



Dundonnell Wind Farm:
First Year Annual Report – Bat and Avifauna
Management Plan

FINAL REPORT

Prepared for Tilt Renewables Pty Ltd

13 May 2022

Biosis offices

NEW SOUTH WALES

Albury

Phone: (02) 6069 9200
Email: albury@biosis.com.au

Newcastle

Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney

Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Western Sydney

Phone: (02) 9101 8700
Email: sydneyoffice@biosis.com.au

Wollongong

Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat

Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne (Head Office)

Phone: (03) 8686 4800
Email: melbourne@biosis.com.au

Wangaratta

Phone: (03) 5718 6900
Email: wangaratta@biosis.com.au

Document information

Report to: Tilt Renewables Australia Pty Ltd

Prepared by: Wyn Russell
Clare McCutcheon

Biosis project no.: 33578

File name: 33578.Dundonnell.WF.BAM.Plan.Yr1.Report.FINAL.20220512

Citation: Biosis 2022. Dundonnell Wind Farm: First Year Annual Report – Bat and Avifauna Management Plan. Report for Tilt Renewables Australia Pty Ltd. W. Russell and C. McCutcheon. Biosis Pty Ltd. Melbourne, VIC. Project no 33578

Document control

Version	Internal reviewer	Date issued
Draft version 01	IS	27/01/2022
Draft version 02	CPM	01/02/2022
Final version 01	CPM	13/05/2022

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Tilt Renewables Australia Pty Ltd: Eliza Budd, Cara Layton
- Skylos Ecology Pty Ltd: Tracy Lyten, Fiona Jackson
- Elmoby Ecology Pty Ltd: Emma Bennett
- Department of Environment, Land, Water and Planning for access to the Victorian Biodiversity Atlas and wetland spatial layers

Biosis staff involved in this project were:

- Ian, Smales, Jules Farquhar and Wyn Russell (Brolga and Peregrine Falcon surveys)
- Inka Veltheim and Mark Venosta (Brolga advice)
- Julian Turner (mapping)
- Ian Smales (quality assurance)

© Biosis Pty Ltd

This document is subject to copyright and may only be used for the purposes in respect of which it was commissioned and in accordance with the Terms of Engagement of the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Disclaimer: Biosis Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation and current industry best practice. The company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report content or for any purpose other than that for which it was intended.

Contents

1.	Introduction	1
1.1	Project background and scope of assessment	1
1.2	Location of the study area	1
2.	Methods	3
2.1	Brolga utilisation monitoring program	3
2.2	Targeted breeding Brolga surveys	5
2.3	Peregrine Falcon breeding surveys	5
2.4	Carcass search correction factor studies.....	6
2.4.1	Carcass persistence trial.....	6
2.4.2	Searcher efficiency trial.....	7
2.5	Brolga carcass survey preferred method trial.....	7
2.6	Routine carcass searches.....	8
2.6.1	Species identifications.....	8
2.7	Raptor and White-throated Needletail monitoring.....	9
2.8	Brolga mortality monitoring.....	9
2.9	Qualifications	10
2.9.1	Wetland and Brolga survey qualifications	10
2.10	Mapping.....	10
3.	Results and discussion	11
3.1	Brolga utilisation monitoring program results.....	11
3.2	Targeted breeding Brolga survey results	12
3.3	Peregrine Falcon breeding survey results.....	16
3.4	Carcass search correction factor studies.....	16
3.4.1	Carcass persistence trial.....	16
3.4.2	Searcher efficiency trial.....	17
3.5	Brolga carcass survey preferred method trial.....	17
3.6	Carcass searches.....	19
3.7	Raptor and White-throated Needletail monitoring.....	21
3.8	Brolga mortality monitoring.....	22
3.9	Summary of onsite activities	22
4.	BAM Plan species impact triggers	23
4.1	Grey-headed Flying-fox	23
4.1.1	Population scale and numbers	23
4.1.2	Significance of effects.....	24
4.2	White-throated Needletail	25
4.2.1	Population scale and numbers	25
4.2.2	Significance of effects.....	26

4.3	White-striped Free-tailed Bat	26
4.3.1	Population scale and numbers	26
4.3.2	Significance of effects	27
5.	Conclusion and recommendations	29
5.1	Brolga utilisation monitoring.....	29
5.2	Peregrine Falcon monitoring.....	29
5.3	Carcass search program	29
5.4	Carcass search correction factor studies.....	30
5.5	Brolga mortality survey method.....	30
	References.....	31
	Appendices	32
Appendix 1	Brolga breeding season survey detailed results	33
Appendix 2	Brolga flocking season survey detailed results	41
Appendix 3	Brolga targeted breeding surveys.....	51
Appendix 4	Peregrine Falcon breeding season survey detailed results.....	57
Appendix 5	Photos.....	59

Tables

Table 1	Brolga utilisation survey wetlands, Year 1	3
Table 2	Brolga utilisation survey schedule, Year 1	4
Table 3	Brolga targeted breeding survey schedule, Year 1	5
Table 4	Peregrine Falcon survey schedule, Year 1	6
Table 5	Brolga utilisation survey result summary.....	11
Table 6	Brolga breeding wetlands, Year 1	13
Table 7	Brolga breeding behaviour summary	13
Table 8	Peregrine Falcon breeding summary, Mount Fyans Wildlife Reserve	16
Table 9	Carcass persistence trial results	17
Table 10	Carcass searcher efficiency results.....	17
Table 11	Brolga carcass preferred survey method summary results (Elmoby Ecology 2020)	17
Table 12	Days required to survey using different Brolga carcass survey methods (Elmoby Ecology 2020).....	18
Table 13	Carcass search program species summary.....	19
Table 14	Wedge-tailed Eagle observation summary, Year 1	21
Table 15	Recommendations for survey method based on grass length and expected daily temperature highs	30

Figures

Figure 1	Dundonnell Wind Farm Brolga survey wetlands, Year 1	2
Figure 2	Dundonnell Wind Farm Brolga survey results, Year 1	15
Figure 3	Proportion of all Brolga carcass proxies found by each survey method (Elmoby Ecology 2020)	18
Figure 4	Locations of BAM Plan impact trigger carcass finds and additional White-striped Free-tailed Bats, Year 1	28

Photos

Photo 1	Pair of adult Brolga and juvenile foraging, wetland F, 21 October 2021	59
Photo 2	Adult Brolga with chick foraging inside predator-proof fence, wetland Q, 09 December 2021	59
Photo 3	Peregrine Falcon chick sitting at entrance of nest in quarry wall, Mount Fyans Wildlife Reserve, 20 October 2021	60
Photo 4	Juvenile Peregrine Falcon standing outside nest in quarry wall, Mount Fyans Wildlife Reserve, 17 November 2021	60
Photo 5	Adult Peregrine Falcon, Mount Fyans Wildlife Reserve, 7 December 2021	61
Photo 6	Adult Peregrine Falcon, Mount Fyans Wildlife Reserve, 7 December 2021	61

1. Introduction

1.1 Project background and scope of assessment

Biosis Pty Ltd (Biosis) was commissioned by Tilt Renewables Australia Pty Ltd (Tilt) to undertake Year 1 post-construction bird and bat utilisation monitoring program at the Dundonnell Wind Farm (DDWF), as outlined in the DDWF Bat and Avifauna Management (BAM) Plan prepared by Brett Lane and Associates Pty Ltd (BL&A 2018). The BAM Plan fulfils Conditions 52, 53 and 55 of Planning Permit No. 105/23858 (Planning Permit)), as part of the approval of the DDWF development. The DDWF consists of 80 turbines (189 metre maximum tip height, 39 metre minimum blade clearance) and key ancillary infrastructure such as access tracks, a substation and an operations and maintenance building.

The BAM Plan requires monitoring and reporting of:

- Brolga *Antigone rubicunda* breeding and flocking activity
- Peregrine Falcon *Falco peregrinus* breeding activity within the Mount Fyans Wildlife Reserve
- Carcass searches for birds and bats within the wind farm
- Flights of raptors and White-throated Needletail *Hirundapus caudacutus*
- Correction factor studies, including carcass persistence and searcher efficiency trials, to allow for mortality rates to be calculated for DDWF at the end of Year 2.

The carcass search program, correction factor studies and monitoring of raptor and White-throated Needletail flights were conducted by Skylos Ecology under contract to Biosis and as agreed by Tilt. Skylos Ecology also undertook a trial to determine the effectiveness of three different search methods for Brolga carcasses. Elmoby Ecology was also involved with the correction factor studies and the Brolga preferred survey method trial.

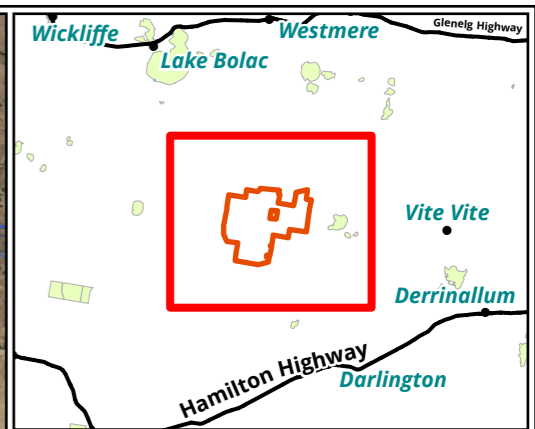
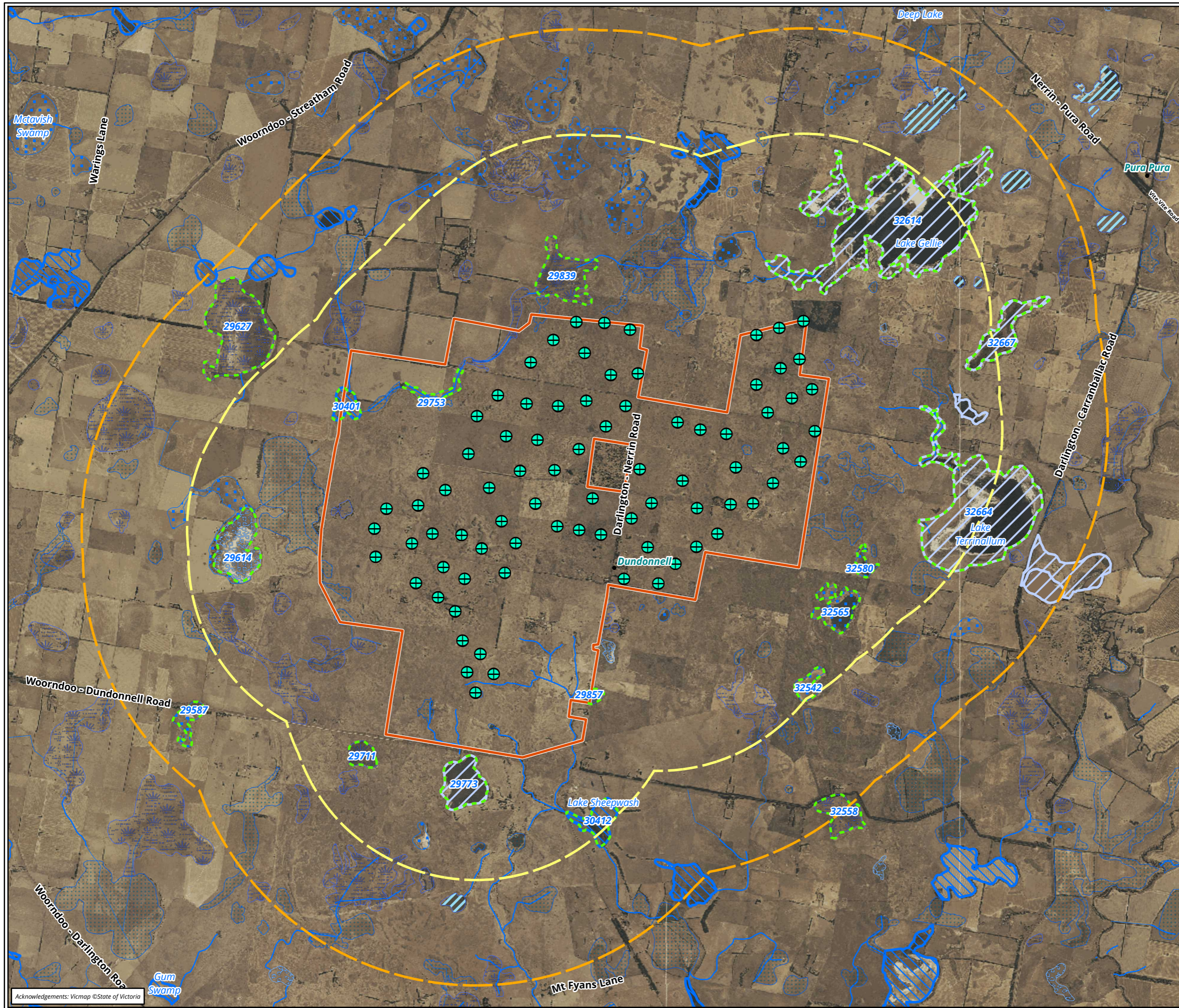
The Brolga and Peregrine Falcon monitoring was undertaken by Biosis. Biosis also assisted with carcass ID and reporting of results where required.

It is a requirement of the BAM Plan and Condition 53 of the Planning Permit that an annual report be prepared and submitted to the Department of Environment, Land, Water and Planning (DELWP) containing details of all BAM Plan activities undertaken during the reporting year. This report presents the findings of the first year (Year 1) of implementation of the BAM Plan at DDWF (November 2020 – October 2021). The first full analysis of all data will be presented in the Year 2 annual report, as specified in the BAM Plan.

1.2 Location of the study area

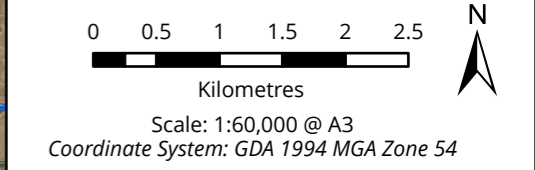
DDWF is located approximately 180 kilometres west of Melbourne and approximately 20 kilometres south-east of Lake Bolac (Figure 1). The DDWF area encompasses 4,200 hectares of grazing and cropping land. The study area is within the Moyne Shire Council and includes:

- Farmland within the wind farm boundary
- Farmland within a 3.2 kilometre and 5 kilometre radius around the perimeter of the wind turbines for brolga breeding and flocking monitoring respectively.
- The Mount Fyans Wildlife Reserve for Peregrine Falcon monitoring



- Legend**
- Wind farm site boundary
 - Turbine layout - 3.2 km buffer
 - Turbine layout - 5 km buffer
 - + Turbine
- Wetlands**
- 2 - Freshwater meadow
 - 3 - Shallow freshwater marsh
 - 4 - Deep freshwater marsh
 - 5 - Permanent open freshwater
 - 6 - Semi-permanent saline
 - 7 - Permanent saline
 - 99 - No Category
 - Surveyed

Figure 1 Dundonnell Wind Farm Broлга Survey Wetlands, Year 1



2. Methods

2.1 Brolga utilisation monitoring program

Brolga and waterbird surveys were conducted monthly at wetlands containing suitable Brolga habitat within 5 kilometres of the DDWF (Figure 1) during the Brolga flocking season (January to June), and within 3.2 kilometres during the breeding season (July to December). Survey wetlands were chosen by Biosis senior zoologists based on habitat quality, accessibility and past records of Brolga foraging, breeding and flocking (Table 1).

Three additional wetlands were incorporated into the survey plan after they were identified as suitable Brolga habitat (Table 1). Wetlands were either surveyed from roadsides or permission to access private property was obtained from landholders. Any landholder observations of Brolgas within the local area that were provided to Biosis were also recorded.

Surveys for Year 1 monitoring were conducted from December 2020 to October 2021, inclusive.

Table 1 Brolga utilisation survey wetlands, Year 1

Biosis Wetland ID	DEWLP Wetland ID	BL&A Wetland ID	Buffer	Survey seasons	Wetland type	
A	29627	118	5km	December 2020. January – August 2021 (Flocking)	Fresh water, shallow seasonal marsh	
B	29614	112	3.2km		Fresh water, permanent lake	
C	29711	138	3.2km		Fresh water, permanent lake	
D	29773	139	3.2km		Saline water, permanent lake	
E	30412	110	Both		Fresh water, shallow seasonal marsh	
F	32558	236	5km		Fresh water, shallow seasonal marsh	
G	29857	602	3.2km		Fresh water, semi-permanent dam	
H	32580	324	3.2km		Fresh water, semi-permanent dam	
I	32565	254	3.2km		December 2020. January – October 2021 (Flocking and Breeding)	Fresh water, permanent lake
J	32664	244	Both			Saline water, permanent lake
K	32667	243	Both	Saline water, semi-permanent lake		
L	32614	239	Both	Saline water, permanent lake. Lake Gellie.		
M	32614	608	3.2km	Saline water, permanent lake. Lake Gellie.		
N	29839	326	3.2km	Fresh water, shallow seasonal marsh		
O	30401	513	3.2km	Fresh water, permanent dam		

Biosis Wetland ID	DEWLP Wetland ID	BL&A Wetland ID	Buffer	Survey seasons	Wetland type
P	29753	117	3.2km	December 2020. June – October 2021 (Breeding)	Fresh water, shallow seasonal marsh
Q	29587	Not listed	5km	March – October 2021 (Breeding)	Fresh water, shallow seasonal marsh
R	32542	137	3.2km	December 2020. August – October 2021 (Breeding)	Fresh water, shallow seasonal marsh

Note: Wetland P was added to the survey plan from June 2021 onwards due to past Brolga nesting records in the area. Wetland Q was surveyed from March 2021 onwards after the landholder reported it was a regular Brolga nesting site. Wetland R was surveyed from August 2021 onwards after a pair of Brolgas was observed inhabiting it.

Surveys were conducted by a Biosis Zoologist during daylight hours using binoculars and a tripod-mounted spotting-scope. Local weather conditions were recorded at the start of each wetland survey using a 'Kestral-3000' weather meter. All relevant weather conditions that may affect survey effectiveness and local Brolga behaviour were recorded, including: precipitation, cloud cover, air temperature, wind speed and wind direction.

All Brolgas, wetland birds and raptors observed at the wetland were identified to species level, counted and recorded. Raptors were recorded as some species are known to predate on wetland birds and Brolga chicks, which may influence their numbers and behaviour. The behaviour of any Brolgas observed was also recorded, including flight patterns, foraging habits and breeding attempts.

Survey start and end time was recorded, with survey time at each wetland varying each between surveys, depending on: wetland size, accessibility, weather conditions, bird numbers and the behaviour of any Brolgas present. The Brolga utilisation survey schedule for Year 1 is summarised in Table 2 below.

Table 2 Brolga utilisation survey schedule, Year 1

Survey month	Survey type	Survey date	Surveyor	Position and qualifications
December	Breeding	16/12/2020 – 17/12/2020	Ian Smales	Principal Zoologist, MSc
January	Flocking	13/01/2021 – 14/01/2021	Jules Farquhar	Zoologist, BAppSci (Hons)
February	Flocking	11/02/2021 – 12/02/2021	Jules Farquhar	Zoologist, BAppSci (Hons)
March	Flocking	16/03/2021 – 17/03/2021	Jules Farquhar	Zoologist, BAppSci (Hons)
April	Flocking	13/04/2021 – 14/04/2021	Jules Farquhar	Zoologist, BAppSci (Hons)
May	Flocking	17/05/2021 – 18/05/2021	Jules Farquhar	Zoologist, BAppSci (Hons)
June	Flocking	15/06/2021 – 16/06/2021	Jules Farquhar Wyn Russell	Zoologist, BAppSci (Hons). Zoologist, BAppSci
July	Breeding	21/07/2021 – 22/07/2021	Wyn Russell	Zoologist, BAppSci
August	Breeding	11/08/2021 – 12/08/2021	Wyn Russell	Zoologist, BAppSci

Survey month	Survey type	Survey date	Surveyor	Position and qualifications
September	Breeding	15/09/2021 – 17/09/2021	Wyn Russell	Zoologist, BAppSci
October	Breeding	20/10/2021 – 22/10/2021	Wyn Russell	Zoologist, BAppSci

2.2 Targeted breeding Brolga surveys

Targeted surveys of breeding Brolgas were triggered by the observation of a pair of Brolgas nesting at a wetland within the 3.2 kilometre boundary of the DDWF (Wetland Q) in August 2021. Two additional pairs of Brolgas were observed displaying breeding behaviour at wetlands within 5 kilometres of the wind farm (Wetlands F and R).

In accordance with the BAM Plan, fortnightly surveys of the three pairs of Brolgas were subsequently conducted from August 2021 to track the outcome of their breeding attempts, and will continue through the breeding season until all chicks fledge or breeding attempts are determined to be unsuccessful (BL&A 2018). The fortnightly breeding Brolga surveys were conducted over two consecutive days, except in cases where scheduling was adjusted to coincide with Brolga utilisation surveys. Surveys were conducted using the same methods used in the Brolga utilisation monitoring program. The Brolga targeted breeding survey schedule for Year 1 is summarised in Table 3 below. The surveys continued into the Year 2 monitoring period.

Table 3 Brolga targeted breeding survey schedule, Year 1

Survey month	Survey wetlands	Survey dates	Surveyor	Position and qualifications
August	F, R and Q	25/08/2021 – 26/08/2021	Wyn Russell	Zoologist, BAppSci
September	F, R and Q	09/09/2021 – 10/09/2021, 16/09/2021 – 20/09/2021	Wyn Russell	Zoologist, BAppSci
October	F, R and Q	06/10/2021 – 07/10/2021, 20/10/2021 – 21/10/2021, 25/10/2021 – 26/10/2021	Wyn Russell	Zoologist, BAppSci

2.3 Peregrine Falcon breeding surveys

The BAM Plan outlines requirements for Peregrine Falcon monitoring at the Mount Fyans Wildlife Reserve. The Mount Fyans Wildlife Reserve encompasses approximately 52 hectares of Stony Knoll Shrubland/Plains Grassy Woodland/Plains Grassy Wetland Mosaic (Ecological Vegetation Class 714) in the centre of the DDWF (excluded from the DDWF site) and includes a decommissioned scoria stone quarry. The BAM Plan requires monitoring for Peregrine Falcon breeding activity and habitat use at the reserve during and immediately after the breeding season (August to December), as Peregrine Falcons have been recorded breeding within the quarry in the reserve prior to the construction of the DDWF.

Peregrine Falcon surveys were conducted in December 2020 and at least once per month from July 2021 to December 2021. Surveys were conducted by a Biosis Zoologist during daylight hours using binoculars and a tripod-mounted spotting-scope.

Surveys were conducted for a minimum of 30 minutes, during which time the surveyor would walk through the reserve from the access gate on the eastern side of the reserve to the quarry on the western edge. All birds observed or heard calling were identified to species level, counted and recorded. Behaviour of any Peregrine Falcons observed was recorded.

Local weather conditions were recorded at the start of each survey using a 'Kestral-3000' weather meter. All relevant weather conditions that may affect survey effectiveness and bird behaviour were recorded, including: precipitation, cloud cover, air temperature, wind speed and wind direction. The Brolga targeted breeding survey schedule for Year 1 is summarised in Table 4 below.

Table 4 Peregrine Falcon survey schedule, Year 1

Survey month	Survey dates	Surveyor	Position and qualifications
January	18/12/2020	Ian Smales	Principal Zoologist, MSc
July	21/07/2021	Wyn Russell	Zoologist, BAppSci
August	11/08/2021, 25/08/2021	Wyn Russell	Zoologist, BAppSci
September	10/09/2021, 15/09/2021	Wyn Russell	Zoologist, BAppSci
October	20/10/2021	Wyn Russell	Zoologist, BAppSci

2.4 Carcass search correction factor studies

2.4.1 Carcass persistence trial

Persistence trials determine how long a carcass persists in the survey area before being removed by scavenging animals such as foxes, ravens, and birds of prey. The results from carcass persistence trials are used to correct for the fact that scavenging reduces the number of bird and bat carcasses detected during routine carcass searches. Trials to determine the rate and speed of scavenging are therefore required to accurately determine the mortality rates of birds and bats via statistical analysis, which is required for DDWF at the completion of Year 2.

In the BAM Plan, carcass persistence (scavenger) trials were proposed to be undertaken by people frequently checking placed carcasses. In November 2020, Biosis proposed to DELWP that automated cameras be used instead, which have been found to have numerous advantages over the method outlined in the BAM Plan. The use of cameras is a far more precise method for determining the duration of carcass persistence (i.e. to either a precise time, or to within an interval of one hour, rather than an interval measured in days). This precision is important to subsequent estimation of total collisions. This method also has capacity for identification of scavengers; minimises the potential for scavengers to follow human scent trails and thus bias results; and is substantially more time and cost effective. It was subsequently determined to undertake the carcass persistence trials with automated cameras.

The trials were carried out twice by Skylos Ecology, once each in autumn and in spring, and each trial lasted for 30 days. Remote cameras mounted on existing fence posts were deployed to monitor carcasses. Cameras were checked at two weeks to ensure they were functioning and to replace batteries and SD cards. Cameras were set to take a photograph every hour. Mounting cameras on existing fence posts means that novel perch sites for scavenging birds are not introduced and obviates the problem for farm activities associated with putting them on new posts in paddocks or crops.

Scavenging animals sometimes move carcasses out of the camera field of view without completely removing them. Carcass persistence trials were therefore set up in the week prior to routine monthly carcass surveys to allow for any placed carcasses found to have been moved to be replaced to continue the persistence trial.

To determine the scavenge rates on birds and bats, the following categories of carcass were used:

- Microbats/small birds - 10

- Medium/large birds - 10 and
- Equivalents to the Brolga (turkeys) - 10

The birds / bat component of the trial was staggered with the turkeys, in order to reduce the amount of carcasses available for scavenging at each site, which was identified as having the potential to influence the data. Two additional cameras were set up in late April 2021 for the autumn trial, due to an error with the time lapse set up on two of the initial trial stations.

2.4.2 Searcher efficiency trial

Searcher efficiency trials determine the likelihood of a survey team detecting a carcass during formal surveys if one is present. This is a further important factor for use in estimation of the total number of collisions from the number of carcasses detected during searches.

The BAM Plan stipulates that searcher efficiency trials be undertaken concurrently with carcass persistence trials, however this was considered unnecessary. Appropriate natural and surrogate carcasses were available to undertake the trials separately, and the use of automated cameras for the carcass persistence trials are not compatible with the requirements for 'blind' searcher efficiency trials. Because dog teams were used for routine searches, searcher efficiency trials were undertaken during routine searches with carcasses placed by a person independent of the dog and handler teams. The use of dogs also obviates requirements for specifically spaced transect intervals as required for human searchers.

A total of 103 carcasses were placed randomly by an independent observer, Emma Bennett of Elmoby Ecology. A total of 38 bat carcasses, 28 bird carcasses and 37 large bird carcasses were placed randomly at turbines subject to monthly searches in both April 2021 and October 2021. These turbine locations were then surveyed by teams of dogs and handlers from Skylos Ecology as part of the monthly carcass search program.

2.5 Brolga carcass survey preferred method trial

In order to determine the optimal method for surveying for Brolga mortality at DDWF, a trial comparing the effectiveness of three separate survey methods (dog searches, human transect searches and human binocular searches) for detecting large bird carcasses was undertaken in accordance with the BAM Plan. The BAM Plan also includes the use of ATVs as a comparable search method, however subsequent risk assessments have ruled out this method due to well-documented safety risks associated with their operation. This method was therefore not included in the trial, and this was communicated to DELWP in November 2020. Comparisons between the remaining three survey methods included assessing and comparing the effort required to undertake each survey method, the effectiveness of each survey method given different vegetation conditions and the time consideration of each survey method. The Brolga carcass survey preferred method trial was undertaken by Skylos Ecology and Elmoby Ecology.

Field method

Grey turkey carcasses weighing 6 to 8 kilograms were used as proxies for Brolga carcasses for this study, and were the most suitable proxy for Brolga that was available. Wings were removed from half the carcasses to provide feather spots. Turbines used for the study were those that were subject to the monthly carcass search program, and each of those turbines were randomly allocated to have between 0 and 2 carcasses and 0 and 2 feather spots. The trial was restricted to a 120 metre radius of each turbine, as stipulated in the BAM Plan. Searches were undertaken over three days. Carcasses were removed and stored fresh overnight to prevent loss due to scavengers, and were redeployed the next day, for the duration of the trial.

2.6 Routine carcass searches

All surveys for bird and bat collision mortalities were undertaken by teams of handlers from Skylos Ecology with trained detection dogs. Searches were carried out using a pulsed monthly program at a selection of 27 turbines specified in the BAM Plan (BL&A 2018), with substitutions made where health and safety or landholder access issues were encountered. The selection of turbines was undertaken randomly by BL&A (2018), with the additional inclusion of turbine 038, to ensure that all four turbines located close to Mount Fyans Wildlife Reserve are searched for the purpose of monitoring impacts on Peregrine Falcons breeding within the reserve. Carcass searches for Year 1 commenced in November 2020 and were undertaken monthly until October 2021. Carcass searches will continue for a total of five years, in accordance with the BAM Plan.

The regime of carcass searches provides a rigorous sampling method for use in ultimate estimation of the total numbers of collisions for relevant species of birds and bats, which will occur at the end of the second year of monitoring. The pulsed method entails two searches with an interval of three days between them in each month. This short interval provides capacity to determine the collision frequency for species like small-bodied birds and bats whose carcasses may be removed rapidly by scavengers. The pulsed survey approach has been widely adopted and is a requirement of the BAM Plan (BL&A 2018).

Detection dogs were used for the carcass search program, at approximately 20 metre spacing. Dogs were sent in straight transects and, as they naturally detect carcasses within this distance, it was not necessary or efficient to require them to conduct left and right sweeps as stated in the BAM Plan. In the first search of each month the area under 27 turbines was searched out to a 120 metre radius of the turbine base. In the second (pulse) search of each month the area out to 60 metre radius of the turbine base was searched.

All collision carcasses detected were documented and stored as per the BAM Plan. For each carcass, the following information was recorded by Skylos, which is consistent with the requirements of the BAM Plan:

- Date, GPS location, distance and bearing from the nearest turbine and observer details.
- Photographs of the carcass *in situ*, and additional photos to assist in identification where necessary.
- Details on the vegetation and substrate at the location of the carcass found.
- Species, age and sex (if possible), signs of injury and estimated carcass age (i.e. time since date of strike).

All data for searches and carcasses were managed to a standard protocol by Skylos Ecology.

2.6.1 Species identifications

Biosis zoologists reviewed and assisted with the species identification of carcasses found. In some instances, carcasses could not be readily identified to species level in which case a precautionary approach was taken whereby the carcass was assessed by one or more Senior Zoologists to determine if it could potentially represent a threatened species. If a threatened species is suspected or cannot be ruled out, the sample was collected and/or analysed further. If it was concluded by one or more Senior Zoologists that the carcass/feather spot was highly unlikely to be from a threatened species, the find was classified as 'native, assumed non-threatened'. Several examples are outlined below to demonstrate how a precautionary approach to identification of threatened species has been applied at DDWF to date:

- **Potential for threatened microbats.** The only threatened microbats that are considered to have some potential to occur over DDWF are Southern Bent-wing Bat *Miniopterus orianae bassanii* and Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*. Both species are relatively large microbats, and

neither have been recorded at DDWF since it commenced operation. Any species with a shorter forearm length can therefore be ruled out as being a threatened species. Attempts to identify any unrecognisable smaller microbats are only made if an impact trigger for non-threatened species may occur (i.e. if four or more unidentified but non-threatened microbats are found at the same turbine over two consecutive months, further attempts will be made to identify or differentiate the species, if possible, to determine if the non-threatened impact trigger is met).

- **Brolga.** In April 2021, some feathers found at the base of H05 were flagged as potentially being from a Brolga. As this could not be confirmed via the images provided, the feathers were delivered to Dr Inka Veltheim (Senior Zoologist at Biosis with Brolga expertise), who compared them to known Brolga wing feathers and measurements. Based on this assessment, the feathers were determined not to be from a Brolga, and therefore the feather spot (DDSF05) was flagged as 'unknown, assumed non-threatened'.
- **White-throated Needle-tail.** Two unidentified partial bird carcasses were found in March, which were flagged by Senior Zoologist review as potentially being White-throated Needle-tails. Without diagnostic tail feathers, it was not possible to definitively identify the carcasses as White-throated Needle-tail. Any further analysis to confirm the identification of the carcasses would likely require DNA analysis. For this reason, a precautionary approach was adopted by assuming that the two strikes were White-throated Needle-tail. A report was therefore prepared in accordance with the threatened species impact trigger in the BAM Plan, and this assessment is summarised in Section 4.2.

As described above for microbats, a similar precautionary approach was also taken with non-threatened species, whereby any carcasses not able to be recognised (this is a term used in the BAM Plan) from photos were given further scrutiny only if their presence would result in an impact trigger being met. For example, in April 2021 one turbine had three White-striped Free-tailed Bat strikes and one unidentified microbat strike over two consecutive months. As the impact trigger for a common species is four strikes at one turbine over two consecutive months, the unidentified bat could trigger that threshold if it was a White-striped Free-tailed Bat. It was, however, able to be confirmed from the images that the carcass was not a White-striped Free-tailed Bat based on the absence of a 'freetail', despite being unable to confirm the exact species.

2.7 Raptor and White-throated Needle-tail monitoring

The BAM Plan requires monthly monitoring of raptor and White-throated Needle-tail flights for the first five years of the operational phase of the wind farm. Raptors and White-throated Needle-tails were recorded by Skylos Ecology as incidental observations on site during monthly carcass searches. The following details were obtained:

- Date, location, time and duration of observation
- Number and age of birds (where possible)
- Flight height above ground (range)
- Habitat over which the flight was observed
- Flight behaviour observed

2.8 Brolga mortality monitoring

The BAM Plan stipulates a requirement to undertake Brolga mortality monitoring beneath all turbines at DDWF for the entire operational period of the wind farm, in order to maximise detection of any Brolgas that

may have collided with turbines. For the first five years of operation, no additional Brolga mortality monitoring is required at the 27 turbines for which monthly carcass searches are required. Therefore, for the first 5 years, additional Brolga mortality monitoring is required at the additional 53 turbines not randomly selected for monthly carcass searches.

In accordance with the results from the preferred Brolga survey method trial (Section 3.5), all Brolga mortality monitoring in year one was undertaken using binoculars to scan the entire area within 120 metres of each turbine.

2.9 Qualifications

2.9.1 Wetland and Brolga survey qualifications

Brolga and waterbird activity may have been influenced by high rainfall throughout 2021, leading to extensive flooding of farmland and increase in water depth of permanent wetlands in the local area. Local landholders have reported that Lake Gellie (Wetland L, 32614) had risen by over 40 centimetres by October 2021. This flooding may have led to an increase in waterbird abundance throughout the region, but is also likely to increase dispersion driving Brolgas and other waterbirds into flooded farmland that was not surveyed. Surveys and landholder reports indicate that an unusually large number of Black Swans had moved to the region, with approx. 1800 individuals recorded at Lake Gellie in October 2021.

Local flooding and increase in permanent wetland depth may also influence Brolga nesting behaviour. Brolgas and Black Swans nest in shallow water with enough aquatic vegetation to build nests. Many paddocks within the local area were flooded from July to December 2021, and had numerous Black Swans nesting in them. Water levels in local dams and lakes may have risen too high for Brolgas and Swans to build nests in them.

During the Brolga surveys, the observer was only able to survey a single wetland at a time, potentially missing peaks of Brolga activity at specific wetlands at certain times, such as early morning, midday and late afternoon. The effects of this survey limitation were reduced by alternating the times when each wetland was surveyed. Local landholders were also contacted regularly to gather information on any Brolga activity they had observed in the local area.

2.10 Mapping

Tilt Renewables supplied aerial photography and spatial data for the wind farm layout, including turbine locations.

The data associated with the first year of monitoring activities at DDWF have been collected using hand-held GPS units and/or GPS-enabled field tablets, which are generally accurate to 7 metres. Mapping has been produced using a Geographic Information System (GIS).

3. Results and discussion

3.1 Brolga utilisation monitoring program results

Monthly Brolga and waterbird surveys were undertaken from December 2020 to October 2021 at accessible habitat wetlands within 5 kilometres of the DDWF during the Brolga flocking season and within 3.2 kilometres of the DDWF during the Brolga breeding season of Year 1 monitoring. Flocking surveys were conducted from January to June 2021, and breeding surveys were conducted in December 2020 and from July to October 2021. A total of 18 wetlands were surveyed during Year 1 monitoring. Of the 18 wetlands (Figure 1), Brolgas were recorded foraging at 7 of the wetlands and breeding at 3 of the wetlands (Table 5; Figure 2). No flocking activity was detected during Year 1.

Waterbirds were recorded regularly at all wetlands aside from wetland E, a small swamp heavily vegetated with Cumbungi (*Typha* sp.) in a grazed paddock. Black Swan *Cygnus atratus* were recorded regularly at all wetlands, aside from wetland E. Local landholders have reported that the number of Black Swans within the region was unusually high during 2021, which was reinforced by the observation of approx. 1800 individuals at Lake Gellie (wetland L and M) in October. Local landholders have also reported seeing Black Swans disturbing nesting Brolgas within the local area. Black Swans build reed nests in wetlands similar to Brolga nests, potentially leading to competition over habitat, destruction of eggs and theft of nests.

Table 5 Brolga utilisation survey result summary

Biosis Wetland ID	Max number of Brolgas observed	Brolga activity months	Brolga behaviour	Waterbird and raptor species observed
A	No Brolgas	-	-	Black Swan, Pacific Black Duck, Straw-necked Ibis
B	2 Adults	March 2021	Foraging	Black Swan, Eurasian Coot, White-faced Heron, Cattle Egret, Grey Teal, Silver Gull, Masked Lapwing, White Ibis, Pacific Black Duck, Australian Shelduck, Little Pied Cormorant
C	2 Adults	June 2021	Foraging	Black Swan, Little Pied Cormorant, Australian Shelduck, Eurasian Coot, Freckled Duck, White-faced Heron, Grey Teal, Pacific Black Duck
D	No Brolgas	-	-	Black Swan, Eurasian Coot, Pacific Black Duck, Australian Shelduck, Little Pied Cormorant, Silver Gull
E	No Brolgas	-	-	Swamp Harrier
F	2 Adults, 1 Chick	July – December 2021	Foraging, breeding	Black Swan, White-necked Heron, Purple Swampphen, Whiskered Tern
G	No Brolgas	-	-	Black Swan, Straw-necked Ibis, Masked Lapwing, Pacific Black Duck, Eurasian Coot, Grey Teal, Freckled Duck, Australian Shelduck, White-faced Heron

Biosis Wetland ID	Max number of Brolgas observed	Brolga activity months	Brolga behaviour	Waterbird and raptor species observed
H	No Brolgas	-	-	Black Swan, Little Pied Cormorant, Royal Spoonbill, Straw-Necked Ibis, White-faced Heron, White Ibis, Grey Teal, Eurasian Coot, Masked Lapwing, Australian Shelduck, Pacific Black Duck
I	No Brolgas	-	-	Black Swan, Masked Lapwing, Pacific Black Duck, Eurasian Coot, Australian Magpie, Australian Shelduck, White-Faced Heron, Grey Teal, Whiskered Tern, Swamp Harrier, White-Necked Heron
J	No Brolgas	-	-	Black Swan, Grey Teal, Australian Shelduck, Eurasian Coot, Banded Stilt, Pacific Black Duck, Straw-necked Ibis, Masked Lapwing, Pink-eared Duck
K	2 Adults	December 2020. March, May, July, August 2021	Foraging	Black Swan, White-faced Heron, Masked Lapwing, Silver Gull, Australian Shelduck, Straw-necked Ibis, Pacific Black Duck
L	7 Adults	January, February 2021	Foraging	Black Swan, Grey Teal, Masked Lapwing, Silver Gull, Eurasian Coot, Banded Stilt, Pacific Black Duck, Australian Shelduck, Musk Duck, Hoary-headed Grebe
M	No Brolgas	-	-	Black Swan, White Ibis, Grey Teal, Australian Shelduck, Pacific Black Duck, Masked Lapwing, Eurasian Coot
N	No Brolgas	-	-	Black Swan, Wedge-tailed Eagle, Pacific Black Duck, White-Faced Heron, Grey Teal,
O	No Brolgas	-	-	Black Swan, White-faced Heron, Grey Teal, Australian Shelduck, Masked Lapwing, White-necked Heron, Silver Gull, Little Pied Cormorant
P	No Brolgas	-	-	Black Swan, Pacific Black Duck
Q	2 Adults, 1 Chick	August – December 2021	Foraging, breeding	Black Swan, Pacific Black Duck, Purple Swampphen, Whiskered Tern, White-faced Heron, Masked Lapwing, White-Necked Heron, Swamp Harrier, Whistling Kite
R	2 Adults, 1 Chick	August – December 2021	Foraging, breeding	Black Swan, Pacific Black Duck, Purple Swampphen, White-faced Heron, Whiskered Tern, Masked Lapwing, Swamp Harrier, Whistling Kite

3.2 Targeted breeding Brolga survey results

Three pairs of Brolgas were recorded breeding at wetlands within 5 kilometres of DDWF turbines during Year 1 surveys (Table 6).

Two wetlands utilised by the breeding Brolgas were identified as containing high quality Brolga habitat by BL&A during the initial DDWF pre-construction Brolga assessment (wetlands F and R). These wetlands were listed as 'likely' to support future Brolga breeding, and were recorded as successful Brolga breeding sites in the past (Table 6).

The third wetland (wetland Q) was not surveyed during the initial DDWF pre-construction Brolga assessment, and the Brolga assessment report listed no prior records of Brolgas utilising the wetland for foraging, breeding or flocking. Reports from the landholder indicate that the wetland has been used as a regular and successful Brolga breeding site.

The three Brolga pairs were consistently recorded foraging within their respective wetlands and adjacent farmland, and were rarely absent during surveys. Brolgas are long-lived, mate for life and are known to use the same wetlands as nesting sites each year. The Brolgas observed breeding at these wetlands are likely to be the same pairs recorded prior to construction of the DDWF.

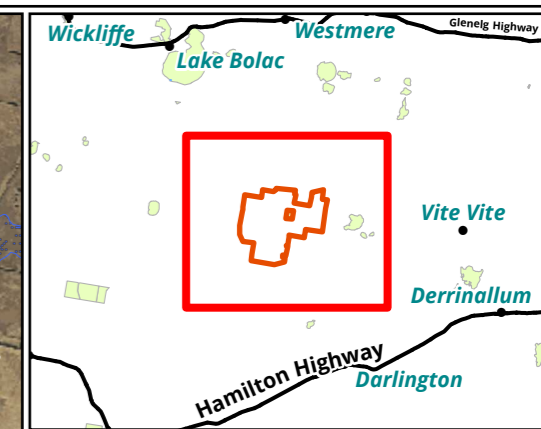
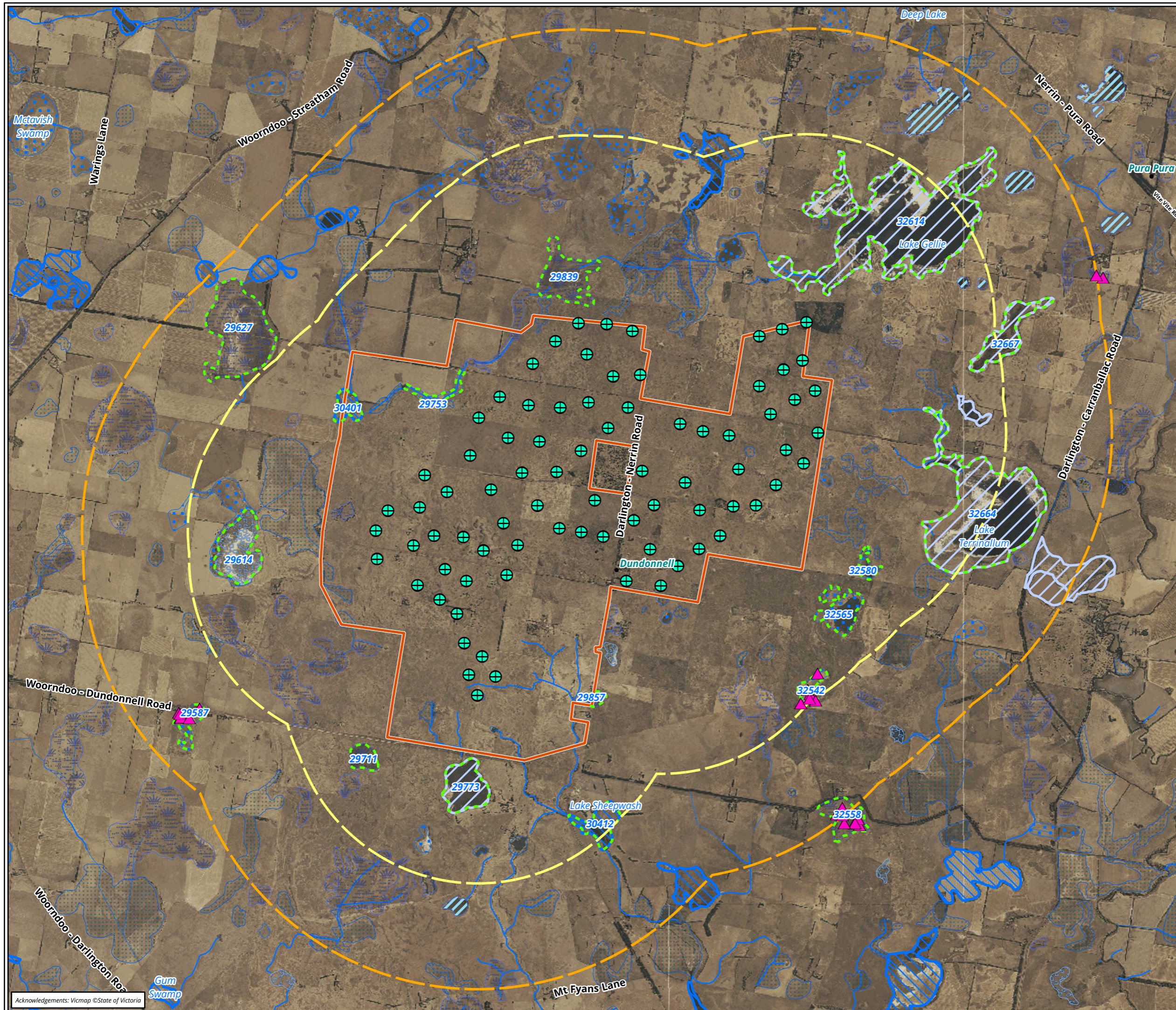
Table 6 Brolga breeding wetlands, Year 1

Survey wetland	Wetland description	Distance from DDWF property boundry	Years Brolgas reported breeding at wetland
Wetland F	Large seasonally flooded marsh, surrounded by volcanic stony hills, adjacent to Dundonnell-Derrinallum Rd.	3.8 kilometres	2002 – 2012, listed in BL&A pre-construction Brolga assessment report
Wetland Q	Large rocky wetland with dense emergent vegetation that floods seasonally, but is reported to hold water late into summer. The wetland is within the predator-proof fence of the Tiverton conservation property.	1.8 kilometres	Wetland not surveyed during DDWF pre-construction Brolga assessment. Landholder reports indicate that the wetland has been used repeatedly as a Brolga nesting site in the past.
Wetland R	Small seasonally flooded drainage line and flooded paddock, adjacent to Dundonnell-Derrinallum Rd.	3 kilometres	2008 - 2013, listed in BL&A pre-construction Brolga assessment report

Table 7 Brolga breeding behaviour summary

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary
August 2021	Pair of adults observed foraging in the wetland and sitting on a nest with two eggs.	Pair of adults observed foraging in the wetland and sitting on a nest in middle of wetland.	Pair of adults observed sitting in reeds in the wetland and foraging in the wetland and adjacent paddocks.

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary
September 2021	<p>Pair of adults observed foraging in the wetland and tending to a single recently hatched chick at their nest (chick first seen 10/09/2021).</p> <p>Chick moved from the nest to a patch of tall grass in the middle of the wetland (first seen in tall grass on 15/01/2021).</p>	<p>Pair of adults observed foraging in the wetland.</p> <p>Brolgas not observed sitting on their original nest and did not react to other waterbirds standing on it.</p> <p>Landholder observed Brolga sitting on newly built nest in the wetland on 27/09/2021.</p>	<p>Pair of adults observed standing on and pecking at Swan nest in wetland and foraging in the wetland and adjacent flooded paddock.</p> <p>Pair observed flying across the wetland (below 20 metre flight height) and dancing together after landing at the flooded paddock.</p>
October 2021	<p>Pair of adults and their chick observed foraging together in the wetland. Chick approx. 30% size of adults on 21/10/2021.</p>	<p>Pair of adults observed foraging in wetland and sitting on new nest with two eggs on 7/10/2021.</p> <p>Landholder observed adult Brolga with a recently hatched chick at the new nest on 19/10/2021.</p>	<p>Pair of adults observed foraging in the flooded paddock adjacent to wetland and sitting on a recently built nest in the flooded paddock. Two eggs observed in the nest between 6 and 26 Oct.</p> <p>Both adult Brolgas observed taking turns foraging and incubating the eggs.</p>
Year 1 survey summary	<p>Pair of Brolga raising a chick in the wetland as of October 2021. Chick first observed on 10/09/2021.</p>	<p>Pair of Brolga raising a chick in the wetland as of October 2021. Chick first observed on 19/10/2021.</p>	<p>Pair of Brolgas nesting in wetland. Eggs had not hatched as of October 2021.</p>
Year 2 unpublished data summary (November 2021 – January 2022)	<p>Brolga pair and chick observed in November 2021, with chick approx. 80% of adult size. No Brolga observed at wetland from December 2021 to January 2022. Chick likely fledged in late November or early December.</p>	<p>Brolga pair and chick observed at wetland from November 2021 to January 2022. Chick observed flying with adults as of January 2022. Successful breeding occurred.</p>	<p>Brolga pair observed having successfully hatched a single chick in December 2021. Brolga pair and chick observed from December 2021 to January 2022. Brolga chick approx. 80% of adult size as of January 2022.</p>



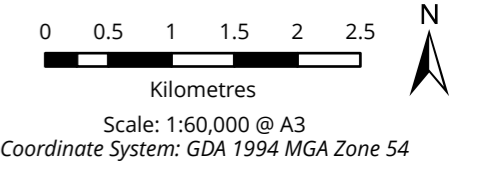
Legend

- Wind farm site boundary
- Turbine layout - 3.2 km buffer
- Turbine layout - 5 km buffer
- + Turbine
- ▲ Bolga record (Biosis)

Wetlands

- 2 - Freshwater meadow
- 3 - Shallow freshwater marsh
- 4 - Deep freshwater marsh
- 5 - Permanent open freshwater
- 6 - Semi-permanent saline
- 7 - Permanent saline
- 99 - No Category
- Surveyed

Figure 2 Dundonnell Wind Farm Bolga survey results, Year 1



Matter: 33578,
Date: 25 January 2022,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F1_Bolga_Wetlands
Location: P:\33500s\33578\Mapping\33578_Project.aprx

3.3 Peregrine Falcon breeding survey results

Surveys for breeding Peregrine Falcons were conducted in December 2020 and from July to December 2021 at the Mount Fyans Wildlife Reserve. A pair of Peregrine Falcons were recorded nesting at the reserve from July to December 2021, but were not detected in the first survey undertaken in December 2020. The pair were observed successfully raising a single chick to fledging stage in a nest in the stone quarry wall in 2021. It remains unknown whether breeding was attempted or successful prior to commencement of surveys in December 2020.

Table 8 Peregrine Falcon breeding summary, Mount Fyans Wildlife Reserve

Wetland	Number of Falcons observed	Peregrine Falcon habitat utilisation and breeding behaviour summary
December 2020	No Peregrine Falcons	Initial site scouting survey. No Peregrine Falcons recorded.
July 2021	2 Adults	Pair of adult Peregrine Falcons observed flying through the Mount Fyans Wildlife Reserve, perching in dead trees above quarry and landing at a nest in a hole in the side of the quarry wall. Remains of one dead Barn Owl found in the reserve.
August 2021	2 Adults	Same behaviour as observed during first survey. Remains of another dead Barn Owl found in the reserve.
September 2021	2 Adults	Same behaviour as observed during first survey. Remains of one dead Pacific Black Duck found in the quarry.
October 2021	2 Adults, 1 Chick	Adults observed flying around the quarry and perching in dead trees above quarry. One Adult observed eating the remains of a small bird. One chick with grey down feathers observed in the quarry wall nest, eating the remains of a bird.
Year 1 survey summary	Pair of adult Peregrine Falcons recorded at Mount Fyans Wildlife Reserve from July 2021. Pair observed nesting in the wall of the stone quarry. One Peregrine Falcon chick observed at quarry nest in October 2021.	
Year 2 unpublished data summary (November – December 2022)	Adults and chick observed in November and December 2021. Chick was observed perched on quarry wall outside nest with adult flight feathers on 15/11/2021, and observed flying on 7/12/2021.	

3.4 Carcass search correction factor studies

3.4.1 Carcass persistence trial

Two carcass persistence trials, with a total of 70 carcasses, were conducted by Skylos Ecology over two seasons in Year 1 (April and October 2021). There were 21 carcasses remaining at the end of the two 30-day trials, nine birds, five large birds (turkeys) and seven White-striped Free-tailed Bats. Table 9 displays the mean number of days each carcass type persisted for, along with the range (minimum and maximum number of days of carcass persistence).

Table 9 Carcass persistence trial results

Row Labels	Average no. of days of persistence	Minimum no. of days until scavenge	Maximum number of days until scavenge
Bat	17.75	0	43
Bird	16.4	0	30
Brolga Proxy	7.1	2	12
Large Bird	8.79	1	30

3.4.2 Searcher efficiency trial

Search efficiency trials were carried out at DDWF throughout Year 1 monitoring. Trials were conducted at a range of turbine locations by several trained Skylos dog/handler teams. A number of locally prevalent bird and microbat species were used to ensure that surveys would pick up species that may be found during carcass searches. Turkey carcasses were used as a proxy for large birds during search trials. Searcher efficiency was 72.97% for large birds, 86.84% for bats and 96.42% for birds (Table 10). These results are presented as a preliminary summary; results will be used in statistical modelling at the end of Year 2 to correct for searcher efficiency.

Table 10 Carcass searcher efficiency results

Carcass type	Detection method	Number placed	Number found	Search efficiency
Large bird	Human (Binoculars)	37	27	72.97%
Bat	Search dog	38	33	86.84%
Bird		28	27	96.42%

3.5 Brolga carcass survey preferred method trial

The following results are extracted from Elmoby Ecology (2020). The survey method which had the highest sensitivity was human based searches which found 29 of 36 targets. Dogs found 19 of 27 targets and observers using binoculars found 23 of 54 targets (Table 2; Figure 3).

Table 11 Brolga carcass preferred survey method summary results (Elmoby Ecology 2020)

	Time spent looking (minutes)	Targets available	Targets found	Average search time	Max search time (minutes)	Min search time (minutes)	Sensitivity
Binocular	1007	54	23	18.6	25	12	43%
Dog	698	27	19	25.9	40	17	70%
Human	2605	36	29	72.4	98	53	81%

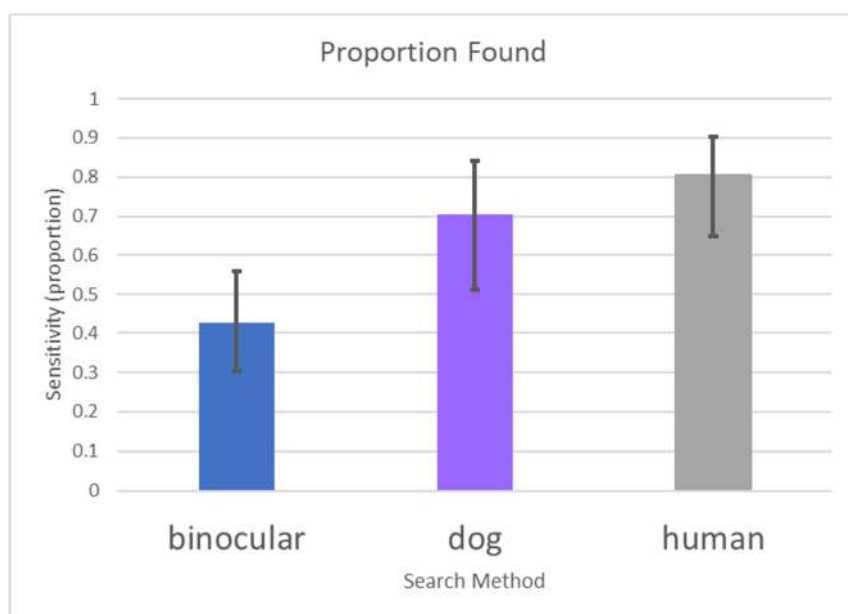


Figure 3 Proportion of all Brolga carcass proxies found by each survey method (Elmoby Ecology 2020)

It was found that the sensitivity of each method decreased as vegetation length increased, particularly for binocular searches. Human surveyors were equally as effective at detecting carcasses and feather spots, however feather spots received slightly lower detection rates than carcasses when using dogs and binoculars. Dogs were the most efficient survey method with more than twice the efficiency of human surveyors. Binoculars were the second most efficient survey method and twice as efficient as human searches alone.

Table 12 Days required to survey using different Brolga carcass survey methods (Elmoby Ecology 2020)

	Number of turbines searched in 1 day	Number of days required to survey 51 turbines
Binocular	12-16	4-5
Dog	8-10	5-6
Human	3	17

At sites with short grass, all three methods were comparable with high detection rates above 80%. In long grass human searchers performed the best, although when the time spent searching is taken into consideration dogs were almost 3 times more efficient than human walkers. This study demonstrated that 80 minutes is required for humans walking transects to detect 80% of all carcasses and feather spots present within the search area regardless of the vegetation length and dogs at least 35 minutes to achieve a similar result. It was also agreed that no more than 3 turbines could be searched by an individual walker in any given day and therefore 17 days of humans walking would be required to survey 51 turbines. Dogs performed better when given up to 40 minutes search time which would allow for 8 to 10 turbine searches per day per dog team, therefore requiring 5 to 6 days of search time to complete the surveys. Binocular surveyors agreed that additional time would not increase detection opportunities and thus 20 minutes was sufficient. This would allow for 12 to 16 turbines to be searched by this method per day requiring 4 to 5 days to complete all

51 turbines. Recommendations for ongoing Brolga carcass monitoring obtained from this study were adopted for the remainder of Year 1 Brolga mortality monitoring and are provided in Section 5.

3.6 Carcass searches

Carcass searches during Year 1 surveys were conducted monthly from November 2020 to October 2021. A total of 672 searches were conducted (336 Pulse surveys, 336 Standard surveys) across a subset of 27 turbines. During these surveys, a total of 211 bird/bat carcasses were recorded across 19 species of birds and 4 species of bats (Table 13). No Brolgas were recorded during the carcass search program.

The most frequently recorded species were:

- White-striped Free-tailed Bat (34 records)
- Nankeen Kestrel (30 records)
- Australian Magpie (27 records)
- Brown Falcon (18 records)
- Barn Owl (14 records)
- Wedge-tailed Eagle (13 records)

Two threatened species were recorded during the carcass search program, the White-throated Needletail (two records) and the Grey-headed Flying-fox (four records). These finds met the BAM Plan threatened species impact trigger and required further assessment and reporting to DELWP, which is summarised in Section 4.

One adult Peregrine Falcon carcass was also found at turbine B02 on 18 September 2021. While not listed as threatened, this species is subject to ongoing monitoring at Mount Fyans Wildlife Reserve in accordance with the BAM Plan (Section 3.3), however this carcass find appears to be unrelated to the breeding pair at the reserve due to the fact that two adults and their chick continued to be observed at the nest site.

Of the 211 bird/bat carcasses found during Year 1 surveys, 15 could be identified as male or female, and 49 could have an age class assigned. Of the 15 carcasses where sex could be determined, nine were White-striped Free-tailed Bats (seven male, two female). Due to varying states of decay, and lack of distinguishing features with many species, it was difficult to confirm the age and sex of many carcasses.

Table 13 Carcass search program species summary

	Species	Formal survey records	Incidental records	Total records	Turbine sites recorded
Birds	Australian Magpie	10	17	27	A01, B01, B07, C03, C09, D02, D06, D10, D11, E01, E02, E04, E07, G02, G03, G05, G07, G08, G10, H08, B03, C06, D03
	Australian White Ibis	1	0	1	B01
	Barn Owl	6	8	14	A03, A08, D07, E05, E07, C07, D01, E06, E08
	Brown Falcon	6	12	18	A05, B02, B03, D03, D11, E03, G01, G02, G09, H01, B01, B05, C07, C08, F09, A03, E05
	Brown Goshawk	1	0	1	E08

	Species	Formal survey records	Incidental records	Total records	Turbine sites recorded
	Common Starling	2	2	4	C08, A03, D06, C01
	Dusky Moorhen	1	0	1	B02
	European Goldfinch	3	0	3	B01, C03, E06
	Galah	2	0	2	E01, E08
	Little-button Quail	1	0	1	E07
	Nankeen Kestrel	9	21	30	A04, A06, B07, C04, C13, D06, D07, D11, E05, F03, H02, H06, H08, B01, B02, C15, E04, E06, A08, F01
	Pallid Cuckoo	0	1	1	B04
	Peregrine Falcon	1	0	1	B02
	Skylark	0	1	1	C06
	Straw-necked Ibis	2	4	6	C11, F04, H01, B02, C13, G05
	Striated Pardalote	1	0	1	E06
	Wedge-tailed Eagle	3	10	13	A01, E03, F04, F07, H03, H05, H07, H09, C06, E07, G04
	Whistling Kite	0	1	1	Not recorded (incidental find)
	White-throated Needletail (possibly)	1	1	2	H06, C03
	Australian Magpie OR Magpie Lark	1	0	1	E04
	Introduced Finch Sp. (Greenfinch or Goldfinch)	1	0	1	G10
	Sparrow Sp.	1	0	1	F02
	Raven Sp.	4	1	5	E08, C16, E06, G05, G10
Ibis Sp.	1	0	1	B02	
Unidentified Bird	8	5	13	C03, B06, D08, F01, H05, D04, E07, D03, B01, C06	
Bats	Gould's Wattled Bat	3	2	5	C02, C06, E01, G05
	Grey-headed Flying-fox	1	3	4	G02, F02
	Lesser Long-eared Bat	0	1	1	B03
	White-striped Free-tailed Bat	27	7	34	A03, A06, C01, C10, C11, D05, G03, B02, B05, B06, B08, C06, D01, D03, E01, G02, G04, G05, H01, H08, F02

	Species	Formal survey records	Incidental records	Total records	Turbine sites recorded
	Unidentified Microbat	15	2	17	C05, G03, B05, B08, C01, C03, C06, C13, E07, H01, H08, F02, F09
	23 species (19 Birds, 4 Bats)	112 (66 Birds, 46 Bats)	99 (84 Birds, 15 Bats)	211 (150 Birds, 61 Bats)	

3.7 Raptor and White-throated Needletail monitoring

Incidental recording of raptor and White-throated Needletail flights during monthly carcass searches recorded 29 Wedge-tailed Eagle flights (Table 14). No White-throated Needletail flights were recorded during the first year of incidental flight recording.

Table 14 Wedge-tailed Eagle observation summary, Year 1

Month	Date	Time	Closest turbine/s	Number	Flight height (meters)	Behaviour
November 2020	15/11/2020	10:07	F06	2	10 – 100	Circling flight
December 2020	18/12/2020	9:16	C14	2	100	Perched on fence, directional flight
	20/12/2020	7:14	H05/G10	1	10 -100	Feeding on roadside
January 2021	11/01/2021	6:30	D03/D01	1	1-2	Circling and directional flight
	12/01/2021	10:05	C03	1	100	Circling and directional flight
	17/01/2021	10:13	A05	1	100	Circling flight, diving
April 2021	6/04/2021	9:54	G10	2	120	Circling flight
	7/04/2021	8:12	B05	1	20	Circling flight, diving
	7/04/2021	8:42	C08	1	1-2	Perched, disturbed by car, directional flight
	8/04/2021	10:45	H08	1	100	Circling and directional flight
	10/04/2021	11:28	D08	1	30 - 80	Circling, diving, landing and then directional flight
	14/04/2021	10:16	G04	1	20	Circling flight, perching
	14/04/2021	12:26	C03	1	30 - 80	Circling and directional flight
May 2021	12/05/2021	10:07	G02	2	30	Circling and directional flight, perching
	13/05/2021	10:38	A07	1	0 - 60	Flying away from pursuing Magpies, perching on rocky outcrop
June	8/06/2021	8:57	H05/H08	2	0	Perching on fence

Month	Date	Time	Closest turbine/s	Number	Flight height (meters)	Behaviour
2021	10/06/2021	13:53	C04	2	0 - 20	Low flight, perching on tree
	15/06/2021	12:48	A06	2	100 - 200	Soaring flight
July 2021	5/07/2021	13:10	F04	2	100 - 200	Gliding flight
	6/07/2021	10:52	G10	1	0 - 60	Circling flight, diving
September 2021	20/09/2021	7:16	H08	1	0 - 50	Feeding on sheep carcass on roadside, directional flight

3.8 Brolga mortality monitoring

No Brolgas were detected during the monthly Brolga mortality monitoring undertaken at the additional turbines that were not subject to monthly carcass monitoring at DDWF. Biosis note that to-date no such collisions have been documented at any operational wind farm in Australia and that there is a very low probability of their occurrence at DDWF.

Brolga monitoring recorded an additional 50 bird carcasses, 15 feather spots and eight bats at the additional turbines surveyed, all of which were included in the overall carcass find results. The Brolga mortality monitoring is required to continue for the operational life of DDWF.

3.9 Summary of onsite activities

Onsite activities relevant to implementation of the BAM Plan at DDWF are summarised below.

- In accordance with the BAM Plan, any dead livestock found near turbines were reported and removed by site personnel or landowners. Removal of livestock carcasses on other areas of the wind farm is to the discretion / action of the landholder. Skylos recorded two carcasses in year 1 which were subsequently reported to site personnel and/or landowners, including a sheep carcass near Turbine H08 in September 2021, and a cow carcass near Turbine G10 in October 2021.
- No formal feral animal control program was undertaken during Year 1. Feral animal control is undertaken by each landowner on their property, and is typically heightened before lambing.
- Incidental records of feral animals on site are reported to DDWF staff. A fox den was located near turbine H05 on 21 April 2021 by Skylos Ecology, and the location was recorded and forwarded on to DDWF staff.

4. BAM Plan species impact triggers

The BAM Plan (BL&A 2018 Section 8) defines impact triggers for threatened and non-threatened birds and bats as follows:

Impact trigger for threatened species: A threatened bird or bat species (or recognisable parts thereof) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Flora and Fauna Guarantee Act 1988* (FFG Act) (including Brolga) or on the Advisory List of Threatened Vertebrate Fauna in Victoria 2013 (DSE 2013) is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel.

Impact trigger for non-threatened species: In any two successive monthly carcass searches, two or more bird or bat carcasses (or parts thereof) of a non-threatened species, other than ravens, magpies and introduced species, are found at the same turbine (i.e. a total of four or more carcasses of the same species in two successive searches at the same turbine).

Impact triggers were met for the following species in the first year of operations at DDWF:

- Grey-headed Flying-Fox (threatened species) – four carcass finds across March and April 2021 at two turbines (F02 and G02)
- White-throated Needletail (threatened species) – two *potential* carcass finds in March 2021 at two turbines (H06 and C03)
- White-striped Free-tailed Bat (non-threatened species) – four carcasses found at the same turbine (E01) over two successive searches in April and May 2021.

In accordance with the BAM Plan, further assessment and reporting of these three impacts was undertaken and submitted to DELWP during Year 1. These assessments are summarised below, and locations of finds that are discussed in this section are displayed in Figure 4.

4.1 Grey-headed Flying-fox

Four Grey-headed Flying-fox carcasses were recorded as a result of carcass searches undertaken in March and April 2021. The species is listed as vulnerable under the EPBC Act and as threatened in Victorian under the FFG Act. The species was not identified in the BAM Plan as a species at risk. With regard to collision fatalities of threatened taxa, the BAM Plan (section 8.1.2) says:

“If the fatality is deemed to be a one-off occurrence or the ongoing risk is unlikely to be significant at a population scale, further action is not considered necessary. This decision will be made in consultation with DELWP and will be determined based on available evidence and using a precautionary approach.”

An assessment was prepared and submitted that detailed available information regarding population numbers and an assessment of the possible effects on the regional population of the species (Biosis 2021). The following text is extracted and summarised from that initial report.

4.1.1 Population scale and numbers

Grey-headed Flying-fox functions throughout its entire distributional range as a single, highly mobile entity with individuals moving widely within it. Nonetheless, the species does aggregate into daytime roosts at specific sites and while substantial movements between these locations makes for a constantly dynamic

overall population, mortalities due to wind turbine collisions can be considered in relation to the number of individuals using the area in the region of a particular facility.

Grey-headed Flying-foxes have been expanding their distribution across Victoria in recent decades with roost-camps increasingly being established from the east to the west of the state. The species established a camp in Geelong in 2003 that is now routinely occupied year-round. Further west, at Warrnambool Botanic Gardens Grey-headed Flying-foxes were first recorded in 2003 and at Colac Botanic Gardens the species was first seen in 2016 and has subsequently established a large summer camp there. Grey-headed Flying-foxes have also been observed in camps at Lower Gellibrand, and other known roosts include Bacchus Marsh and Merrimu. Establishment of the species in Victoria in recent decades is generally considered to be occurring in response to climate change and to the maturation and flowering of various tree species that provide favoured food resources.

Within the broader local area, Grey-headed Flying-fox roosts have been recorded in Warrnambool, Colac and Hexham. Since May 2013 the roost in Warrnambool has variously been present or absent. When the species has been present, counts have sometimes been between 1 and 500 Grey-headed Flying-foxes and at others between 500 and 2,500 Grey-headed Flying-foxes. The site is approximately 50 kilometres south-east of DDWF. Colac Botanical Gardens roost was first formally recorded in December 2016 and has been intermittently used, with Grey-headed Flying-foxes present during each summer since 2019. The numbers have peaked at approximately 6,500 in early 2019 and early 2020. In each winter the number of Grey-headed Flying-foxes has significantly reduced. The site is approximately 80 kilometres south-east of DDWF. The Hexham roost site is approximately 20 kilometres south-west of DDWF. It was first recorded in 2020 from satellite tracking data.

Biosis conducted counts of Grey-headed Flying-foxes at the Warrnambool and Colac roosts in February, March and April 2021, and of the Hexham roost in March and April 2021. The approximate overall total number of Grey-headed Flying-foxes across the three roosts in March 2021 was 6430 Grey-headed Flying-foxes and in April 2021 was 1820. It is not clear whether Grey-headed Flying-foxes from the Warrnambool and Colac roosts are within nightly foraging flight distances from Dundonnell, but records from satellite tracking of the species demonstrates that movements between Warrnambool and Hexham can occur within a matter of one or two nights and it is thus probable that animals may readily move between these three sites. For the purposes of the question related to DDWF, the Warrnambool, Colac and Hexham roosts may be considered to represent a 'regional' population.

4.1.2 Significance of effects

A number of widely applied policies for assessment of impact on biodiversity define a significant impact as one in which mortality rates meet or exceed 1% of the population (e.g. DSE 2006, Commonwealth of Australia 2015). The *EPBC Act Policy Statement 2.3 Wind Farm Industry* (Commonwealth of Australia 2009) provides explanation and examples specific to potential effects of the wind industry. The following excerpt indicates that the risk should be considered as proportional to the population size of particular species:

"An activity that affects, or is likely to affect, a small number of individuals usually would not be expected to have a significant impact on the species as a whole. However, when a species or community is in small numbers nationally, or its distribution or habitat is limited, or if the habitat has particular importance for the species, the activity could have a significant impact. In general, this would apply to species or communities that are most at risk of extinction and are, as such, listed as critically endangered or endangered."

There is significant variability in numbers documented at roost camps within the region and it is logistically difficult to frequently and precisely count Grey-headed Flying-foxes. It is also quite possible that new roosts will establish and that existing ones will diminish over time (for example Colac Otway Shire has an approved

plan to disperse the species from Colac Botanical Gardens (Colac Otway Shire 2019)). So it will not be feasible to know accurately what proportion of the regional population may be affected by interactions with wind turbines at any given time. The dynamic variation in numbers at roost sites in western Victoria makes it very difficult to apply a timeframe over which wind farm mortalities might affect the population.

Despite these limitations, applying the 1% 'rule' to the known regional population in early 2021, a significant effect would constitute mortalities within the range of 18 to 64 Grey-headed Flying-foxes.

At DDWF, two Grey-headed Flying-fox carcasses were found during monthly monitoring in March 2021 and another two wings were found in April 2021 (the latter may be from one individual but are treated as separate finds as a precautionary approach). No further carcasses of the species were detected during the remainder of Year 1 monitoring. At present, the number of fatalities detected or, based on those detected, additional Grey-headed Flying-fox collisions that may have occurred at unsearched turbines, will have no measurable influence on the viability of the regional population, as defined here.

The results from the first year of monitoring at DDWF confirm that it is unlikely that Grey-headed Flying-foxes will be at much risk of collisions during the colder months of the year as relatively few are likely to be flying within the local area as evidence indicates that the animals using the region do not remain there during the cooler portion of the year. The on-going program of monthly carcass searching under turbines at DDWF will continue and, in line with the BAM Plan, all Grey-headed Flying-fox carcasses will be reported to DELWP. Statistical analyses to determine mortality rates will be undertaken at the completion of two years of monitoring.

4.2 White-throated Needletail

4.2.1 Population scale and numbers

Two potential White-throated Needletail carcasses were recorded as a result of carcass searches undertaken in March and April 2021, months when the species may still be present in Australia. The species is listed as vulnerable and migratory under the EPBC Act and as threatened in Victorian under the FFG Act. During surveys undertaken in early March, two unidentified partial bird carcasses were found (DDSF03 at Turbine H06 and DDX06 at Turbine C03). Upon review of images, it was found that the wing length and shape is broadly consistent with White-throated Needletail. While the tail feathers of White-throated Needletail are diagnostic due to the presence of spines extending beyond the end of each feather, no tail feathers are present in either sample. Without tail feathers, it is not possible to definitively identify the carcasses as White-throated Needletail. Any further analysis to confirm the identification of the carcasses is likely to require DNA analysis. For this reason, a precautionary approach was adopted by assuming that the two strikes are White-throated Needletail. Further assessment and reporting was therefore undertaken and submitted to DELWP, which is provided below.

The White-throated Needletail is a migratory species that is present in Australia during its non-breeding period between roughly October and March. It is an almost exclusively aerial species and occurs over most habitats within its geographic range. During their annual sojourn in Australia the entire population is highly mobile and the birds' movements are strongly related to weather systems rather than terrestrial habitats. In Australia, the population is a single entity with no recognisable subdivisions. The global population is unknown (DAWE 2021), however the 'Draft referral guideline for 14 birds listed as migratory species under the EPBC Act' (Commonwealth of Australia 2015) identifies that 100 birds represent 1% of the population for White-throated Needletail.

4.2.2 Significance of effects

100 birds, or 1% of the population, is considered a threshold for consideration of significant impacts. Any action that results in the mortality of 100 or more birds per year is considered to constitute a serious disruption to an ecologically significant proportion of White-throated Needle-tail (Commonwealth of Australia 2015). At the lower threshold, any action that results in the mortality of 10-100 White-throated Needle-tails, or 0.1-1% of the population, should be investigated further (Commonwealth of Australia 2015).

If the two carcasses are assumed to be White-throated Needle-tail, guidance provided by the Commonwealth of Australia (2015) indicates that the annual mortality of 2 individuals does not constitute a significant impact on the population, and also does not require further investigation for Year 1 monitoring of DDWF. The ongoing program of monthly carcass searching under turbines at DDWF will continue and, in line with the BAM Plan and the precautionary approach described above, all confirmed and potential White-throated Needle-tail carcasses will be reported to DELWP.

4.3 White-striped Free-tailed Bat

A total of four White-striped Free-tailed Bat carcasses (or parts thereof) were detected beneath turbine E01 over two consecutive months (one carcass in April 2021 and three in May 2021). The species is a common endemic species in Australia, and is not listed as threatened under state or Commonwealth legislation. The BAM Plan defines an impact trigger for turbine collisions by non-threatened species as follows:

"In any two successive monthly carcass searches, two or more bird or bat carcasses (or parts thereof) of a non-threatened species, other than ravens, magpies and introduced species, are found at the same turbine (i.e. a total of four or more carcasses of the same species in two successive searches at the same turbine)."

It was determined that the BAM Plan non-threatened species trigger was met by these four finds, despite the fact that "two or more" carcasses were not detected in April 2021. Thus, the approach taken is considered to be a precautionary one, given the wording of the impact trigger definition. White-striped Free-tailed Bats are known to fly at heights of 50 metres or more (Churchill 2008), and represent the majority of all bat carcass finds at wind farms across Victoria (Moloney et al. 2019).

The non-threatened species trigger was met only once during Year 1 monitoring at DDWF, however an additional 30 White-striped Free-tailed Bat carcasses were found at other turbines at DDWF in Year 1. None of these additional 30 finds met the non-threatened species impact trigger. White-striped Free-tailed Bat was also not identified as a species of concern in the BAM Plan (BL&A 2018).

4.3.1 Population scale and numbers

The species is recognised as being in decline according to an IUCN assessment undertaken in July 2019 by Pennay (2019), however there is no information available on population numbers for the species. It is therefore not currently possible to differentiate between different population scales, nor assess the broader implications of the mortalities observed so far at DDWF. In the absence of population information, other wind farms provide additional and useful context to the mortalities observed. At one Victorian wind farm, Moloney et al. (2019) calculated mortality rates of 6.2 White-striped Free-tailed Bats per turbine per year, which equated to 397 individuals per year at that particular wind farm (location not specified). At the nearby Salt Creek Wind Farm, which consists of 15 turbines, 34 White-striped Free-tailed Bat carcasses were found from August 2019 to July 2020, which represented 54.7% of all bat mortalities detected within that monitoring year. White-striped Free-tailed Bats can therefore be expected to account for approximately half of the 277 bat mortalities that are predicted to have occurred at Salt Creek Wind Farm during that period. This would

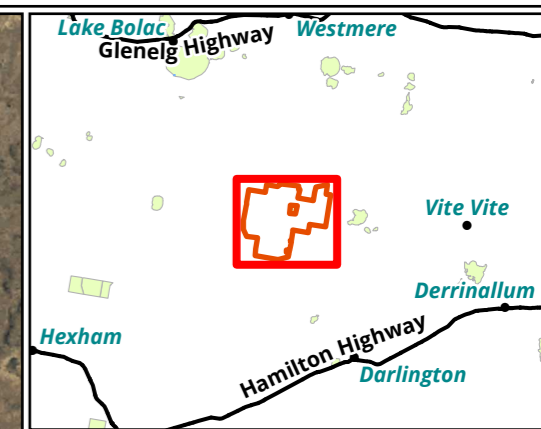
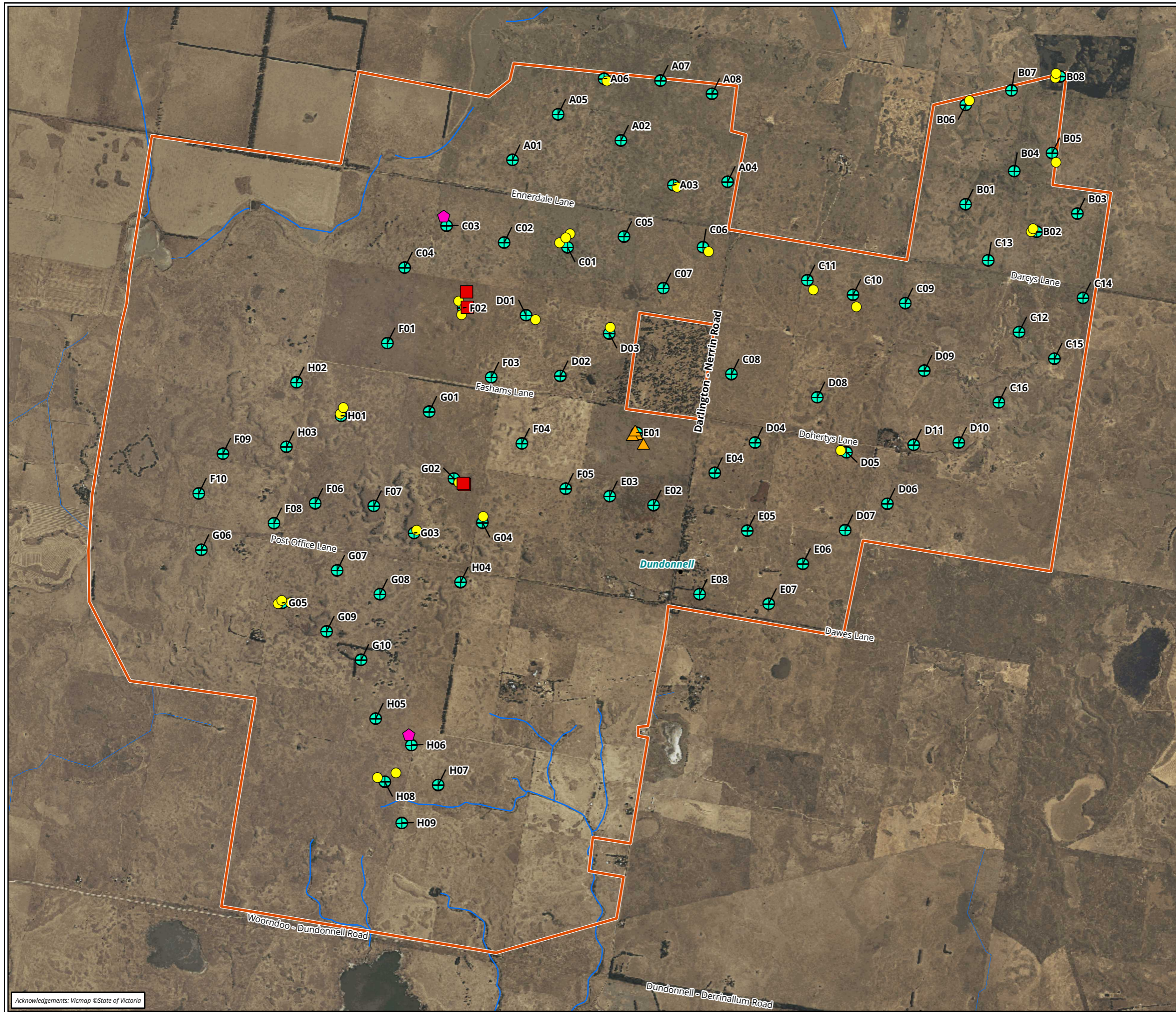
represent a higher mortality rate of approximately 10 individual White-striped Free-tailed Bats per turbine per year at Salt Creek Wind Farm, compared to the rate of 6.2 individuals per turbine per year reported in Moloney et al. (2019).

4.3.2 Significance of effects

Year 1 monitoring at DDWF has recorded a total of 34 White-striped Free-tailed Bat mortalities at a wind farm of significantly greater size than those described above (80 turbines), which does not appear to be unusual or unexpected when compared to results at Salt Creek Wind Farm and the findings presented in Moloney et al. (2019).

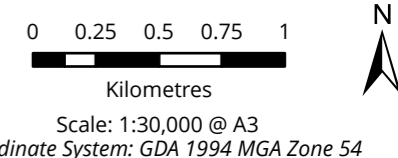
Most young, White-striped Free-tailed Bats are weaned between mid-February and May (Churchill 2008). Given the addition of juveniles into the population between mid-February and May, these months could represent periods of peak mortalities for wind farms in south-western Victoria. While more data are required to determine whether a peak is occurring during these months at DDWF, the results so far obtained during Year 1 show 33 of the 34 mortalities (i.e. 97%) occurring between mid-February and May, with April representing a notable peak (17, or 50%). White-striped Free-tailed Bats are not known to hibernate, and are thought to migrate from southern parts of their range during the cooler months, with very few records of the species occurring in Victoria from June to August (Churchill 2008). On the basis of this information, it was considered that White-striped Free-tailed Bat collisions at DDWF are likely to occur regularly, but particularly during the period from September to April/May, with possible peaks occurring in the middle of the known weaning period.

The White-striped Free-tailed Bat is considered a common and widespread species, due to its ability to utilise a wide range of habitats and its occurrence across much of southern Australia. Despite this, collision with turbines is recognised as a localised threat to the species in south-western Victoria (Pennay 2019). It has been assessed based on the results during Year 1 monitoring at DDWF that ongoing risk of collision is unlikely to lead to an unacceptable impact on the species at the broader population level, and thus that further action is not necessary at this stage. This is consistent with an assessment from Pennay (2019) which states that these localised impacts are unlikely to cause significant decline in the species overall population. Detailed analysis of predicted mortality rates after the completion of the Year 2 of monitoring will provide further information, allow for more detailed discussion and assessment and will provide a baseline for subsequent years of monitoring at DDWF.



- Legend**
- Wind farm site boundary
 - ⊕ Turbine
- Threatened species**
- Grey-headed Flying-fox - Impact trigger met
 - ⬠ White-throated Needletail (possible) - Impact trigger met
- Non-threatened species**
- ▲ White-striped Free-tailed Bat - Impact trigger met
 - Additional White-striped Free-tailed Bat finds - Impact trigger not met

Figure 4 Locations of BAM Plan impact trigger carcass finds and additional White-striped Freetail Bat



Matter: 33578.
Date: 25 January 2022.
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F4_BAM_Triggers
Location: P:\33500s\33578\Mapping\33578_Project.aprx

5. Conclusion and recommendations

This report compiles the methods and findings from the first year of implementation of the approved BAM Plan at DDWF. This section summarises the key findings and recommendations for ongoing BAM Plan implementation at DDWF.

5.1 Brolga utilisation monitoring

A total of 18 wetlands were surveyed during Year 1 monitoring for breeding and flocking Brolgas, of which seven wetlands were recorded being utilised by foraging Brolgas, and three wetlands were recorded being utilised by breeding Brolgas. Of the three wetlands where Brolga breeding was recorded, two wetlands were within the 3.2 kilometre buffer of the wind turbines while the remaining one was within the 5 kilometre buffer of the wind turbines. All three wetlands were subject to additional fortnightly breeding surveys, which continued into the Year 2 of operational monitoring at DDWF. Therefore, it is recommended that:

- Brolga utilisation monitoring to continue into Year 2, in accordance with the BAM Plan. Additional fortnightly Brolga breeding monitoring has continued into Year 2 of monitoring and will continue until breeding behaviour ceases.

5.2 Peregrine Falcon monitoring

Monitoring at Mount Fyans Wildlife Reserve confirmed the presence of a breeding pair of Peregrine Falcons in 2021, which were monitored monthly until the single chick fledged. This confirms that successful breeding occurred within the first operational year of the DDWF. As only one survey of the nest site was undertaken in 2020, it remains unknown whether breeding was attempted or successful during that year. Therefore, it is recommended that:

- Peregrine Falcon monitoring to continue into the second Year 2 of monitoring at DDWF, in accordance with the BAM Plan.

5.3 Carcass search program

A program of monthly carcass searches was successfully undertaken at 27 turbines (with substitutes where required) during Year 1 of operational monitoring at DDWF, during which a total of 211 bird/bat carcasses were found. BAM Plan impact triggers were met for two threatened species (Grey-headed Flying-fox and possible White-throated Needle-tail) and one non-threatened species (White-striped Free-tailed Bat). The latter species was the most commonly recorded carcass during Year 1 of monitoring. Therefore, it is recommended that:

- Carcass search program is to continue into Year 2 and until Year 5, in accordance with the Bam Plan. Statistical analysis of the dataset, incorporating the results of the correction factor studies, is to be undertaken at the completion of Year 2, as per the requirements of the BAM Plan.
- It is recommended that the notification period to DELWP be adjusted to allow for the pulse component of the monthly surveys, therefore allowing for one submission of survey results per month. This will improve efficiency of reporting and undertaken carcass identifications. This recommended change in reporting timing could either be to 10 days instead of seven days, or be

measured from the completion of monthly pulse surveys instead of the date of the carcass find. The seven day notification period for incidental finds would remain unchanged.

5.4 Carcass search correction factor studies

Year 1 of monitoring at DDWF included the completion of two carcass persistence trials and two searcher efficiency trials. These trials will be repeated during year two, and the results compiled and used to calculate mortality estimates at the end of the second year of operational monitoring.

5.5 Brolga mortality survey method

The following recommendations are provided by Elmoby Ecology (2020) relating to the methods used to monitor Brolga mortality at DDWF. During cooler weather it is recommended that in regions with long grass either dogs or humans are engaged to search for Brolga carcasses. For a similar sensitivity, dogs can achieve three times the search area as human surveyors on a daily basis (9 turbines per dog/handler team versus 3 turbines per human walker). During the summer months at sites with long grass it is not recommended that any of the search methods which transverse the long grass be used due to the risk posed by the high number of snakes observed on site. Therefore, binoculars would provide an advantage as they are able to search all cleared areas with similar sensitivity and higher efficiency than the other survey methods but with reduced risks associated with snakes. Binoculars are an effective method where grass is short and visibility is clear. Elmoby Ecology (2020) therefore recommend a combination of methods to best suit the temperature, season and grass length of the survey sites (Table 15).

Table 15 Recommendations for survey method based on grass length and expected daily temperature highs

Vegetation Length	Temperature >24°C	Temperature <24°C
Low	Binoculars	Binoculars or dogs
Medium	Binoculars	Dogs
High	No recommendations	Dogs

- With these recommendations, it is proposed to continue with the binocular surveys on an ongoing basis for all conditions, due to the high accuracy achieved and the increased time and cost efficiency compared to dogs. Having a consistent method for the duration of the project is also considered of benefit.
- It is proposed to continue to assess areas of long grass as the environment changes, and if visibility becomes an issue for binocular surveys, dogs can be deployed for those specific areas only.
- No further assessment of the effectiveness of Brolga survey methods is required.

References

- Biosis 2021. Advice re: Dundonnell Wind Farm effects on population of Grey-headed Flying-fox. Letter report to Tilt. Project No. 33578.
- Brett Lane & Associates 2018. Dundonnell Wind Farm Bat and Avifauna Management Plan.
- Churchill, S. 2008. *Australian Bats*. Allan & Unwin, Sydney.
- Colac Otway Shire 2019. Colac Grey-headed Flying-fox Management Plan 2019 – 2024.
- Commonwealth of Australia 2009. EPBC Act Policy Statement 2.3 Wind Farm Industry.
- Commonwealth of Australia 2015. Referral guideline for 14 birds listed as migratory species under the EPBC Act.
- Elmoby Ecology (2020). Dundonnell Wind Farm Brolga Carcass Survey Methods Investigation. Draft report to Skylos Ecology. Elmoby Ecology, Clunes, Victoria. November 2020. Project No. 231.
- DAWE 2021. Species Profile and Threats Database - Listed Key Threatening Processes. Australian Government Department of Agriculture, Water and the Environment, Canberra. Accessed 29 April 2021.
<http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl>
- Department of Sustainability and Environment 2006. Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978. State of Victoria. Melbourne.
- DSE 2013. *Advisory List of Threatened Vertebrate Fauna in Victoria – 2013*, Victorian Government Department of Sustainability and Environment. Melbourne, Victoria.
- Moloney, P. D., Lumsden, L. F. and Smales, I. 2019. *Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates*. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg.
- Pennay, M. 2019. *Austronomus australis*. The IUCN Red List of Threatened Species 2020: e.T21313A22121905. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T21313A22121905.en>. Downloaded on 23 September 2021.

Appendices

Appendix 1 Brolga breeding season survey detailed results

Table A1.2 Year 1 Brolga breeding season survey data, December 2020 and July-October 2021

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
16/12/2020	E (30412)	-	-	-	-	-	-	-	No birds	
16/12/2020	B (29614)	-	-	-	-	-	-	-	No birds	
16/12/2020	P (29753)	-	-	-	-	-	-	-	No birds	
16/12/2020	A (29627)	-	-	-	-	-	-	-	No birds	
16/12/2020	R (32542)	-	-	-	-	-	-	-	No birds	
16/12/2020	C (29711)	-	-	-	-	-	-	-	No birds	
16/12/2020	D (29773)	-	-	-	-	-	-	-	No birds	
16/12/2020	F (32558)	-	-	-	-	-	-	-	No birds	
16/12/2020	K (32664)	-	-	-	-	-	-	-	No birds	
17/12/2020	L (32614)	-	-	-	-	-	-	-	No birds	
17/12/2020	K (32667)	-	-	-	-	-	-	-	2 Brolga (Adult)	Standing, walking, together in shallow water
17/12/2020	I (32565)	-	-	-	-	-	-	-	No birds	
17/12/2020	N (29839)	-	-	-	-	-	-	-	No birds	
17/12/2020	O (30401)	-	-	-	-	-	-	-	No birds	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
17/12/2020	G (29857)	-	-	-	-	-	-	-	No birds	
21/07/2021	A (29627)	815	855	100	nil	5.3	11	NW	2 Pacific Black Duck	
21/07/2021	O (30401)	820	845	100	nil	8.6	12.3	NW	43 Pacific Black Duck; 1 Little Pied Cormorant; 1 White Faced Heron	
21/07/2021	P (29753)	915	935	100	light rain	8.8	14	NW	2 Pacific Black Duck	
21/07/2021	C (29711)	955	1045	100	light rain	9.4	11.2	NW	22 Pacific Black Duck	
21/07/2021	D (29773)	1050	1125	80	light rain	9.7	10.4	NW	12 Black Swan; 27 Silver Gull	
21/07/2021	B (29614)	1345	1505	70	nil	10	8.3	W	7 Black Swan; 23 Grey Teal	
21/07/2021	N (29839)	1535	1555	80	nil	10.1	7.6	W	12 Pacific Black Ducks; 2 Black Swan	
21/07/2021	G (29857)	1610	1635	90	nil	11.2	9.2	W	3 Black Swan; 6 Pacific Black Duck	
22/07/2021	E (30412)	815	845	100	light rain	5.6	8.3	NNE	No birds	
22/07/2021	F (32558)	855	930	100	light rain	6.4	11.2	NNE	3 Black Swan; 3 Purple Swamphen	
22/07/2021	J (32664)	945	1025	80	nil	6.1	7.4	NE	58 Black Swan	
22/07/2021	K (32667)	1040	1105	80	nil	6.3	12.3	NE	2 Brolga (Adult); 48 Black Swan; 1 Silver Gull	Foraging together in paddock on north side of Bromleys Lane on way into wetland

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
22/07/2021	L (32614)	1115	1225	90	nil	6.2	12.7	NE	146 Black Swan; 26 Eurasian Coot; 36 Grey Teal;	
22/07/2021	M (32614)	1235	1255	70	nil	6.8	14.6	E	23 Black Swan; 16 Pacific Black Ducks	
22/07/2021	I (32565)	1355	1440	70	nil	8.2	19.7	E	2 Pacific Black Duck; 6 White-faced heron	
22/07/2021	H (32580)	1455	1515	100	light rain	7.3	23.4	E		
22/07/2021	R (32542)	1535	1545	100	light rain	7.5	22	E	4 Swans (2 nesting; 2 empty nests); 2 Pacific Black Duck; 8 Purple Swamphen	
11/8/2021	A (29627)	1010	1045	100	light rain	13	6.4	NE	2 Black Swan	
11/8/2021	O (30401)	1105	1115	100	light rain	12.6	8.4	E	No birds	
11/8/2021	P (29753)	1125	1135	100	light rain	12.7	8	E	No birds	
11/8/2021	C (29711)	1155	1220	100	light rain	13.2	12.4	NNW	No birds	
11/8/2021	D (29773)	1225	1250	100	light rain	13.4	13.8	NW	65 Silver Gull; 165 Pacific Black Duck	
11/8/2021	F (32558)	1345	1400	100	light rain	11.2	7.8	N	1 Brolga (Adult); 1 Black Swan (nesting)	Foraging
11/8/2021	J (32664)	1410	1435	100	light rain	11.4	6.8	NW	45 Pacific Black Ducks; 16 Black Swan; 25 Pied Stilt	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
11/8/2021	K (32667)	1445	1505	100	light rain	11.2	4.2	NW	2 Brolga (Adult); 4 Black Swan; 1 Masked Lapwing	Foraging together in paddock on north side of Bromleys Lane on way into wetland
11/8/2021	L (32614)	1510	1525	100	light rain	11	5	NW	24 Black Swan; 8 Silver Gull	
11/8/2021	M (32614)	1530	1545	100	light rain	11.3	6.3	NW	No birds	
12/8/2021	E (30412)	840	920	10	nil	12	5.6	N	No birds	
12/8/2021	G (29857)	925	950	10	nil	12.2	3.4	N	No birds	
12/8/2021	R (32542)	1015	1030	40	nil	11.4	2.4	N	1 Brolga (Adult); 7 Black Swan (5 nesting); 22 Purple Swamphen; 12 Pacific Black Duck	Sitting on nest in middle of wetland; then got off nest to forage in wetland
12/8/2021	I (32565)	1055	1110	60	nil	13.5	4.3	NW	5 Black Swan; 120 Grey Teal; 2 Masked Lapwing; 8 Pacific Black Ducks	
12/8/2021	H (32580)	1150	1200	60	nil	13.6	6.8	NW	No birds	
12/8/2021	B (29614)	1245	1305	70	nil	14.1	8	NW	4 Black Swan; 23 Pacific Black Ducks	
12/8/2021	N (29839)	1335	1345	60	nil	14.3	10.2	NW	2 Black Swan (1 Swan Nest; No Bird On Nest). 12 Pacific Black Duck	
12/8/2021	F (32558)	1220	1230	70	nil	13.9	8	NW	2 Brolga (Adult); 1 Black Swan (nesting)	One sitting in reeds in wetland. One foraging.

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
12/8/2021	Q (29587)	1240	1245	70	nil	13.8	7.2	NW	2 Brolga (Adult); 8 Black Swan (2 adults, 6 chicks); 1 Pacific Black Duck	One sitting in reeds in wetland. One foraging in paddock south of wetland.
15/09/2021	B (29614)	1100	1120	90	nil	14.3	6.8	SE	No birds	
15/09/2021	F (32558)	1130	1320	90	nil	14.7	7	SE	3 Brolga (2 Adult, 1 Chick); 2 Black Swan (2 nesting, 1 empty nest); 3 Purple Swamphen; 1 White-necked Heron 3 Black-shouldered Kite	Adults foraging together on east edge of wetland. Both walked to tall grass in north-west of wetland which prompted chick to stand up from grass. Chick had been moved from nest to tall grass.
15/09/2021	E (30412)	1330	1350	95	nil	15.2	4	E	1 Swamp Harrier	
15/09/2021	D (29773)	1500	1530	100	nil	14.8	3.3	E	7 Black Swan; 4 Pacific Black Duck	
15/09/2021	C (29711)	1535	1545	100	nil	14.6	4.8	E	No birds	
16/09/2021	N (29839)	1605	1620	100	nil	14.3	7.8	E	No birds	
16/09/2021	R (32542)	1025	1045	5	nil	13.2	17	E	7 Black Swans and numerous Chicks (2 nesting, 2 nesting with chicks, 5 empty nests); 1 White-faced Heron; 24 Pacific Black Duck; 20 Purple Swamphen; 1 Whistling Kite	Brolga nest in middle of wetland appears unused

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
16/09/2021	I (32565)	1145	1205	10	nil	14.3	13.8	E	2 Black Swan adults and 6 chicks (1 empty swan nest in west section of wetland); 18 Pacific Black Ducks; 1 White-necked Heron; 4 Masked Lapwing	
16/09/2021	H (32580)	1210	1225	10	nil	14.2	9	E	6 Pacific Black Ducks; 2 Masked Lapwing; 2 Little Pied Cormorant	
16/09/2021	G (29857)	1240	1300	20	nil	15.2	4.3	E	2 Black Swan; 1 White-faced Heron	
16/09/2021	J (32664)	1310	1320	20	nil	15.8	2.8	E	32 Black Swan; 80 Pacific Black Ducks; 1 Straw-necked Ibis	
16/09/2021	K (32667)	-	-	-	-	-	-	-	Unable to access wetland this survey	
16/09/2021	L (32614)	1330	1400	70	nil	16.3	0	NO WIND	1300 Black Swan (5 nesting); 80 Eurasian Coot; 40 Pacific Black Ducks; 4 Musk Duck; 2 Silver Gull	
16/09/2021	M (32614)	1400	1420	70	nil	16.5	0	NO WIND	20 Black Swan; 3 Eurasian Coot	
17/09/2021	O (30401)	1225	1245	20	nil	19.9	43.2	N	2 Pacific Black Duck; 1 White-faced Heron; 4 Silver Gull	
17/09/2021	P (29753)	1300	1320	10	nil	20.5	37.7	N	No birds	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
20/10/2021	C (29711)	1400	1420	0	nil	21.5	6.8	N	8 Black Swan	
20/10/2021	D (29773)	1425	1450	0	nil	22	7.8	N	45 Silver Gull; 5 Black Swan	
20/10/2021	G (29857)	1455	1515	0	nil	21.9	12.3	N	7 Black Swan (1 adult, 6 chicks)	
21/10/2021	O (30401)	1030	1100	5	nil	22.1	18.3	N	15 Australian Wood Duck	
21/10/2021	P (29753)	1115	1145	5	nil	22.3	20.6	N	7 Black Swan (2 adults, 5 large chicks)	
21/10/2021	E (30412)	1200	1215	20	nil	23	13.2	NE	No birds	
21/10/2021	F (32558)	1230	1240	25	nil	23.2	3.9	E	3 Brolga (2 adult; 1 large chick); 3 Purple Swamphen	Foraging together in wetland, Brolga chick around 1/3 size of adult
21/10/2021	J (32664)	1255	1320	25	nil	23.2	6.8	N	12 Black Swan; 1 Masked Lapwing; 6 Eurasian Coot	
21/10/2021	L (32614)	1325	1348	30	nil	23	5.8	NW	1500 Black Swan; 180 Eurasian Coot	
21/10/2021	M (32614)	1350	1400	30	nil	23.1	6.4	NW	30 Black Swan	
21/10/2021	K (32667)	1410	1430	35	nil	23.6	5.8	NW	6 Black Swan; 4 Australian Wood Duck; 2 Masked Lapwing	
21/10/2021	B (29614)	1440	1520	60	nil	23.4	8.5	N	8 Grey Teal; 31 Pacific Black Duck	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
22/10/2021	R (32542)	930	1100	100	nil	17.6	2.5	N	110 Whiskered Tern; 2 Brolga (adults) ; 2 Masked Lapwing; 2 Pacific Black Duck; 10 Purple Swamphen	Foraging together in east edge of wetland and calling loudly
22/10/2021	I (32565)	1110	1130	90	nil	18.2	2.8	N	12 Grey Teal; 28 Pacific Black Duck; 2 Masked Lapwing	
22/10/2021	H (32580)	1135	1155	90	nil	18.5	1.9	N	2 Masked Lapwing; 8 Pacific Black Duck; 3 Little Pied Cormorant; 24 Straw-necked Ibis	
22/10/2021	N (29839)	1235	1255	70	nil	19.6	5.6	N	4 Pacific Black Duck; 1 White-faced Heron	

Appendix 2 Brolga flocking season survey detailed results

Table A2.1 Year 1 Brolga flocking season survey data, January 2021 – June 2021, Year 1

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
13/01/2021	O (30401)	-	-	-	-	-	-	-	2 White-Faced Heron; 2 Black Swan	
13/01/2021	A (29627)	-	-	-	-	-	-	-	No birds	
13/01/2021	B (29614)	-	-	-	-	-	-	-	47 Black Swan; 3 Cattle Egret; Numerous Grey Teal; 1 White-Faced Heron	
13/01/2021	N (29839)	-	-	-	-	-	-	-	1 Black Swan; 15 Pacific Black Duck; 1 Wedge-tailed Eagle	
14/01/2021	C (29711)	622	-	-	-	-	-	-	2 Little Pied Cormorant	
14/01/2021	D (29773)	-	-	-	-	-	-	-	12 Black Swan	
14/01/2021	G (29857)	-	-	-	-	-	-	-	2 Black Swan	
14/01/2021	E (30412)	-	-	-	-	-	-	-	No birds	
14/01/2021	F (32558)	-	-	-	-	-	-	-	No birds	
14/01/2021	J (32664)	-	-	-	-	-	-	-	37 Black Swans; Over 150 Ducks; 13 Terns	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
14/01/2021	H (32580)	-	-	-	-	-	-	-	4 Little Pied Cormorant; 1 Royal Spoon Bill	
14/01/2021	I (32565)	-	-	-	-	-	-	-	2 Black Swan; Over 150 Ducks	
14/01/2021	K (32667)	-	-	-	-	-	-	-	74 Black Swan; 25 White Faced Heron	
14/01/2021	L (32614)	-	-	-	-	-	-	-	3 Brolga (adults); Hundreds of Black Swan	Foraging at edge of lake
14/01/2021	M (32614)	-	-	-	-	-	-	-	No birds	
11/02/2021	O (30401)	1015	1058	100	nil	28.3	12.3	W	7 Grey Teal (2 adults, 5 chicks)	
11/02/2021	A (29627)	1109	1200	100	nil	28	8.9	W	No birds	
11/02/2021	B (29614)	1305	1347	100	nil	29.5	10.2	W	127 Black Swan; 56 Eurasian Coot; 2 Silver Gull; 1 Masked Lapwing; 5 White Ibis; 30 Pacific Black Duck	
11/02/2021	N (29839)	1425	1452	100	nil	30	6.4	W	2 Black Swan	
11/02/2021	C (29711)	1747	1800	100	nil	29.8	11.4	W	No birds	
11/02/2021	D (29773)	1703	1734	100	nil	30.7	7	S	4 Black Swan; 50 Eurasian Coot; 35 Pacific Black Duck	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
11/02/2021	G (29857)	1537	1600	100	nil	31.6	9.2	S	27 Straw-necked Ibis; 2 Masked Lapwing; 12 Pacific Black Duck	
11/02/2021	E (30412)	1625	1642	100	nil	31	4.5	W	No birds	
12/02/2021	F (32558)	630	657	60	nil	15	3.7	SW	No birds	
12/02/2021	J (32664)	730	820	70	nil	16.5	2.1	W	40 Black Swan; Over 100 Grey Teal; Australian Shelduck; Eurasian Coot; 18 Banded Stilt	
12/02/2021	H (32580)	945	1030	80	nil	17.2	5.3	W	70 Straw-necked Ibis; 5 White-faced Heron; 5 Australian White Ibis; Grey Teal; 20 Eurasian Coot; 6 Masked Lapwing	
12/02/2021	I (32565)	1035	1130	80	nil	20	7.8	NW	25 Masked Lapwing; 50 Pacific Black Duck; 12 Eurasian Coot	
12/02/2021	K (32667)	1222	1337	80	nil	24.5	3.2	NW	5 Masked Lapwing; 2 White-faced Heron; 2 Silver Gull	
12/02/2021	L (32614)	1355	1500	60	nil	24	1.3	NW	7 Brolga; hundreds of Black Swan; Over 50 Grey Teal; 20 Masked Lapwing; 5 Silver Gull	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
12/02/2021	M (32614)	1501	1532	40	nil	24.5	6.5	W	36 Black Swan; 4 Australian White Ibis; 25 Grey Teal	
16/03/2021	O (30401)	945	1030	30	nil	13.9	9	SE	5 Australian Shelduck; 10 Masked Lapwings 5 Grey Teal	
16/03/2021	A (29627)	1057	1110	30	nil	15.3	6.5	SE	No birds	
16/03/2021	B (29614)	1140	1300	30	nil	16	8.7	SE	2 Brolga; 60 Black Swan; hundreds Of coots and Pacific Black Duck; 70 Australian Shelduck; 2 Silver Gull; 35 Masked Lapwing	Both foraging in shallow smaller wetland at northern end of main wetland
16/03/2021	N (29839)	1347	1412	30	nil	19.9	9	E	3 Masked Lapwing; 5 Pacific Black Duck	
16/03/2021	C (29711)	1500	1550	30	nil	20.8	7	S	15 Australian Shelduck	
16/03/2021	D (29773)	1605	1635	0	nil	22	6	SW	15 Black Swan; 10 Little Pied Cormorant; 100 Eurasian Coots; 5 Australian Shelduck	
16/03/2021	G (29857)	1700	1723	0	nil	22.4	7.4	SW	8 Masked Lapwing; 2 Black Swan	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
16/03/2021	E (30412)	1739	1800	0	nil	21.1	19	SW	No birds	
17/03/2021	F (32558)	815	825	5	nil	14.5	13	E	No birds	
17/03/2021	J (32664)	630	728	5	nil	14	11	E	Hundreds of Australian Shelduck and Pacific Black Duck; 30 Banded Stilt; 10 Black Swan	
17/03/2021	H (32580)	910	950	5	nil	15.5	17	SE	10 Australian Shelduck; 15 Pacific Black Duck; 2 Masked Lapwing	
17/03/2021	I (32565)	1008	1103	5	nil	18.6	11	S	No birds	
17/03/2021	R (32542)	1210	1243	5	nil	24.4	9	S	3 Brolga	Foraging in dry grass in wetland
17/03/2021	K (32667)	1340	1450	5	nil	27.7	7.7	E	1 Brolga	Foraging in tall dry grass at south edge of wetland
17/03/2021	L (32614)	1506	1600	5	nil	28.8	6	E	Over 100 Black Swan, Eurasian Coot and Australian Shelduck; 20 Banded Stilt; 50 Pacific Black Duck	
17/03/2021	M (32614)	1636	1700	5	nil	27.4	6.2	SE	7 Black Swan; 12 Australian Shelduck	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
13/04/2021	O (30401)	945	1024	50	nil	11.5	22	N	20 Grey Teal 1 White-faced Heron	
13/04/2021	A (29627)	1043	1100	50	light rain	12.9	19.3	N	No birds	
13/04/2021	B (29614)	1130	1230	50	light rain	13.6	24.8	N	30 Silver Gull; hundreds Of Eurasian Coot and Pacific Black Duck; 23 Australian Shelduck; 2 Australian White Ibis	
13/04/2021	N (29839)	1325	1358	50	light rain	17.9	23.5	N	8 Pacific Black Duck	
13/04/2021	C (29711)	1430	1500	40	light rain	18.8	20.4	N	37 Eurasian Coot; 5 Freckled Duck; 10 White-Faced Heron	
13/04/2021	D (29773)	1515	1533	40	nil	20	18	N	10 Black Swan; 7 Little Pied Cormorant; 40 Grey Teal; 40 Pacific Black Duck	
13/04/2021	G (29857)	1600	1630	30	nil	20.4	17.3	N	4 Black Swan; 100 Eurasian Coots; 17 Grey Teal; 10 Freckled Duck; 30 Pacific Black Duck	
13/04/2021	E (30412)	1710	1720	30	nil	19.1	22.4	N	No birds	
14/04/2021	F (32558)	626	628	80	nil	10.9	12.4	N	2 White-necked Heron	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
14/04/2021	J (32664)	700	727	80	nil	10.4	3.5	NW	Over 100 Eurasian Coots, Australian Shelduck and Pacific Black Duck	
14/04/2021	H (32580)	812	930	80	nil	11.9	3.8	NW	2 Little Pied Cormorant; 2 Royal Spoonbill; 6 White-faced Heron; 23 Pacific Black Duck; 15 Grey Teal	
14/04/2021	I (32565)	935	1020	80	nil	15	9.3	NW	20 Masked Lapwing; 5 Australian Magpie	
14/04/2021	R (32542)	1100	1124	80	nil	14	5.5	NW	No birds	
14/04/2021	K (32667)	1252	1343	100	nil	16.1	5.8	NW	4 Australian Shelduck; 7 White-faced Heron; 10 Black Swan; 14 Straw-necked Ibis	
14/04/2021	L (32614)	1411	1530	100	nil	14.2	6.1	NW	Over 100 Black Swan, Eurasian Coot and Australian Shelduck	
14/04/2021	M (32614)	1543	1610	100	nil	13.8	8.5	NW	4 Black Swan; 8 Pacific Black Duck; 2 Masked Lapwing	
17/05/2021	O (30401)	900	920	100	light rain	11.4	11.4	SW	2 White-necked Heron; 2 Masked Lapwing	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
17/05/2021	A (29627)	955	1025	100	light rain	11.6	6	SW	25 Straw-necked Ibis	
17/05/2021	C (29711)	1057	1130	100	light rain	12.2	6.6	SW	2 Brolga	Foraging on south edge of wetland
17/05/2021	D (29773)	1135	1200	100	light rain	12.7	10.7	SW	18 Black Swan; 60 Eurasian Coot; 12 Pacific Black Duck	
17/05/2021	E (30412)	1207	1220	100	light rain	13	8.3	SW	No birds	
17/05/2021	G (29857)	1226	1240	100	light rain	14.1	10.2	SW	8 Black Swan; 12 Pacific Black Duck; 2 Australian Shelduck	
17/05/2021	B (29614)	1310	1350	100	nil	13	11	SW	7 White-faced Heron; 30 Black Swan;	
17/05/2021	N (29839)	1420	1435	70	nil	13.5	12.7	SW	2 Grey Teal; 1 White-faced Heron	
17/05/2021	F (32558)	1520	1545	70	nil	13.9	11.4	SW	No birds	
17/05/2021	J (32664)	1610	1648	70	nil	12.5	9.5	SW	37 Black Swan; 20 Australian Shelduck; 15 Grey Teal/Pacific Black Duck; 50 Eurasian Coot	
18/05/2021	I (32565)	830	915	50	nil	9	12.7	SW	No birds	
18/05/2021	H (32580)	930	945	50	nil	10.5	9.4	SW	6 Pacific Black Duck; 2 Grey Teal; 5 Black Swan; 5 Little Pied Cormorant	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
18/05/2021	R (32542)	1020	1050	50	nil	11.8	10.4	SW	No birds	
18/05/2021	K (32667)	1130	1150	50	nil	12	10.6	NW	1 Brolga; 100 Black Swan; 5 Australian Shelduck	Foraging in wetland
18/05/2021	L (32614)	1200	1240	20	nil	12.9	10.9	NW	Over 130 Black Swan; 30 Pacific Black Duck; many Eurasian Coot and Australian Shelduck	
18/05/2021	M (32614)	1240	1300	20	nil	12.6	11.1	NW	10 Black Swan	
15/06/2021	A (29627)	950	1020	100	nil	13.2	3.4	SW	No birds	
15/06/2021	O (30401)	1040	1100	100	nil	13.1	4.2	SW	2 Australian Wood Duck	
15/06/2021	P (29753)	1115	1125	100	nil	13.4	5.8	SW	No birds	
15/06/2021	C (29711)	1150	1215	100	nil	14.2	2.3	SW	70 Pacific Black Duck; 20 Pink-eared Duck	
15/06/2021	D (29773)	1220	1250	100	nil	15.8	4.3	SW	6 Black Swan; 25 Pacific Black Duck; 30 Eurasian Coot	
15/06/2021	B (29614)	115	145	100	nil	14.5	6.4	SW	6 Black Swan; 15 Masked Lapping; 5 Eurasian Coot; 3 Little Pied Cormorant	

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
15/06/2021	I (32565)	230	310	100	light rain	13.9	8.9	SW	70 Black Swans; 40 Australian Shelduck; 20 Eurasian Coot; 30 Pacific Black Ducks.	
15/06/2021	H (32580)	335	410	100	light rain	13.4	9.5	SW	3 Black Swans; 3 Pied Cormorant; 25 Australian Shelduck; 60 Grey Teal; 30 Pacific Black Ducks; 10 Eurasian Coot	
15/06/2021	R (32542)	440	500	100	light rain	12.9	6.8	SW	No birds	
16/06/2021	E (30412)	730	800	90	nil	9.6	14.3	NW	No birds	
16/06/2021	G (29857)	810	835	90	nil	10	12.8	NW	2 Black Swan	
16/06/2021	N (29839)	920	945	90	nil	10.4	12.2	NW	No birds	
16/06/2021	F (32558)	1025	1040	90	nil	11.2	8.6	NW	No birds	
16/06/2021	J (32664)	1050	1135	100	nil	11.8	7.4	NW	3 Black Swan	
16/06/2021	K (32667)	1150	1230	100	nil	11.9	12.8	NW	6 Black Swan;	
16/06/2021	L (32614)	100	135	100	nil	12.1	13.7	NNW	85 Black Swan; 15 Australian Shelduck	
16/06/2021	M (32614)	155	225	100	nil	12.1	18.9	NNW	25 Black Swan	

Appendix 3 Brolga targeted breeding surveys

Table A3.1 Targeted Brolga breeding survey data, Year 1

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
25/08/2021	F (32558)	1050	1130	90	nil	15.4	11	WSW	2 Brolga (adult); 3 Black Swan (2 nesting); 2 Black-shouldered Kite	Both foraging in wetland. One sat on nest in SE of wetland, got off nest 5 minutes later to forage. 2 Eggs seen on nest.
25/08/2021	R (32542)	1140	1310	70	nil	15.6	9	W	2 Brolga (adult); 1 Pacific Black Duck	One foraging in paddock south of wetland. One sitting in reeds in wetland.
25/08/2021	F (32558)	1445	1515	100	nil	12.9	4	SW	1 Brolga (adult); 2 Black Swans (2 nesting)	Sitting in reeds in wetland, foraging in wetland.
26/08/2021	Q (29587)	925	1125	100	nil	11.8	0	NO WIND	2 Brolga (adult); 10 Black Swans (6 nesting; 1 with chicks); 42 Pacific Black Duck; 8 Purple Swamphen; 14 Eurasian Coot; 1 Swamp Harrier (circling above wetland; swooping at ducks)	Foraging on east bank of wetland.

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
26/08/2021	F (32558)	1145	1300	100	nil	12	4.3	S	2 Brolga (adult); 2 Black Swan (2 nesting)	One foraging on east bank of wetland then flew to south bank. One foraging next to nest, then walked to its partner on south edge.
26/08/2021	R (32542)	1315	1415	100	nil	12.1	5.6	S	2 Brolga (adult)	One sitting in reeds in wetland. One foraging in paddock south of wetland.
09/09/2021	Q (29587)	950	1035	30	nil	17.9	20	N	2 Brolga (adult); . 4 Black Swans (3 nesting, 3 empty nests); 2 Masked Lapwing; 6 Purple Swamphen; 12 Pacific Black Duck	Foraging in south-west of wetland. Nest in middle of wetland appeared unused.
09/09/2021	R (32542)	1050	1120	20	nil	18.2	16	W	2 Brolga (adult); 8 Grey Teal; 1 Purple Swamphen	One sitting on sitting and standing on swan nest in wetland. One foraging in wetland, then walked to its partner at the swan nest.
09/09/2021	R (32542)	1210	1320	10	nil	22.6	15.2	NW	2 Brolga (adult)	Both foraging in wetland, then flew from centre of wetland to west edge of wetland at 12:25 and performed a brief jumping dance together before starting to forage.

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
09/09/2021	F (32558)	1330	1450	10	nil	23.6	24	NW	2 Brolga (adult)	One sitting in reeds. One foraging in wetland.
10/09/2021	R (32542)	930	1100	100	nil	13	2.2	N	2 Brolga (adult); 4 Pacific Black Duck	Both standing on swan nest and foraging in wetland, then flew from centre of wetland to west edge of wetland at 10:18 and performed a brief jumping dance together before starting to forage. Max flight height was approx. 15 meters above ground.
10/09/2021	F (32558)	1220	1410	100	nil	15.8	7.2	N	3 Brolga (2 adults, 1 chick); 4 Black Swan (2 nesting); 2 Pacific Black Duck; 3 Purple Swamphen; 1 Black-shouldered Kite	Both adults foraging in west of wetland. Adults walked to nest at 13:40, prompting a chick to stand up in the nest.
16/09/2021	Q (29587)	1045	1130	5	nil	13.8	15.3	E	7 Black Swan and many chicks (2 on nests; 2 with young chicks; 5 empty swan nests); 1 empty Brolga nest; 1 White-faced Heron; 24 Pacific Black Ducks; 20 Purple Swamphen; 1 Whistling Kite (circling above ducks in wetland))	One empty Brolga nest

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
17/09/2021	R (32542)	950	1050	80	nil	14.7	17.8	N	12 Pacific Black Ducks; 1 Black Swan; 1 Swamp Harrier (circling above wetland; perched in reeds at edge of wetland)	
17/09/2021	F (32558)	1105	1205	100	nil	17.7	36	N	2 Brolga (adult) ; 1 Black Swan (sitting on nest); 1 Purple Swamphen; 2 Black-shouldered Kites	Foraging together in north section of wetland in tall grass where Chick was seen previously.
20/09/2021	R (32542)	1100	1140	100	moderate rain, hail	7.7	13.3	W	3 Pacific Black Duck	
20/09/2021	R (32542)	1140	1340	50	light rain	7.9	17.3	W	2 Brolga (adult) ; 3 Pacific Black Duck; 1 White-faced Heron; 2 Purple Swamphen;	Foraging together in paddock south of wetland.
20/09/2021	F (32558)	1350	1520	100	light rain	8.5	22.3	W	2 Brolga (adult) ; 1 Black Swan (sitting on nest); 2 Purple Swamphen; 2 Masked Lapwing	Foraging in wetland near where chick was last seen.
27/09/2021	Q (29587)	Landholder observation	-	-	-	-	-	-	At least 1 Brolga	Sitting on nest in wetland. Observed during BirdLife survey at Tiverton property
6/10/2021	Q (29587)	Landholder observation	-	-	-	-	-	-	At least 1 Brolga	Sitting on nest in wetland

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
6/10/2021	R (32542)	1100	1330	80	nil	14.2	12.8	N	2 Brolga (adult)	One foraging in paddock adjacent to wetland, one sitting on new nest in flooded paddock, at least one egg seen in nest.
6/10/2021	F (32558)	1345	1615	100	nil	19.6	3.8	NW	2 Brolga (adult); 6 Purple Swamphen	Foraging together in south-west section of wetland
7/10/2021	R (32542)	850	1000	10	nil	10	8	W	2 Brolgas (adult)	One foraging in wetland, one sitting on nest.
7/10/2021	Q (29587)	1020	1230	60	nil	12.3	19.3	NW	1 Brolga (adult); 9 Purple Swamphen	Foraging in wetland. Brolga nest in middle of wetland visible with 2 eggs.
7/10/2021	F (32558)	1255	1355	90	light rain	13.9	6.4	N	1 Brolga (adult)	Foraging in wetland
7/10/2021	R (32542)	1410	1520	108	light rain	14.2	7.5	N	2 Brolga (adult)	One sitting on nest, one sitting next to nest.
19/10/2021	Q (29587)	Landholder observation	-	-	-	-	-	-	2 Brolga (1 adult, 1 recently hatched chick)	Sitting on nest in wetland.
20/10/2021	R (32542)	1345	1355	0	nil	21.5	7.8	N	2 Brolga (adult); 1 Black Swan; 2 Purple Swamphen	One foraging in wetland, one sitting on nest, 2 eggs seen in nest.
21/10/2021	F (32558)	1230	1240	25	nil	23.2	3.9	E	3 Brolga (2 adult; 1 large chick); 3 Purple Swamphen	Foraging together in wetland, chick approx. 1/3 size of adult.

Survey date	Survey wetland	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Brolga behaviour
25/10/2021	R (32542)	1100	1245	100	light rain	12.2	3.8	W	2 Brolga (adult); 3 White Ibis; 1 Black Swan	One foraging in wetland, one sitting on nest.
25/10/2021	F (32558)	1250	1420	100	nil	15.2	2.5	W	3 Brolga (2 adult; 1 juvenile); 2 Purple Swamphen; 2 Whiskered Tern	Foraging together in wetland.
25/10/2021	R (32542)	1430	1550	100	nil	16.6	3.5	W	2 Brolga (adult); 3 Australian White Ibis; 1 Black Swan; 3 Great Egret	One foraging in wetland, one sitting on nest. Foraging Brolga walked to nest, Brolga on nest stood up and both called loudly. Foraging Brolga sat down on nest and its partner started foraging.
26/10/2021	Q (29587)	930	1140	10	nil	13.8	6.8	E	2 Brolga (adult); 9 Purple Swamphen; 1 Little Pied Cormorant; 2 Pacific Black Duck; 1 Swamp Harrier (circling above wetland)	Foraging together in southern edge of wetland.
26/10/2021	F (32558)	1155	1230	10	nil	15.3	4.5	E	3 Brolga (2 adult; 1 juvenile); 2 Purple Swamphen	Foraging together in wetland.
26/10/2021	R (32542)	1240	1400	0	nil	16.3	3.2	E	2 Brolga (adult); 7 Black Swan (2 adults; 5 chicks); 3 Great Egret	One foraging in wetland, one sitting on nest, 2 eggs seen in nest.

Appendix 4 Peregrine Falcon breeding season survey detailed results

Table A4.1 Year 1 Peregrine Falcon breeding season survey data, July – October 2021

Survey date	Observer	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Peregrine falcon behaviour
21/07/2021	WR	11:30	13:30	70	nil	8.9	9.6	NW	2 Peregrine Falcon; 2 Wedge-tailed Eagle; 3 Red Wattlebird; Numerous Raven sp., Australian Magpie and Long-billed Corella; Remains of 1 dead Barn Owl	Flying around quarry, perched above quarry, perched at nest entrance in quarry wall
11/08/2021	WR	13:05	13:35	100	light rain	12.4	8.9	NW	2 Peregrine Falcon; 13 Australian Shelduck; 2 Australian Magpie; 2 Red Wattlebird; 2 Galah; remains of 1 dead Barn Owl	Flying around quarry, perched above quarry, perched at nest entrance in quarry wall
25/08/2021 Additional survey	WR	13:30	14:30	100	nil	15.9	7.2	S	1 Peregrine Falcon; 1 Wedge-tailed Eagle; Remains of 1 Pacific Black Duck	Flying around quarry, perched above quarry, perched at nest entrance in quarry wall.

Survey date	Observer	Survey start time	Survey end time	Cloud cover %	Precipitation	Air temperature (c)	Wind speed (km/h)	Wind direction	Species observed	Peregrine falcon behaviour
10/09/2021 Additional survey	WR	11:20	12:00	100	nil	15.3	4.4	N	2 Peregrine Falcon; numerous Long-billed Corella and Sulphur-crested Cockatoo	Flying around quarry, perched above quarry, perched at nest entrance in quarry wall
15/09/2021	WR	14:00	14:55	100	nil	14.3	4.6	E	1 Peregrine Falcon; 1 Red Wattlebird; 3 Raven sp.; 2 Australian Magpie; Numerous Long-billed Corella and Galah	Flying around quarry, perched above quarry, perched at nest entrance in quarry wall
20/10/2021	WR	15:20	15:50	0	nil	22.3	12.3	N	3 Peregrine Falcon (2 adults, 1 chick), 18 Galahs	Adults flying around quarry and perched above quarry. One adult carrying and eating remains of a small bird. Chick at mouth of quarry wall nest, eating remain of a small bird. Chick still had its grey down feathers.

Appendix 5 Photos



Photo 1 Pair of adult Brolga and juvenile foraging, wetland F, 21 October 2021



Photo 2 Adult Brolga with chick foraging inside predator-proof fence, wetland Q, 09 December 2021



Photo 3 Peregrine Falcon chick sitting at entrance of nest in quarry wall, Mount Fyans Wildlife Reserve, 20 October 2021



Photo 4 Juvenile Peregrine Falcon standing outside nest in quarry wall, Mount Fyans Wildlife Reserve, 17 November 2021



Photo 5 **Adult Peregrine Falcon, Mount Fyans Wildlife Reserve, 7 December 2021**



Photo 6 **Adult Peregrine Falcon, Mount Fyans Wildlife Reserve, 7 December 2021**