding nearby and relying on the Shire's food resources during breeding, by protecting existing food resources and planting new food within 12km and preferably 6km⁵⁷ of breeding locations (Birdlife Australia can provide location details; some nests may be just outside the Shire, with the birds relying on the Shire's food resources to feed their young). The Shire can also support all its black cockatoos, including those that breed elsewhere, by ensuring there are enough food resources in the Shire during the non-breeding season to help the birds build body condition and thereby breed successfully. **See Table 1 for food species to plant.**

Support young black cockatoos

The Shire can support the survival of the chicks that are born locally, and the fledglings that arrive back in the Shire with their parents at the end of the breeding season, by providing sufficient quantity and diversity of food plants for the parent birds while they are feeding their dependent young in the Shire, and for the young birds as they learn to forage. Roosting habitat, reliable fresh drinking water and vegetation corridors (see earlier sections of this Plan) will also help young black cockatoos to survive.

Protect current and future breeding habitat and plan for breeding habitat succession

Existing black cockatoo nest hollows are protected under law. In breeding areas (outside the built-up urban 'exclusion zone'), large eucalypts of hollow-forming species⁵⁸ are critical to retain as breeding habitat; those with diameter-at-breast-height >500mm have the potential to form suitable hollows within decades. It is equally important (and often overlooked) to protect younger hollow-forming eucalypts, and plant new trees, to provide succession breeding habitat over time.

Repair natural nest hollows where required

In some areas, natural hollows in which black cockatoos are breeding are in urgent need of repair. This work is important, as breeding pairs return to the same hollows in which they have bred successfully in the past; and there are already too few hollows in most areas to allow all pairs to breed⁵⁹.

Protect breeding habitat on private land

Many black cockatoo breeding sites are on private land, including 73% of confirmed Carnaby's cockatoo breeding sites (EPA 2019). Protecting breeding habitat on private land is a particular challenge for local governments, which can be addressed by undertaking regular community awareness-raising to inform land owners of the value of preserving

current and future breeding habitat. Many land owners, for example, are unaware of the value of single large 'paddock trees', including stags (dead trees), as breeding habitat for Carnaby's cockatoos.⁶⁰

Consult relevant authorities regarding artificial hollows

- » **Do not install artificial hollows in areas west of the red line in Figure 11.** Black cockatoo breeding is not recommended in built-up areas of Perth and Peel.
- » Consult DBCA, Birdlife Australia or WA Museum to discuss whether artificial hollows (outside the exclusion zone) are useful to support the Shire's Carnaby's cockatoos. There is no guarantee that artificial hollows will be used, and they should never be used as an excuse to remove suitable natural hollows. All artificial hollows should follow DBCA guidelines, and must be monitored and maintained throughout their lifespan (the recommended design has a 50-year lifespan), after which they **must** be removed, to avoid becoming death traps. DBCA's guideline on use of artificial hollows, including siting, installation, monitoring and maintenance, is: DBCA (2023) 'Fauna Notes: Artificial hollows for black cockatoos'.⁶¹

⁵⁷ Murdoch University data show that Carnaby's cockatoos will fly 12km or, more rarely, up to 15km from their nests to find food; however Saunders (1980; 1982; cited in EPA 2019) found that when the parent birds had to fly 12km to find food, their chicks had significantly lower growth rates and likelihood of survival than chicks whose parents had enough food available within 6–7km of their nest.

⁵⁸ Hollow-forming eucalypts in which Carnaby's cockatoos or forest red-tailed black cockatoos are known to breed include, for example, jarrah, marri, tuart, wandoo, salmon gum, blackbutt, flooded gum and York gum. Contact Birdlife Australia for a full list of suitable trees and associated advice: Carnabys@birdlife.org.au

⁵⁹ Birdlife Australia (for Carnaby's cockatoos) and WA Museum (for all species) can provide advice about whether natural hollows in particular areas currently need maintenance. This repair is undertaken by Australian Black Cockatoo Specialists, the only specialist operation which undertakes maintenance of natural hollows in southwest Western Australia.

⁶⁰ Department of Climate Change, Energy, the Environment and Water (n.d.) draft Guide to nationally protected species significantly impacted by paddock tree removal.

⁶¹ Department of Biodiversity, Conservation and Attractions, (2023). Fauna Notes – Artificial hollows for black cockatoos. Retrieved from <http://www.dbca.wa.gov.au/>



Manage nest hollow competitors

- » Smaller, more common parrot species such as corellas can build up in urban areas and then travel to breeding areas outside the city, where they can compete with black cockatoos for scarce nest hollows. For guidance on managing common parrot species so that they do not become overabundant, contact Birdlife Australia or the Department of Primary Industries and Regional Development (DPIRD).⁶²
- » Feral European honey bees are a major threat to black cockatoo conservation. When these bees are allowed to swarm away from their hives and become feral, they can take over tree hollows from black cockatoos or other wildlife, making them unavailable to breed in. Black cockatoo chicks have been found either stung to death or suffocated by feral bee swarms.⁶³ Local governments in urban and peri-urban areas can support black cockatoos by raising awareness of the need for apiarists to ensure bees do not swarm away from hives and become feral. The Shire can also work with relevant authorities (e.g. DBCA, Birdlife Australia) to monitor nest hollows and ensure they remain free of bees.

Key points

- » In breeding areas, large hollow-forming eucalypts are critical to retain as breeding habitat.
- » Retain younger hollow-forming eucalypts and plant new trees for breeding habitat succession.
- » Breeding sites need enough food within 12km (or preferably 6km) and reliable fresh water.
- » Smaller introduced parrots and honey bees can take over nest hollows, and should be managed to ensure they do not prevent black cockatoos from breeding.
- » Consult relevant authorities to discuss use of artificial hollows (outside the urban 'exclusion zone') and follow DBCA guidelines regarding maintenance to prevent them from becoming death traps.



PHOTO Rick Dawson

Crèche trees for fledglings

For the first few weeks after returning from their breeding sites, when young black cockatoos are particularly vulnerable, flocks will 'crèche' their young birds in a suitable tree near their roost, to shelter during the day while the flock forages. The flock then collects the young birds before returning to the roost to sleep. The Shire of Serpentine Jarrahdale could support its black cockatoo flocks by identifying a quiet green space within 1–2km of each roost, in which to plant a few trees that will grow to become medium to large trees with relatively dense foliage, to act as crèche or nursery trees. Macadamia trees are ideal, as they provide both dense foliage for young birds to hide in, and high-energy food. If the Shire is installing some Cockitrough bird waters (see 'Lack of water' section of this Plan), planting crèche trees at the same location as the bird waters could be ideal, as it allows flocks to drink and crèche their young at the same time, freeing up more of the day for foraging.

⁶² As of 2023, DPIRD is developing an official strategy for managing overabundant parrot species.

⁶³ Research conducted by the WA Museum: <https://museum.wa.gov.au/explore/online-exhibitions/cockatoo-care/feral-bees>

1.5 Tree diseases

- » Black cockatoo food resources and roosting habitat are at risk from a number of plant diseases. The national Carnaby's Cockatoo Recovery Plan identifies a range of pathogens that can kill black cockatoo habitat, including leaf and canker pathogens (e.g. marri canker), and soil borne pathogens, such as the highly aggressive root rot pathogen *Phytophthora cinnamomi*.

- » Phytophthora root rot disease or 'dieback' is a particular threat to black cockatoos. The pathogen is difficult to remove once it is in the soil and can cause devastating losses in banksia and other Proteaceous habitat, as well as jarrah – all critical resources for Carnaby's cockatoo survival.
- » In the Perth-Peel region, particular vigilance is required to manage the health of black cockatoo food resources, because most native habitat in the region has been reduced to small, fragmented patches. Small patches are more vulnerable than larger patches to disease being introduced from outside.

Actions »

1. **Prioritise** monitoring and management of the health of the Shire of Serpentine Jarrahdale's native vegetation and follow best practice in disease prevention.
2. **Ensure** the Shire and its contractors have appropriate hygiene policies and practices to prevent dieback disease from entering new areas of native vegetation in the Shire. Common ways that the pathogen can be introduced include via contaminated soil, mulch and fill products (including during planting), and on shoes, tools, tyres and other vehicle components. Use gardening materials accredited with the Nursery Industry Accreditation Scheme Australia (NIASA accredited products)⁶⁴.
3. **Ensure** the Shire and its contractors have appropriate hygiene policies and practices to manage marri canker e.g. sterilising pruning tools.

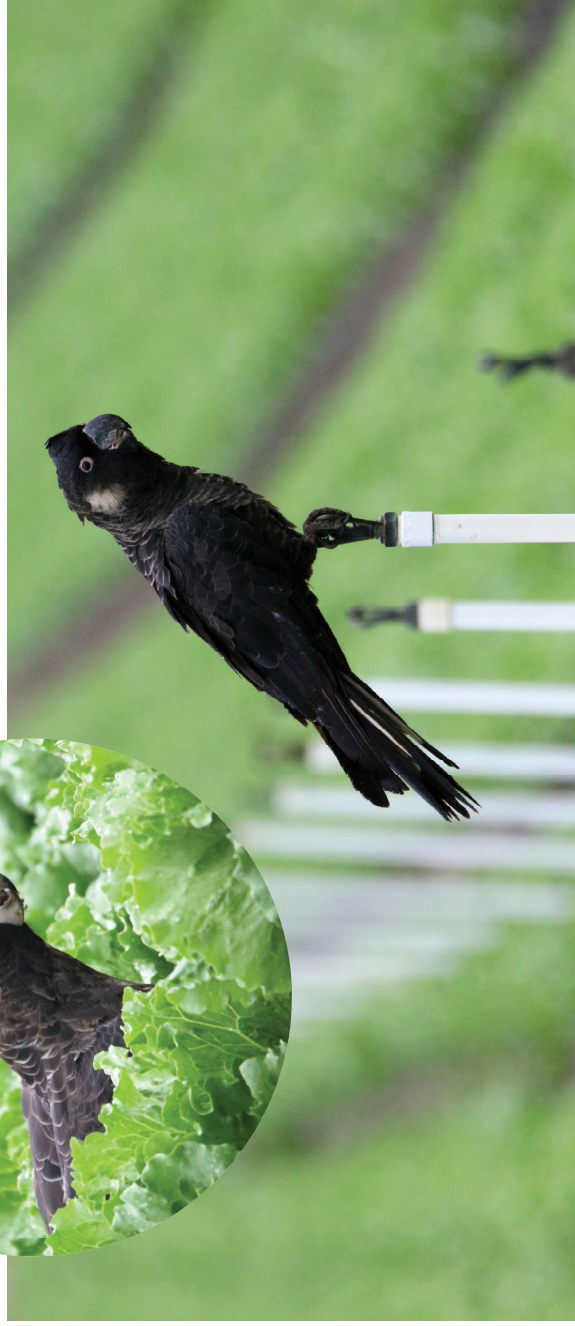
⁶⁴ Birdlife Australia has a printable pamphlet on the topics of choosing the best food plants for black cockatoos and managing the risk of dieback in native trees: https://direct.birdlife.org.au/documents/Choose_for_BCs_plant_brochure_2021.pdf

1.6 Habitat loss from fire

- » Fire in native vegetation can cause large direct losses of black cockatoo food-resources, and also (depending on the site) roosts and breeding habitat.
- » Black cockatoo habitat in the Perth-Peel region is at particular risk from deliberately-lit fires, given that most habitat in the region is readily accessible.
- » The risk to black cockatoo habitat from fire is exacerbated by climate changes. The Perth-Peel region is now experiencing hotter temperatures, less rainfall, and other harmful climate changes which are making fires hotter and more destructive to black cockatoo habitat.

Actions »

1. **Monitor** and manage the risks from fire using latest evidence-informed approaches.
1. **Manage** the increasing risks of high-intensity fires in the Perth-Peel region by ensuring the Shire becomes a leader at local government level regarding climate change mitigation (see **Climate change and Urban Heat Island effects**).



Threat 2. Lack of fresh drinking water

Lack of access to fresh drinking water is a threat to black cockatoos across the Perth-Peel region. Risks and impacts include heat stress, disease from contaminated water sources, and vehicle strike when drinking from pooled water on roads and verges.

2.1 Heat stress

- » Without water, black cockatoos can die quickly from heat stress on very hot days. Losses of almost entire flocks have occurred due to heat stress. This risk will increase as Perth-Peel becomes hotter, with the region now experiencing record-breaking heat.

- » Black cockatoos have specific water requirements.
 - They need access to fresh water twice daily, in the morning and late afternoon, as they leave and return to their roosts.
 - They need the fresh water source to be as close as possible to their roost, preferably within 1km, and in a safe location.

Heat stress avoidance strategies

As well as drinking water every morning and evening, black cockatoos avoid dangerous overheating by refraining from flying and foraging activity once temperatures become too warm, and retreating into trees with heavy shade. Carnaby's cockatoos have been found to remain inactive for as long as temperatures remain over 30°C (Saunders 1977). New Murdoch University research shows that for every 5°C increase in maximum temperature, Carnaby's cockatoos need to shelter in place for an additional 30 minutes.⁶⁵

2.2 Poor water quality

- » Black cockatoos have a natural preference to drink from shallow water, rather than deeper water bodies such as lakes, and this can expose them to poor quality water. They will drink from pond-edges, troughs and bird baths, water that has pooled in potholes and beside roads without adequate drainage, and even water that collects in leaves of leafy vegetables in market gardens (see left).
- » In the Perth-Peel region, poor-quality and contaminated water sources have been linked to disease outbreaks and deaths of black cockatoos.
- » In 2023, an outbreak of black cockatoo illness and deaths occurred in Perth's northern suburbs. Investigations by Murdoch University and Perth Zoo Veterinary Department are ongoing, however chemicals were detected in the gut contents of deceased birds, including pesticides; suspected to have been ingested from contaminated drinking water.
- » Botulism outbreaks can occur in ponds and lakes in Perth and Peel. The bacterium that produces botulism toxin is often present in standing water; but is only triggered to produce the toxin in certain environmental conditions, when oxygen levels in water are low (e.g. in warm weather with low water levels or build-up of organic matter). Botulism outbreaks can occur repeatedly if water quality is not managed. The disease is often fatal in birds, and can kill large numbers. Water birds are most commonly affected, but any bird drinking the water is at risk.

2.3 Vehicle strike when drinking on roads and verges

- » As black cockatoos prefer to drink from shallow rather than deep water, in the absence of reliable drinking water sources they are attracted to drink from rainwater or sprinkler runoff that has pooled in potholes and on roadsides without adequate drainage. This leads to high risk of vehicle strike. See [Vehicle strike](#) section.

⁶⁵ Riley et al. (2023).

Actions »

Establish a network of bird water drinking stations

This will provide all black cockatoo flocks in the Shire of Serpentine Jarrahdale with safe, reliable access to fresh drinking water close to their roosts.



Cockitrough' bird waterers installed in Jirdarup Bushland, Victoria Park, being used by a flock of forest red-tailed cockatoos. Note the importance of installing waterers near trees, which offer shade and perches for flock members as they wait their turn.

PHOTO Georgina Wilson

What to install

- » Artificial waterers for black cockatoos have specific design requirements for effectiveness and safety. A leading design is the Cockitrough, designed and supplied by the Town of Victoria Park.
- » The Cockitrough features several shallow-water drinking platforms to allow several birds to drink at once, which aligns with natural black cockatoo behaviour. Troughs are self-flushing and situated high off the ground to protect birds from cats and dogs. In 2023, the Shire of Serpentine Jarrahdale collaborated with the Keep Carnaby's Flying – Ngoolarks Forever project, to purchase a Cockitrough and install it near a known roost.
- » Information on the Cockitrough is available from the Town of Victoria Park: www.victoriapark.wa.gov.au/Around-town/Environment/Bird-waterers

Where to install:

- » Prioritise provision of water at key (large) roosts that do not have appropriate sources of fresh drinking water sources nearby (lakes and ponds should not be considered appropriate sources, given the potential for poor water quality, and given black cockatoos' preference to drink from shallow water). Roost location and flock size data are available from DBCA and Birdlife Australia; Birdlife is also available to discuss location options and provide advice (Carnabys@birdlife.org.au).
- » Install the water drinking station at the roost site or, if this is not possible, at the closest suitable location, preferably within 1km.
- » To avoid health risks for the birds, water provided at drinking stations should be potable water. Cockitroughs can be easily installed at sites with scheme water, or as an off-grid system using an intermediate bulk container (IBC) which can be filled periodically.
- » Install in a quiet location away from traffic, carparks and too much human or dog activity.

- » Install close to shaded trees or other shaded perch options, to protect birds from heat stress on very hot days while they take turns drinking, and to protect the 'sentinel birds' which act as lookouts for the flock.
- » Cockitrough suppliers will have additional information about location requirements. Birdlife Australia is an appropriate expert organisation to contact to discuss location options (Carnabys@birdlife.org.au).
- » Aim to establish a network of drinking stations across the Shire, so that all roosts have a source of safe fresh drinking water.
- » Engage the community and seek support from local businesses and community organisations to raise funds for Cockitroughs for the Shire to install.

Manage water quality in ponds and lakes

- » Monitor and manage water quality in ponds, lakes and wetlands, including risks of chemical contaminants and disease outbreaks from bacteria and algal blooms.
- » Manage botulism outbreaks.
- » Maintain records of water quality in individual ponds, lakes and wetlands to help with water resource management.
- » Where a pond, lake or wetland has repeated water quality issues and is within 1km of a black cockatoo roost, prioritise installation of a Cockitrough at that roost to provide a safer option.

Note: as noted earlier (see 'Where to install' drinking stations), the presence of ponds and lakes does not mean these are appropriate sources of drinking water for black cockatoos. There may be accessibility issues, and water quality may be poor. It is preferable to provide a network of water drinking stations.

As part of this Conservation Action Plan, roost data and locations of green space in the Shire of Serpentine Jarrahdale were analysed to identify priority locations for installation of Cockitrough water drinking stations (Figure 12). These locations take into account where an important roost already has a bird waterer installed.

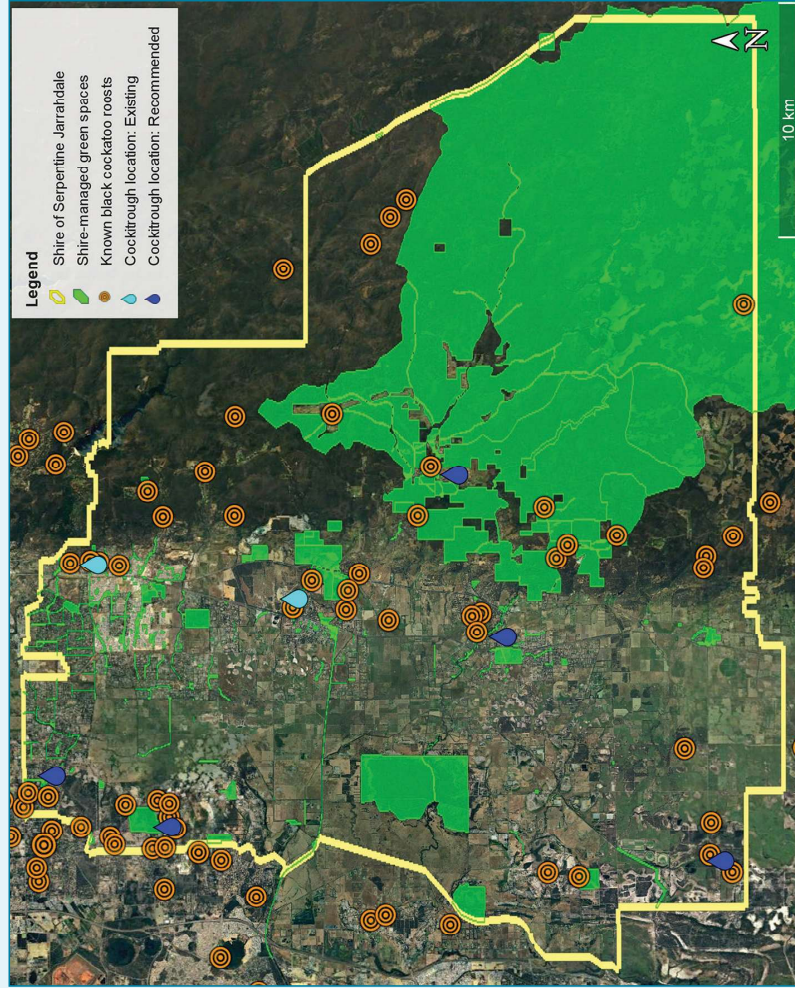


Figure 12. Recommended locations to install Cockitrough water stations

Priority locations identified based on proximity to key night roosts (or occasionally key food resources) and overall site suitability, to create a network of safe watering points across the Shire. Where possible, locations are at the key roost or within 1km. Where Shire-managed green space was not available, a Bush Forever site was selected. From north to south, sites are: Oakford Community Centre, Oakford; Modong Nature Reserve, Oakford; King Jarrah Circle, Jarrahdale; Clem Kentish Reserve, Serpentine; and the Yandegi Road/Elliott Road Bush Forever site.

Note: While these locations are considered ideal due to roost proximity and overall site suitability, if installation is not feasible logistically at a site, an alternative location should be sought, close to the recommended location.

Source: Birdlife Australia and Murdoch University. Shire-managed green space data were obtained using spatial layers provided by the Shire ('SJS_ReserveRegister_May2023.shp'; obtained 02/05/2023 and 'SJ_Managed_Lands_V2.shp'; obtained 27/07/23). Figure produced using Google Earth Pro (<https://earth.google.com>).

Reduce access to drinking water on and beside roads

- » Maintain roads and verges to prevent potholes and improve water drainage away from roadsides. Maintain water infrastructure near roads to avoid water leaks. Redirect sprinklers away from roads. For further details, see actions listed under **Vehicle strike**.

Together these Actions to address the threat to black cockatoos from lack of fresh drinking water will be relevant to feed into a number of the Shire's strategies, policies and plans, such as those related to urban biodiversity, climate adaptation, and roads.

Key points

- » Black cockatoos need water daily, close to their roosts.
- » They will drink from potholes and roadsides after rain. Repair potholes and road drainage to prevent vehicle strike.
- » Poor water quality has resulted in illness and death of black cockatoos in the Perth-Peel region.
- » Cockitroughs or similar designs provide safe potable water (see previous page).

Threat 3. Vehicle strike

After loss of habitat, vehicle strike is one of the most significant threats to black cockatoos throughout their distribution range, particularly in high-traffic areas and on roads where vehicles are travelling at speed⁶⁶. Vehicle strike causes traumatic injuries ranging from minor wounds and bruises to catastrophic bone fractures.

Common vehicle strike injuries include keel fractures, wing fractures, concussions, and trauma causing internal bleeding. Many vehicle strike cases can be treated successfully, but a large proportion of cases (around 40%) have injuries too severe for treatment and are euthanased. Black cockatoos are at risk of vehicle strike when:

- » feeding on low to medium-height vegetation on roadsides and median strips, as the birds will be at vehicle height when flying in and out of these food resources.
- » feeding on grain spill (on roads used by grain haul vehicles).
- » drinking from potholes in roads or puddles that have formed in roadside depressions.

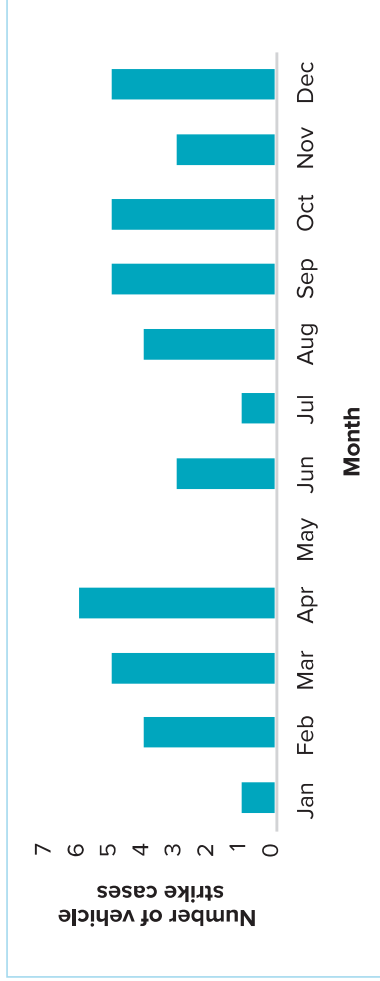


Figure 13. Shire of Serpentine Jarrahdale black cockatoo admissions to Perth Zoo Veterinary Department 2018–22: Vehicle strikes

Vehicle strikes in the Shire of Serpentine Jarrahdale

To support this Black Cockatoo Conservation Action Plan, Murdoch University undertook an epidemiological analysis to identify the causes of admission to the Perth Zoo Veterinary Department (PZVD) for black cockatoos from the Shire between 2018–22. Vehicle strike was the main identified cause; accounting for 62% of cases admitted (**Figure 13**. See also **Appendix 2**).

Between 2018–22, 42 black cockatoos from the Shire of Serpentine Jarrahdale were admitted to PZVD with evident road strike injuries: 32 forest red-tailed cockatoos, seven Baudin’s cockatoos and three Carnaby’s cockatoos. Several other cases were admitted with ‘unknown cause’; many of these are also likely to be vehicle strike cases that were momentarily stunned or had minor concussions (**Appendix 2**). These cases represent a minimum, as many birds with vehicle strike injuries may not be found or reported.



⁶⁶ Le Souëf, A., Holyoake, C., Vitali, S., & Warren, K. (2015). Presentation and prognostic indicators for free-living black cockatoos (Calyptorhynchus spp.) admitted to an Australian zoo veterinary hospital over 10 years. *Journal of Wildlife Diseases*, 51(2), 380–388.

Actions »

- 1. Apply set-backs from roads:** To ensure black cockatoos have enough food in urban areas, it is important to plant food trees, rather than non-food trees, whenever possible. Road verges often present an excellent opportunity. When planting food trees near roads, apply set-backs to avoid vehicle strike:
 - in quiet suburban streets (speed limit <50km/hr), plant food trees at least 3–5m back from road edges. Plant food trees on a single side to reduce the risk of birds flying across the road between trees⁶⁷.
 - for busy roads (speed limit higher than 50km/hr), plant food trees at least 10m from road edges.
 - maintain existing large food trees (jarrah and marri) on verges by pruning low branches.
 - never plant black cockatoo food plants on median strips; this is a death trap for the birds.

Figure 14 shows the reported locations of vehicle strike cases in the Shire of Serpentine Jarrahdale, for black cockatoos admitted to PZVD 2018–22. This map has been produced to support the Shire's record-keeping and monitoring of this threat over time, and to enable investigation of any issues near that location that could predispose black cockatoos to vehicle strike (e.g. potholes, road drainage issues, or food resources next to the road).

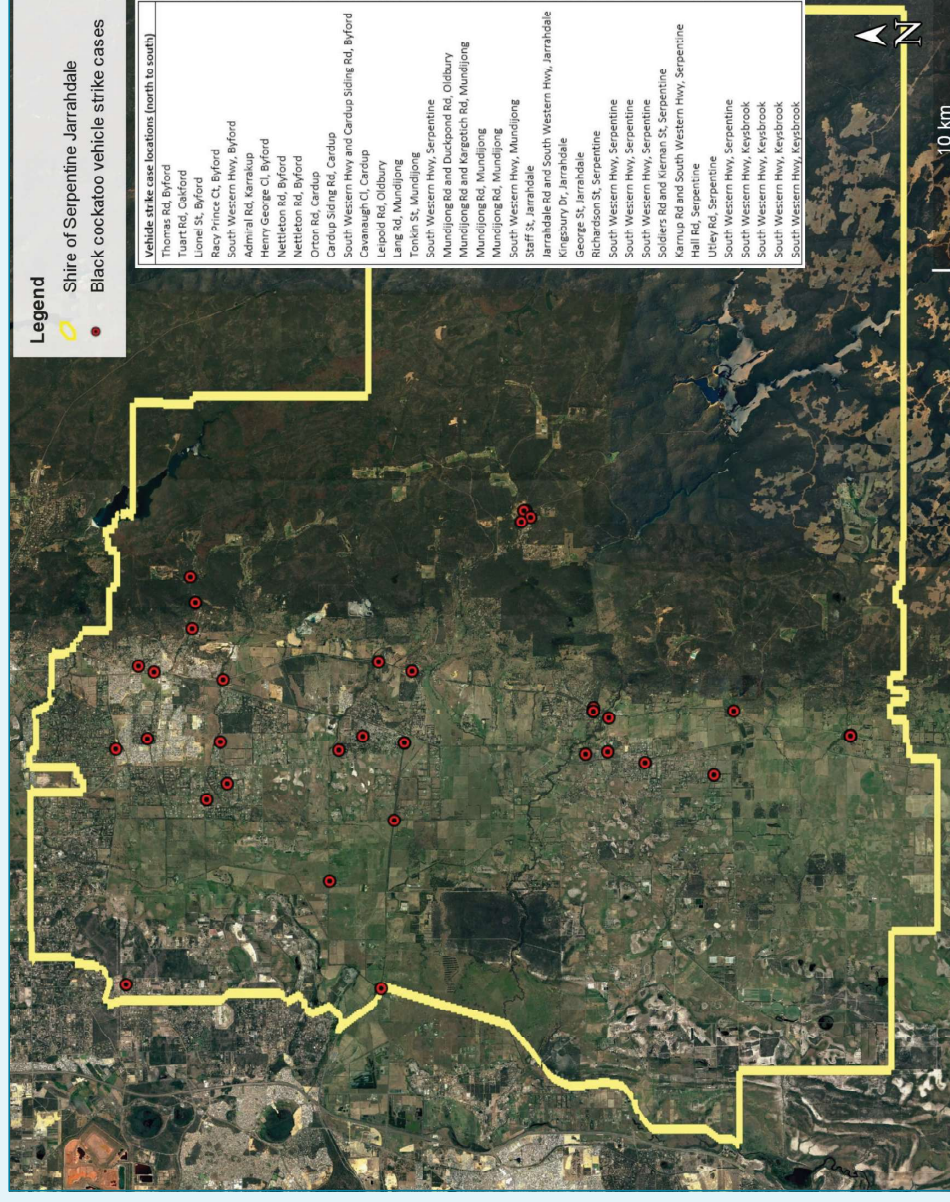


Figure 14. Reported locations of vehicle strike cases in the Shire of Serpentine Jarrahdale, for black cockatoos admitted to Perth Zoo Veterinary Department 2018–22

⁶⁷ Peck A. & Stokes V. (2019). *Black-cockatoo conservation and recovery: Guidelines for councils and land managers*. BirdLife Australia, November 2019.

BLACK COCKATOO CONSERVATION

2. **Plant** and maintain areas of high-quality food resources in areas away from roads, to attract flocks to those areas.
3. **Maintain** road surfaces and verges to avoid pooling water which attracts black cockatoos:
 - monitor and fill potholes and depressions.
 - ensure road water runoff drains well away from verges.
4. **Maintain** council-managed water infrastructure near roads (taps, pipes, hoses) to prevent water leaks.
5. **Direct** verge sprinklers away from roads.
6. **Maintain** records and build a dataset of vehicle strike locations. If hotspots for vehicle strike are identified, particularly repeated strikes at the same location, investigate and undertake mitigation actions if required, and consider installation of road signage.
7. **Report** injured black cockatoos to the volunteer-run Black Cockatoo Rescue Service at [Kaarakin Black Cockatoo Conservation Centre](#): (08) 9390 2288 during work hours or 0448 046 202 after hours, or Parks and Wildlife (DBCA) Wildlife Helpline: (08) 9474 9055.
8. **Support** black cockatoos with community engagement in the Shire of Serpentine Jarrahdale, highlighting 'What to do if you find an injured black cockatoo' on the Shire's website, including providing links to the Black Cockatoo Rescue Service at [Kaarakin Black Cockatoo Conservation Centre](#) and the [Found an injured bird?](#) page on the *Keep Carnaby's Flying* – Ngoolarks Forever website.



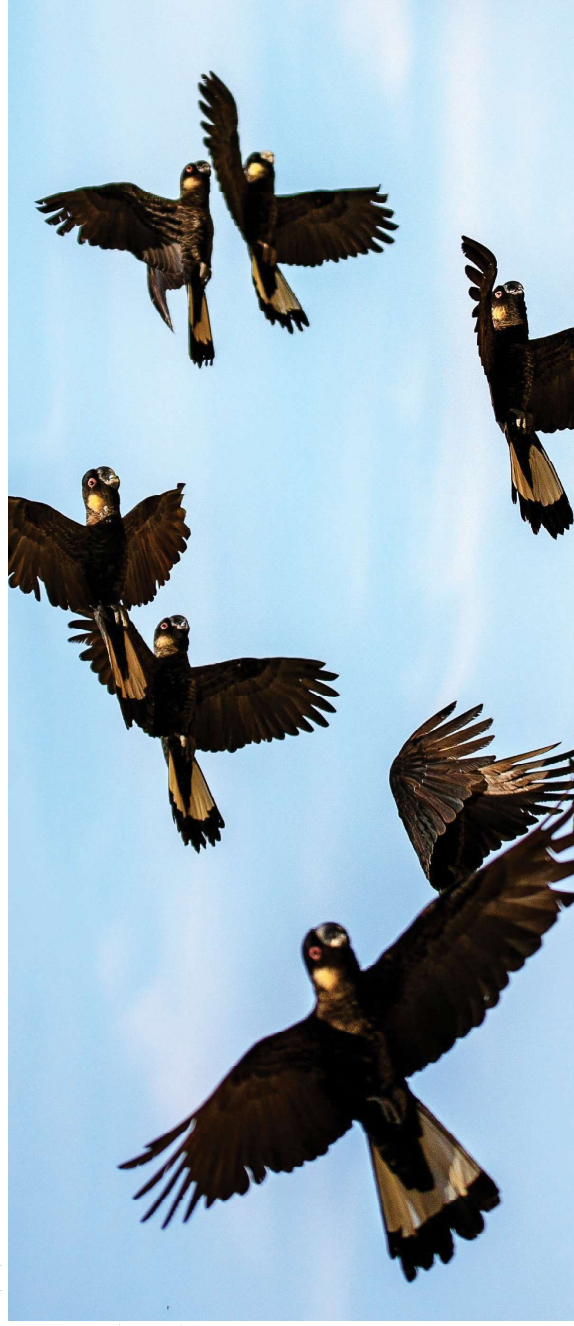
Key points

- » Fix potholes and roadside drainage to deter birds from drinking on and near roads.
- » Apply setbacks from roads when planting food trees.

ACTIONS

Actions »

1. **Mitigation** measures for CHIIPS are difficult to identify at present and require further research into the source(s) of the toxin. However, awareness of the condition is important, as although the affected birds will die if left in the wild, many can be successfully rehabilitated if taken into care. Sick or injured black cockatoos should be reported to the volunteer-run Black Cockatoo Rescue Service at [Kaarakin Black Cockatoo Conservation Centre](#): (08) 9390 2288 during work hours or **0448 046 202** after hours, or Parks and Wildlife (DBCA) Wildcare Helpline: **(08) 9474 9055**.
2. **Support** black cockatoos with community engagement, highlighting 'What to do if you find an injured black cockatoo' on the Shire's website (See [Vehicle strike](#) section of this Plan for details).



CHIIPS-affected Carnaby's cockatoos can often be rehabilitated and returned to the wild if they receive veterinary care.

PHOTO Rick Dawson

Threat 4. Carnaby's Hindlimb Paralysis Syndrome

Carnaby's Hindlimb Paralysis Syndrome (CHIIPS) has been recognised in Carnaby's cockatoos since 2012⁶⁸. To date Carnaby's cockatoos are the only species known to be affected.

Carnaby's cockatoos with this syndrome are admitted to Perth Zoo Veterinary Department (PZVD) in the summer and autumn months with a weakness or paralysis in their hindlimbs, thought to be a delayed-onset neurological disease caused by pesticide exposure. Some black cockatoos with CHIIPS are too sick to be treated and require euthanasia, but most can be treated with supportive care and released back to the wild. CHIIPS-affected Carnaby's

cockatoos tend to present to PZVD having been found in urban areas where there are key roost sites that support relatively large numbers of birds, and from areas where there are more people to notice the affected birds.

Research into this syndrome is ongoing, however it is thought the birds may be exposed to pesticides in agricultural areas outside Perth during the breeding season and, given the suspected delayed onset of this condition, are noticed in a debilitated condition when they return to their urban roosts and foraging areas at the start of the non-breeding season.

For the period of investigation there were no CHIIPS cases admitted to PZVD from within the Shire (Appendix 2). However, it is important to note that CHIIPS cases may go unnoticed and unreported; particularly in peri-urban and rural areas with fewer people to notice and report debilitated birds.

⁶⁸ Le Souëf, A., Vitelli, S., Dawson, R., Vaughan-Higgins, R., & Warren, K. (2020). Hindlimb paralysis syndrome in wild Carnaby's cockatoos (*Calyptorhynchus latirostris*): A new threat for an endangered species. *Journal of Wildlife Diseases*, 56(3), 609–619.

Threat 5. Raven attack

Raven attack is a threat to black cockatoos which has emerged in the last decade and mainly affects forest red-tailed cockatoos. The increase in raven attacks on this species in urban areas coincides with a trend in movements of forest red-tailed cockatoo flocks into urban areas, starting in the mid-2000s, to forage on introduced Cape Lilac; in line with the declines in their main food sources (marri and jarrah) due to habitat clearing, fire and detrimental climate changes⁶⁹. There has also been an increase in ravens, a successful urban wildlife species, in Perth over the past 30 years.

Injuries caused by ravens tend to be around the tail end of the cockatoo, with a classic presentation being loss of tail feathers. There are sometimes wounds to the skin as well, and in some cases these wounds are too severe for treatment and require euthanasia. However, most raven-attacked black cockatoos can be treated and returned to the wild. 'Secondary' raven attacks sometimes occur when black cockatoos of any species are debilitated for another reason, such as vehicle strike or Carnaby's hindlimb paralysis syndrome. Secondary attacks further reduce these black cockatoos' chances of survival. Ravens are more numerous in areas populated by more people, because they benefit from the changes associated with urbanisation.

In the epidemiological analysis undertaken for this Conservation Action Plan to examine causes of admission to Perth Zoo Veterinary Department for black cockatoos from the Shire of Serpentine Jarrahdale (2018–22), raven attack was one of the reasons for admission; with nine confirmed primary cases (one Carnaby's cockatoo and eight forest red-tailed black cockatoos) plus secondary raven attack

on two displaced juveniles (**Appendix 2**). Most cases were admitted between July–October, coinciding with raven breeding season. Recorded locations of raven attack were concentrated in more heavily populated areas of the Shire between Byford and Mundijong (**Figure 15**).

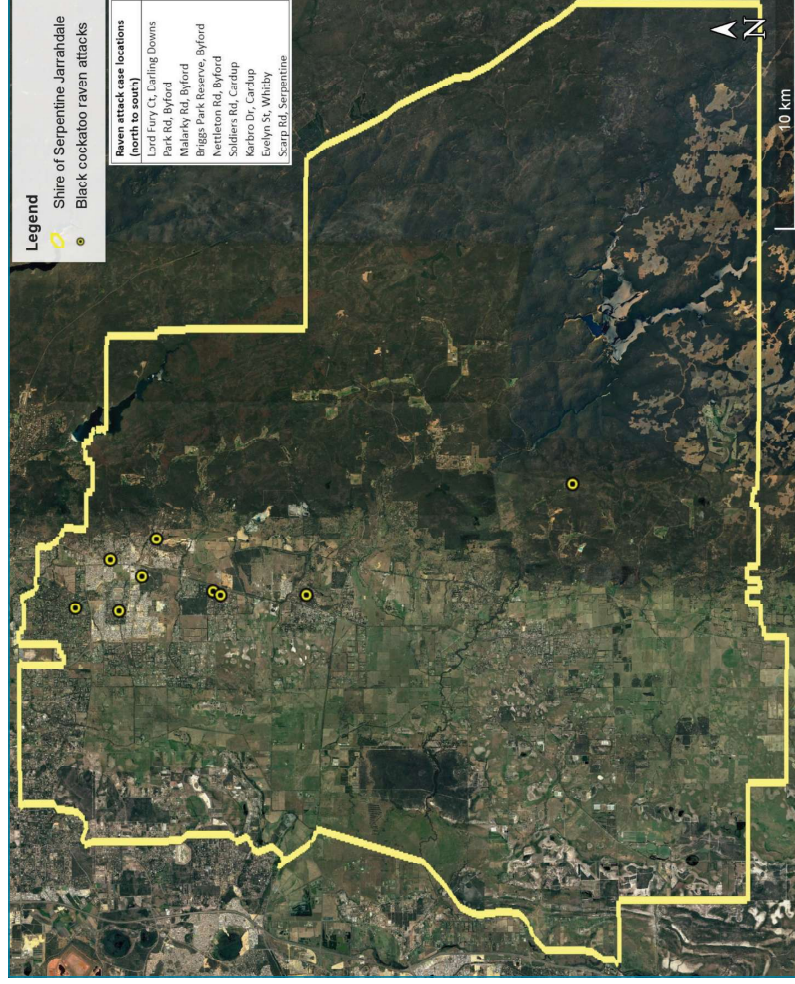


Figure 15. Locations in the Shire of Serpentine Jarrahdale where black cockatoos suffering from raven attack were found, as recorded during admission to Perth Zoo Veterinary Department for treatment, 2018–22

Source: Figure produced using Google Earth Pro (<https://earth.google.com>).

⁶⁹ Johnstone, R.E., Kirkby, T., & Sarti, K. (2017). The distribution, status, movements and diet of the forest red-tailed black cockatoo in the south-west with emphasis on the Greater Perth Region, Western Australia. *Western Australian Naturalist*, 30, 193–219.

Actions »

- 1. Manage** food waste to avoid attracting ravens.
 - Self-closing bin lids
 - Community awareness-raising regarding food waste management and the importance of not feeding ravens and other wildlife, including fact sheets; monitoring and compliance as required
 - If hotspots for raven attack are identified, investigate and reduce access to artificial food sources

Several Perth-Peel local governments have produced information sheets about 'Living with ravens', which advise that food waste management is the most effective deterrent. Although raven culls have occurred (with relevant lawful authority) in the past in Perth-Peel to control raven numbers in problem areas, it is not clear if this is an effective measure to safeguard black cockatoos, and appropriate food waste management is the recommended deterrent.

- 2. Report** sick or injured black cockatoos to **Kaarakin Black Cockatoo Conservation Centre: (08) 9390 2288** during work hours or **0448 046 202** after hours, or DBCA's Wildlife Helpline: **(08) 9474 9055**.
- 3. Support** black cockatoos with community engagement, highlighting 'What to do if you find an injured black cockatoo' on the Shire's website (see details in the **Vehicle strike** section of this Plan), and advising the public to report cases of black cockatoos that are being attacked by ravens on the ground and appear to be struggling.

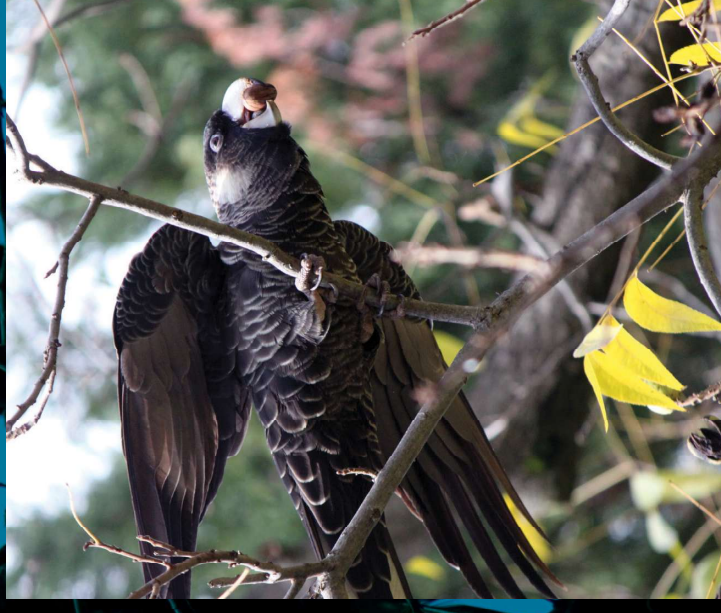
Threat 6. Shooting

Black cockatoos are sometimes illegally shot, particularly when entering fruit or nut orchards in regional areas. Black cockatoos that are found with shooting injuries have not necessarily been shot locally, but may have travelled from other areas after being injured. As of 2023, fines for shooting black cockatoos are up to \$400,000 for individuals⁷⁰. Shooting injuries can include soft tissue trauma, as well as bone fractures and internal bleeding.

In the epidemiological analysis undertaken for this Conservation Action Plan by Murdoch University to examine the causes of admission to the Perth Zoo Veterinary Department for black cockatoos from the Shire 2018–22, three shooting cases were admitted (**Appendix 2**). Some cases will go unreported.

Actions »

- 1. Share** information with the community about the large penalties for shooting. Provide information about where the public can go for advice (e.g. DBCA; Birdlife Australia), and what to do if they find an injured bird (see previous sections for helpline numbers).
- 1. Protect** black cockatoos that may be drawn to food resources in orchards; critically endangered Baudin's cockatoos are most at risk. The Shire can protect these birds by engaging with orchardists to encourage netting of orchards, and sharing DBCA advice about deterrence (e.g. DBCA's 'Best practice guidelines for bird scaring in orchards').⁷¹



⁷⁰ As per section 150(1) of the BC Act in relation to taking of threatened fauna [as of 2023].

⁷¹ Guideline available at: www.dbca.wa.gov.au/management/threatened-species-and-communities/resources/threatened-and-priority-fauna-resources

Threat 7. Climate change and Urban Heat Island effects

Perth-Peel is experiencing higher temperatures, declining rainfall and other climate changes driven by use of fossil fuels and greenhouse gas emissions.

Climate threats are increasing in the absence of effective mitigation nationally and globally. Effective mitigation by government will require direct action at the local level, as well as community engagement, planning, advocacy and longer-term action by all levels of government.

The WALGA Advocacy Position Manual (2023) states the following:

Local Government acknowledges:

1. The science is clear: climate change is occurring and greenhouse gas emissions from human activities are the dominant cause.
2. Climate change threatens human societies and the Earth's ecosystems.
3. Urgent action is required to reduce emissions, and to adapt to the impacts from climate change that are now unavoidable.

WA Local Government is committed to addressing climate change [and calls for] strong climate change action, leadership and coordination at all levels of government.

Climate threats to black cockatoos in the Perth-Peel region include increasing risk of heat stress-related deaths (see **Lack of fresh drinking water** section) and loss of food resources from drought and higher-intensity fires (see **Habitat loss from fire** section).

Hotter temperatures and lower rainfall lead to poorer tree health and lower seed productivity for key black cockatoo food species, reducing food availability.⁷²

Additional climate-related risks include longer enforced non-feeding periods during the warmest parts of the day (once temperatures reach around 30 degrees), during which time black cockatoos need to stop foraging and shelter-in-place in shady vegetation to avoid heat stress.⁷³ This shorter feeding time reduces their capacity to build energy reserves in the lead-up to the breeding season, or to feed nestlings during the breeding season.

Plants that provide urban cooling and black cockatoo food together – an opportunity for local government:

» A missed opportunity for local governments arises from the erroneous belief that native plants such as banksia and hakea (critical Carnaby's cockatoo food) are not appropriate to plant to mitigate Urban Heat Island effects. Several local governments are currently planting species of trees for urban cooling that are useless for black cockatoos and other threatened wildlife.

» It is useful to recognise that the types of native vegetation which are important for black cockatoo survival, including banksia and hakea, can contribute to urban cooling and Urban Heat Island mitigation due to the plant's evapotranspiration, whereby water is transpired through the plant to the leaf surface and absorbs heat energy from the air as it evaporates,

thereby cooling the air. (Taller food trees, i.e. marri, jarrah and non-local macadamia and pine, also provide shading; but all black cockatoo food plants, including banksia and hakea, assist urban cooling via evapotranspiration).

» Lack of awareness of the role of evapotranspiration in urban cooling can lead local governments to believe that they need to plant tall shady trees to mitigate Urban Heat Island effects, when they could instead plant black cockatoo food plants which cool the air through evapotranspiration. This would have the major advantage of assisting urban cooling while simultaneously helping to safeguard black cockatoos.

» **Planting trees for urban cooling that specifically include black cockatoo food trees and shrubs will enable local government to achieve outcomes for urban cooling, urban forests, biodiversity and black cockatoo conservation in a single action.**

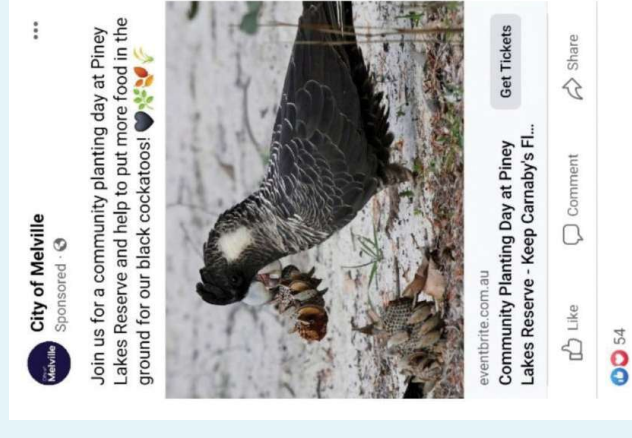
⁷² Government of Western Australia (2019) EPA Advice: Carnaby's Cockatoo in Environmental Impact Assessment in the Perth and Peel Region; Saunders et al. (2021) Carnaby's Black-Cockatoo *Zanda latirostris*. In *The Action Plan for Australian Birds 2020*.

⁷³ Saunders D.A. (1977) The effect of agricultural clearing on the breeding success of the White-tailed Black Cockatoo. These findings are supported by new Murdoch University flock tracking research: Riley et al. (2023). Accelerometry reveals limits to use of an energy-saving anthropogenic food source by a threatened species; a case of Carnaby's cockatoos (*Zanda latirostris*) and canola. *Ecology and Evolution*, 2023;13:e10598.

Actions »

- 1. Undertake** actions to reduce the Shire's greenhouse gas emissions to net zero and encourage other local governments to do the same, to help avoid the worst impacts of hotter temperatures on the region's people and black cockatoos.
- 2. Educate** and support the Shire's residents to reduce their carbon footprint, including promoting and supporting clean energy modes of travel and energy-saving/ clean energy options and supporting community tree-planting initiatives.
- 3. Prioritise** planting of black cockatoo food species wherever possible, when planting for urban cooling. Recognise that planting native trees and shrubs will mitigate Urban Heat Island effects and promote urban cooling even without shading effects; the urban cooling will occur due to the native vegetation's evapotranspiration capacity. This includes evapotranspiration from black cockatoo food trees and shrubs such as banksia and hakea (even small patches), as well as larger trees (marri, jarrah).
 - Adopting a strategy of “net gain” of black cockatoo food resources will meet urban forest / canopy goals and reduce Urban Heat Island effects while simultaneously supporting black cockatoos and local biodiversity.
- 4. Encourage** the Shire's residents to plant gardens (preferably with black cockatoo food species). Educate the community that trees, bushes, shrubs and even vegetable garden beds in private gardens have much higher evapotranspiration and urban cooling capacity than lawns.⁷⁴ Compared with lawns, native gardens that include black cockatoo food plants (see **Table 1**) also provide food for wildlife and help to conserve Perth's increasingly limited water.

- 5. Engage** with and support local NRM groups, 'Friends of bushland' groups and Winjan Aboriginal Corporation, to optimise the capacity of these groups to help the Shire by planting native vegetation that can provide both black cockatoo food and urban cooling effects.
- 6. Look** for opportunities to simultaneously take action for urban cooling and for the Shire's black cockatoos. For example, the WALGA provides information and resources about climate change for local governments. When accessing and using this information, look for possibilities to simultaneously take action for black cockatoos, such as by leveraging the urban cooling capacity of black cockatoo food trees.
- 7. Advocate** to the WALGA for their Urban Forest recommendations to explicitly support the planting of black cockatoo food trees, including banksia, hakea, marri and jarrah, in recognition of the capacity of this native vegetation to mitigate Urban Heat Island effects through evapotranspiration (as well as shading, for marri and jarrah). Promotion of Urban Forest actions that address both urban cooling and black cockatoo conservation (local biodiversity) will be critical for the WALGA to undertake in urban areas, where limited space exists for tree planting, and where addressing several outcomes simultaneously will support local governments to meet key climate and biodiversity goals.
- 8. Update** the Shire's strategies, policies, plans and guidelines, where required, to support the above actions for climate change mitigation, urban cooling and concurrent black cockatoo conservation.



Planting for black cockatoos will help mitigate climate change (example from City of Melville).

Key points

- » Net zero greenhouse gas emissions is critical to avoid the worst impacts of urban heating.
- » Planting black cockatoo food trees will contribute to urban cooling through the trees' evapotranspiration, while helping address food scarcity for black cockatoos.

⁷⁴ Small, G., Jimenez, I., Salzi, M., & Shrestha, P. (2020). Urban heat island mitigation due to enhanced evapotranspiration in an urban garden in Saint Paul, Minnesota, USA. *WIT Trans. Ecol. Environ.*, 243, 39–45.

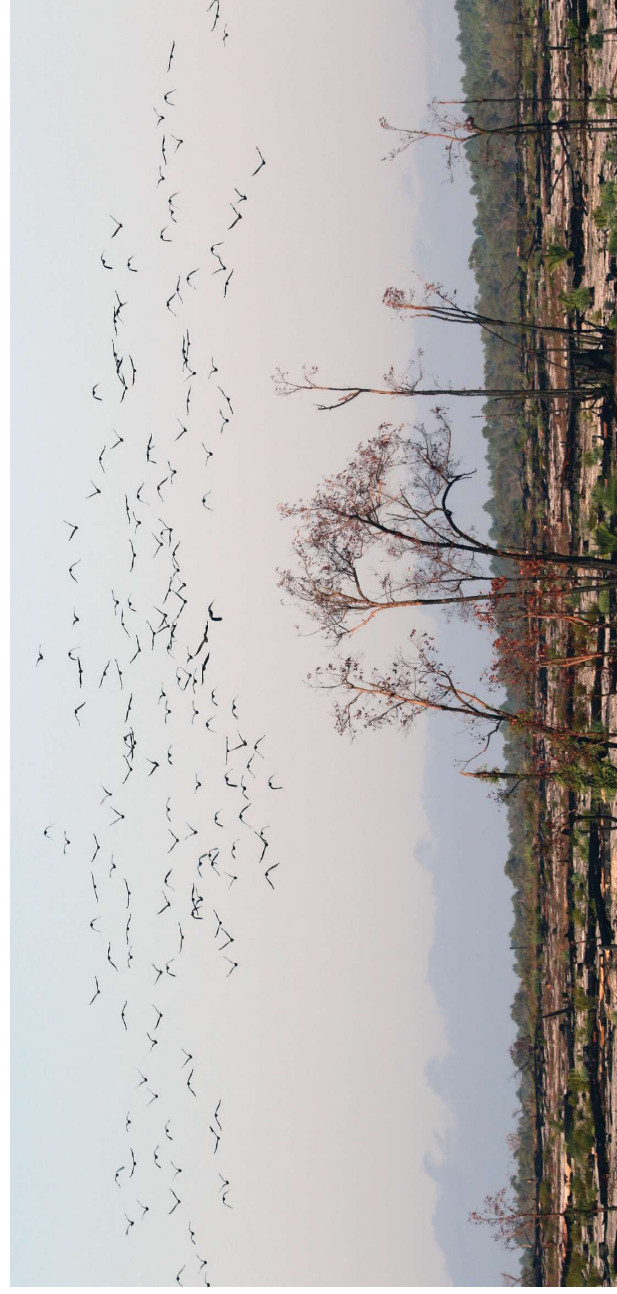
Threat 8. Cumulative impacts

In the past, and in some cases still today, local government planners and decision-makers have neglected to consider cumulative impacts, when considering the impacts of decisions and actions on threatened black cockatoos.

It is this failure of planners and decision-makers to recognise the cumulative harm from many individual actions that has allowed the ongoing 'net habitat loss' in local government areas, thereby forcing black cockatoo populations to continue to decline.

There is currently a large number of development actions and associated clearing of remnant black cockatoo habitat across the Perth-Peel region. Many clearing actions involve clearing of small patches of important habitat or individual important trees that do not individually meet the threshold for requiring referral or controlled action (under the federal EPBC Act), but which together involve the loss of extensive areas of foraging, breeding and/or corridor habitat used by black cockatoo populations.

The risks and impacts posed to the viability of black cockatoos from cumulative habitat losses are, at present, greatly under-appreciated. The likely impacts become even greater when the impacts from other individual sources of harm, including vehicle strikes, disease and destructive climate changes, are added to the cumulative impact total.



A Carnaby's cockatoo flock flies over a cleared area that used to contain food resources and roosts.

Actions »

- 1. Ensure** all planning and decision-making related to black cockatoo habitat and conservation involve explicit consideration of the risks from cumulative impacts, including future risks, and management of these risks.
- 2. Ensure** the Shire's planning and regulatory decisions and actions avoid net loss (and ideally, achieve net gain) of food resources for the Shire's black cockatoos. Success regarding net gain of foraging habitat could be reported annually on the Shire's website.
- 3. Advocate** to state government, directly or through the WALGA, for additional local government powers to protect significant trees on private property, to help local government to manage the cumulative impacts of habitat loss on black cockatoos and other threatened wildlife. Similarly, advocate for additional resources to support evaluation and management of cumulative impacts on local biodiversity, including the Shire's black cockatoo flocks.
- 4. Update** the Shire's strategies and plans to promote planting of black cockatoo food trees where possible, and to support 'net gain' of food resources.

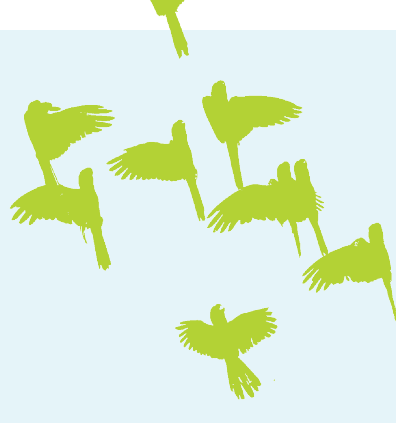
Key points

- » Impacts to black cockatoos may seem insignificant when considered separately, when cumulatively they represent 'death by a thousand cuts'.
- » Proper consideration of cumulative impacts from all sources is essential to safeguard the Shire's black cockatoos for current and future generations.

Summary of Actions to safeguard the Shire's black cockatoos

This table summarises the key threats to black cockatoos in the Shire of Serpentine Jarrahdale, and actions for the Shire to undertake to retain its flocks of Carnaby's cockatoos, forest red-tailed cockatoos and Baudin's cockatoos. All actions are suitable to develop into SMART-style goals. For details about each action, refer to the relevant section of the Plan, including maps to support the implementation of specific actions.

Threat	Actions	Page
1 Loss of habitat	Lack of food resources <i>For details of this threat, see page 12</i>	
	Retain and improve existing food resources	page 16
	Create additional food resources	page 18
	Update the Shire's strategies, policies and plans to prioritise retention and creation of food resources for black cockatoos	page 28
	Lack of roosts <i>For details of this threat, see page 29</i>	
	Retain existing night roosts	page 31
	Create new roost habitat	page 31
	Engage the community	page 31
	Lack of vegetation corridors <i>For details of this threat, see page 32</i>	
	Retain existing vegetation corridors	page 34
	Create new corridor habitat	page 34
	Ensure safe set-back planting distances from roads when planting black cockatoo food trees	page 34
	Engage the community	page 34
	Lack of breeding habitat <i>For details of this threat, see page 35</i>	
	Support breeding success	page 36
	Support young black cockatoos	page 36
	Manage nest hollow competitors (feral European honeybees; smaller parrots)	page 37
	Monitor and manage native vegetation health	page 38
	Ensure effective hygiene practices to prevent dieback	page 38
	Update the Shire's strategies, policies and plans as required	page 38
	Manage direct risks	page 38
	Habitat loss from fire <i>For details of this threat, see page 38</i>	
	Manage indirect risks from climate changes/urban heating	page 38



Summary of Actions to safeguard the Shire's black cockatoos *cont.*

Threat		Actions	Page
2	Lack of fresh drinking water	For details of this threat, see page 39	
		Establish a network of water drinking stations	page 40
		Manage water quality in ponds and lakes	page 40
		Reduce access to drinking water on/beside roads	page 41
3	Vehicle strike	For details of this threat, see page 42	
		Apply planting set-backs from roads when planting food trees. For safe set-back distances depending on road speed limits	page 43
		Maintain road surfaces and verges to avoid pooling water (water drinking hazard)	page 44
		Maintain water infrastructure near roads (water drinking hazard)	page 44
4	Carnaby's Hindlimb Paralysis Syndrome	Maintain records of vehicle strike hotspots	page 44
		Promote awareness of this disease and what the public can do if they find a debilitated black cockatoo	page 45
5	Raven attack	Manage food waste to avoid attracting ravens	page 47
		Report sick or injured black cockatoos to helplines	page 47
6	Shooting	For details of this threat, see page 47	
		Raise awareness about this issue in the community, including the severity of fines, and how to report injured birds to helplines	page 47
7	Climate change and Urban Heat Island effects	For details of this threat, see page 48	
		Reduce the Shire's greenhouse gas emissions	page 49
		Support the Shire's residents to reduce their emissions	page 49
		Prioritise planting of black cockatoo food trees for their evapotranspiration (urban cooling) capacity	page 49
8	Cumulative impacts	Support Shire of Serpentine Jarrahdale residents and community groups to plant black cockatoo food trees for urban cooling	page 49
		Update the Shire's strategies, policies and plans as required	page 49
		Recognise and account for cumulative impacts in the Shire's planning and decision-making	page 50
		Avoid cumulative net loss of foraging habitat	page 50
		Advocate to state government for local government powers to protect significant trees on private property	page 50

Thank you to everyone at the Shire of Serpentine Jarrahdale for your efforts to support the survival of Western Australia's iconic black cockatoos in the urban landscape. Murdoch University's black cockatoo research team hopes that this Conservation Action Plan is of use to the Shire's planners, decision-makers, land managers and other relevant personnel, to help safeguard the Shire's threatened black cockatoos and their habitat.



Appendices

Appendix 1. Selected references and resources

Following is a list of the references cited in this Plan, and a selection of other references and resources to support the conservation of black cockatoos and their habitat. This list is not exhaustive. Birdlife Australia (Carnabys@birdlife.org.au) and DBCA are appropriate authorities to contact for specific information.

Note: hyperlinks are provided for some resources, and were functional at time of this Plan's publication.

Government black cockatoo and habitat guidelines, recovery plans and other resources

1. Department of Biodiversity, Conservation and Attractions, (n.d.). Fauna Notes: Artificial hollows for black cockatoos. file:///C:/Users/s930282j/Downloads/fauna_note_artificial_hollows_for_all_black_cockatoos-1.pdf

DBCA's guideline on use of artificial hollows, including siting, installation, and required monitoring and maintenance to ensure the artificial hollow does not become a death trap. The guideline includes important information about where not to install hollows in built-up metropolitan areas of Perth and Peel.

2. Department of Biodiversity, Conservation and Attractions, information on black cockatoos: www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals/black-cockatoos

3. Department of Biodiversity, Conservation and Attractions, (2023). Best practice guidelines for bird scaring in orchards. Accessed from: www.dbca.wa.gov.au/management/threatened-species-and-communities/resources/threatened-and-priority-fauna-resources

4. Department of Agriculture, Water and the Environment [now DCCCEW], (2022). *Referral guideline for 3 WA threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black-cockatoo.*

www.dcceew.gov.au/sites/default/files/documents/referral-guideline-3-wa-threatened-black-cockatoo-species-2022.pdf

See also the related DCCCEW factsheet: Black cockatoos and development in south-west Western Australia.

www.dcceew.gov.au/sites/default/files/documents/black-cockatoos-development-south-west-wa-factsheet.pdf

Note: The referral guideline will be updated periodically; ensure to use the latest available version.

5. Department of Climate Change, Energy, the Environment and Water (n.d.) draft Guide to nationally protected species significantly impacted by paddock tree removal.
6. Department of Climate Change, Energy, the Environment and Water information on black cockatoos: Relevant background information on the biology and ecology of the black cockatoos is provided in the department's Species Profile and Threats (SPRAT) database.

7. Environment Protection Authority of Western Australia, (2019). *EPA Technical Advice: Carnaby's Cockatoo in Environmental Impact Assessment in the Perth and Peel Region.*

8. Western Australian Department of Parks and Wildlife, (2013). *Carnaby's cockatoo Recovery Plan:* www.dcceew.gov.au/sites/default/files/documents/carnabys-cockatoo-recovery-plan.pdf

Note: This 10-year plan is outdated and is being revised at time of writing, with a new Recovery Plan expected soon.

9. Western Australian Department of Parks and Wildlife, (2008). *Forest black cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and forest red-tailed black cockatoo Calyptorhynchus banksii naso) Recovery Plan* www.environment.gov.au/system/files/resources/48e4fc8c-9cb7-4c85-bc9f-6b847cf4c017/files/wa-forest-black-cockatoos-recovery-plan.pdf

Note: This plan is outdated and is being revised at time of writing, with a new Recovery Plan expected soon.

Murdoch University and other scientific research articles

1. Glossop, B., Clarke, K., Mitchell, D., Barrett, G., & Region, S. (2011). Methods for mapping of Carnaby's cockatoo habitat. Department of Environment and Conservation. Perth, Australia.
2. Groom, C., (2015). *Roost site fidelity and resource use by Carnaby's cockatoo, Calyptorhynchus latirostris, on the Swan Coastal Plain*, Western Australia. PhD thesis, University of Western Australia, Perth.
3. Johnstone, R. E., & Kirkby, T. (1999). Food of the forest red-tailed Black Cockatoo *Calyptorhynchus banksii naso* in south-west Western Australia. *Western Australian Naturalist*, 22, 167–178.
4. Johnstone, R. E., Kirkby, T., & Sarti, K. (2017). The distribution, status, movements and diet of the forest red-tailed black cockatoo in the south-west with emphasis on the Greater Perth Region, Western Australia. *Western Australian Naturalist*, 30, 193–219.
5. Le Roux, C. (2017). *Nocturnal roost tree, roost site and landscape characteristics of Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) on the Swan Coastal Plain*. Masters thesis, Edith Cowan University.



6. Le Souëf, A., Holyoake, C., Vitali, S., & Warren, K. (2015). Presentation and prognostic indicators for free-living black cockatoos (*Calyptorhynchus spp.*) admitted to an Australian zoo veterinary hospital over 10 years. *Journal of Wildlife Diseases*, 51(2), 380–388.
7. Le Souëf, A., Vitali, S., Dawson, R., Vaughan-Higgins, R., & Warren, K. (2020). Hindlimb paralysis syndrome in wild Carnaby's cockatoos (*Calyptorhynchus latirostris*): A new threat for an endangered species. *Journal of Wildlife Diseases*, 56(3), 609–619.
8. Mawson, P. R., (1995). *The Red-capped Parrot Purpureicephalus spurius (Kuhl 1820): a pest by nature or necessity?* PhD Thesis, Department of Geography, University of Western Australia, Perth.
9. Riley, K., Warren, K.S., Armstrong, N., Yeap, L., Dawson, R., Mawson, P., Saunders, D., Cooper, C., Shephard, J. Accelerometry reveals limits to use of an energy-saving anthropogenic food source by a threatened species; a case of Carnaby's cockatoos (*Zanda latirostris*) and canola. *Ecology and Evolution*. 2023;13:e10598.
10. Robinson, A. (1960). The importance of the marri as a food source to south-western Australian birds. *The Western Australian Naturalist*, 7(5), 109–115.
11. Saunders, D. A. (1977). The effect of agricultural clearing on the breeding success of the White-tailed Black Cockatoo. *Emu*, 77(4), 180–184.
12. Saunders, D. A., Mawson, P. R., Dawson, R., Johnstone, R. E., Kirkby, T., Warren, K., ... & Garnett, S. T. (2021). Carnaby's Black-Cockatoo *Zanda latirostris*. In *The Action Plan for Australian Birds 2020* (pp. 402–407). CSIRO Publishing.
13. Saunders, D. A., & Pickup, G. (2023). A review of the taxonomy and distribution of Australia's endemic Calyptorhynchinae black cockatoos. *Australian Zoologist*. August 2023.
14. Small, G., Jimenez, I., Salzi, M., & Shrestha, P. (2020). Urban heat island mitigation due to enhanced evapotranspiration in an urban garden in Saint Paul, Minnesota, USA. *WIT Transactions on Ecology and the Environment*, 243, 39–45.

15. Williams, M. R., Yates, C. J., Saunders, D. A., Dawson, R., & Barrett, G. W. (2017). Combined demographic and resource models quantify the effects of potential land-use change on the endangered Carnaby's cockatoo (*Calyptorhynchus latirostris*). *Biological Conservation*, 210, 8–15.
- Note: See Appendix A of this research article (available a separate document from the main article) for information about recurring low-yield years for banksia; with implications with respect to providing sufficient food for black cockatoos.*

Resources from Birdlife Australia, Western Australian Museum and other specialist organisations

1. Birdlife Australia. Information for councils and other land-owners and managers about plant selection and planting design for black cockatoo conservation: <https://www.birdlife.org.au/how-to-plant-for-black-cockatoos/>
2. Birdlife Australia information on black cockatoo food plants and dieback management: https://direct.birdlife.org.au/documents/Choose_for_BC_s__plant_brochure_2021.pdf
Printable pamphlet on choosing the best food plants for black cockatoos in your garden and school, and managing the risk of 'dieback disease' in native trees.
3. Birdlife Australia Cocky Notes newsletter. Free newsletter about WA's black cockatoos, including research and conservation actions and how councils and the public can get involved (e.g. citizen-science Great Cocky Count). To subscribe, email wa@birdlife.org.au
4. Birdlife Australia. (n.d.) Black cockatoos and your property. <https://direct.birdlife.org.au/documents/swbc-BCs-and-your-property.pdf>
Detailed booklet on making farms and properties black cockatoo-friendly.
5. Birdlife Australia. Identifying south-west black cockatoos: <http://direct.birdlife.org.au/documents/SWBC-SouthwestBlackCockatoolID.pdf>



6. BirdLife International. 2022. *Zanda latirostris*. The IUCN Red List of Threatened Species 2022: e.T22684733A212974328. <https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T22684733A212974328.en>
7. BirdLife International (2023) Species factsheet: *Zanda baudinii*. <http://datazone.birdlife.org/species/factsheet/baudins-black-cockatoo-zanda-baudinii>
8. Dieback Working Group Inc.: www.dwg.org.au
Website with resources and publications regarding the relative resilience of various local native plants to dieback, as well as about how best to manage dieback in bushland.
9. Kaarakin Black Cockatoo Conservation Centre: www.blackcockatoorecovery.com
10. Peck A. & Stokes V. (2019). *Black-cockatoo conservation and recovery: Guidelines for councils and land managers*. BirdLife Australia, November 2019.
Birdlife Australia information for councils. <https://rewildperth.com.au/>

Appendix 2. Black cockatoos from the Shire of Serpentine Jarrahdale: Causes of admission to Perth Zoo Veterinary Department 2018–22

Dr Anna Le Souef

Wildlife and zoo veterinarian and *Keep Carnaby's Flying* – *Ngoolarks Forever* project officer, in collaboration with Perth Zoo Veterinary Department

Extracts of this report have been used in relevant sections of this plan. The full report is provided here for reference.

Background

To support the development of the Black Cockatoo Conservation Action Plan for the Shire of Serpentine Jarrahdale, Murdoch University undertook an epidemiological analysis to identify the causes of admission to the Perth Zoo Veterinary Department (PZVD) for black cockatoos from the Shire of Serpentine Jarrahdale 2018–22.

Causes of admission for black cockatoos from the Shire of Serpentine Jarrahdale were vehicle strike, raven attack, displaced juveniles, shooting, or other/unknown.

Threatening processes associated with admission of black cockatoos to Perth Zoo Veterinary Department – Perth-Peel region Vehicle strike

Vehicle strike is one of the most significant threats to black cockatoos throughout their distribution range, particularly in high-traffic areas and on roads where vehicles are travelling at speed. Vehicle strike causes traumatic injuries ranging from minor wounds and bruises to catastrophic bone fractures. Common injuries are keel fractures, wing fractures, concussions, and trauma causing internal bleeding. Many cases can be treated successfully, but a large proportion (approximately 40%) of vehicle strike cases have injuries too severe for treatment and are euthanased. Black cockatoos are at risk when feeding from vegetation and spilt grain on roadsides and median strips, and drinking from potholes in roads or puddles that have formed in roadside depressions.

Measures to mitigate the risk of vehicle strike include road signage, timely repair of potholes and other depressions in road surfaces and verges, and ensuring that plants which are black cockatoo food species (e.g. banksias and hakeas) are planted with set-backs of several metres from roads, and never on median strips (Note: see section on **Vehicle strike** in the Plan for recommended set-back distances for different road speed limits). Records of vehicle strike locations are important to maintain, as they help identify potential problem areas that may require investigation and mitigation measures.

Carnaby's hindlimb paralysis syndrome

Carnaby's hindlimb paralysis syndrome (CHIPS) has been recognised in Carnaby's cockatoos since 2012⁷⁵. To date Carnaby's cockatoos are the only species known to be affected. Carnaby's cockatoos with this syndrome are admitted to PZVD predominantly in the summer and autumn months with a weakness or paralysis in their hindlimbs; thought to be a delayed-onset neurological disease caused by pesticide exposure. Some black cockatoos with CHIPS are too sick to be treated and require euthanasia, but most can be treated with supportive care and released back to the wild. CHIPS-affected Carnaby's cockatoos tend to present to PZVD having been found in urban areas where there are key roost sites that support relatively large numbers of birds, and from areas where there are more people to notice the affected birds. Research into this syndrome is ongoing, however it is thought the birds may be being exposed to pesticides in agricultural areas outside Perth during the breeding season (spring and early summer), and, given the suspected delayed onset of this condition, are noticed in a debilitated condition when they return to their urban roosts and foraging areas in the non-breeding season. Mitigation measures for CHIPS are difficult to identify at present and require further research into the source(s) of the toxin. However, awareness of the condition is important, as many of the affected black cockatoos can be successfully rehabilitated if taken into care.

75 Le Souef A, Vitali, S, Dawson R, Vaughan-Higgins R and Warren K, 2020, Hindlimb paralysis syndrome in wild Carnaby's cockatoos (*Calyptrorhynchus latirostris*): A new threat for an endangered species, *Journal of Wildlife Diseases*, 56(3), 2020, pp. 609–619

Raven attack

Raven attack is a threat to black cockatoos in urban areas which has emerged in the last decade and predominantly affects forest red-tailed cockatoos. The observed increase in raven attacks on forest red-tailed cockatoos in urban areas coincides with the increase in movements of this species into urban areas starting in the mid-2000s, to forage on introduced Cape Lilac, in line with declines in their main food sources (marri and jarrah) due to habitat clearing, fire and detrimental climate changes. There has also been an increase in ravens, a successful urban wildlife species, in Perth over the past 30 years.

Injuries caused by ravens tend to be around the tail end of the cockatoo, with a classic presentation being loss of tail feathers. There are sometimes wounds to the skin as well, and in some cases these wounds are too severe for treatment and require euthanasia. However, most raven-attacked black cockatoos can be treated and returned to the wild. 'Secondary' raven attacks sometimes occur when black cockatoos of any species are debilitated for another reason, such as vehicle strike or Carnaby's hindlimb paralysis syndrome. Secondary attacks further reduce these black cockatoos' chances of survival. Ravens are more numerous in areas populated by more people, because they benefit from the changes associated with urbanisation. The most successful measures for deterring ravens lie in appropriate waste management, such as self-closing bin lids. Although raven culls have occurred (with relevant lawful authority) in the past to control raven numbers in problem Perth-Peel areas, it is not clear if this is an effective measure to safeguard black cockatoos.

Displaced juveniles

This term is used to describe juvenile black cockatoos that have become separated from their parents. Sometimes this is through the well-intentioned rescue of a juvenile that was actually being cared for by parents which were not in the immediate vicinity, and sometimes it is due to injury or death of the parents. Some juveniles also seem to be targeted and injured by ravens during the vulnerable fledgling period; this appears to predominantly affect forest red-tailed cockatoos.

Shooting

Black cockatoos are sometimes illegally shot, particularly when entering fruit or nut orchards. Black cockatoos that are found with shooting injuries have not necessarily been shot locally, but may have travelled from other areas after being injured. As of 2023, fines for shooting black cockatoos are up to \$400,000 for individuals⁷⁶. Shooting injuries can include soft tissue trauma, as well as bone fractures and internal bleeding.

Other/unknown

This category includes cockatoos that are found without apparent injuries. It is likely many are actually vehicle strike cases that were momentarily stunned or had minor concussions. Other causes include misadventure, which has included flying into poles, fences or power lines, and entanglement in string or fishing line. These cases are not numerous enough to have their own category, they further highlight the risks that these birds face in Perth and Peel.



⁷⁶ As per section 150 (1) taking threatened species of the BC Act, as of 2023

Shire of Serpentine Jarrahdale statistics 2018–22

A total of 51 forest red-tailed cockatoos, 6 Carnaby's cockatoos and 11 Baudin's cockatoos were admitted from the Shire to Perth Zoo Veterinary Department between 2018–22. Main identified causes of admission were vehicle strike (all three species) and raven attack and displaced juveniles (forest red-tailed cockatoos) (**Table A2.1** and **Figure A2.1**).

Secondary raven attacks were also reported for two displaced juvenile forest red-tailed black cockatoos.

Vehicle strikes accounted for 42 of the cases (32 forest red-tailed black cockatoos, three Carnaby's cockatoos and seven Baudin's cockatoos) (**Figure A2.2**). This is likely due to the increased presence of migratory flocks of Carnaby's cockatoos moving on to the Swan Coastal Plain during the first half of the year, to spend the non-breeding season in this area.

Locations of vehicle strike cases in the Shire of Serpentine Jarrahdale for 2018–22 are shown in the Vehicle Strike section of the Plan.

There were no CHIPS cases admitted from the Shire between 2018–22 (**Table A2.1**). However, cases may go unnoticed and unreported.

Nine confirmed cases of raven attack were admitted to PZVD from the Shire between 2018–22 (one Carnaby's cockatoo and eight forest red-tailed cockatoos). There were also two cases of secondary raven attack on displaced juvenile forest red-tailed black cockatoos. Most cases were admitted between July–October, coinciding with raven breeding season. Recorded locations of raven attack were concentrated in the more heavily populated areas of the Shire between Byford and Mundijong.

A relatively high number of Baudin's cockatoos were admitted from the Shire of Serpentine Jarrahdale compared with other areas; one-sixth of all Baudin's cockatoos found anywhere in the state from 2018–22 were found in the Shire. This highlights the importance of the Shire of Serpentine Jarrahdale for this critically endangered species.

Table A2.1 Shire of Serpentine Jarrahdale black cockatoo admissions to Perth Zoo Veterinary Department 2018–22

Species	Vehicle strike	Raven attack	Displaced juvenile	Shot	CHIPS	Other/unknown*	Total
Carnaby's cockatoo	3	1	0	1	0	1	6
Baudin's cockatoo	7	0	0	2	0	2	11
Forest red-tailed black cockatoo	32	8	6	0	0	5	51
							68

* Included possible heat stroke following a bushfire (n=1 Carnaby's cockatoo), developmental abnormality (n=1 Baudin's cockatoo); Secondary raven attacks reported for n=2 (displaced juvenile forest red-tailed cockatoo)

Note: Baudin's cockatoo found in the Shire accounted for 1/6 of all Baudin's cockatoos found in any location from 2018–22

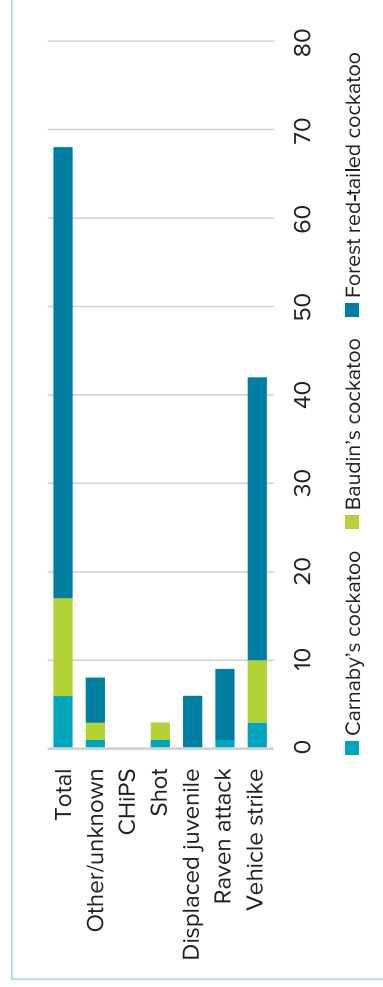


Figure A2.1 Shire of Serpentine Jarrahdale black cockatoo admissions to Perth Zoo Veterinary Department 2018–22

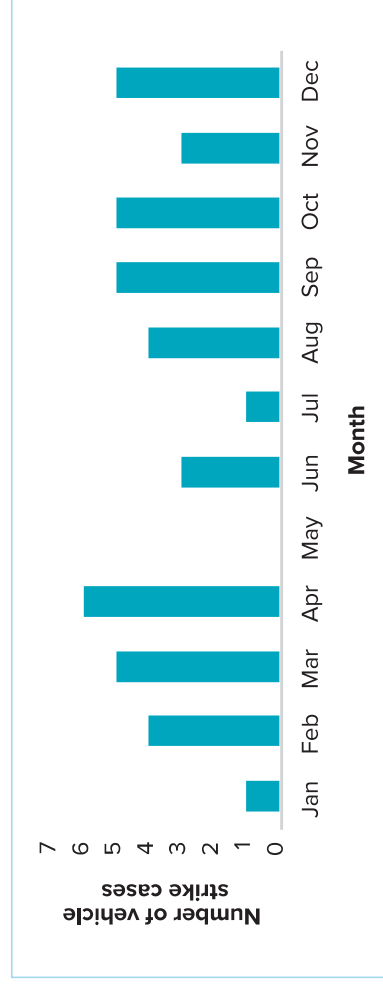


Figure A2.2 Shire of Serpentine Jarrahdale black cockatoo admissions to PZVD 2018–22: Vehicle strike data

Appendix 3. eDNA dietary study

Preliminary report on analyses of eDNA samples collected from Carnaby's cockatoos in the Shire of Serpentine Jarrahdale 2023

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Role of eDNA

eDNA is ubiquitous in the environment: it can be extracted from soil, scats, or water and provide information on everything from assessing biodiversity in multiple environments to detecting rare species, understanding the small-scale use of habitats by organisms and – of relevance to the *Keep Carnaby's Flying – Ngoolarks Forever* project – determining the diet of threatened species.

Understanding the diet of Ngoolark (Carnaby's cockatoo) in urban areas, including their use of non-native trees in metropolitan parks and gardens, is of considerable interest to the Black Cockatoo Conservation Management Program. This study will provide vital diet-related information to inform not only the *Keep Carnaby's Flying – Ngoolarks Forever* project, but ongoing local government and community actions for revegetation and re-wilding across Perth beyond the end of this ignition program, to maintain our urban populations of Ngoolarks.

We collected faeces from below roosts of Ngoolarks across Perth, which we then analysed to identify the plant diet of the black cockatoos at each roost. Since this dietary analysis provides a snapshot at the time the sample was collected, and there will be seasonal differences in the types of food available, repeated collection and analysis of eDNA samples from Ngoolark roost sites at different times of year will allow us to provide information to researchers and local government regarding seasonal/temporal shifts in Ngoolark diet, to inform decisions around planting in the longer term.

eDNA offers an opportunity to explore and monitor ecosystems at multiple levels, not just what we are able to easily see, hear and identify under a microscope. This new lens can allow us to better understand ecosystem changes including those from restoration and conservation work.

Sampling

We collected faecal samples from multiple locations across the Perth-Peel region during March–June 2023, wherever we found reliable places with confident identification of both Ngoolarks and their scats. The locations included known Carnaby's cockatoo roost sites within the four local government areas that were participating in the *Keep Carnaby's Flying – Ngoolarks Forever* project during 2023. The sites from which we sampled in the Shire of Serpentine Jarrahdale, and for which we present data here, were:

- » Site 1: Junction of Old Haul Road and Phillips Road, Jarrahdale
- » Site 2: Junction Gobby and Scarp road, Keysbrook

At roost sites, Ngoolark droppings were identified in the field on the basis of their size, shape and consistency. Each sample was stored in a sterile container and frozen prior to DNA extraction.

eDNA metabarcoding

DNA was extracted from a total of 35 individual faecal samples (five per site) and plant DNA amplified (chloroplast trnL and rbcL barcode regions), sequenced and species identified using our standard protocols (see Fernandes et al. 2022 and van der Heyde et al. 2020).

Discussion

Plant foods in the diet were identified to family level for this first sampling season. Differences in dietary components between samples indicate that at time of sampling, Ngoolarks at different roosts or foraging sites were eating different things, and that individuals may have shown preferences as well.

Plant DNA sequences for the trnL and rbcL barcode regions were obtained from all 35 faecal samples. Of the 22 food-plant families identified, only two are entirely exotic (i.e. introduced) to Australia. The Pinaceae (pine family) is one, and represents an important food source for Ngoolarks, being heavily represented in our Wanneroo samples. The other, the Fagaceae, includes oaks and chestnuts – all bearers of large nut-like fruit. Despite site variation, Ngoolarks were most regularly feeding on Proteaceae, which includes banksias and hakeas (**Figure A3.1**).

For samples from the Shire, foods from the Myrtaceae (jarrah, marri) were common in scats from the Keysbrook site. At the Jarrahdale site, Poaceae (grasses) were common in the samples, perhaps representing direct feeding on grasses, as has been recorded for red-tailed cockatoos, or contamination from plant material during collection, or feeding on spilt transported wheat grain (Ngoolarks often feed on spilt grain along roadsides in some areas, but we are not aware of grain trucks traveling through Jarrahdale). The lack of Proteaceae, a critical food for Ngoolarks, in the scats at either site suggests the need to investigate whether there is a scarcity of Proteaceae near these roosts, which may indicate a need to plant more banksia and hakea near both roosts.

The findings of this study can be applied to developing conservation strategies for Ngoolarks in urban and peri-urban areas. Knowledge gained includes confirmation of the wide range of plant species eaten by Ngoolarks and the variation of that diet both within and across different roosts. A significant proportion of the plants eaten by Ngoolarks at time of sampling may have been exotic species; potentially associated with a lack of availability of native foods at that particular time and location. In 2024, we will increase the temporal and spatial resolution of the study, with support from citizen scientists recruited from interest groups (e.g. Birdlife Australia), by collecting samples from more roosts and over a greater time range.

References

1. Fernandes, Kristen, Kit Prendergast, Philip W. Bateman, Benjamin J. Saunders, Mark Gibberd, Michael Bunce, and Paul Nevill. "DNA metabarcoding identifies urban foraging patterns of oligolectic and polylectic cavity-nesting bees." *Oecologia* 200, no. 3–4 (2022): 323–337.
2. Van Der Heyde, Mieke, Michael Bunce, Grant Wardell-Johnson, Kristen Fernandes, Nicole E. White, and Paul Nevill. "Testing multiple substrates for terrestrial biodiversity monitoring using environmental DNA metabarcoding." *Molecular Ecology Resources* 20, no. 3 (2020): 732–745.

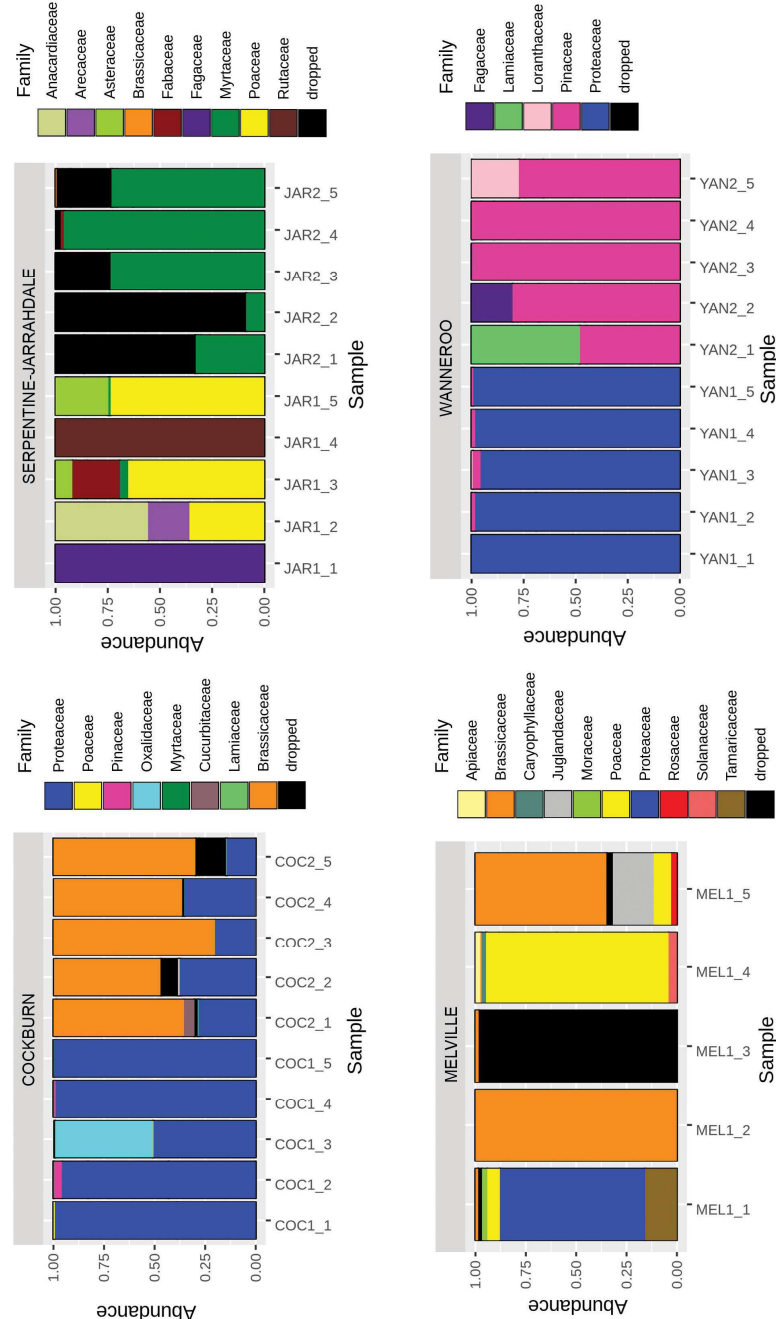


Figure A3.1 Relative abundance of DNA sequence reads. "dropped" indicates the DNA sequence could not be assigned at the family level



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