

20 July 2018

Belinda McCawley
Environmental Asset Officer
City of Wanneroo
Locked Bag 1,
Wanneroo, WA, 6946

Re: City of Wanneroo Black-Cockatoo Habitat Survey

Dear Belinda

Terrestrial Ecosystems has completed the Black-Cockatoo Habitat Survey for the nominated Site and Offset areas in the Neerabup Industrial Area.

Background and Introduction

The Neerabup Industrial Area (NIA) is a general industrial estate within the suburb of Neerabup, located approximately 30km north of the Perth Central Business District (Figure 1). The City of Wanneroo landholdings within the NIA consist of Lot 9100 (previously Lot 9000) Mather Drive, part Lot 9003 Mather Drive and part of Lot 600 Wattle Avenue, Neerabup and are referred to hereafter as the 'Site'. The City of Wanneroo manages offset sites associated with development which consist of Lot 8001 (previously Lot 9000) Flynn Drive, Neerabup and Lot 24 Mary Street, Wanneroo and are referred to hereafter as the 'Offset Sites'.

The City is proposing the development of the Site for industrial land development purposes. The project is expected to be undertaken in stages over the next 20 to 30 years and includes resource extraction, development of general industrial lots and longer term strategic employment options.

In accordance with the City's Conservation Area Management Plan (AECOM 2016a), any hollows in trees to be cleared from the development site should be salvaged and used in the Offset Sites. The City is also required to identify Black-Cockatoo habitat within the Offset Sites that requires additional monitoring and protection.

Terrestrial Ecosystems has undertaken an assessment of the Site and Offset Sites for tree hollows that may be suitable for Offset sites. The specific tasks undertaken during our field survey and reporting included:

Field survey

- Site survey to identify tree hollows, assess their suitability for Black-Cockatoo habitat (inclusive of DBH, tree height, tree health, species and hollow size) for trees that have been previously identified in the project area;
- Black-Cockatoo activity observed during the project area;
- Record locations for all previously identified Black-Cockatoo habitat trees that contain hollows; and
- On-site demarcation using metal tags of all previously identified Black-Cockatoo habitat trees that contain hollows.

Results and reporting

- Desktop assessment of previous reports and management plans;
- Recommendations for Black-Cockatoo habitat management and the salvage of hollows from the Development Site for use in the Offset Sites;
- Appropriate methodology for salvaging, storing, installing and maintaining tree hollows;
- Recommended methodology(ies) and timing for monitoring hollows (existing and artificial) in the Offset Sites; and
- Any other action(s) and associated management advice (if any) and timeframe(s), when best to action.

Methodology

Prior to the field investigations Terrestrial Ecosystems reviewed some of the historical flora and fauna assessments completed for the site and broader region. These included:

- 360 Environmental. (2017a). *Hardcastle Park, Landsdale -EPBC Act Referral Supporting Document*. Perth.
- 360 Environmental. (2017b). *Lot 1665 Wanneroo Road, Singara EPBC Act Referral Supporting Document*. Perth.
- AECOM (2016a). *Conservation Area Management Plan. City of Wanneroo Landholdings Meridian Business Park - Neerabup Industrial Area*. Perth.
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- Alan Tingay & Associates. (1999a). *Pt Lot 2 Burns Beach, Vertebrate Fauna*. Perth.
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- Alan Tingay & Associates. (1999c). *Shire of Wanneroo, Town Planning Scheme No. 1, Amendment 837 - Yanchep / Two Rocks, Environmental Review*. Perth.
- ATA Environmental. (2004). *Lot 6765 Wanneroo Road, Nowergup: Fauna Assessment*. Perth.
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- Aurecon. (2017). *Wanneroo Road/Ocean Reef Road Grade Separation PEIA & EMP*. Perth.
- Bamford Consulting Ecologists. (1998). *Report on a Vertebrate Survey at Burns Beach*. Perth.
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- Department of Conservation and Land Management. (1993). *Fauna studies in water supply Reserve 34537, adjacent to Neerabup National Park*.
- Eco Logical Australia. (2012a) Environmental Review Lot 701 Flynn Drive, Neerabup. Unpublished report for Landcorp.
- Eco Logical Australia. (2012c) Vertebrate Fauna Survey Lot 701 Flynn Drive, Neerabup. Unpublished report for Landcorp.
- Eco Logical Australia. (2012b). *Ground Truthing of Environmental Values for Lot 4 Flynn Drive, Neerabup*. Perth.
- Eco Logical Australia. (2013b). *Targeted Flora and Fauna Assessment, Lot 4 Flynn Drive Neerabup*. Perth.
- Eco Logical Australia. (2013a). *Meridian Business Park Industrial Development, Neerabup Western Australia (2007/3479). Preliminary Documentation – Information request*. Perth
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- GHD. (2014b). *Neerabup Road Extension*. Perth.
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- GHD. (2014a). *Neerabup Road Extension Level 2 Fauna Survey*. Perth.
- Terratree. (2016). *Level 2 Flora & Vegetation Assessment of Conservation Offset Areas*. Perth.

Other reports are available for the region, however, they provided limited additional value to this assessment.

The reports by ATA Environment (2007), Eco Logical (2013a, b) and Terratree (2016) were the most relevant. These reports identified trees that were considered 'significant' for Black-Cockatoos and contained hollows that may be suitable for Black-Cockatoos and therefore suitable for salvaging.

On 20 June 2018, Dr Scott Thompson reassessed each of the trees identified during previous assessments as having hollows suitable for Black-Cockatoos. For all trees the diameter at breast height (DBH) was measured, the tree height estimated, tree species recorded, and the hollow entrance dimensions and height above the ground estimated. Other notable observations of the tree hollow(s) (i.e. historical use for breeding/feeding, presence of bees etc) were also recorded.

All assessed trees had a metal tag attached at breast height for subsequent identification purposes.

Results and Reporting

Twenty-eight trees were assessed, and the details of each tree recorded (Figure 2; Table 1; Attachment 1). Twenty-six were previously recorded and two were recorded during this assessment for the first time. Only trees containing hollows which may be suitable for Black-Cockatoos were assessed. None of the assessed trees contained a hollow which was or has been used as a nesting site for Black-Cockatoos. There are no suitable trees at Lot 24 Mary Street, Wanneroo.

There were no trees containing a hollow that could be salvaged cost effectively and erected in a suitable location for Black-Cockatoos use. All of the hollows are too small, have substantial cracks or have been extensively burnt out. Terrestrial Ecosystems recommends that the City of Wanneroo commits to the purchase and installation of Cockatubes instead of attempting to recover tree hollows that have limited suitability.

Carnaby's Black-Cockatoo breed between July and November mostly in eucalypt woodland (Saunders 1980, 1986). They nest in tree hollows that are created by fire, fungi, termites or old age, with hollows between 2.5 and 12m above the ground (Saunders 1979, Higgins 1999). Hollows are large, ranging from 10 to over 250cm in depth (Higgins 1999) and these hollows are usually in live or dead smooth-barked Salmon Gum (*Eucalyptus salmonophloia*) or Wandoo (*Eucalyptus wandoo*). However, Carnaby's Black-Cockatoo will also nest in Red Morrell (*E. longicornis*), York Gum (*E. loxophleba*), Tuart (*E. gomphocephala*), Flooded Gum (*E. rudis*), Gimlet (*E. salubris*), Swamp Yate (*E. occidentalis*) and Marri (*Corymbia calophylla*; Higgins 1999, Cale 2003). Eggs are laid on a mat of wood chips chewed from the sides of the hollow. Clutches are 1-2, but most often only one chick is raised. Incubation takes 29 days, and only the female incubates and broods (Johnstone and Kirkby 2011). Initially the female will return to the nest mid-morning to feed the chick, but after about 2-3 weeks both parents leave in the early morning and return late evening.

In comparison to natural tree hollows, Cockatubes are purpose-built hollows that have been designed and tested by the Department of Biodiversity, Conservation and Attractions (Groom 2010) and others (Johnstone et al. 2015) over numerous years. These artificial hollows are now being selected by Black-Cockatoos often in preference to natural tree hollows that have been used in the past as a nesting site (Taillier 2016). So not only do we know that Cockatubes work, but they are cheaper to erect and, in many circumstances, last longer than recovered hollows. Terrestrial Ecosystems would therefore strongly encourage the City of Wanneroo to use Cockatubes in preference to salvaged tree hollows as potential Black-Cockatoo nesting sites as they work better and are cheaper. Cockatubes can be purchased from Landcare SJ (<http://landcaresj.com.au/cookatubes-saving-black-cockatoos/>) for approximately \$500ea and are easily installed into existing bushland reserves. There is no prescribed number of Cockatubes or tree hollows that should be installed for every significant tree that is removed, however, Terrestrial Ecosystems recommends that one Cockatube is installed for each 'significant' tree that contains a hollow (irrespective of size or suitability of the hollow) and one Cockatube per five 'significant' trees (not containing hollows yet) that are removed. We have given greater importance to trees which have small hollows as it shows they are of appropriate age and quality to develop hollows and it is not unreasonable to assume that given adequate time these small hollows would become suitable for larger species. A significant tree in an area which could be considered breeding habitat is described by the Commonwealth as trees of species known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow. For most tree species, suitable diameter at breast height is 500mm and for salmon gum and wandoo is 300mm (Department of Sustainability Environment Water Population and Communities 2012).

Carnaby's Black-Cockatoo have high site-fidelity, with females often using the same or a nearby breeding hollow each year (Saunders et al. 2018). Within the greater Perth urban area there is only one known breeding

area (e.g. Edith Cowan University campus in Joondalup). There is a known breeding population near the Yancheep National Park, which is the next closest to the off-set area. It is therefore highly unlikely in the near future that Carnaby's Black-Cockatoos would nest in the Offset Sites, however, both Carnaby's and Forest Red-tailed Black-Cockatoos could forage in the Offset Sites. If the City was keen to contribute to the breeding success of Carnaby's Black-Cockatoos, then the erection of Cockatubes in known breeding locations would be a much better option than erecting them in the Offset Sites.

A brief description of Cockatubes and how to erect them is attached.

Other actions and management

A small number of Carnaby's Black-Cockatoos were observed flying over the Site early in the morning, however, none were observed foraging on site. However, a large number of Forest Red-tailed Black-Cockatoos (*Calyptorhynchus banksii naso*) were observed feeding in both the Site and Offset areas (Plates 1 and 2). It is unknown why, but Forest Red-tailed Black-Cockatoos have become more commonly observed foraging on the Swan Coastal Plain over the past six years. Forest Red-tailed Black-Cockatoos have very similar ecological requirements to Carnaby's Black-Cockatoos and Terrestrial Ecosystems therefore recommends that the management actions described in the Conservation Area Management Plan (AECOM 2016a) are updated to reflect the use of the Site and Offset area by Forest Red-tailed Black-Cockatoos and Carnaby's Black-Cockatoos.



Plate 1. Jarrah nuts eaten by Forest Red-tailed Black-Cockatoos



Plate 2. Forest Red-tailed Black-Cockatoos

The Site and Offset Sites also maintain a small population of Quenda (*Isodon fusciventer*; Plate 3). Quenda are listed as Priority 4 with the Department of Biodiversity, Conservation and Attractions.

Based on the scats and tracks recorded by Terrestrial Ecosystems in 20 June 2018 the Site and Offset Sites also have a relatively high-density population of cats and foxes (Plate 4). Evidence of rabbits was also common. One dead bird was recorded in the Offset area following predation by a fox or cat.



Plate 3. Quenda tracks

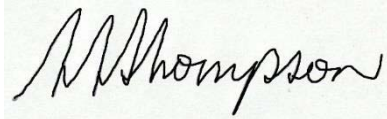


Plate 4. Fox tracks

If the Quenda (and other native fauna including Black-Cockatoos) are to continue to survive in these areas a feral and pest management program is required. This program should target feral cats and foxes, but where funds permit also reduce the rabbit numbers. Terrestrial Ecosystems recommends that the Conservation Area Management Plan (AECOM 2016a) is revised to include a more detailed section on feral and pest animal management. This section should be reviewed by someone who regularly undertakes feral and pest fauna management and control programs to ensure that the recommendations are workable and appropriate to an urban reserve.

Please do not hesitate in contacting the undersigned (0407 385 239), if you require any further information regarding this information.

Yours sincerely



Dr Scott Thompson
Partner and Principal Zoologist

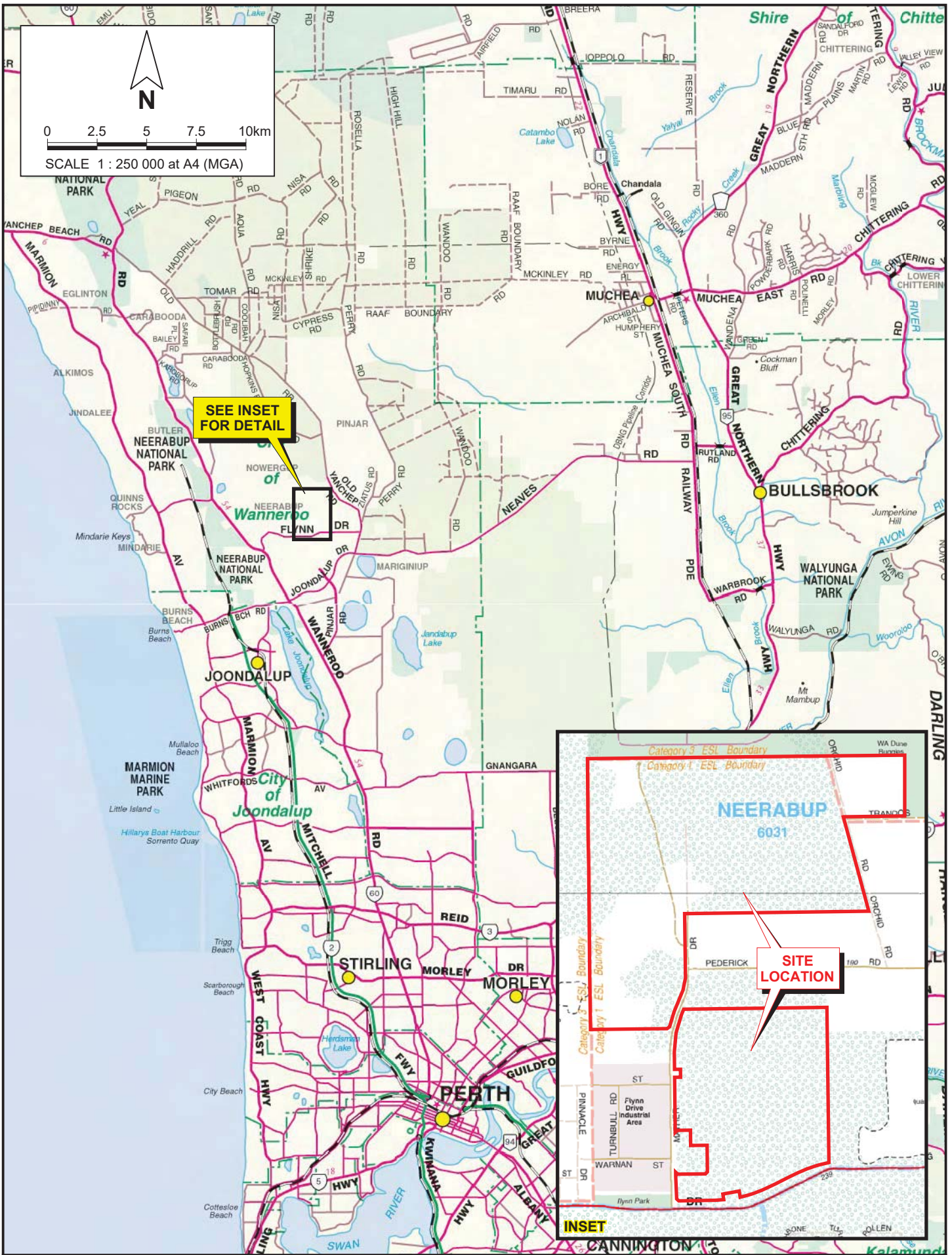
Attachments:

- 1 – Images of trees inspected
- 2 – Erection of Cockatubes
- 3 - Cockatube installation guidelines (Landcare SJ)
- 4 - How to design and place artificial hollows for Carnaby's Black-Cockatoo

References:

- 360 Environmental. 2017a. Hardcastle Park, Landsdale -EPBC Act Referral Supporting Document. Perth.
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- Department of Sustainability Environment Water Population and Communities. 2012. EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*. Canberra.
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- Eco Logical Australia. 2012c. Vertebrate Fauna Survey Lot 701 Flynn Drive, Neerabup. Perth.
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- Taillier, S. 2016. Fresh hopes for Carnaby's black cockatoos as numbers 'increase dramatically' with artificial hollows. ABC News, Perth.
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PINPOINT CARTOGRAPHICS (08) 9562 7136
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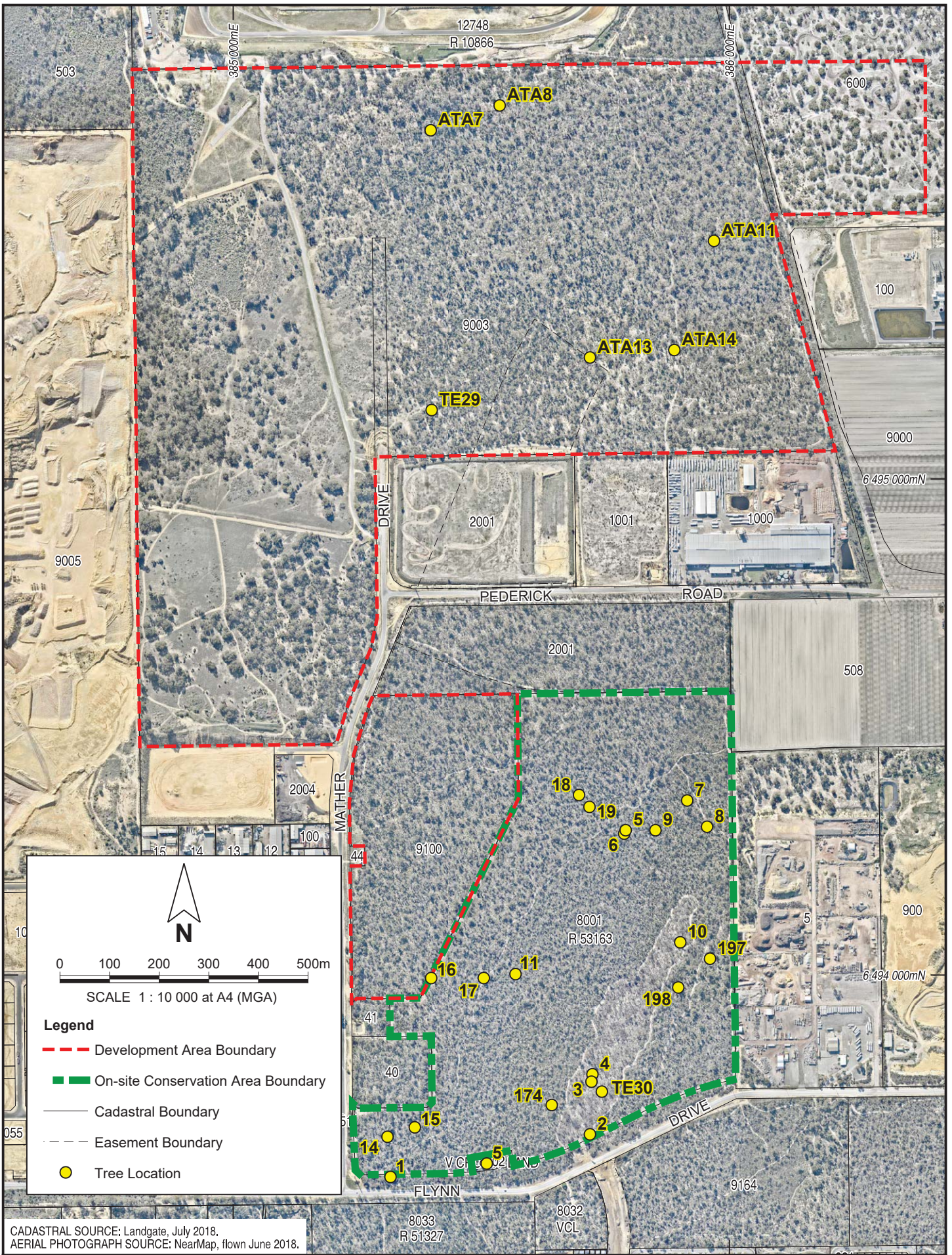
TERRESTRIAL ECOSYSTEMS	
Drawn: S. Thompson	Date: 11 Jul 2018

City of Wanneroo
 BLACK COCKATOO HABITAT SURVEY
 NEERABUP

REGIONAL LOCATION

Figure 1

Job: 2018-0029



N

0 100 200 300 400 500m

SCALE 1 : 10 000 at A4 (MGA)

Legend

- - - Development Area Boundary
- - - On-site Conservation Area Boundary
- Cadastral Boundary
- - - Easement Boundary
- Tree Location

CADASTRAL SOURCE: Landgate, July 2018.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown June 2018.

City of Wanneroo
BLACK COCKATOO HABITAT SURVEY
NEERABUP

Figure 2

LOCATION OF TREES

Drawn: S. Thompson

Date: 11 Jul 2018

Job: 2018-0029

PINPOINT CARTOGRAPHICS (08) 9562 7136 2018-0029-02.dgn



Table 1. Observations and details of each assessed tree (UTM Zone WGS 84)

Tree #	Tree type	Location	Easting	Northing	DBH (cm)	Hollow attributes	Comment
TE29	Jarrah	Site	385400	6495139	90	~8m high, 250*250mm hollow	Burnt tree approx. 20m high
ATA7	Marri	Site	385398	6495703	103	No useable hollows, bees in fallen bits	Dead with majority fallen over
ATA8	Jarrah	Site	385337	6495753	101	No useable hollows. Dirt in some parts	
ATA14	Jarrah	Site	385889	6495260	95	9m high tree with bees in the trunk. No useable hollows	Burnt
ATA11	Jarrah	Site	385969	6495480			Fallen
ATA13	Jarrah	Site	385719	6495245			Fallen
198	Jarrah	Offset	385897	6493975	112	~25m high. Small hollow (100*100mm)	Being used (or has been used) by a small parrot. Not suitable for Black-Cockatoos
10	Jarrah	Offset	385901	6494066	54	No obvious hollows, but potentially on the end of the branch	Extensively burnt, no obvious use
197	Jarrah	Offset	385961	6494033	79	~10m high. Chewed bark on tree indicates there is a hollow, but it wasn't obvious from the ground.	
8	Jarrah	Offset	385955	6494299	151	~15m high. Possible hollow (250*250mm)	No obvious use
7	Jarrah	Offset	385915	6494352	83	~15m high. 100*100mm hollow at ~8m above the ground.	No obvious use
19	Jarrah	Offset	385718	6494339	104	~15m high. 200*200mm flat hollow at the top of the tree.	Bees in the smaller hollows
18	Jarrah	Offset	385697	6494363	122	~25m high. Multiple small hollows (100*100mm and 150*150mm)	Most hollows had bees and none showed evidence of use by birds
6	Jarrah	Offset	385788	6494285	131	~20m high. Multiple dead stags but no hollows.	Bees were present
5	Jarrah	Offset	385791	6494292	89	~20m high. Upright hollow (150*150mm) and dead stags.	Most hollows have bees. Very limited potential for nesting.
9	Jarrah	Offset	385851	6494292	59	~15m high. 150*150mm hollow @ 7m; 100*100mm hollow above the dead stags.	No obvious use
16	Jarrah	Offset	385399	6493994	113	~25m high with multiple hollows. 100*100mm, 250*250mm upright hollow in dead stag	No obvious use
17	Jarrah	Offset	385505	6493994	61	No hollows	
11	Jarrah	Offset	385569	6494002	83, 68	~15m high. Large spout with multiple twisted holes.	No obvious use
1	Jarrah	Offset	385317	6493593	85	~20m high. 1m high hollow on the end of a historical branch.	Overhangs boundary fence but is outside the reserve. Obvious chew marks
14	Jarrah	Offset	385311	6493674	54	~12m high. 200*200mm hollow in side of trunk ~6m high	No obvious use
15	Jarrah	Offset	385366	6493693	153	~15m high.	Burnt out and no obvious hollows
5	Jarrah	Offset	385511	6493620	67	~18m high.	No large obvious hollows, but maybe the end of a dead branch (10m high)
2	Jarrah	Offset	385719	6493679	134	~12m high.	Burnt out and no obvious hollows. Maybe the end of the stag
174	Jarrah	Offset	385642	6493738	76	~20m high. Horizontal flat hollow (150*250mm) approximately 14m high	No obvious use
4	Jarrah	Offset	385724	6493800			Fallen over and burnt
3	Jarrah	Offset	385722	6493785	57	~20m high. Hollow in trunk (~3m high) but majority is filled with dirt.	No obvious use
TE30	Jarrah	Offset	385743	6493765	51	~20m high. 150*100mm hollow about 10m high.	No obvious use



Attachment 1. Images of trees inspected



TE29



TE29 - hollow



ATA7



ATA7 - bees

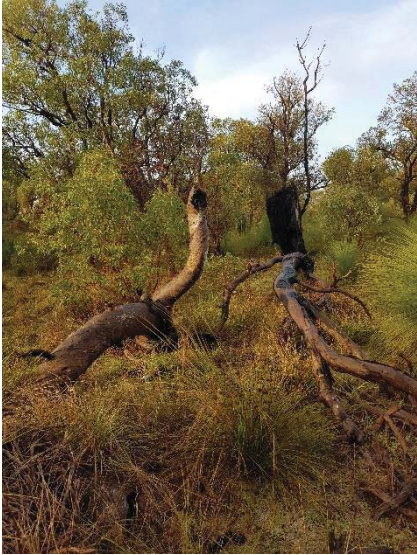


ATA8



ATA14





ATA11



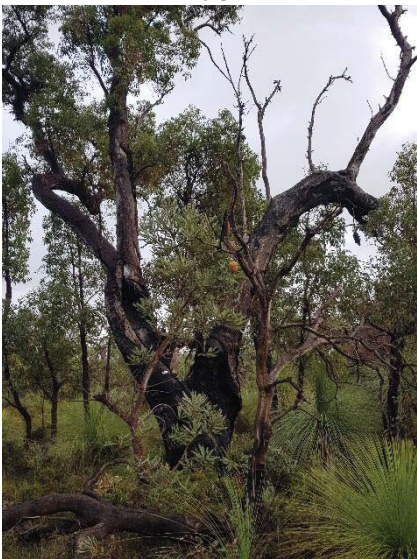
ATA13



198



10



197



8



7



19



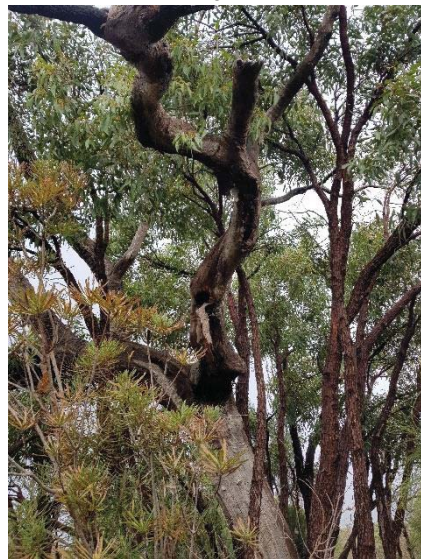
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6



5



9



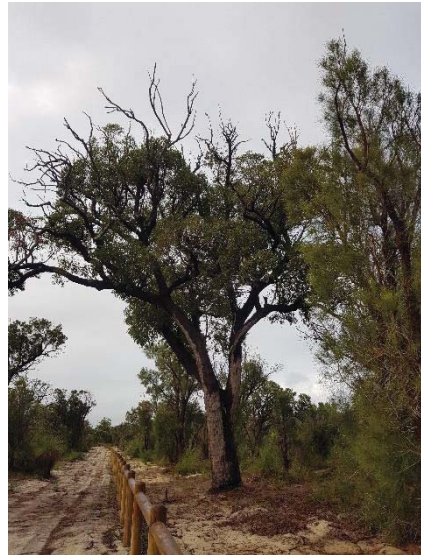
16



17



11



1



1 - hollow



14



14 - hollow



15



5



2



174



4



3



TE30

Attachment 2 - Erection of Cockatubes

Cockatubes are available from the Landcare SJ. They come with a chain and coach bolts.

Cockatubes are constructed of black poly pipe with a 'ladder' added internally so that cockatoos can climb down to the bottom of the tube, where there is a piece of flat black plastic with drain holes. The optimum size is 450mm diameter by 1500mm deep for Carnaby's Black-Cockatoo and a smaller size of 375mm diameter and 1400mm deep for Forest Red-tailed Black-Cockatoos. The tube contains a piece of sacrificial Marri that is hooked to the inside of the tube to allow the cockatoos to chew on it to create nesting material. The floor of the Cockatube should contain approximately 20cm of coarse mulch that will form the base of the nest and drains the water out of the tube.

Cockatubes are chained to the south-eastern side of suitable large trees at a height that can be subsequently accessed for inspections, replacement of the piece of sacrificial Marri and removal of bees should they invade the hollow. The Landcare SJ group recommend a height of 8m above the ground in publicly accessible areas and 5m above the ground in private property. Typically, because of their size and weight, two people using an elevated work platform are required to erect each Cockatube. Galvanised chain is used for attachment to the tree, and they are secured to minimise lateral movement independent of the tree.

Ideally, erected Cockatubes are inspected annually to ensure that the tree is healthy and sound, the tube is still appropriately positioned, and the piece of sacrificial Marri does not need to be replaced. Bees occasionally construct hives in the tubes and they will need to be removed.

Should Council wish to know whether the Cockatubes are being used as nesting sites by Carnaby's Black-Cockatoos, then each tube should be visited during the breeding season, normally on two occasions because of the extended egg laying period of mid-July to October. Hollows can be inspected for eggs or chicks during the day or just before sunset for adult birds returning to the nest.

Attachment 3 and 4 are the Cockatube installation guidelines provided by Landcare SJ.

Attachment 3 - Cockatube installation guidelines (Landcare SJ)

COCKATUBE® installation guidelines

Landcare SJ recommends that Cockatubes be placed:

- in cockatoo breeding areas;
- away from prevailing weather conditions on the south east side of a tree;
- under tree canopy or where shade conditions are maximised;
- to allow access for monitoring and maintenance; and,
- at a height of 8 metres and above from the ground in publicly accessible areas and above 5 metres on private property.

Prior to installation:

- add approximately 20cm of coarse mulch inside Cockatube base; and,
- insert sacrificial post (stirrup allows post to hang on inside wall of artificial hollow).

FOLLOW OCCUPATIONAL HEALTH AND SAFETY PRINCIPLES FOR ELEVATED WORK CONDITIONS AND PREPARE SPECIFIC JOB SAFETY ANALYSIS PRIOR TO INSTALLATION

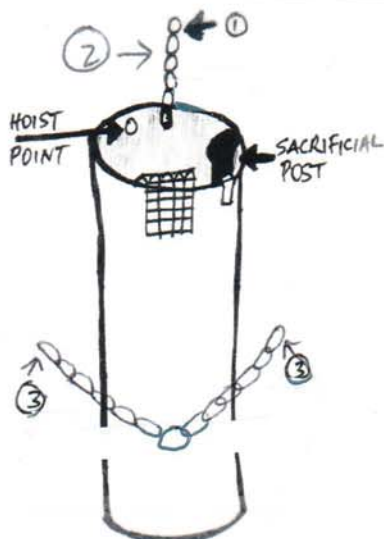
Installation methods:

- Cherry picker or elevated work platform;
- Qualified tree climber/arborist
- Hoist and pulley system

Fixing Cockatubes to the tree:

- Hoist Cockatube to installation position on tree;
- First fixing point – Through top link in top chain - drill hole in tree suitable for M10 x 75mm* coach screw (supplied), place screw through top link and fasten to tree with socket wrench or spanner;
- Second fixing point – use second link high in top chain, drill hole suitable for M10x50mm coach screw (supplied) and fasten to tree;
- Third fixing point – bottom chain – extend one end to tree trunk on an angle (approx. 45°) to allow for tree growth, ensuring Cockatube hangs straight and vertical, drill hole suitable for M10x50mm coach screw (supplied) and fasten to tree through last chain link (when possible), extend chain on opposite side on an angle to trunk, drill hole and fix.

*screw lengths may vary, however use longest screws supplied to attach to tree through top chain.



Attachment 4 - How to design and place artificial hollows for Carnaby's Black-Cockatoo



How to design and place artificial hollows for Carnaby's black cockatoo

Artificial hollows can be used to help conserve the threatened Carnaby's black cockatoo by enabling the cockatoos to breed in areas where natural hollows are limited.

A wide variety of artificial hollow designs have been used with mixed success. Evidence suggests that, while the hollow must meet some basic requirements, other factors such as proximity to existing breeding areas may be more important in determining the success of artificial hollows. Before using this information sheet to construct or install an artificial hollow, you should refer to the criteria listed in the separate information sheet, *When to use artificial hollows for Carnaby's black cockatoo*.

This information sheet contains broad guidelines for the design and placement of artificial hollows for Carnaby's black cockatoo.

Walls

The walls of the artificial hollow need to be constructed from a material that is;

- Durable enough to withstand exposure to elements for an extended period of time (i.e. 20+ years).
- Able to simulate the thermal properties of a natural tree hollow.
- Not less than 380mm in internal diameter.
- Preferably 1.2m deep overall and 1m deep to top of substrate/nesting material.

Successful artificial hollows have been constructed from sections of salvaged natural hollow, black and white industrial pipe. When using non-natural materials care must

be taken to ensure there are no toxic residues and that the materials are safe to ingest.



Figure 1: Carnaby's cockatoo eggs in an artificial hollow. Photo by Rick Dawson.

Base

The base of the artificial hollow must be;

- Able to support the adult and nestling(s).
- Durable enough to last the life of the nest.
- Free draining.
- Covered with 200mm of sterile, dry, free draining material such as charcoal, hardwood woodchips or wood debris. Do not use saw dust or fibre products that will retain moisture.
- At least 380mm in diameter.

Example materials that could be used for artificial hollow bases include heavy duty stainless steel, galvanised or treated metal (e.g. Zinalume[®]), thick hardwood timber slab or marine ply (not chipboard or MDF). The base material must be cut to size to fit internally with sharp or rough edges ground away or curled inwards and fixed securely to the walls.



Figure 2: bottom of an artificial hollow showing ladder that is fixed to the wall and a chewed sacrificial post which is 200mm from the floor. Photo by Rick Dawson.

Entrance

The entrance of the artificial hollow must;

- Have a diameter of at least 270 mm).
- Preferably be top entry which will minimise use by non-target species.

Top entry hollows are unattractive to nest competitors such as feral bees, galahs and corellas. Side entry hollows have been successful in areas where feral bees are not a problem and where galahs and corellas are deterred.

Ladder

For artificial hollows made of non-natural materials, or of processed boards, it is necessary to provide a ladder to enable the birds to climb in and out of the hollow easily.

The ladder must be;

- Securely mounted to the inside of the hollow.
- Made from an open heavy wire mesh such as WeldMesh™ with mesh size of 30-50mm, or heavy chain.
- Not made of a material that the birds can chew.
- Not galvanized because the birds may grip or chew the ladder and ingest harmful compounds.

If using mesh for the ladder, the width will depend on the curvature of the nest walls. A minimum width of about 60-100mm is recommended.

Sacrificial chewing posts

For artificial hollows made of non-natural materials, or of processed boards, it is necessary to provide sacrificial chewing posts. The birds chew material to prepare a dry base on which to lay their egg(s).

The sacrificial chewing posts must:

- Be made of untreated hardwood such as jarrah, marri or wandoo
- Be thick enough to satisfy the birds' needs between maintenance visits.
- Extend beyond the top of the hollow as an aid to see whether the nest is being used.
- Be placed on the inside of the hollow.
- Be attached in such a way that they are easy to replace e.g. hook over the top of hollow or can slide in/out of a pair of U bolts fitted to the side of the hollow.

It is recommended that at least two posts are provided. Posts 70 x 50 mm have been used, but require replacing at least every second breeding season when the nest is active. Birds do vary in their chewing habits and therefore the frequency at which the chewing posts require replacement will also vary.

Mountings

The artificial hollows must be mounted such that:

- The fixings used will last the duration of the nest e.g. galvanized bracket or chain fixed with galvanized coach screws.
- It is secured by more than one anchor for security and stability.
- It is positioned vertically or near vertically.

Placement

Sites should be chosen within current breeding areas and where they can be monitored, but preferably not conspicuous to the general public. It is important that artificial hollows are placed where they will be accessible for future monitoring and maintenance. For more detail refer to the separate information sheet, *When to use artificial hollows for Carnaby's black cockatoo*.

The height at which artificial hollows should be placed is variable. The average height of natural hollows in dominant tree species in the area is a good guide. Natural hollows used by Carnaby's black cockatoos have been recorded as low as 2 m above the ground. If located on private property the hollows can be placed lower to the ground so they are accessible by ladder or a rope and pulley system can be used. Where public access is possible artificial hollows should be placed at least 7 m high (i.e. higher than most ladders) and on the side of the tree away from public view to reduce the chance of interference or poaching.

Carnaby's black cockatoo show no preference for aspect of natural hollows, however, it may still be beneficial to place artificial hollows facing away from prevailing weather and where they receive the most shade and protection.

Artificial hollows to be placed in trees require:

- Accessibility of the tree for a vehicle, elevated work platform or cherry picker.
- A section of trunk 2-3 m long suitable for attaching the hollow

If necessary, artificial hollows may be placed on poles, but this may result in excessive exposure to sun during very hot weather. When erected on poles there should be"

- A hinge at the bottom of the pole that can be secured when the pole is in the upright position.
- Access for a vehicle to assist raising the pole.

Safety

Care needs to be taken when placing artificial hollows to ensure safety is considered at all times. Artificial hollows are heavy and require lifting and manoeuvring into position up to 7 m above the ground.

Maintenance and monitoring

Once artificial hollows have been placed they require monitoring and maintenance to ensure they continue to be useful for nesting by Carnaby's black cockatoo. It is important to monitor artificial hollows to determine use by Carnaby's

black cockatoo, other native species as well as pest species. By undertaking monitoring the success of the design and placement of artificial hollows can be determined and areas for improvement identified for future placement of artificial hollows.

Monitoring can also assess whether any maintenance is required. Without regular maintenance artificial hollows are unlikely to achieve their objective (that is, they will fail to provide nesting opportunities for threatened cockatoos). Therefore it is important to continue a regime of regular maintenance while the artificial hollow is required. It may be several (to many) decades until a natural replacement hollow is available.

For further advice on monitoring and maintenance of artificial hollows please refer to the separate information sheet *How to monitor and maintain artificial hollows for Carnaby's black cockatoo*.

Acknowledgements

This information sheet is a joint initiative of Birdlife Australia, the Western Australian Museum and the Department of Environment and Conservation. Many individuals have contributed to its preparation. Special acknowledgement is made for the contributions of Ron Johnstone from the WA Museum, Alan Elliott from the Serpentine-Jarrahdale Land care Centre and Denis Saunders. This updated version was compiled by Rick Dawson (Department of Parks and Wildlife).



Figure 3: examples of successful artificial hollows. Note the signs of fresh chewing on the hollow entrances (left) and chewing posts (middle). Photos by Christine Groom and Rick Dawson

Further information

Contact your local office of the Department of Parks and Wildlife

See the department's website for the latest information: www.dpaw.wa.gov.au

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Last updated 28/04/2015

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No. of copies	Report File Name	Report Status	Date	Prepared for:	Initials
Electronic	2018-0029-002-st	Draft	7 July 2018	City of Wanneroo	ST
Electronic	2018-0029-002-st V2	Final	20 July 2018	City of Wanneroo	ST

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