



PHOENIX

ENVIRONMENTAL SCIENCES

Black cockatoo breeding activity census 2020-21 for Muceha North Great Northern Highway, Muceha to Wubin Upgrade Stage 2 Project

Prepared for Main Roads WA

June 2021

Final



Black cockatoo breeding activity census 2020-21 for Muchea North.
Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project.
Prepared for Main Roads WA

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1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Main Roads WA, to undertake a Carnaby's Cockatoo breeding activity census over the 2020-21 breeding season within and surrounding the disturbance footprint for the Muchea North Upgrade project area (Figure 1). This report presents the results of the census.

1.1 BACKGROUND

Main Roads has recently upgraded the Great Northern Highway (GNH) between Straight Line Kilometre (SLK) 38.60 and 51.40, referred to as Muchea North Upgrade (Muchea North in this report). The Muchea North proposal was referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 1 March 2016 (EPBC 2016/7656), assessed as a controlled action and granted conditional approval in August 2018 (DotEE 2018).

Muchea North resulted in the loss of 13 Carnaby's Black Cockatoo nesting hollows. To mitigate and offset the loss of these, Main Roads was required to install 39 artificial nest boxes (Figure 1). In accordance with EPBC 2016/7656 Conditions 4f(i) and (ii) each artificial nesting hollow installed must:

- EPBC 2016/7656 condition f(i): be inspected at least twice a year by a suitably qualified person during the peak breeding season to record any evidence of use by the Carnaby's Black Cockatoo and to identify any maintenance requirements.
- EPBC 2016/7656 condition f(ii): be monitored and maintained in accordance with relevant artificial hollow guidance for the life of the approval, with maintenance actions, if required, undertaken outside of the breeding season and before the commencement of the next breeding season.

The monitoring program also required monitoring of previously recorded natural hollows suitable for Carnaby's Cockatoo (Figure 1). Monitoring of artificial and natural hollows is required to be monitored in accordance with How to Monitor and Maintain Artificial Hollows for Carnaby's Cockatoo (DPaW 2015).

Detailed black cockatoo habitat assessments conducted as part of the baseline assessments for the Muchea North (Phoenix 2015, 2017a) recorded all potential breeding trees of species known to support black cockatoo breeding and identified suitable nesting hollows and hollows with evidence of use.

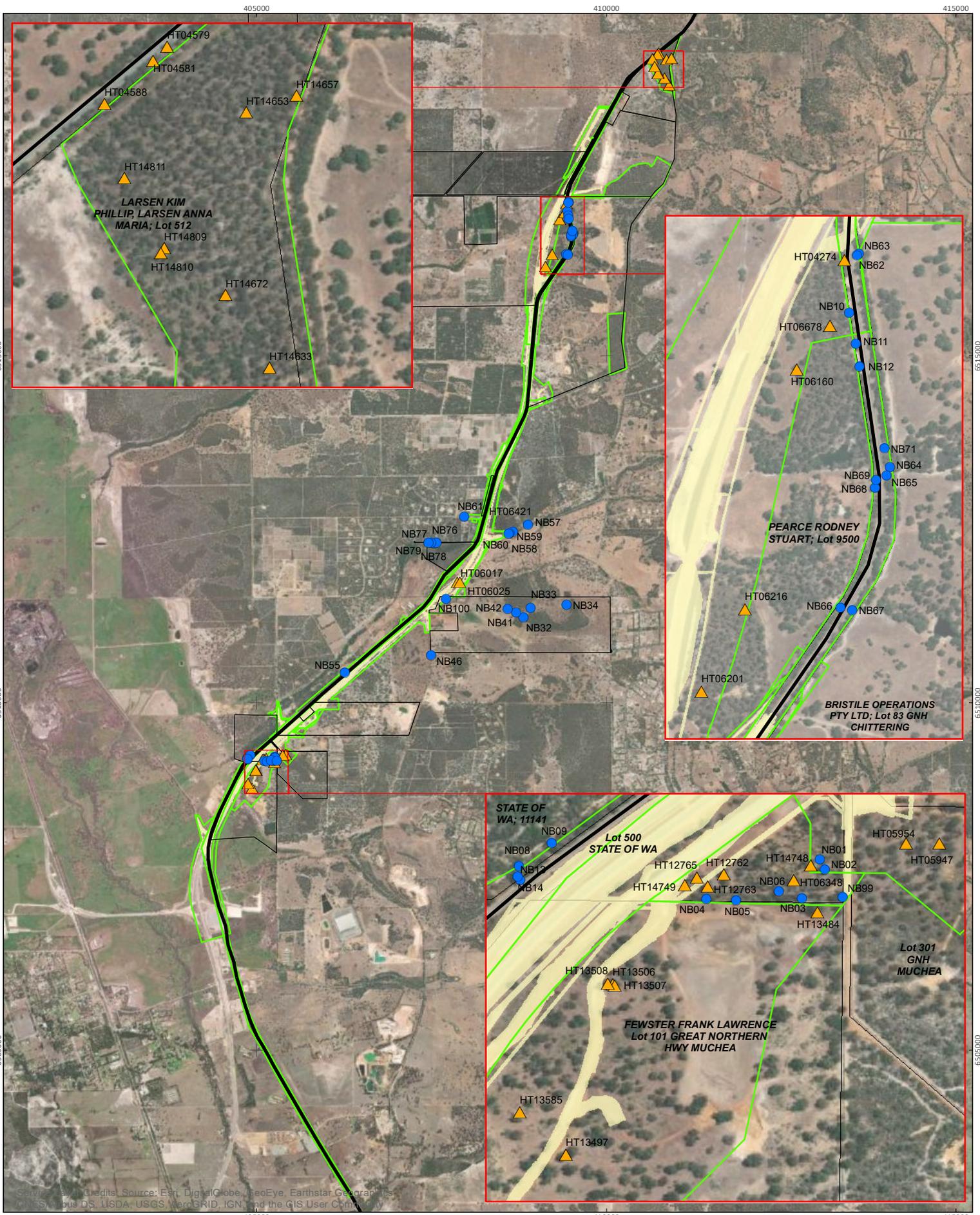
A native vegetation clearing permit (NVCP) for Muchea North (Permit no. 7563/2) has been approved by the WA Department of Water and Environmental Regulation (DWER) under the *Environmental Protection Act 1986* (EP Act).

To support Condition 4c of EPBC 2016/7656, Main Roads commissioned Phoenix to undertake monitoring of confirmed and suitable nesting hollows recorded within the EPBC Act Approval Boundary and wider baseline survey area (Phoenix 2015, 2017a) (the study area; Figure 1). A series of monitoring events have taken place to support this condition (Table 1). The initial baseline monitoring program was conducted in the 2017-18 breeding season (August 2017 – February 2018) and assessed hollow usage of suitable nesting hollows and hollows with evidence of use within the study area (Phoenix 2018). A second year of monitoring for hollow usage within the study area in the 2018-19 breeding season was undertaken by Phoenix from August 2018 to February 2019 (Phoenix 2019). The artificial nesting hollows were installed during the 2018-2019 breeding season, therefore the results of these first two surveys collectively represent the pre-impact breeding density.

Impact monitoring was subsequently conducted in the 2019-2020 breeding season (Phoenix 2020) and the 2020-2021 season. This report incorporates the results of the 2020-2021 monitoring season into the nesting hollow usage dataset for Muchea North.

Table 1 Summary of black cockatoo monitoring activity

Year	Activity
2014-2016 Various times	Habitat assessment including recording all potential breeding trees and suitability for nesting.
2017-2018 August to January	Baseline assessment: Assessment of nest hollows for evidence of breeding.
2018-2019 August to February	Baseline assessment: Assessment of nest hollows for evidence of breeding. <i>Road works commenced and artificial nesting hollows were installed during this breeding season.</i>
2019-2020 August to January	Assessment of both natural nest hollows and artificial nesting hollows for evidence of breeding
2020-2021 August to February	Assessment of both natural nest hollows and artificial nesting hollows for evidence of breeding



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No 1333
Date 09-Mar-21
Drawn by AJ
Map author AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Disturbance footprint
- Road
- Artificial nesting hollow
- ▲ Natural nesting hollow

Figure 1
Study area and sampling sites



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1.2 SCOPE OF WORK

The scope of work was as follows:

- Six rounds of monitoring of artificial and natural nest hollows to be undertaken between August 2020 and January 2021.
- During inspections of artificial and natural hollows, record evidence of use by Carnaby's Cockatoos at each artificial and natural hollow in accordance with (DPaW 2015).
- During inspections, identify any artificial nest box maintenance needs in accordance with (DPaW 2015) and whether natural hollows remain suitable for use by Carnaby's Black Cockatoo.
- Provide a report that summarises all records required by Conditions 4f(i) and (ii) of EPBC 2016/7656 for all artificial and natural hollows inspected. The draft report shall be provided to Main Roads in electronic PDF and Word version copy format.

2 CENSUS METHODOLOGY (DPAW 2015)

Methods were consistent with the approach undertaken in previous monitoring events for Muchea North (Phoenix 2018, 2019, 2020).

Prior to the surveys, site locations (artificial and natural nest hollows) were loaded onto field tablets. Data was collected electronically using a customised data collection template and included:

- site code
- signs of use – birds prospecting hollows, fresh chewings, birds perching, birds entering/existing hollows, birds flushed from hollows, gender of observed birds, chick calls, eggs observed (inc. status if possible – incubated or abandoned), chick/s observed, chick/s fledged
- other indicators, e.g. gender mix of flocks, evidence of nesting at base of trees
- condition of hollow, current suitability for use (natural hollows), maintenance requirements (artificial hollows).

The knocking and scraping method was conducted at the base of trees for all monitored hollows. Other observational methods were also employed, i.e. pole camera inspections of hollows where possible, listening for nest activity, flock and individual bird behaviour.

Consistent with previous methodology the following activities were undertaken:

- evidence of nesting activity was noted where fresh chewing is around the hollow entrance and/or birds are seen prospecting hollows.
- a confirmed breeding event was noted where eggs are seen in hollow and/or other clear evidence observed that a chick is present (i.e. female seen at hollow entrance when during brooding eggs, and/or parents seen preparing to feed chick in the hollow).

Maintenance checks of artificial hollows will assess the following as a minimum:

- condition of chewing posts
- condition of attachment points
- condition of hollow bases
- stability of tree or pole used to mount the artificial hollow.

As per previous surveys, site visits were undertaken every 4-5 weeks between August 2020 and January 2021: 24 August, 22 September, 26 October, 27 November, 31 December and 07 February.

The baseline surveys for Muchea North identified a total of 57 trees in the study area containing suitable nesting hollows for black cockatoos, of which 25 had evidence of nesting activity (Table 2). In the initial survey, 37 of these were monitored as the remaining 20 were unable to be assessed due to access constraints.

In the 2018-19 season, 47 natural nesting hollows and 36 artificial nesting hollows were monitored (Table 2). This included two new natural hollows added to the census in the current season and 14 trees that were not accessible in the 2017-18 season. Twelve further natural nesting hollows were not monitored; five of these were not able to be accessed, three were not relocated and four hollows were removed from monitoring in the 2017-18 season due to collapse, cracks forming or tree death.

In the 2019-2020 season, 73 hollows were monitored, of which 33 were natural nesting hollows and 40 were artificial nesting hollows (Table 2). Prior to that survey, 13 trees which contained suitable nesting hollows were removed as part of the GNH road upgrades (HT05911, HT05923, HT06020, HT06046, HT06261, HT06278, HT06655, HT08752, HT08753, HT08754, HT13533, HT13534 and HT13535), 12 of these were monitored in the previous two monitoring programs and one was not accessible. These 13 trees were offset by the installation of the 39 artificial nesting hollows of which all were able to be monitored in the 2019-2020 season. An additional artificial nesting hollow (NB100) was included in the survey which was erected to replace HT04059. Four natural nesting hollows from the baseline dataset that had not been monitored in the previous two years were able to be surveyed in the 2019-2020 season because landowner access had been granted. Four trees with natural nesting hollows were not surveyed in the 2019-2020 season because the tree or hollow was no longer considered suitable.

In the current 2020-2021 survey, the same trees and artificial nesting hollows from the 2019-2020 season were monitored.

In this report:

- *confirmed breeding event* – means eggs were seen in hollow and/or other clear evidence observed that chick was present (i.e. female seen at hollow entrance when brooding eggs and/or parents seen preparing to feed chick in the hollow)
- *evidence of nesting activity* – means chewing around the hollow entrance and/or bird seen prospecting hollows. It does not necessarily mean that a breeding event took place that year; however, it is evidence that the hollow is suitable and was considered and may have been used in previous years.

Table 2 Monitored hollows

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
HT04059	Evidence of nesting activity, artificial hollow	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT04274	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT04579 (NB)	Suitable, artificial hollow, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT04581 (NB)	Suitable, artificial hollow, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT04588 (NB)	Suitable, artificial hollow, no evidence of breeding	<i>Eucalyptus accedens</i>	Yes	Yes	Yes	Yes
HT05911	Suitable, artificial hollow, no evidence of breeding	<i>Eucalyptus accedens</i>	No access	No access	No (tree cleared)	n/a
HT05923	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT05938	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	No	No (not suitable – hollow has cracked or degraded)	n/a
HT05947	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	No	Yes	Yes
HT05954	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT06017	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT06020	Suitable, no evidence of breeding	<i>Corymbia calophylla</i>	No access	Yes	No (tree cleared)	
HT06025	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT06046	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	No (tree cleared)	n/a
HT06148	Suitable, no evidence of breeding	<i>Corymbia calophylla</i>	Yes	No	No (not suitable – hollow has cracked or degraded)	n/a
HT06160	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT06201	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT06216	Suitable, no evidence of breeding	<i>Eucalyptus marginata</i>	Yes	Yes	Yes	Yes
HT06261	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
HT06278	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT06330	Not currently suitable	<i>Eucalyptus wandoo</i>	No	Yes	No (tree cleared)	n/a
HT06348	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT06421	Evidence of nesting activity	<i>Corymbia calophylla</i>	No access	No access	No (no access)	n/a
HT06655	Suitable, no evidence of breeding	<i>Corymbia calophylla</i>	Yes	No	No (tree cleared)	n/a
HT06678	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT08752	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT08753	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT08754	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	No access	Yes	No (tree cleared)	n/a
HT12761	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	No	No	Yes	No (not suitable – hollow has cracked or degraded)
HT12762	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT12763	Evidence of nesting activity (FRTBC)	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT12765	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT13484	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT13497	Suitable, no evidence of breeding	<i>Eucalyptus marginata</i>	No access	Yes	Yes	Yes
HT13503	Suitable, no evidence of breeding	<i>Eucalyptus marginata</i>	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13505	Suitable, no evidence of breeding	<i>Eucalyptus sp.</i>	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13506	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT13507	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT13508	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	Yes	Yes
HT13511	Suitable, no evidence of breeding	<i>Corymbia calophylla</i>	No access	Yes	No (not suitable –	n/a

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Prepared for Main Roads WA

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
					hollow has cracked or degraded)	
HT13523	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	Yes	No (not suitable – hollow has cracked or degraded)	n/a
HT13533	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT13534	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT13535	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	No (tree cleared)	n/a
HT13585	Not currently suitable	<i>Corymbia calophylla</i>	No	Yes	Yes	Yes
HT14633	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14653	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14657	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14670	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	No	No (not suitable – hollow collapsed)	n/a
HT14672	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14748	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14749	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14805	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14806	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14807	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	No access	No (not suitable – hollow has cracked or degraded)	n/a
HT14808	Suitable, no evidence of breeding	<i>Eucalyptus wandoo</i>	No access	No access	No (not suitable – hollow has	n/a

Black cockatoo breeding activity census 2020-21 for Muchea North

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HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
					cracked or degraded)	
HT14809	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14810	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
HT14811	Evidence of nesting activity	<i>Eucalyptus wandoo</i>	Yes	Yes	Yes	Yes
NB01	n/a	n/a	n/a	Yes	Yes	Yes
NB02	n/a	n/a	n/a	Yes	Yes	Yes
NB03	n/a	n/a	n/a	Yes	Yes	Yes
NB04	n/a	n/a	n/a	Yes	Yes	Yes
NB05	n/a	n/a	n/a	Yes	Yes	Yes
NB06	n/a	n/a	n/a	Yes	Yes	Yes
NB08	n/a	n/a	n/a	Yes	Yes	Yes
NB09	n/a	n/a	n/a	Yes	Yes	Yes
NB10	n/a	n/a	n/a	Yes	Yes	Yes
NB11	n/a	n/a	n/a	Yes	Yes	Yes
NB12	n/a	n/a	n/a	Yes	Yes	Yes
NB13	n/a	n/a	n/a	Yes	Yes	Yes
NB14	n/a	n/a	n/a	Yes	Yes	Yes
NB32	n/a	n/a	n/a	Yes	Yes	Yes
NB33	n/a	n/a	n/a	Yes	Yes	Yes
NB34	n/a	n/a	n/a	n/a	Yes	Yes
NB41	n/a	n/a	n/a	n/a	Yes	Yes
NB42	n/a	n/a	n/a	n/a	Yes	Yes
NB46	n/a	n/a	n/a	Yes	Yes	Yes
NB55	n/a	n/a	n/a	Yes	Yes	Yes
NB57	n/a	n/a	n/a	Yes	Yes	Yes
NB58	n/a	n/a	n/a	Yes	Yes	Yes
NB59	n/a	n/a	n/a	Yes	Yes	Yes
NB60	n/a	n/a	n/a	Yes	Yes	Yes
NB61	n/a	n/a	n/a	Yes	Yes	Yes
NB62	n/a	n/a	n/a	Yes	Yes	Yes
NB63	n/a	n/a	n/a	Yes	Yes	Yes
NB64	n/a	n/a	n/a	Yes	Yes	Yes
NB65	n/a	n/a	n/a	Yes	Yes	Yes
NB66	n/a	n/a	n/a	Yes	Yes	Yes
NB67	n/a	n/a	n/a	Yes	Yes	Yes
NB68	n/a	n/a	n/a	Yes	Yes	Yes
NB69	n/a	n/a	n/a	Yes	Yes	Yes

HT ID*	Baseline records (pre-2017)	Species	2017-18	2018-19	2019-20	2020-21
NB71	n/a	n/a	n/a	Yes	Yes	Yes
NB76	n/a	n/a	n/a	Yes	Yes	Yes
NB77	n/a	n/a	n/a	Yes	Yes	Yes
NB78	n/a	n/a	n/a	Yes	Yes	Yes
NB79	n/a	n/a	n/a	Yes	Yes	Yes
NB99	n/a	n/a	n/a	Yes	Yes	Yes
NB100	HT04059 was cleared and this nestbox was installed to replace it in 2019	n/a	n/a	n/a	Yes	Yes

* HT = habitat tree (natural); NB = nest box (artificial); HT (NB) = this tree had an artificial nest box installed prior to the baseline records (pre-2017) and has been counted as a natural habitat tree for the pre- and post- baseline analysis.

3 RESULTS

3.1 CENSUS RESULTS 2020-21 BREEDING SEASON

Confirmed breeding events were recorded in 12 artificial nesting hollows and one natural nesting hollow during the 2020-2021 monitoring season (Table 3; Figure 2). Evidence of nesting activity was observed in a further seven artificial nesting hollows and six natural nesting hollows (Table 3; Figure 2).

Of the confirmed breeding events:

- HT14809, NB01, NB03, NB32, NB34, NB41, NB62, NB71 and NB78 – are presumed to have resulted in successful fledging of a chick. Images of chicks were seen with a camera in all three artificial nest hollows between October and February 2020 (Figure 3).
- NB10 – a single egg was seen in the nest in October but the nest was empty in December. The nest could not be accessed in November so unsure if this chick fledged or was predated.
- NB12, NB63 and NB99 – two addled or broken eggs were observed with a camera in the hollow in October and November 2020.

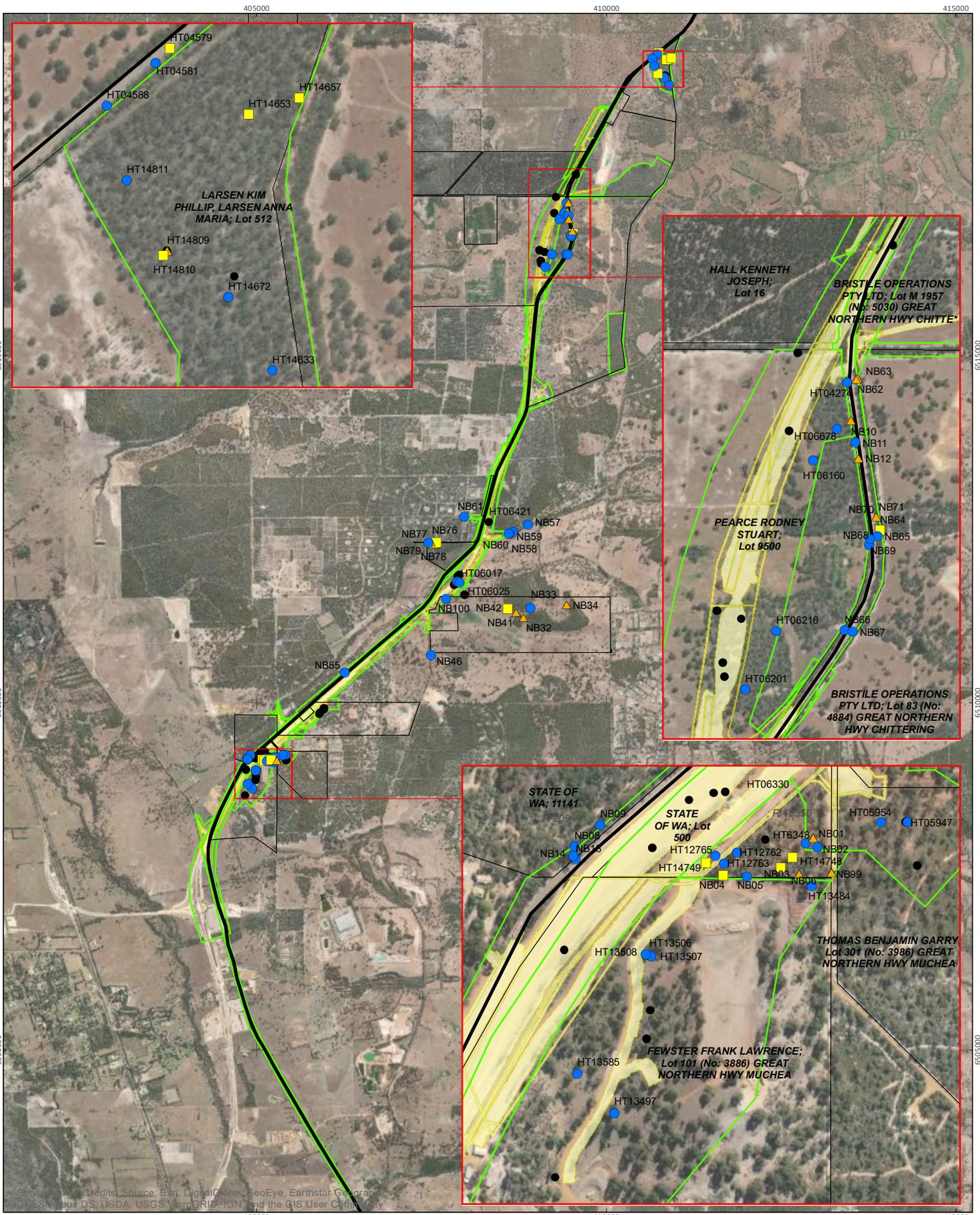
There were eight instances where females were flushed from a hollow but a later inspection saw no chicks or eggs and the bird was likely to be prospecting. A further five had observations of prospecting birds or recent chewing around the hollow or on the post. No evidence of nesting activities were observed in the remaining natural nesting hollows or artificial nesting hollows (Appendix 1).

Table 3 Evidence of breeding records by Phoenix during the 2020-21 census

HT ID	Inspection date						Result
	24/08/2020	22/09/2020	26/10/2020	27/11/2020	31/12/2020	07/02/2021	
HT04579 (NB)^				Post chewed			Evidence of nesting activity
HT06348			Carnaby flushed				Evidence of nesting activity
HT14653				Chewed entrance, pair prospecting			Evidence of nesting activity
HT12657		Female prospecting		Pair prospecting			Evidence of nesting activity
HT14749			Carnaby flushed				Evidence of nesting activity
HT14809			Carnaby flushed	Pin feathered chick	Large- feathered chick	Chick fledged	Confirmed breeding event: assumed successful
HT14810		Carnaby flushed					Evidence of nesting activity
NB01			Carnaby flushed	Pin feathered chick in nest	Large- feathered chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB03				Small chick and addled egg	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB04				Flushed female Carnaby, likely to be prospecting hollow	No flush, no eggs in hollow		Evidence of nesting activity
NB06		Carnaby flushed					Evidence of nesting activity
NB10		Carnaby flushed	Single egg in nest	No access			Confirmed breeding event: uncertain outcome
NB12			Carnaby flushed	2 broken eggs			Confirmed breeding event: unsuccessful

HT ID	Inspection date						Result
	24/08/2020	22/09/2020	26/10/2020	27/11/2020	31/12/2020	07/02/2021	
NB32			Carnaby flushed	Check in nest	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB34			Prospecting female	Single egg in nest	Chick in nest	Chick fledged	Confirmed breeding event: assumed successful
NB41		Carnaby flushed	Chick in nest				Confirmed breeding event: assumed successful
NB42					Pair of Carnaby prospecting		Evidence of nesting activity
NB62	Carnaby flushed	Carnaby flushed	Downy chick in nest	Large-feathered chick in nest	Chick fledged		Confirmed breeding event: assumed successful
NB63	Carnaby flushed	Carnaby flushed	Cracked egg in nest				Confirmed breeding event: unsuccessful
NB64	Carnaby flushed			<i>Chick in natural hollow underneath NB64</i>			Evidence of nesting activity (Confirmed breeding event: assumed successful - in a natural hollow under the box in the same tree)
NB71			Carnaby flushed	Nestling in hollow	Feathered chick in hollow	Chick fledged	Confirmed breeding event: assumed successful
NB76		Heavily chewed post					Evidence of nesting activity
NB77			Carnaby flushed				Evidence of nesting activity
NB78		Carnaby flushed		Pin-feathered chick	Chick fledged		Confirmed breeding event: assumed successful
NB79			Post chewed				Evidence of nesting activity
NB99		Pair at nest, female stays		Two addled or broken eggs			Confirmed breeding event: unsuccessful

^ this tree had an artificial nest box installed prior to the baseline records (pre-2017).



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No 1333
Date 19-Feb-21
Drawn by AJ
Map author AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

- Study area
 - Disturbance footprint
 - Road
- Results**
- ▲ Confirmed breeding event
 - Evidence of nesting activity
 - No evidence of breeding
 - Not surveyed (no access/no longer suitable, cleared)

Figure 2

Monitoring results for 2020-21 breeding season

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Figure 3 Pin-feathered chick a nest box (November 2020)



Figure 4 Almost ready to fledge (December 2020)

3.2 COMPARISON BETWEEN BREEDING SEASONS

The number of hollows which had either confirmed Carnaby's Cockatoo breeding events in the 2020-21 breeding season is significantly higher than both the pre-impact average and the previous year's (2019-2020) post-impact survey. Overall, the number of confirmed breeding events in 2020-2021 (13) was more than double that of the pre-impact average of five (Table 4). Evidence of nesting activity has also been higher in the two post impact monitoring events than the pre-impact average (Table 4). The current breeding season was slightly lower than the previous year, but this was offset but a much higher number of confirmed breeding events.

Most significantly, the results of the monitoring program clearly show a trend toward increased usage of the artificial nesting hollows installed under the Muchea North offset. The nest boxes were installed during the 2018-2019 breeding season so there were few records of use of these during that season, with only one confirmed breeding event and two records of evidence of nesting activity (Table 4). This increased in the 2019-2020 breeding season to three confirmed breeding events and 11 records of nesting activity in the artificial nesting hollows. In 2020-2021, the number of confirmed breeding events in the artificial nesting hollows increased by 400% to 12, with the majority assumed to have had a successful outcome i.e., a chick hatched and fledged (Table 4).

In contrast, the number of confirmed breeding events in natural nest hollows declined from three in 2020-2021 to one in the current breeding season. The results suggest the birds are preferentially choosing the artificial hollows over the natural hollows.

Repeated use of the same hollows for breeding was also apparent from the 2020-2021 season. All of the natural nesting hollows which had evidence of nesting or a confirmed breeding event in the current season also had evidence of use or a confirmed breeding in previous breeding seasons.

Of the 19 new artificial nesting hollows which recorded evidence of nesting activity or a confirmed breeding event in the current breeding season, six had evidence of nesting activity in the previous (2019-20) season and three had a successful breeding event. The three artificial nesting boxes that recorded a confirmed breeding event in 2019-2020 also had confirmed breeding in 2020-2021.

Breeding events and evidence of nesting activity in the 2020-21 season were identified in the same general areas as in the previous seasons, including the three areas that were identified as having a higher rate of breeding activity, Reserve 40350 and Lot 512, and the old GNH adjacent to Lot 9500. An additional cluster of activity was identified at Nesci Estate and the surrounding road reserve; this was a location where several artificial nesting hollows were installed after it was observed that Carnaby's Cockatoos were present in higher numbers, indicating the area could be a favourable breeding area (Phoenix 2017b).

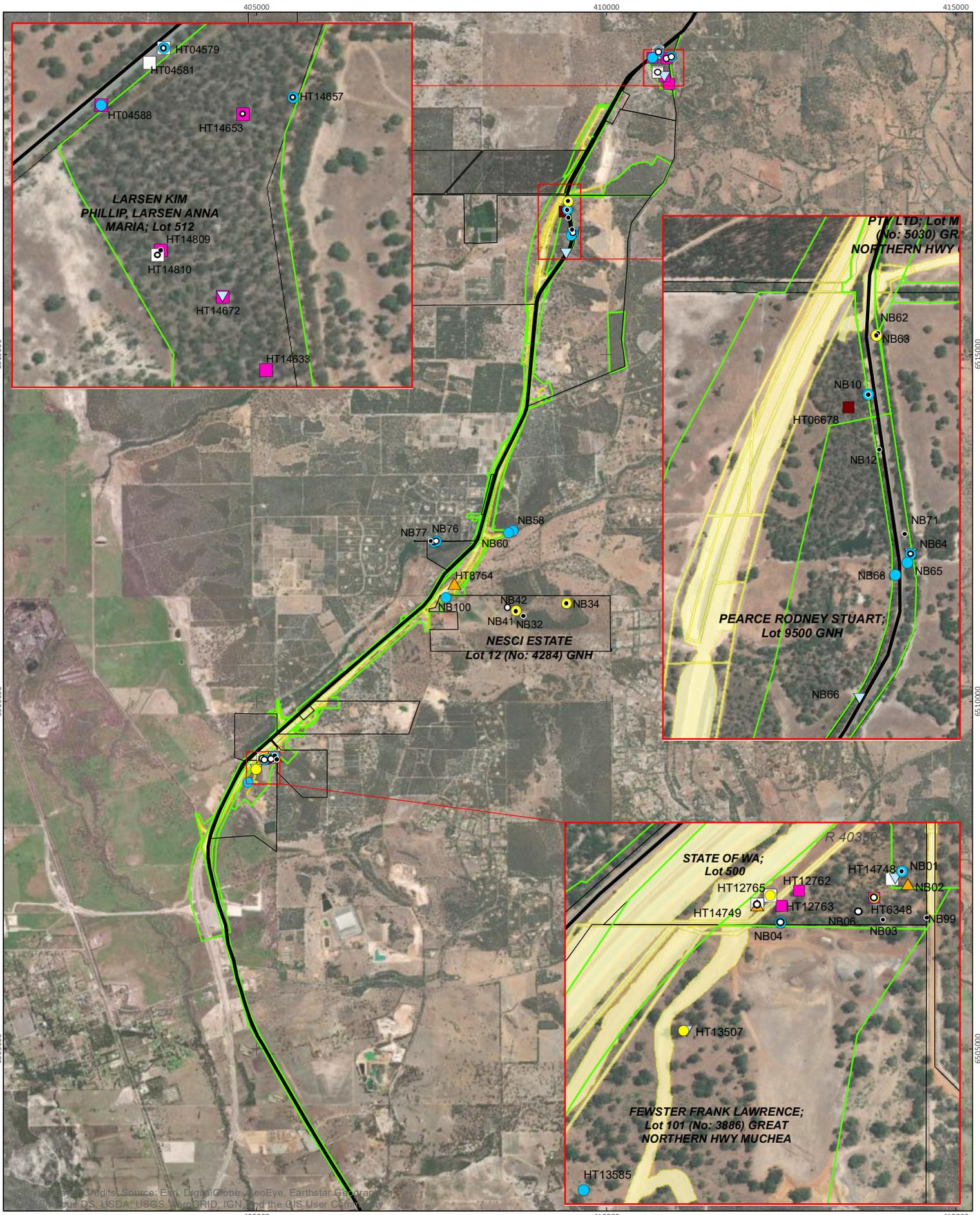
3.1 CONDITION OF ARTIFICIAL NESTING HOLLOWES

All of the artificial nesting hollows surveyed were observed to be in good condition.

Table 4 Summary of results for each breeding season

Result type	Baseline records pre 2017-18¹ Natural hollows and existing artificial hollows	2017-18 breeding season Natural hollows and existing artificial hollows	2018-19 breeding season All hollows (natural & existing artificial hollows/new artificial hollows)	Pre-impact average (2017-18 and 2018-19) All hollows	2019-20 breeding season All hollows (natural & existing artificial hollows/new artificial hollows)	2020-21 breeding season All hollows (natural & existing artificial hollows/new artificial hollows)	Post-impact average (2019-20 and 2020-21) All hollows
Confirmed breeding event	n/a	6	3 (2/1)	5	6 (3/3)	13 (1/12)	10 (2/8)
Evidence of nesting activity	24	14	5 (3/2)	10	15 (4/11)	13 (6/7)	14 (5/9)
No evidence of breeding	35	13	63 (30/33)	38	52 (26/26)	45 (24/21)	49 (25/23)
Total no. hollows surveyed	59	33	71	53	73	71	72
Trees not surveyed: no longer suitable, not accessible, cleared	n/a	26	25 (24/1)	23	17 (17/0)	19 (19/0)	18

¹ Evidence of nesting activity recorded at some point. Not annual census data and cannot be compared with annual census results.



Main Roads WA
Great Northern Highway, M2W Upgrade Project

Project No 1333
Date 19-Mar-21
Drawn by AJ
Map author AJ

0 1 2
Kilometers

1:70,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Disturbance
- 2020-2021 breeding**
 - Confirmed breeding
 - Evidence of nesting activity
- 2019-2020 breeding**
 - Confirmed breeding
 - Evidence of nesting activity

- 2018-2019 breeding**
 - ▲ Confirmed breeding
 - ▼ Evidence of nesting activity
- 2017-2018 breeding**
 - Confirmed breeding
 - Evidence of nesting activity

Figure 5
Confirmed breeding events and evidence of nesting activity across breeding seasons



4 CONCLUSION AND RECOMMENDATIONS

The 2020-2021 breeding season results indicate that breeding activity is occurring throughout the Muchea North area and that it is an important breeding area for Carnabys Cockatoo. This breeding season was remarkably more successful than previous seasons, with more than double the number of confirmed breeding events recorded compared to last breeding season and also the pre-impact average. Thirteen confirmed Carnaby's Cockatoo breeding events were observed in the 2020-21 season and evidence of nesting was observed in a further 13 hollows. Both natural and artificial nesting hollows showed activity but there was a clear trend towards confirmed breeding in the artificial nesting hollows.

The difference in nesting activity recorded between the breeding seasons is not unexpected as the sample size for this monitoring program is small and breeding activity can be highly variable between years; however, the increased rate of post-impact breeding observed over the past three years is promising for mitigating population decline.

The willingness of Carnabys Cockatoo to utilise the artificial nesting hollows as an alternative to natural nest hollows is evident from the 2020-2021 breeding data. Considering the artificial nesting hollows were installed during the 2018-2019 season, the uptake of many of these for breeding and several more with evidence of nesting activity in the first two years post-installation is encouraging, particularly this breeding season where the rate of confirmed breeding events is much higher in artificial nesting hollows than natural nesting hollows.

Of the 13 hollows with evidence of breeding, eight were from artificial nesting hollows (seven from the new and one from an existing artificial nesting hollows), and five from natural nesting hollows. This is a good indication that the artificial nesting hollows are providing a suitable alternative to natural nesting hollows and may even be preferred in the Muchea area.

The repeated use of the same hollows suggests that Carnaby's Cockatoo have preferred locations, either in the landscape, breeding areas or within the tree itself. Additional years of monitoring are required to confirm this notion.

The rate of unsuccessful breeding events is standard across the monitoring project so far.

All of the artificial nesting hollows were in good condition and none required any maintenance.

Due to the historic large-scale clearing of trees and continuing decline of suitable trees with hollows in the area, all remaining suitable nesting hollows in the study area should be considered of high value to Carnaby's Cockatoo.

Under EPBC 2016/7656 (DotEE 2018), condition 4d states: "*Adaptive management may cease when at least one artificial nesting hollow for each known nesting hollow cleared has shown evidence of use by the Carnaby's Black Cockatoo, as verified by the suitable qualified person, for three consecutive years; the artificial nesting hollow in use for three consecutive years need not be the same artificial nesting hollow each year*". At least one more year of monitoring is therefore required to demonstrate that condition 4d has been met.

For future monitoring of the nesting hollows, consistent methodology should be employed to that used in the 2019-2020 and 2020-2021 breeding censuses, including continuing the use of pole cameras to inspect suspected breeding events where possible.

5 REFERENCES

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Appendix 1 Results for all hollows in in the 2019-20 breeding season

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
HT04274	No flush	No flush	No flush	No flush	No flush	No flush
HT04579	No flush	No flush	No flush	Post chewed	No flush	No flush
HT04581	No flush	No flush	No flush	No flush	No flush	No flush
HT04588	No flush	No flush	No flush	No flush	No flush	No flush
HT05947	No flush	No flush	No flush	No flush	No flush	No flush
HT05954	No flush	No flush	No flush	No flush	No flush	No flush
HT06017	No flush	No flush	No flush	No flush	No flush	No flush
HT06025	No flush	No flush	No flush	No flush	No flush	No flush
HT06160	No flush	No flush	No flush	No flush	No flush	No flush
HT06201	No flush	No flush	No flush	No flush	No flush	No flush
HT06216	No flush	No flush	No flush	No flush	No flush	No flush
HT06330	No flush	No flush	No flush	No flush	No flush	No flush
HT06348	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
HT06678	No flush	No flush	No flush	No flush	No flush	No flush
HT12761	No flush	No flush	No flush	No flush	No flush	No flush
HT12762	No flush	No flush	No flush	No flush	No flush	No flush
HT12763	No flush	No flush	No flush	No flush	No flush	No flush
HT12765	No flush	No flush	No flush	No flush	No flush	No flush
HT13484	No flush	No flush	No flush	No flush	No flush	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
HT13497	No flush	No flush	No flush	No flush	No flush	No flush
HT13506	No flush	No flush	No flush	No flush	No flush	No flush
HT13507	No flush	No flush	No flush	No flush	No flush	No flush
HT13508	No flush	No flush	No flush	No flush	No flush	No flush
HT13585	No flush	No flush	No flush	No flush	No flush	No flush
HT14633	No flush	No flush	No flush	No flush	No flush	No flush
HT14653	No flush	No flush	No flush	Chewed entrance, pair prospecting	No flush	No flush
HT14657	No flush	Female prospecting	No flush	Pair prospecting	No flush	No flush
HT14672	No flush	No flush	No flush	No flush	No flush	No flush
HT14748	No flush	No flush	No flush	No flush	No flush	No flush
HT14749	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
HT14809	No flush	No flush	Carnaby flushed	Pin-feathered chick	Large-feathered chick	Chick fledged
HT14810	No flush	Carnaby flushed	No flush	No flush	No flush	No flush
HT14811	No flush	No flush	No flush	No flush	No flush	No flush
NB01	No flush	No flush	Carnaby flushed	Pin feathered chick in nest	Large-feathered chick in nest	Chick fledged
NB02	No flush	No flush	No flush	No flush	No flush	No flush
NB03	No flush	No flush	No flush	Small chick in nest	Chick in nest	Chick fledged
NB04	No flush	No flush	No flush	Flushed female CBC, likely to be prospecting	No flush, no eggs in hollow	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
NB05	No flush	No flush	No flush	No flush	No flush	No flush
NB06	No flush	Carnaby flushed	No flush	No flush	No flush	No flush
NB08	No flush	No flush	No flush	No flush	No flush	No flush
NB09	No flush	No flush	No flush	No flush	No flush	No flush
NB10	No flush	Carnaby flushed	Single egg in nest	No access	No flush	No flush
NB11	No flush	No flush	No flush	No flush	No flush	No flush
NB12	No flush	No flush	Carnaby flushed	2 broken eggs	No flush	No flush
NB13	No flush	No flush	No flush	No flush	No flush	No flush
NB14	No flush	No flush	No flush	No flush	No flush	No flush
NB32	No flush	No flush	Carnaby flushed	Check in nest	Chick in nest	Chick fledged
NB33	No flush	No flush	No flush	No flush	No flush	No flush
NB34	No flush	No flush	Prospecting female	Single egg in nest	Chick in nest	Chick fledged
NB41	No flush	Carnaby flushed	Chick in nest	No flush	No flush	No flush
NB42	No flush	No flush	No flush	No flush	Pair of Carnaby's prospecting	No flush
NB46	No flush	No flush	No flush	No flush	No flush	No flush
NB55	No flush	No flush	No flush	No flush	No flush	No flush
NB57	No flush	No flush	No flush	No flush	No flush	No flush
NB58	No flush	No flush	No flush	No flush	No flush	No flush
NB59	No flush	No flush	No flush	No flush	No flush	No flush
NB60	No flush	No flush	No flush	No flush	No flush	No flush

HT ID	24/08/20	22/09/20	26/10/ 20	27/11/20	31/12/20	07/02/2021
NB61	No flush	No flush	No flush	No flush	No flush	No flush
NB62	Carnaby flushed	Carnaby flushed	Downy chick in nest	Large-feathered chick in nest	No flush	No flush
NB63	Carnaby flushed	Carnaby flushed	Cracked egg in nest	No flush	No flush	No flush
NB64	Carnaby flushed	No flush	No flush	<i>Chick in natural hollow underneath NB64</i>	No flush	No flush
NB65	No flush	No flush	No flush	No flush	No flush	No flush
NB66	No flush	No flush	No flush	No flush	No flush	No flush
NB67	No flush	No flush	No flush	No flush	No flush	No flush
NB68	No flush	No flush	No flush	No flush	No flush	No flush
NB69	No flush	No flush	No flush	No flush	No flush	No flush
NB71	No flush	No flush	Carnaby flushed	Nestling in hollow	Feathered chick in hollow	Chick fledged
NB76	No flush	Heavily chewed post	No flush	No flush	No flush	No flush
NB77	No flush	No flush	Carnaby flushed	No flush	No flush	No flush
NB78	No flush	Carnaby flushed	No flush	Pin-feathered chick	Chick fledged	No flush
NB79	No flush	No flush	Post chewed	No flush	No flush	No flush
NB99	No flush	Pair prosecting	No flush	Two old eggs	No flush	No flush
NB100	No flush	No flush	No flush	No flush	No flush	No flush

Appendix 2 Results for all hollows in all breeding seasons

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT04059	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT04274	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT04579	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT04581	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT04588	Evidence of nesting activity	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
HT05911	No access	Hollow not located	Tree cleared. Further monitoring not required	n/a
HT05923	No evidence of breeding	Tree cleared. Further monitoring not required	n/a	n/a
HT05938	No longer suitable hollow. Further monitoring not required	n/a	n/a	n/a
HT05947	No evidence of breeding	Not located	No evidence of breeding	No evidence of breeding
HT05954	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06017	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06020	No access	Tree cleared. Further monitoring not required	n/a	n/a
HT06025	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06046	No access	Tree cleared. Further monitoring not required	n/a	n/a
HT06148	No longer suitable. Further monitoring not required	n/a	n/a	n/a
HT06160	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06201	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT06216	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT06261	No evidence of breeding	Tree cleared. Further monitoring not required.	n/a	No evidence of breeding
HT06278	Evidence of nesting activity	Tree cleared. Further monitoring not required.	n/a	No evidence of breeding
HT06330	Not sampled	No evidence of breeding. Added to breeding census in 2018-19	No evidence of breeding	No evidence of breeding
HT06348	Evidence of nesting activity	No evidence of breeding	Confirmed breeding event - failed	Evidence of nesting activity
HT06421	No access. Evidence of nesting activity (from a distance)	No access	n/a	n/a
HT06655	No longer suitable. Further monitoring not required	Tree cleared. Further monitoring not required	n/a	n/a
HT06678	Evidence of nesting activity (FRTBC)	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT08752	No evidence of breeding	Tree cleared. Further monitoring not required	n/a	n/a
HT08753	Evidence of nesting activity	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT08754	No access	Confirmed breeding event	Tree cleared. Further monitoring not required	n/a
HT12761	Hollow not located	Hollow not located	No evidence of breeding	n/a
HT12762	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT12763	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT12765	Confirmed breeding event - successful	No evidence of breeding	Confirmed breeding event	No evidence of breeding
HT13484	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13497	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13503	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13505	No access	No longer suitable. Further monitoring not required	n/a	n/a

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT13506	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13507	No access	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT13508	No access	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT13511	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13523	No access	No longer suitable. Further monitoring not required	n/a	n/a
HT13533	No evidence of breeding	No evidence of breeding	Tree cleared. Further monitoring not required	n/a
HT13534	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a	n/a
HT13535	Evidence of nesting activity	Tree cleared. Further monitoring not required	n/a	n/a
HT13585	Not sampled	No evidence of breeding. Added to breeding census in 2018-19, chewing observed at hollow	Evidence of nesting activity	No evidence of breeding
HT14633	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	No evidence of breeding
HT14653	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT14657	No evidence of breeding	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
HT14670	Collapsed, no longer suitable. Further monitoring not required	n/a	n/a	n/a
HT14672	Evidence of nesting activity	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14748	Confirmed breeding event - successful	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
HT14749	Confirmed breeding event - successful	Confirmed breeding event	No evidence of breeding	Evidence of nesting activity
HT14805	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14806	No access	No access	No longer suitable. Further monitoring not required	n/a

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
HT14807	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14808	No access	No access	No longer suitable. Further monitoring not required	n/a
HT14809	Evidence of nesting activity	No evidence of breeding	No evidence of breeding	Confirmed breeding event
HT14810	Confirmed breeding event - failed	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
HT14811	No evidence of breeding	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB01	n/a	No evidence of breeding	Evidence of nesting activity	Confirmed breeding event
NB02	n/a	Confirmed breeding event	No evidence of breeding	No evidence of breeding
NB03	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB04	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
NB05	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB06	n/a	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
NB08	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB09	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB10	n/a	No evidence of breeding	Evidence of nesting activity	Confirmed breeding event
NB11	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB12	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB13	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB14	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB32	n/a	No evidence of breeding/no access	No evidence of breeding	Confirmed breeding event
NB33	n/a	No evidence of breeding/no access	No evidence of breeding	No evidence of breeding

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
NB34	n/a	n/a	Confirmed breeding event	Confirmed breeding event
NB41	n/a	n/a	Confirmed breeding event	Confirmed breeding event
NB42	n/a	n/a	No evidence of breeding	Evidence of nesting activity
NB46	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB55	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB57	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB58	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB59	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB60	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB61	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB62	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB63	n/a	No evidence of breeding	Confirmed breeding event	Confirmed breeding event
NB64	n/a	Evidence of nesting activity	Evidence of nesting activity	Evidence of nesting activity
NB65	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB66	n/a	Evidence of nesting activity	No evidence of breeding	No evidence of breeding
NB67	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB68	n/a	No evidence of breeding	Evidence of nesting activity	No evidence of breeding
NB69	n/a	No evidence of breeding	No evidence of breeding	No evidence of breeding
NB71	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB76	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity

HT ID	Result 2017-18	Result 2018-19	Result 2019-20	Result 2020-2021
NB77	n/a	No evidence of breeding	Evidence of nesting activity	Evidence of nesting activity
NB78	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB79	n/a	No evidence of breeding	No evidence of breeding	Evidence of nesting activity
NB99	n/a	No evidence of breeding	No evidence of breeding	Confirmed breeding event
NB100	n/a	n/a	Evidence of nesting activity	No evidence of breeding

