Dundonnell Wind Farm:
Year 2 Annual Report – Bat and Avifauna Management Plan Implementation

FINAL REPORT

Prepared for Tilt Renewables Pty Ltd

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Biosis offices

NEW SOUTH WALES

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

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

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

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

Western Sydney
Phone: (02) 91018733
Email: WesternSydneyOffice@biosis.com.au

VICTORIA

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

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

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

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Prepared by:	Clare McCutcheon Wyn Russell
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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 post-construction bird and bat utilisation monitoring 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. Implementation of the DDWF BAM Plan commenced in November 2020, with Year 1 monitoring running from November 2020 to October 2021.The results from the first year of bird and bat monitoring are detailed in the first annual report, prepared by Biosis (2022).

The current report contains the findings from the second year of implementing the actions and monitoring activities of the BAM Plan for DDWF, and in accordance with the BAM Plan, includes the first full analysis of data from the first two years of operations.

The BAM Plan for DDWF requires annual monitoring and reporting within the first five years of:

- Brolga *Grus rubicunda* utilisation *(*breeding and flocking activity) and mortality (carcass searches)
- Peregrine Falcon *Falco peregrinus* breeding activity within the Mount Fyans Wildlife Reserve
- Carcass searches for birds and bats within the wind farm
- Flights of Wedge-tailed Eagles *Aquila audax* 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 the first two years of operations.

Brolga monitoring is required for the operational life of DDWF. The carcass search program, correction factor studies and monitoring of Wedge-tailed Eagle and White-throated Needletail flights were conducted by Skylos Ecology. Skylos Ecology undertook a trial to determine the effectiveness of three different search methods for Brolga carcasses during the first year of operation, the results of which are detailed in the first annual report (Biosis 2022). Elmoby Ecology was also involved with the correction factor studies and Brolga preferred survey method trial, and was under contract to Skylos Ecology.

The Brolga and Peregrine Falcon monitoring was undertaken by Biosis. Biosis also assisted with carcass ID, monthly reporting of results and, where required, reporting associated with any BAM Plan impact triggers.

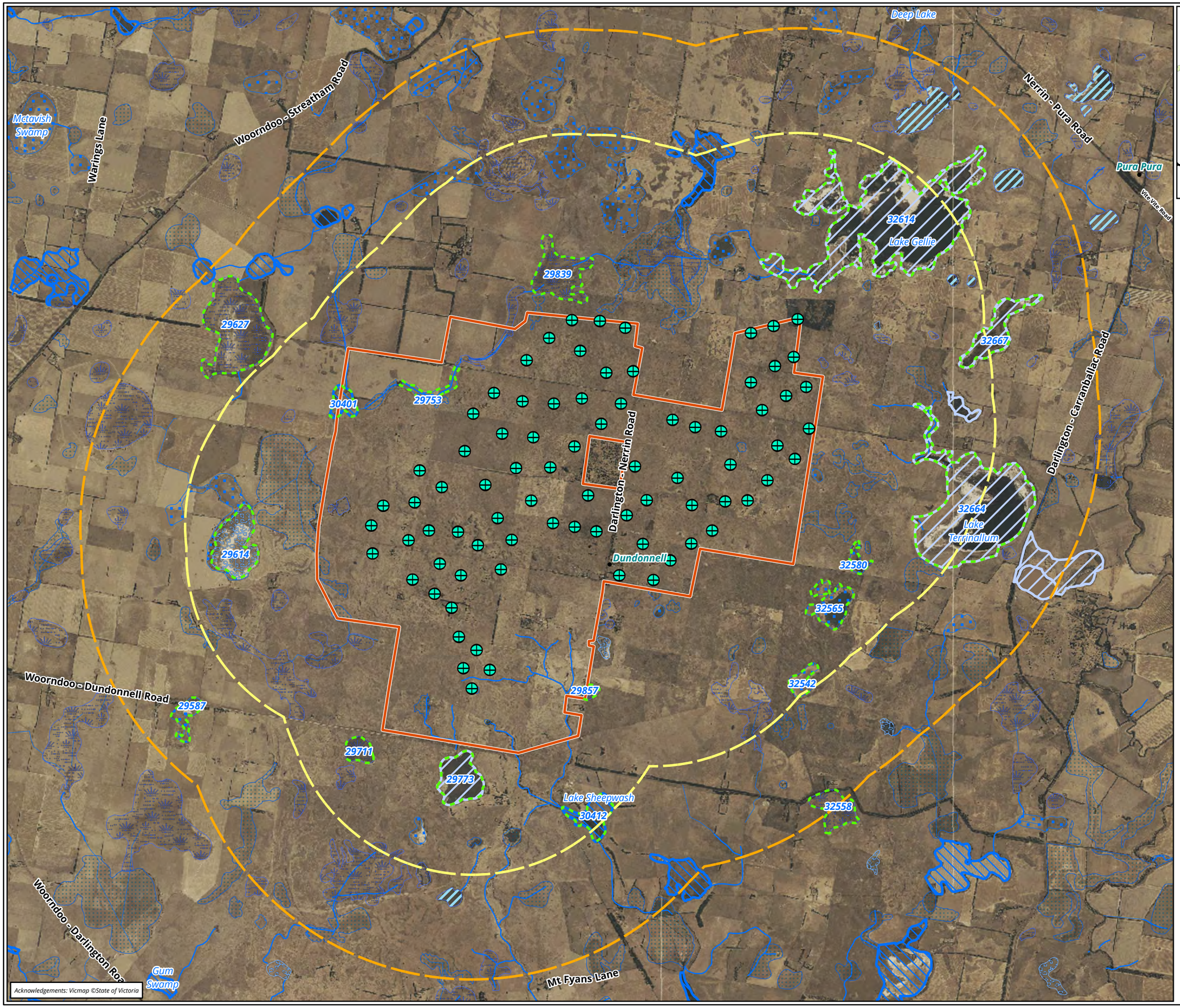
The analysis of the first two years of data was undertaken by Symbolix, which includes estimates of annual mortalities of birds and bats occurring as a result of turbine collision.

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 Victorian Department of Energy, Environment and Climate Action (DEECA, formerly DELWP) containing details of all BAM Plan activities undertaken during the reporting year. This report presents the findings of the second year (Year 2) of implementation of the BAM Plan at DDWF (November 2021 – October 2022). This report also presents the first full analysis of all year 1 and 2 data and associated mortality estimates, in accordance with 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 monitoring of Brolga breeding and flocking, 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 Location of Dundonnell Wind Farm and Brolga Survey Wetlands

0 0.5 1 1.5 2 2.5

Kilometres

N

Scale: 1:60,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 33578,
Date: 25 January 2022,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F1_Brolga_Wetlands
Location: P:\33500s\33578\Mapping\
33578_Project.aprx

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 2) 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 in Year 1 (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 2 monitoring were conducted from December 2020 to October 2021, inclusive.

Table 1 Brolga utilisation survey wetlands, Year 2

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 1	Wetland type
A	29627	118	5km	No Brolga activity	Fresh water, shallow seasonal marsh, usually dry throughout year
B	29614	112	3.2km	2 Adults foraging	Fresh water, shallow permanent lake
C	29711	138	3.2km	2 Adults foraging	Fresh water, deep permanent lake
D	29773	139	3.2km	No Brolga activity	Saline water, deep permanent lake
E	30412	110	Both	No Brolga activity	Fresh water, shallow seasonal marsh, choaked with reeds
F	32558	236	5km	2 Adults nesting, raised 1 chick	Fresh water, shallow seasonal marsh, usually dry from January – July
G	29857	602	3.2km	No Brolga activity	Fresh water, small permanent lake
H	32580	324	3.2km	No Brolga activity	Fresh water, holding water year-round, likely spring-fed
I	32565	254	3.2km	No Brolga activity	Fresh water, shallow permanent lake
J	32664	244	Both	No Brolga activity	Saline water, permanent spring-fed lake
K	32667	243	Both	2 Adults foraging,	Saline water, shallow semi-permanent lake
L	32614	239	Both	7 Adults foraging	Lake Gellie. Saline water, deep permanent spring-fed lake with some shallow shore sections
M	32614	506	3.2km	No Brolga activity	
N	29839	326	3.2km	No Brolga activity	Fresh water, shallow seasonal marsh

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 1	Wetland type
O	30401	513	3.2km	No Brolga activity	Fresh water, deep permanent dam
P	29753	117	3.2km	No Brolga activity	Fresh water, shallow dam and seasonally flooded adjacent marshy paddock
Q	32542	Not listed	3.2km	2 Adults nesting, raised 1 chick	Fresh water, shallow seasonal marsh
R	29587	137	5km	2 Adults nesting, raised 1 chick	Fresh water, shallow dam and seasonally flooded adjacent marshy paddock
S	33291	Not listed	3.2km	Not surveyed in Year 1.	Fresh water, permanent dam
T	32671	241	5km	Not surveyed in Year 1	Fresh water, permanent dam
U	32610	521	> 5km	Not surveyed in Year 1.	Fresh water, seasonal dam

Wetland addition notes:

- Wetland **S** was added to the monthly survey schedule from February 2022 after the landholder reported that it had been restored in Autumn of 2021, and Brolgas and other waterbirds were using it regularly.
- Wetland **T** was added to the monthly survey schedule from June 2022 after the landholder reported that Brolgas foraged in the paddocks surrounding it occasionally.
- Wetland **U** was added to the monthly survey schedule from August 2022 as an opportunistic survey site after the landholder reported that the wetland had been restored in early 2022 and was occupied by a nesting Brolga. This wetland is located 5.1 kilometres from the wind farm boundary, but was included as Brolgas nesting at the wetland are likely to forage with chicks within the 5 kilometre study area buffer.

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 'Kestrel-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.

Wetland water level was recorded from December 2021, to demonstrate seasonal changes in suitability for Brolga foraging and nesting. Water level was estimated visually, and recorded on a scale of 0 to 4:

- 0: No standing water.
- 1: Some shallow standing water, not covering entire wetland.
- 2: Shallow standing water covering entire wetland, no/minimal deep water.
- 3: Deep water covering entire wetland, no/minimal shallow water.
- 4: Wetland overflowing usual boundary, flooding.

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 nesting 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. If Brolgas were known to be nesting or have chicks, surveys were kept as short as practical to minimise disturbance. The Brolga utilisation survey schedule for Year 2 is summarised in Table 2 below.

Table 2 Brolga utilisation survey schedule, Year 2

Survey month	Survey type	Survey date	Surveyor
November 2021	Breeding	17/11/2021 – 18/11/2021	Wyn Russell - Project Zoologist
December 2021	Breeding	6/12/2021 – 9/12/2021	
January 2022	Flocking	13/1/2022 – 14/1/2022	
February 2022	Flocking	9/2/2022 – 11/2/2022	
March 2022	Flocking	8/3/2022 – 10/3/2022	
April 2022	Flocking	12/4/2022 – 14/4/2022	Wyn Russell - Project Zoologist Inka Veltheim - Senior Zoologist
May 2022	Flocking	4/5/2022 – 6/5/2022	Wyn Russell - Project Zoologist
June 2022	Flocking	2/6/2022 – 3/6/2022	
July 2022	Breeding	4/7/2022 – 6/7/2022	
August 2022	Breeding	15/8/2022 – 17/8/2022	
September 2022	Breeding	7/9/2022 – 9/9/2022	Wyn Russell - Project Zoologist Claire Tingate – Zoologist
October 2022	Breeding	4/10/2022 – 7/10/2022	Wyn Russell - Project Zoologist

2.2 Targeted breeding Brolga surveys

Additional fortnightly targeted surveys of breeding Brolgas were triggered by the observation of Brolgas nesting at wetlands within the 3.2 kilometre DDWF survey buffer between August 2021 – February 2022, and September 2022 – ongoing into 2023. During these periods, in accordance with the BAM plan, fortnightly surveys of Brolgas nesting, or with unfledged chicks were conducted, until all chicks fledged, or breeding was deemed to be unsuccessful.

The fortnightly breeding 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 2 is summarised in Table 3 below. Surveys continue into the Year 3 monitoring period, which commenced in November 2022. The results of the year 3 surveys will be presented in the Year 3 annual report.

Table 3 Brolga targeted breeding survey schedule, Year 2

Survey month	Survey wetlands	Survey dates	Surveyor
November 2021	F, R and Q	8/11/2021 – 9/11/2021 24/11/2021 – 25/11/2021	Wyn Russell - Project Zoologist
December 2021	F, R and Q	7/12/2021 – 9/12/2021 22/12/2021 – 23/12/2021	
January 2022	F, R and Q	4/1/2022 – 5/1/2022 20/1/2022 – 21/2/2022	
February 2022	137, 236	3/2/2022 – 4/2/2022	
September 2022	F, R, Q, N and U	20/9/2022 – 21/9/2022	Wyn Russell - Project Zoologist Inka Veltheim - Senior Zoologist
October 2022	R, Q, N and U (F inaccessible due to post-flood roadworks)	18/10/2022 – 20/10/2022	Claire Tingate – Zoologist

2.3 Targeted flocking Brolga surveys

Additional targeted surveys of flocking Brolgas were triggered on three occasions during Year 2 monitoring, by the observation or report of at least 10 Brolgas foraging or roosting together within the study area. After the observation or report of a flock, in accordance with the BAM plan, four consecutive days of targeted monitoring of the flock was conducted as soon as possible, to assess the behaviour and habitat use of the flock within the study area.

During targeted flocking survey periods, a Biosis zoologist would conduct dawn and dusk surveys at known or potential roosting habitat, to assess flock size, activity periods and flight patterns. Dawn surveys commenced 30 minutes before first light and continued until an hour after sunrise. Dusk surveys commenced an hour before dusk and continuing until 30 minutes after last light, or until too dark to survey. Weather and wetland status conditions were recorded at the start of each survey, following the same methodology as the Brolga utilisation monitoring program.

During the day the surveyor followed the Brolga flock to assess use of foraging habitat, flight paths between roosting and foraging sites, and any differences in midday and night roosting habitat. When the location of

the flock was unknown, surveys were conducted throughout the DDWF area at potentially suitable foraging or roosting habitat in an attempt to locate the flock. The Brolga flock trigger details and targeted survey dates are summarised in Table 4 below. All targeted flock surveys in Year 2 were conducted by Biosis Project Zoologist Wyn Russell.

Table 4 Brolga targeted flocking survey triggers and dates, Year 2

Flock survey instance	Initial flock observation or report date	Initial flock size	Initial flock location and behaviour	Flock survey dates
November 2021	Landholder report 23/11/2021	21 (Adults)	Foraging in paddocks north of wetland H. Roosting in unknown wetland.	30/11/2021 – 03/12/2021
February 2022	Biosis observation 10/02/2022	15 (Adults)	Foraging in paddocks surrounding wetland B. Roosting in wetland B.	Opportunistic dawn and dusk survey immediately after flock identification: 10/02/2022 – 11/02/2022 Triggered flock survey: 22/02/2022 – 25/02/2022
April 2022	Biosis observation 13/04/2022	26 (22 Adults, 4 Juveniles)	Foraging in recently harvested wheat crop north of wetland L. Roosting in wetland L.	Opportunistic dawn and dusk survey immediately after flock identification: 13/04/2022 – 14/04/2022 Triggered flock survey: 19/04/2022 – 22/04/2022

2.4 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 and at least once per month from July 2021 - December 2021, and July 2022 – December 2022. Surveys were conducted by a Biosis Zoologist during daylight hours and suitable weather conditions, 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 Peregrine Falcons observed or heard calling were counted and their behaviour recorded.

Local weather conditions were recorded at the start of each survey using a 'Kestrel-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 Peregrine Falcon targeted breeding survey schedule for Year 2 is summarised in Table 5 below.

Table 5 Peregrine Falcon survey schedule, Year 2

Survey month	Survey dates	Surveyor
November 2021	15/11/2021	Wyn Russell - Project Zoologist
December 2021	7/12/2021	
February 2022 (opportunistic survey)	4/02/2022	
July 2022	4/07/2022	
August 2022	15/08/2022	
September 2022	7/09/2022	Wyn Russell - Project Zoologist Claire Tingate - Zoologist
October 2022	5/10/2022, 19/10/2022	Wyn Russell - Project Zoologist Inka Veltheim - Senior Zoologist
November 2022 (Year 3)	2/11/2022, 29/11/2022	Wyn Russell - Project Zoologist
December 2022 (Year 3)	30/12/2022	

2.5 Carcass search correction factor studies

2.5.1 Carcass persistence trial

Persistence trials determine how long a carcass stays in the survey area before being removed by scavenging animals such as foxes, ravens and/or birds of prey. The results from these 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.

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 DEECA 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.

Remote cameras mounted on existing fence posts were deployed to monitor carcasses. Cameras were checked once per deployment to ensure they were functioning and to replace batteries and SD cards. Cameras were set to take a photograph every hour. Mounting cameras on exiting 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. The trials were carried out twice per year by Skylos Ecology, once each in autumn and in spring, and each trial lasted for approximately 30 days. Table 6 presents the timing and number of trials (carcasses and cameras) utilised in the first two years at DDWF.

Table 6 Number and timing of carcass persistence trials within the first two years at DDWF

Month	Number of trials
November 2020	10
March 2021	20
April 2021	6
October 2021	30
March 2022	10
April 2022	20
October 2022	20

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 and numbers of carcass were used:

- Bat - 14
- Bat proxy (mice) – 26
- Bird – 40, and
- Brolga proxy (turkeys) - 39

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.

2.5.2 Searcher efficiency trial

Searcher efficiency trials quantify the effectiveness of observers at locating carcasses, by determining 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 158 carcasses were placed randomly by an independent observer, Emma Bennett of Elmoby Ecology. A total of 58 bat carcasses, 49 bird carcasses and 51 Brolga proxy (turkey) carcasses were placed randomly at turbines subject to monthly searches during the first two years of operation, namely in November 2020, April 2021, 2022 and October 2021, 2022. These turbine locations were then surveyed by teams of dogs and handlers (bird and bat carcasses) or via binocular searches (Brolga proxy) as part of the

monthly carcass search program undertaken by Skylos Ecology. Table 7 presents the number, type and timing of searcher efficiency trials undertaken at DDWF within the first 2 years of operation.

Table 7 Number and timing of searcher efficiency trials (binocular and dog) within the first two years at DDWF

Month	Number of binocular trials	Number of dog trials	Total
November 2020	27	0	**27**
April 2021	10	38	**48**
October 2021	0	28	**28**
April 2022	14	20	**34**
October 2022	0	21	**21**
Total	**51**	**107**	**158**

2.6 Mortality monitoring

2.6.1 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 approximately 28 turbines per month, as 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 will continue for a total of five years, in accordance with the BAM Plan. This report provides details for the first two years of carcass searches, which commenced in November 2020 and concluded in October 2022.

The regime of carcass searches provides a rigorous sampling method for use in calculating estimates of the total numbers of collisions for relevant species of birds and bats. 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 meter spacing. Dogs were sent in straight transacts 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 (standard) search of each month the area under each selected turbine was searched out to a 120 meter radius of the turbine base. In the second (pulse) search of each month the area out to 60 meter radius of the turbine base was searched. Table 8 presents the number of routine carcass searches (standard and pulse) undertaken each month for the first two years at DDWF.

All collision carcasses detected were documented and stored as per the BAM Plan. All data for searches and carcasses were managed to a standard protocol by Skylos Ecology. 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).

2.6.2 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 52-53 turbines not randomly selected for monthly carcass searches.

In accordance with the results from the preferred Brolga survey method trial (Section 3.5 in Biosis (2021)), all Brolga mortality monitoring was undertaken using binoculars to scan the entire area within 120 metres of each turbine. Table 8 presents the number of routine carcass searches (standard and pulse) undertaken each month for the first two years at DDWF.

Table 8 Number and timing of routine carcass searches (standard and pulse) and Brolga binocular searches within the first two years at DDWF

Date	Standard	Pulse	Brolga survey
Year 1			
November 2020	28	28	52
December 2020	27	27	51
January 2021	28	28	52
February 2021	28	28	50
March 2021	28	28	50
April 2021	28	28	50
May 2021	28	28	51
June 2021	26	26	53
July 2021	28	28	51
August 2021	28	28	50
September 2021	28	28	51
October 2021	28	28	52
Year 2			
November 2021	28	28	52
December 2021	28	28	52
January 2022	32	28	58
February 2022	32	28	46
March 2022	20	28	52
April 2022	28	28	52
May 2022	28	28	42
June 2022	28	28	43
July 2022	28	27	50
August 2022	56	28	75*
September 2022	0*	28	28*

Date	Standard	Pulse	Brolga survey
October 2022	28	28	42

***September standard surveys were undertaken at the end of August 2022, hence they appear in the totals for that month instead.**

2.6.3 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'.

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.

2.7 Monitoring for Wedge-tailed Eagle and White-throated Needletail

The BAM Plan requires monthly monitoring of Wedge-tailed Eagle and White-throated Needletail flights for the first five years of the operational phase of the wind farm. Flights of these species of interest 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 Qualifications and limitations

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.

Access to some sections of the DDWF and/or Brolga wetlands were occasionally limited by weather events, roadworks or at the request of landowners. Where this impacted carcass searches, replacement turbines were substituted in. Roadworks and flooding restricted access to one wetland during Brolga utilisation monitoring, which is detailed in Section 3.1

Mortality estimates were calculated for all birds combined, all bats combined and a separate mortality estimate was also calculated for Brolga. Calculating mortality estimates for all birds combined and all bats combined is standard practice for BAM Plan implementation and reporting, and is particularly helpful when limited data are available to form statistically robust estimates for individual species. For DDWF, it is a requirement of the BAM Plan that a species-specific mortality estimate be provided each year for Brolga. For combined bird and combined bat mortality estimates, the BAM Plan requires these to be calculated and reported at year 2 (the current assessment) and year 5. There is currently insufficient data to prepare species-specific mortality estimates for any other species at the completion of year 2, and it is therefore considered more appropriate to consider whether any species-specific mortality estimates can be calculated at the completion of year 5, or earlier if an impact trigger occurs and sufficient data is available at that time.

2.9 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 for Year 2 monitoring were undertaken from November 2021 to October 2022 at accessible habitat wetlands within 5 kilometres of the DDWF during the Brolga flocking season (January – June) and within 3.2 kilometres of the DDWF during the Brolga breeding season (July – December).

A total of 21 wetlands were surveyed during Year 2 monitoring (Figure 2).Brolgas were recorded foraging at 15 of the 21 wetlands and in adjacent grassland. Pairs nested at five wetlands, and flocks were recorded roosting at two wetlands (Figure 3, Table 9).

Waterbirds were recorded regularly at all wetlands. Black Swan *Cygnus atratus* were recorded in large numbers (approx. 1800 individuals) at Lake Gellie (wetlands L and M) in November 2021. Local landholders reported that Black Swan numbers were unusually high in 2021. Swan numbers at Lake Gellie in September – November 2022 were significantly lower, varying between 90 – 130 individuals. Local landholders have also reported seeing Black Swans disturbing nesting Brolgas within the local area in the past. Black Swans build reed nests in wetlands similar to Brolga nests, potentially leading to competition over habitat, destruction of eggs and theft of nests.

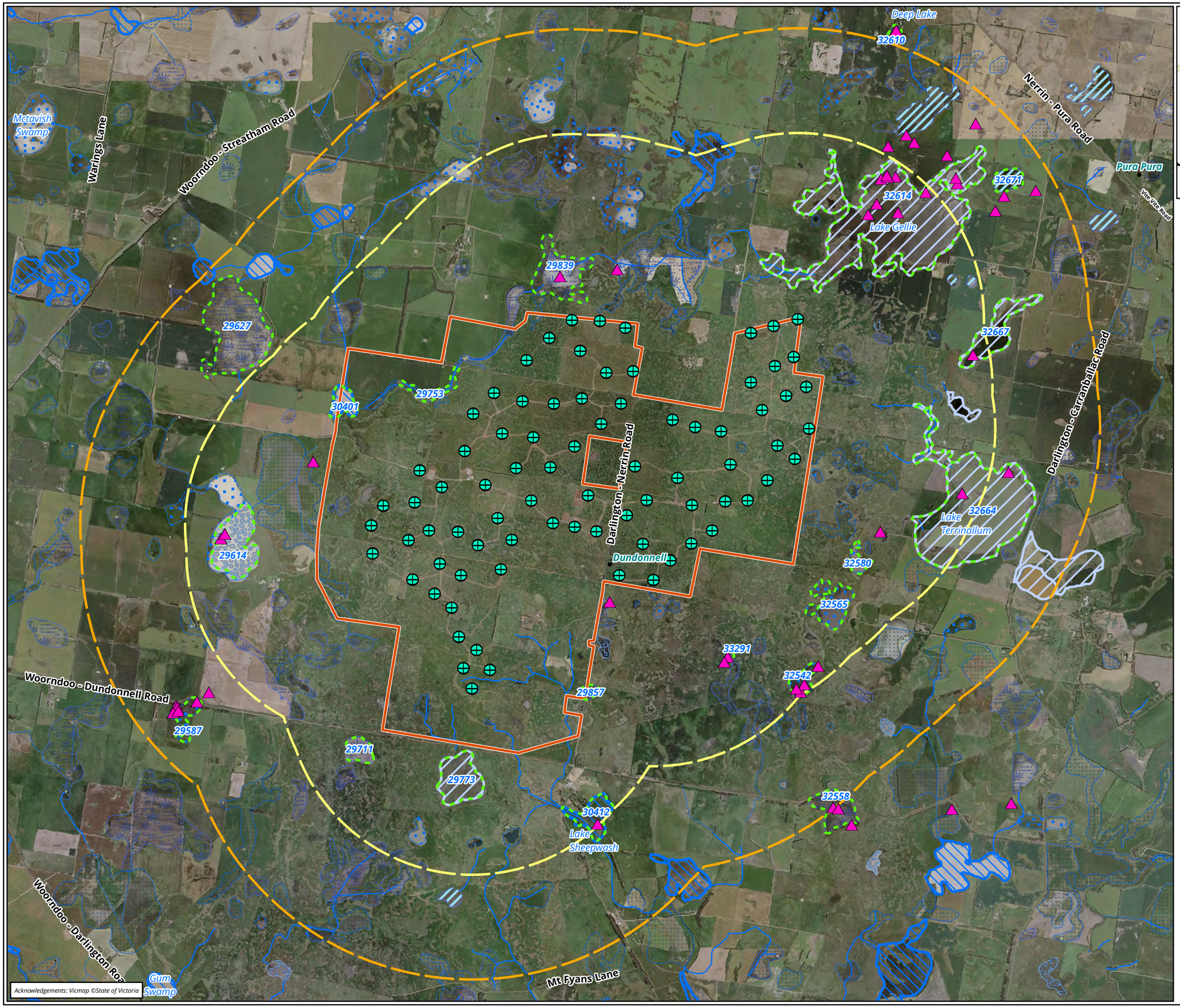
Significant flooding occurred within the Dundonnell region over September – November 2022, with many survey wetlands overflowing their usual borders, displacing nesting Brolgas and Black Swans.

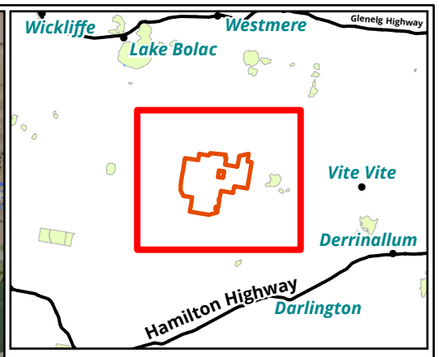
Table 9 Brolga utilisation survey result summary, Year 2

Wetland ID	Brolga habitat use	Brolga numbers and active months	Waterbirds and raptors recorded at wetland
A (29627)	No Brolgas recorded.		Pacific Black Duck, Straw-necked Ibis
B (29614)	Foraging in adjacent paddocks, Flock roosting site.	• 2 Adults (Oct 2022), • 11 Adults (Feb 2022)	Pacific Black Duck, Black Swan, Australian Shelduck, Silver Gull, White-faced Heron, Little Eagle
C (29711)	No Brolgas recorded.		Black Swan, Grey Teal, Pacific Black Duck, Australian Shelduck, Silver Gull, Eurasian Coot, Banded Stilt, Australian Wood Duck
D (29773)	No Brolgas recorded.		Black Swan, Eurasian Coot, Pacific Black Duck, Silver Gull, Australasian Grebe
E (30412)	Foraging on edge of wetland	• 3 Adults (Dec 2022)	Silver Gull, Australian White Ibis, Australasian Swamphen, Pacific Black Duck, Straw-necked Ibis
F (32558)	Nesting, Foraging in wetland and adjacent paddocks.	• 2 Adults, 1 Juvenile (Nov-Dec 2022) • 3 Adults, 2 Juveniles (May 2022), • 2 Adults (Oct 2022)	Australasian Swamphen, White-faced Heron, Swamp Harrier, Masked Lapwing, Black Swan

Wetland ID	Brolga habitat use	Brolga numbers and active months	Waterbirds and raptors recorded at wetland
G (29857)	Foraging in adjacent paddocks	• 2 Adults, 1 Juvenile (July 2022)	White-faced Heron, Black Swan, Australian Shelduck, Eurasian Coot, Australian Pelican, Masked Lapwing, Pacific Black Duck, Silver Gull
H (32580)	Flock foraging in paddock between wetland J and H.	• 21 Flocking (Dec 2022)	Black Swan, Pacific Black Duck, Little Pied Cormorant, Australian Shelduck, Grey Teal, Chestnut Teal, Australasian Grebe, White-faced Heron, Australian White Ibis
I (32565)	Foraging in adjacent paddocks	• 3 Adult (Mar 2022)	Australasian Swamphen, Masked Lapwing, White-faced Heron, Whiskered Tern, Swamp Harrier, Australian Wood Duck, Pacific Black Duck, Banded Stilt, Black Swan, Silver Gull, Chestnut Teal
J (32664)	Foraging on edge of wetland.	• 2 Adult (Feb 2022), • 1 Adult, 1 Juvenile (May 2022),	Banded Stilt (approx. 600 in November 2021), Black Swan, Eurasian Coot, Australian Shelduck, Little Pied Cormorant, Masked Lapwing, Pacific Black Duck, Chestnut Teal, Grey Teal, Wedge-tailed Eagle, White-faced Heron, Australian White Ibis, Pink-Eared Duck
K (32667)	Foraging in wetland	• 2 Adult (Feb 2022)	Black Swan, Masked Lapwing, White-faced Heron, Silver Gull, Pacific Black Duck,
L (32614)	Foraging in adjacent paddocks, Flock roosting site.	• 27 Adult, 11 Juvenile (Apr 2022), • 42 (landholder observation, May 2022)	Black Swan (approx. 1800 in November 2021), Eurasian Coot, Little Black Cormorant, Australian Pelican, Silver Gull, Pacific Black Duck, Little Pied Cormorant
M (32614)	No Brolgas recorded.		Black Swan
N (29839)	Nesting, Foraging in wetland	• 2 Adult (Sep 2022)	Black Swan, White-faced Heron, Yellow-billed Spoonbill, Eurasian Coot, Masked Lapwing, Australasian Swamphen, Little Black Cormorant,
O (30401)	No Brolgas recorded.		Grey Teal, Pacific Black Duck, White-faced Heron, Australian Wood Duck, Masked Lapwing, Little Pied Cormorant, Australian Shelduck, Chestnut Teal, Black Swan
P (29753)	No Brolgas recorded.		Australian Shelduck
Q (32542)	Nesting, Foraging in wetland and adjacent paddocks	• 2 Adult, 1 Chick (Nov 2021 - Jan 2022). • 2 Adult, 1 Chick (Sep – Oct 2022)	Whiskered Tern, Australasian Swamphen, Black Swan, Swamp Harrier, Yellow-billed Spoonbill, Masked Lapwing, Straw-necked Ibis, Pacific Black Duck, Chestnut Teal, Whistling Kite, Little Pied Cormorant,

Wetland ID	Brolga habitat use	Brolga numbers and active months	Waterbirds and raptors recorded at wetland
R (29587)	Nesting, Foraging in wetland and adjacent paddocks	• 2 Adult (Nov 2022), • 2 Adult, 1 Juvenile (Nov 2021 – July 2022) • 3 Adult, 1 Juvenile (July 2022), • 2 Adult (Sep - Nov 2022)	Black Swan, Australasian Swamphen, Whistling Kite, Brown Falcon, Great Egret, Little Pied Cormorant, White Ibis, White-faced Heron, Masked Lapwing, Pacific Black Duck, Australasian Grebe, Wedge-Tailed Eagle
S (33291)	Foraging in adjacent paddocks. Brolgas observed are pair and juvenile from wetland Q.	• 2 Adult, 1 Juvenile (Feb 2022) • 2 Adult, 1 Juvenile (Apr 2022) • 1 Adult (Jun 2022)	Black Swan, Pacific Black Duck, White-faced Heron, Masked Lapwing, Swamp Harrier, Wedge-tailed Eagle, Hoary-headed Grebe, Wood Duck, Grey Teal, Australian Shelduck, Australasian Grebe
T (32671)	Flock and adult pairs foraging in adjacent paddock.	• 26 (Apr 2022) • 3 Adult (Apr 2022) • 2 Adult (Aug 2022)	Black Swan
U (32610)	Nesting, Foraging in wetland and adjacent paddocks	• 2 Adult (Sep – Oct 2022) • 2 Adult, 1 Juvenile (Nov 2022)	Black Swan, Masked Lapwing, Chestnut Teal





Legend

- Wind farm site boundary
- Turbine layout - 3.2 km buffer
- Turbine layout - 5 km buffer
- Turbine
- Brolga 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 Brolga Survey Wetlands Records, Year 2

0 0.5 1 1.5 2 2.5
Kilometres

N

Scale: 1:60,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 36297/33578,
Date: 17 February 2023,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F2_Brolga_Wetlands
Location: P:\36200s\36297\Mapping\
36297_33578_Dundonnell_Yr2.aprx

3.2 Targeted breeding Brolga survey results

Five pairs of Brolgas were recorded attempting to nest at wetlands during Year 2 surveys (Table 10). Observation of Brolgas nesting triggered additional surveys in Year 2 over November 2021 – February 2022 (2021/2022 breeding season), and September 2022 – ongoing into 2023 (2022/2023 breeding season).

Three breeding Brolga pairs were each recorded successfully raising a single chick to fledging over the 2021/2022 breeding season (wetlands F, Q and R). Three breeding pairs successfully hatched a single chick over the 2022/2023 breeding season (wetlands F, Q and U), and one pair hatched two chicks (wetland R).

One pair attempted to nest at wetland N in early summer of 2022/2023 breeding season, however their nest was flooded, and the pair was not observed to return to the wetland. The Brolga pairs at wetland R and F also had their first nests flooded in early summer of 2022/2023, however both pairs nested a second time over December 2022 – January 2023 and have successfully hatched chicks (Year 3 survey data).

Table 10 below details the wetlands where Brolgas have been recorded nesting during year 2 monitoring, and historic breeding use.

Table 10 Brolga breeding wetlands, Year 2

Survey wetland	Wetland description	Distance from DDWF property boundary	Historic and Year 1 Brolga breeding history at wetland
F (32558)	Large seasonally flooded tussock marsh, surrounded by volcanic stony hills. Suitable Brolga nesting habitat while wetland holds water. Wetland tends to dry completely over summer-autumn months.	3.8 kilometres	Breeding from 2002 – 2012, listed in BL&A pre-construction Brolga assessment report. Successful breeding attempt in Year 1, with pair of adults and one juvenile observed in October 2021.
Q (32542)	Large rocky wetland with dense emergent vegetation that holds 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 that the wetland has a long history of Brolga breeding activity. Successful breeding attempt in Year 1, with pair of adults and one juvenile observed in October 2021.
R (29587)	Small drainage line and seasonally flooded paddock. Suitable Brolga nesting habitat while wetland holds water. Wetland tends to dry completely over summer-autumn months, with standing water remaining at a small adjacent dam year-round.	3 kilometres	Breeding from 2008 - 2013, listed in BL&A pre-construction Brolga assessment report. Nesting attempt commenced during Year 1 monitoring. Eggs had not hatched as of October 2021.
N (29839)	Large seasonally flooded marsh, surrounded by volcanic stony hills and large River Redgums. Wetland tends to dry completely over summer-autumn months.	500 meters	No recorded breeding history. Wetland was not included in targeted breeding surveys in Year 1.
U (32610)	Small dam with dense emergent	5.1 kilometres	Wetland was drained until restoration in

Survey wetland	Wetland description	Distance from DDWF property boundary	Historic and Year 1 Brolga breeding history at wetland
	vegetation, restored by landholder in early 2022 by damming eastern edge to allow water retention into summer.		early 2022. No recorded historic breeding use. Wetland was not included in targeted breeding surveys in Year 1.

Table 11 below summarises the Brolga breeding behaviour and outcomes at each survey wetland during Year 2 monitoring.

Table 11 Brolga breeding behaviour and success summary, Year 2

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary	Wetland N summary	Wetland U summary
Year 1 Summary	Successful breeding, one chick hatched as of October 2021.	Successful breeding, one chick hatched as of October 2021.	Pair nesting, two eggs unhatched as of October 2021.	Not surveyed.	Not surveyed.
2021/2022 Breeding season					
November 2021	Pair of adults with one chick foraging in wetland. Chick approx. 80% size of adults.	Pair of adults with one chick foraging in wetland. Chick approx. 80% size of adults.	Pair of adults with one recently hatched chick foraging in wetland.	Not surveyed.	Not surveyed.
December 2021	Pair of adults with large chick foraging in wetland.	Pair of adults with one chick foraging in wetland. Chick approx. 50% size of adults.	Pair of adults with one chick foraging in wetland. Chick approx. 25% size of adults on 7/12/21 and 50% size on 22/12/21.	Not surveyed.	Not surveyed.
January 2022	No Brolgas observed at wetland from January - march. Wetland completely dry. **Chick likely fledged** and family group moved from wetland to join local flock.	Pair of adults with one chick foraging in wetland. Adults and chick observed flying across wetland on 21/1/21. **Chick confirmed fledged.**	Pair of adults with one chick foraging in wetland. Chick approx. 60% size of adults on 4/1/21 and 80% size on 20/1/21	Not surveyed.	Not surveyed.

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary	Wetland N summary	Wetland U summary
February 2022		No Brolgas recorded at wetland. Landholder reported seeing pair and fledged chick flying and feeding on grain lines in Tiverton property.	Pair of adults with one chick foraging in wetland. Chick approx. 90% size of adults with black primary wing feathers.	Not surveyed.	Not surveyed.
March 2022		No Brolgas observed.	Pair of adults with one chick foraging in wetland. **Chick past usual fledging age of 10-14 weeks.**	Not surveyed.	Not surveyed.
2022/2023 Breeding season					
September 2022	Not surveyed, no Brolgas observed at wetland during prior Brolga utilisation survey.	Single Brolga observed sitting on nest in middle of wetland.	Brolga pair nesting in roadside wetland patch.	Single Brolga observed sitting on nest in middle of wetland.	Single Brolga observed sitting on nest in middle of wetland.
October 2022	Single Brolga observed sitting on nest in middle of wetland on 4/10/2022. Pair of Brolga foraging in wetland and nest flooded and abandoned on 18/10/2022.	Pair of adults with one recently hatched chick foraging in wetland. Nest flooded.	No Brolgas recorded, nest flooded and abandoned.	No Brolgas recorded, nest flooded and abandoned.	Pair of adults foraging in wetland. No eggs in nest, chick likely hatched and hidden.
Year 2 Summary	Pair successfully nested at wetland and raised a chick to fledging over 2021/2022 breeding season. First nesting attempt over 2022/2023 breeding season ruined due to flooding.	Pair successfully nested at wetland and raised a chick to fledging over 2021/2022 breeding season. Pair successfully hatched a chick in 2021/2022 breeding season before nest was flooded.	Pair successfully nested at wetland and raised a chick to fledging over 2021/2022 breeding season. First nesting attempt over 2022/2023 breeding season ruined due to flooding.	No nesting attempt at wetland over 2021/2022 breeding season. Nesting attempt over 2022/2023 season ruined due to flooding.	Wetland not surveyed over 2021/2022 breeding season. Pair nested in 2022/2023 breeding season, likely hatched chick.

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary	Wetland N summary	Wetland U summary
Year 3 unpublished data summary (Nov 2022 – Feb 2023)	Pair returned to wetland and nested in December 2022. One chick hatched as of January 2023.	Pair and chick seen at Tiverton property, **confirmed fledged** as of February 2023.	Pair returned and nested in flooded paddock in December 2022. Two chicks hatched as of January 2023.	No further Brolga breeding activity at wetland after initial nest was flooded.	Brolga pair confirmed to have hatched one chick as of January 2023.

3.3 Targeted flocking Brolga survey results

Three Brolga flocks were recorded within the DDWF study area during Year 2 monitoring, between November 2021 and April 2022. The flocks' movement and habitat use appeared largely driven by the availability of suitable roosting wetlands and foraging habitat.

Two flocks (February 22 and April 2022 instances) were recorded foraging in recently harvested grain crops immediately adjacent to suitable roosting wetlands (Table 1, Figure 4).

One flock was recorded during monthly Brolga utilisation surveys foraging in recently harvested grain crops and roosting in wetland B on 11/02/2022. Targeted surveys were conducted starting 22/02/2022 and found that the wetland had dried significantly and the Brolga flock was no longer foraging in the area or roosting at the wetland (Table 12)

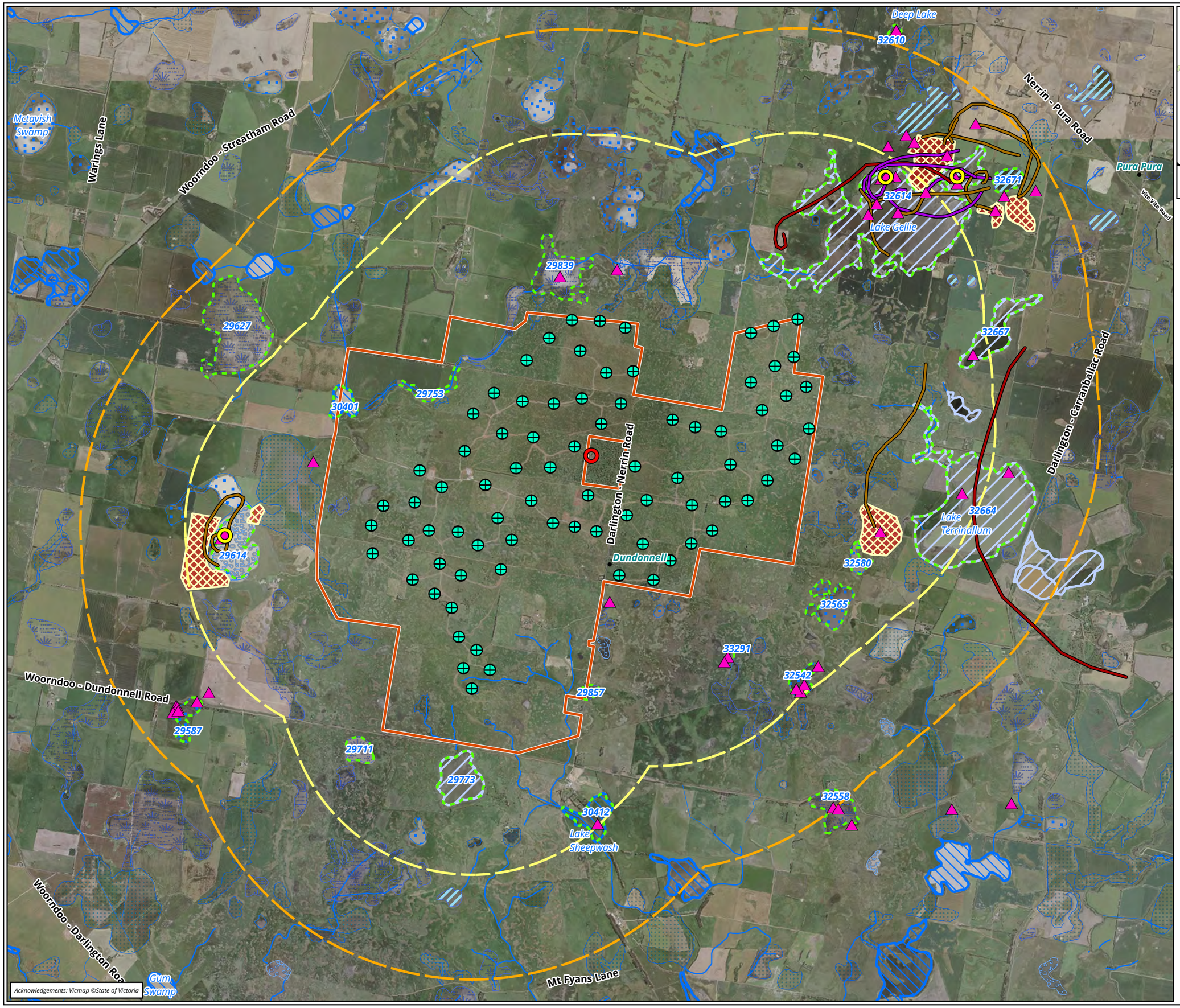
Brolga records within the region prior to construction of the wind farm were retrieved from the VBA and mapped (Figure 4). These records show widespread Brolga use of wetlands within the region throughout the year. Few records exist within the DDWF property boundary, aligning with post-construction Brolga utilisation, breeding and flocking survey results.

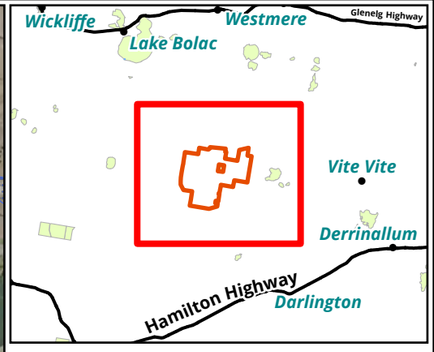
The Brolga flock survey summary for Year 2 monitoring is detailed in Table 12 below.

Table 12 Brolga flocking behaviour, timing and habitat use, Year 2

Flock survey date	Flock size and composition	Survey effort	Flock habitat and movements
November 2021	Landholder reported seeing 21 within the DDWF survey area, triggering targeted flock survey. 8 (adults) recorded during targeted flock survey.	Four days of daytime surveys to assess flock habitat use, flight paths and midday roosting wetland. Two dawn surveys and two dusk surveys to identify flock flight paths and roosting wetland.	Flock of 8 Adults was observed foraging in a grazed sheep paddocks immediately north of wetland H during afternoons and early evenings, approximately 1.3 kilometres from the DDWF property boundary (Figure 3). Roosting wetland was not identified during dawn or dusk surveys. Flock was observed flying north from wetland H during a dusk survey and landing out of sight in paddocks south of Lake Gellie (wetland L). brolga flight height was a maximum of 50 meters above the ground.

Flock survey date	Flock size and composition	Survey effort	Flock habitat and movements
			Midday and dusk surveys at wetlands south of Lake Gellie did not reveal the flock's roosting wetland.
February 2022	15 (adults) recorded during Brolga utilisation survey, triggering targeted flock survey.	Dusk survey on the day flock was recorded, and dawn survey the following day to identify roosting wetland and flight paths. Four days of daytime surveys, two dawn surveys and two dusk surveys at wetlands throughout DDWF survey area in an attempt to track new foraging and roosting habitat of flock.	Flock of 15 adults was observed foraging in recently harvested grain crops surrounding wetland B, and roosting in the wetland at night (Figure 3). Brolgas primarily walked between crops and wetland; flights were a maximum of 50 meters above the ground. No Brolgas were observed during the subsequent targeted flock survey, as B wetland had almost completely dried, and flock had left the area. Dawn, dusk and daytime surveys throughout the DDWF survey area did not locate the flock.
April 2022	12 (adults) recorded during Brolga utilisation survey, triggering targeted flock survey. 38 (27 adults, 11 juveniles) recorded during targeted flock survey.	Dusk survey on the day flock was recorded, and dawn survey the following day to identify roosting wetland and flight paths. Four days of daytime surveys, two dawn surveys and two dusk surveys at wetland L to identify roosting habitat and flight paths.	Large flock of 38 individuals was recorded foraging in harvested grain crops in paddocks immediately north and east of Lake Gellie (wetland L). Flock roosted in shallow sections of Lake Gellie at night and midday. Flights between lake and foraging habitat were usually between 3 and 15 meters above the ground, with a maximum of 35 meters.





Legend

- Wind farm site boundary
- Turbine layout - 3.2 km buffer
- Turbine layout - 5 km buffer
- Turbine
- Brolga record (Biosis)
- Flock roosting site
- Peregrine Falcon Nest Site
- Foraging habitat

Brolga flight paths

- Brolga flight - 2 Adults
- Brolga flock flight
- Brolga flock flight - Roosting

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 3 Dundonnell Wind Farm Brolga Flock Movements And Habitat Use, Year 2

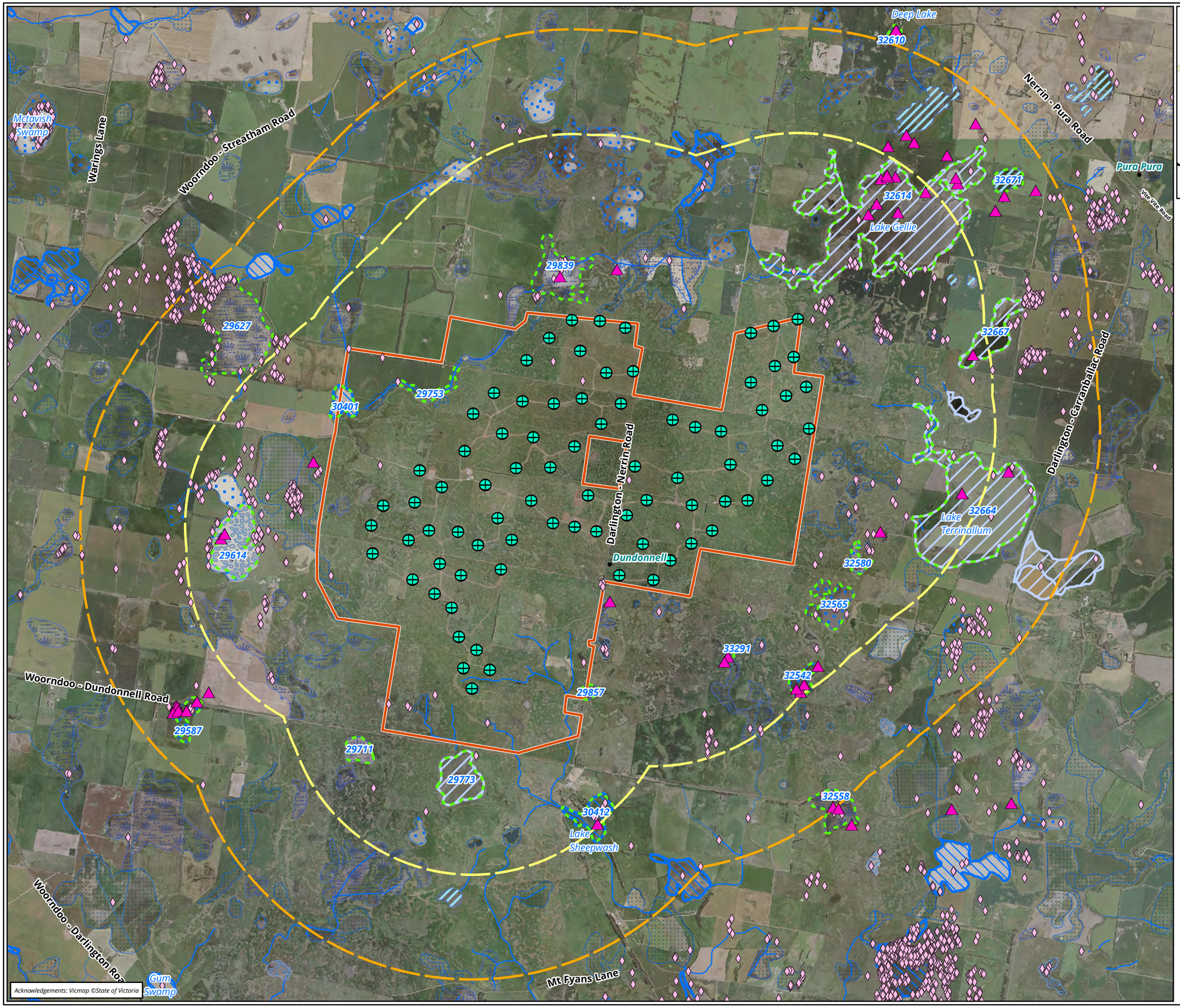
0 0.5 1 1.5 2 2.5
Kilometres

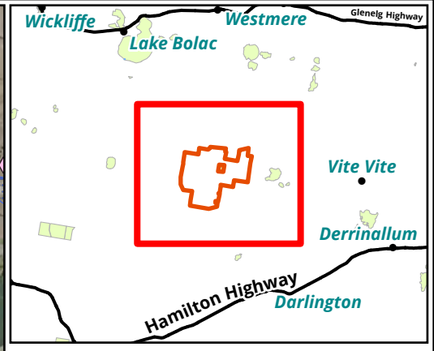
N

Scale: 1:60,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 36297/33578,
Date: 20 February 2023,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F3_Brolga_FlockMovements
Location: P:\36200s\36297\Mapping\
36297_33578_Dundonnell_Yr2.aprx





Legend

- Wind farm site boundary
- Turbine layout - 3.2 km buffer
- Turbine layout - 5 km buffer
- Turbine
- Brolga record (Biosis) - all surveys, years 1 and 2
- Brolga record (VBA)

Wetlands

- 1 - Flooded river flats
- 2 - Freshwater meadow
- 20 - Sewage oxidation basin
- 21 - Salt evaporation basin
- 3 - Shallow freshwater marsh
- 4 - Deep freshwater marsh
- 5 - Permanent open freshwater
- 6 - Semi-permanent saline
- 7 - Permanent saline
- 99 - No Category
- Surveyed

Figure 4 Dundonnell Wind Farm Pre-construction Brolga habitat utilization comparison

0 0.5 1 1.5 2 2.5
Kilometres

N

Scale: 1:60,000 @ A3
Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 36297/33578,
Date: 24 February 2023,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F4_Brolga_PreCon_Utilization
Location: \\bio-data-01\matters$\36200s\36297\Mapping\36297_33578_Dundonnell_Yr2.aprx

3.4 Peregrine Falcon breeding survey results

Surveys for breeding Peregrine Falcons during Year 2 monitoring were conducted from November – December 2021, and from July to December 2022 at the Mount Fyans Wildlife Reserve.

A pair of Peregrine Falcons was recorded at the Mount Fyans Wildlife Reserve during Year 1 monitoring, foraging, roosting, and nesting in a hole in the decommissioned stone quarry wall (Figure 3). The pair successfully hatched a single chick, which was observed inside the quarry wall nest in October 2021 (Biosis 2022). Monitoring of the pair and their chick continued into year 2. The chick was observed having fledged in December 2021 (Table 13). Successful breeding was confirmed over the 2021/2022 breeding season. Monitoring recommenced in July 2022 for the 2022/2023 breeding season. A single adult Peregrine Falcon was observed roosting and flying through the wildlife reserve from September 2022 – October 2022.

The single falcon did not exhibit any behaviour that would indicate it had a partner nesting as it remained perched in a tree above the nest site after noticing the Biosis surveyor, rather than circling overhead, calling loudly. A single Peregrine Falcon carcass was recorded during carcass search surveys in August 2022, at turbine D05, located 1.2 kilometres east of Mount Fyans Wildlife Reserve.

Table 13 Peregrine Falcon survey summary, Mount Fyans Wildlife Reserve, Year 2

Survey month	Number observed	Peregrine Falcon habitat utilisation and breeding behaviour summary
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 chick observed in October 2021.	
2021/2022 Breeding season		
November 2021	3 (2 Adult, 1 juvenile)	Adults perched on trees overlooking quarry. Juvenile perched at mouth of nest.
December 2021	2 (1 Adult, 1 juvenile)	No falcons seen at start of survey. Adult flew in carrying mouse, calling loudly. Juvenile emerged from nest, took prey from adult, and flew up to a nearby tree to feed while adult circled overhead, calling.
Additional opportunistic survey outside breeding survey period		
February 2022	1 (Adult)	Seen briefly, flying above reserve, and perching in dead trees above quarry.
2022/2023 Breeding season		
July 2022	No falcons	-
August 2022		
September 2022	1 (Adult)	Perched in dead tree above quarry throughout entire survey, did not appear perturbed by obvious presence of surveyor, indicating lack of nesting partner.
5 October 2022	1 (Adult)	
19 October 2022	1 (Adult)	Seen briefly, flying through SW corner of reserve, did not appear perturbed by obvious presence of surveyor, indicating lack of nesting partner.
Year 2 survey summary	Pair of adults successfully raised a single chick to fledging in breeding season of 2021/2022. Single adult was observed in 2022/2023 season, no breeding attempt recorded.	

Survey month	Number observed	Peregrine Falcon habitat utilisation and breeding behaviour summary
Year 3 unpublished data summary (Nov – Dec 2022)	No peregrine Falcons observed at wildlife reserve between November and December 2022	

3.5 Carcass search correction factor study results

3.5.1 Carcass persistence trial

Five carcass persistence trials were conducted within the first two years at DDWF; these occurred in November 2020, March - April 2021, October 2021, March-April 2022 and October 2022. A total of 119 carcasses were used during these trials, including 40 bird carcasses, 14 bat carcasses, 39 Brolga proxies (turkey) and 26 bat proxies (mice).

It is noted by Symbolix (2023, Appendix 5) that the bat carcass cohort was comprised of both White-striped Free-tailed Bats and bat proxies (mice), which experienced different persistence rates at DDWF. White-striped Free-tailed Bat carcasses experienced an unusually high persistence rate of approximately 30 days at DDWF. In Victoria, carcass persistence for bats is typically less than 5 days (Stark and Muir 2020), and the mice proxies at DDWF were more consistent with this expectation. Symbolix (2023) has therefore combined the persistence data for bats and bat proxies in their modelling to determine mortality estimates.

The median time from mortality to total carcass loss due to scavenging was found to be 4.9 [2, 9.8] days for bats, 8.3 [4, 18.9] days for birds and 10.5 [7, 16.8] days for Brolga (turkeys). The numbers presented in square brackets represent 95% confidence intervals on mean persistence periods (Symbolix 2023; Appendix 5).

3.5.2 Searcher efficiency trial

Five searcher efficiency trials were conducted within the first two years at DDWF; these occurred in November 2020, April 2021, October 2021, April 2022 and October 2022. A total of 158 carcasses were used during these trials, including 49 bird carcasses, 58 bat carcasses and 51 Brolga proxies (turkey).

A summary of the detection efficiencies calculated by Symbolix (2023) is provided in Table 14. Bird and bat efficiencies are aggregated while Brolga detection efficiencies are presented separately due to the different search methods (visual binocular searches).

Table 14 Survey detection efficiencies for birds/bats and Brolga, from Symbolix (2023)

Variable	Bats and birds	Brolga
Number placed	107	51
Number found	101	39
Mean detectability proportion	0.94	0.76
Detectability lower bound (95% CI)	0.88	0.63
Detectability upper bound (95% CI)	0.98	0.87

3.6 Carcass search results

Carcass searches during the first two years of operation at DDWF were conducted monthly from November 2020 to October 2022. A total of 1337 searches were conducted (669 standard surveys, 668 pulse surveys) across a subset of approximately 28 turbines per month. During these surveys, a total of 171 bird/bat carcasses and 55 bird feather spots were recorded across approximately 39 species/species categories

including 34 birds and five bats (Table 15). An additional 135 carcasses or feather spots were recorded incidentally, including 3 additional species not recorded during routine searches, resulting in a grand total of 361 recorded mortalities across DDWF within the first two years of operation (Table 15).

The most frequently recorded species were:

- White-striped Free-tailed Bat (59 records)
- Australian Magpie (48 records)
- Nankeen Kestrel (40 records)
- Brown Falcon (33 records)
- Barn Owl (19 records)
- Wedge-tailed Eagle (19 records)
- Straw-necked Ibis (16 records)

Three threatened species were recorded during the carcass search program, White-throated Needletail (two records in Year 1), Grey-headed Flying-fox (four records in Year 1) and Brolga (one record in Year 2). These finds met the BAM Plan threatened species impact trigger and required further assessment and reporting to DEECA, which is summarised in Section 4. In accordance with the BAM Plan, all native bird and bat finds were reported to DEECA within 7 days of being detected.

Two adult Peregrine Falcon carcasses have been recorded within the first two years at DDWF, including one found at turbine B06 on 18 September 2021 during routine surveys, and another found at turbine D05 on 29 August 2022 as an incidental find. While not listed as threatened, this species is subject to ongoing monitoring at Mount Fyans Wildlife Reserve in accordance with the BAM Plan (Section 2.3 and 3.3). The carcass find in Year 1 appeared to be unrelated to the breeding pair at the reserve due to the fact that two adults and their chick were all observed at the nest site following this find. Only one adult Peregrine Falcon was recorded at the former nesting site at Mount Fyans Wildlife Reserve from July-December 2022, and no breeding attempt was recorded. This suggests that the Peregrine Falcon carcass find in August 2022 could have been one of the adult birds that successfully bred at the site the previous season. Monitoring at the site will continue in accordance with the BAM Plan.

Of the bird/bat carcasses found during the first two years of surveys, 29 could be identified as male or female, and 113 could have an age class assigned. Of the 29 carcasses where sex could be determined, 20 were White-striped Free-tailed Bats (16 male, four 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 the majority of carcasses.

Table 15 Carcass search program species summary years 1 and 2 combined (threatened species in bold text)

Species	Carcass finds	Feather spots	Incidental	Total
Birds				
Australian Magpie	9	18	21	48
Australian Magpie or Magpie-lark	0	1	0	1
Australian White Ibis	0	2	0	2
Barn Owl	4	5	10	19
Black-shouldered Kite	1	0	0	1
Brolga	**1**	**0**	**0**	**1**
Brown Falcon	15	1	17	33

Species	Carcass finds	Feather spots	Incidental	Total
Brown Goshawk	1	0	0	1
Common Starling	3	0	4	7
Dusky Moorhen	1	0	0	1
European Goldfinch	4	0	0	4
Fantail/Wagtail	1	0	1	2
Galah	2	0	1	3
Grey Fantail	1	0	0	1
Ibis sp.	1	0	0	1
Introduced finch sp. (Goldfinch or Greenfinch)	1	0	0	1
Little Button-quail	1	0	0	1
Musk Lorikeet	1	0	0	1
Nankeen Kestrel	9	4	27	40
Painted Buttonquail	1	0	0	1
Peregrine Falcon	1	0	1	2
Raven sp.	5	0	3	8
Rock Dove	0	1	0	1
Rosella sp.	0	1	0	1
Silvereye	1	0	0	1
Skylark or pipit	1	0	0	1
Sparrow sp.	1	0	0	1
Straw-necked Ibis	6	6	4	16
Striated Pardalote	2	0	0	2
Stubble Quail	2	0	0	2
Unknown Bird	8	15	10	33
Wedge-tailed Eagle	7	0	12	19
Whistling Kite	1	0	1	2
White-throated Needletail	**0**	**1**	**1**	**2**
Pallid Cuckoo	0	0	2	2
Skylark	0	0	1	1
Bats				
Gould's Wattled Bat	4		2	6
Gould's or Chocolate Wattled Bat	2		0	2
Grey-headed Flying-fox	**1**		**3**	**4**
Unidentified Bat	23		3	26
White-striped Freetail Bat	49		10	59
Lesser Long-eared Bat	0		1	1
TOTAL	**171**	**55**	**135**	**361**

3.7 Wedge-tailed Eagle and White-throated Needletail monitoring

Incidental recording of Wedge-tailed Eagle and White-throated Needletail flights during monthly carcass searches recorded 48 Wedge-tailed Eagle flights (Table 16). No White-throated Needletail flights were recorded during the first two years of incidental flight recording.

Table 16 Wedge-tailed Eagle incidental observation summary for the first two years of operation at DDWF

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	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	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 2021	8/06/2021	8:57	H05/H08	2	0	Perching on fence
	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
December 2021	8/12/2021	7:40	G10	1	0	Perched on top of large eucalypt approx. 220 metres SE of G10 turbine
	8/12/2021	10:55	H07	1	30 - 150	Flying away from raven at first, soaring, then being chased by raven back east at speed and

Month	Date	Time	Closest turbine/s	Number	Flight height (meters)	Behaviour
						possibly landed out of view. Flying near H04 and G08.
January 2022	8/01/2022	7:30	H06	2	20	One gliding to top of dead cypress, the second was perched on dead tree.
	9/01/2022	8:18	G04	2	0 - 60	Flying directional
March 2022	4/03/2022	10:00	C01, F02, C04, C03	2	100 - 200	Flying together, soaring, circling, magpies attacking
	4/03/2022	14:00	C07	2	0 - 100	Perched on ground before heading to wildlife reserve
	6/03/2022	14:07	F07	1	100 - 200	Gliding
	7/03/2022	12:30	C07	1	0 - 50	Scavenging the turkey carcass
April 2022	4/04/2022	12:40	C07	1	20	Flying directional
	9/04/2022	11:25	A01	2	0 - 50	Circling
May 2022	7/05/2022	8:32	C08	1	0 - 200	Circling, sitting, dodging magpies
July 2022	9/07/2022	11:48	A08	2	0 - 50	Circling
October 2022	11/10/2022	9:10	C06/C07	1	0 - 100	Circling

3.8 Brolga mortality monitoring

During the first two years of operation at DDWF, Brolga mortality monitoring resulted in the detection of one Brolga carcass. The Brolga carcass was detected on 5 October 2022 at turbine H09 and is discussed in further detail in Section 4. The Brolga carcass was detected using visual (binocular) searches.

Brolga monitoring (binocular searches) recorded an additional 56 bird carcasses, 31 feather spots and 11 bats at the additional turbines surveyed, all of which were included in the overall carcass find results as incidental finds. 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 five carcasses in year 2 which were subsequently reported to site personnel and/or landowners, including three sheep carcasses (one at turbine F01 and two at turbine F08) and two kangaroo carcasses (one each at turbines C06 and C08).
- No formal feral animal control program was undertaken during Year 2. 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 Mortality estimates

Quantifying bird and bat mortality from turbine collision is an ongoing management issue for wind energy facilities, and different sites present different risks. Differences in monitoring requirements across Victoria means that data analysis must account for variations in survey effort, survey detection success, and scavenger efficiency.

It is a requirement of the BAM Plan for DDWF that statistical analyses of carcass search results and subsequent estimation of total mortalities is undertaken after two years of wind farm operation. Symbolix was contracted to undertake this analysis and produce a report on the methods and findings, which is provided in Appendix 5. Symbolix used the results of the correction factor studies (searcher efficiency and carcass persistence) as well as information about survey coverage, including carcass fall-zone, to calculate an estimate of the overall mortality at DDWF for the period of 15 October 2020 to 11 October 2022.

This section of the report provides a summary overview of the findings and conclusions made by Symbolix (2023). The full methods and results can be found at Appendix 5.

4.1 Bird mortality estimate

During the first two years of operation of DDWF, a total of 146 bird carcasses and/or feather spots were found during formal surveys, as presented in Section 3.6. Of these, 67 were found in Year 1 and 79 were found in Year 2. Based on these detected carcasses, searcher efficiency rates, carcass persistence rates and survey effort, it is estimated that there was a total site loss of approximately 926 birds over the full survey period, with around 418 lost during Year 1 and around 485 lost in Year 2 (Symbolix 2023).

The full report (Appendix 5) provides further information on the distributions and confidence intervals associated with these estimates.

4.2 Bat mortality estimate

During the first two years of operation of DDWF, a total of 79 bat carcasses were found during formal surveys, as presented in Section 3.6. Of these, 46 were found in Year 1 and 33 were found in Year 2. Based on these detected carcasses, searcher efficiency rates, carcass persistence rates and survey effort, it is estimated that there was a total site loss of approximately 564 bats over the full survey period, with around 348 lost during Year 1 and around 241 lost in Year 2 (Symbolix 2023).

The full report (Appendix 5) provides further information on the distributions and confidence intervals associated with these estimates.

4.3 Brolga mortality estimate

During the first two years of operation of DDWF, a total of 1 Brolga carcass was found during formal surveys, as presented in Section 3.8. The single carcass was found in Year 2; no Brolga carcasses were found during Year 1. It is a requirement of the BAM Plan for DDWF that statistical analyses of carcass search results and subsequent estimation of total mortalities is undertaken after two years of wind farm operation. Symbolix have calculated a mortality estimate for Brolga, however as this is based on one carcass find, the accuracy and reliability of any derived estimate is considered to be low.

Based on the single detected carcass, searcher efficiency rates, carcass persistence rates and survey effort, it is estimated that there was a total site loss of approximately five Brolgas over the full survey period, with around two lost during Year 1 and around four lost in Year 2 (Symbolix 2023).

The full report (Appendix 5) provides further information on the distributions and confidence intervals associated with these estimates. Additional assessment of these estimates against the predicted mortalities presented in the BAM Plan, and against the Brolga Compensation Plan (Tilt Renewables 2019) is presented in Section 5.1.3.

5 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).

During the first two years of operation at DDWF, a total of four impact triggers were met, including three in Year 1 and one in Year 2. Impact triggers were met for the following species:

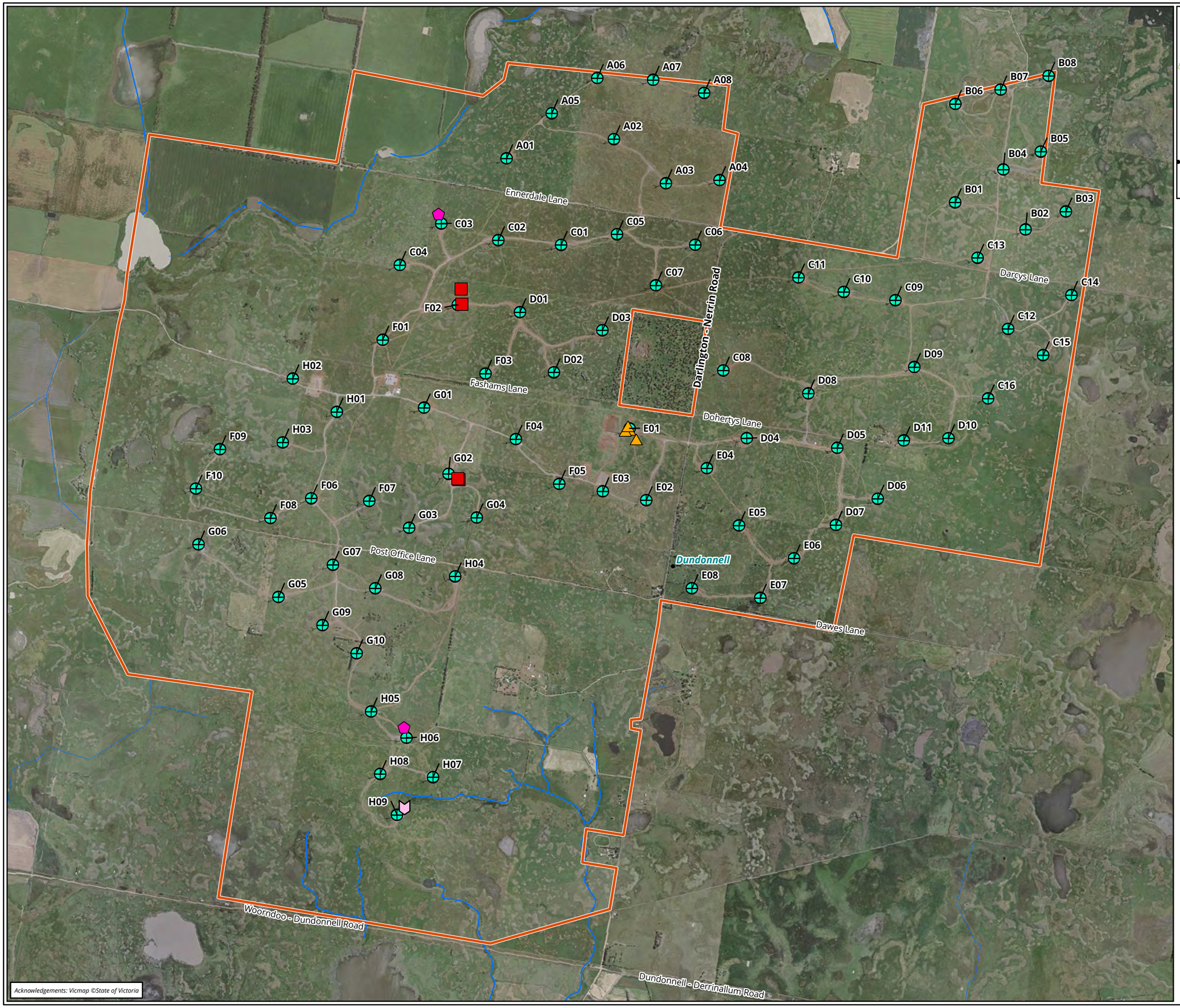
- Grey-headed Flying-Fox (threatened species) – four carcass finds across March and April 2021 at two turbines (F02 and G02) (Year 1).
- White-throated Needletail (threatened species) – two *potential* carcass finds in March 2021 at two turbines (H06 and C03) (Year 1).
- Brolga (threatened species) – one carcass find in October 2022 (Year 2).
- 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 (Year 1).

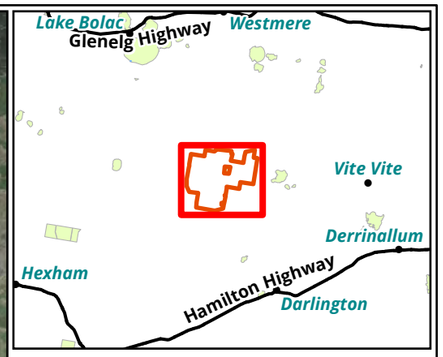
In accordance with the BAM Plan, further assessment and reporting of these four impact triggers was undertaken and submitted to DEECA. The assessments for Grey-headed Flying-Fox, White-throated Needletail and White-striped Free-tailed Bat are provided in the Year 1 report (Biosis 2022). These assessments all concluded that impacts are unlikely to be significant, and further investigation was not required.

For the two threatened species impact triggers that occurred in Year 1 (Grey-headed Flying-Fox and White-throated Needletail), no additional finds of either species have occurred since. For the non-threatened species impact trigger that occurred during Year 1 (White-striped Free-tailed Bat), no further impact triggers have occurred during Year 2, however an additional 22 carcass finds for this species were recorded. This is slightly less than the total of 34 finds for Year 1.

The assessment for the Brolga impact trigger which occurred during Year 2 is provided in Section 5.1.

The locations of all impact trigger finds for the first two years of operations at DDWF are displayed in Figure 5.





Legend

- Wind farm site boundary
- Turbine

Threatened species

- Brolga - Impact trigger met
- 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

Figure 5 Locations of BAM Plan impact trigger carcass finds

0 250 500 750 1,000

Metres

N

Scale: 1:30,000 @ A3

Coordinate System: GDA 1994 MGA Zone 54

biosis

Matter: 36297/33578,
Date: 06 March 2023,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F5_BAM_Triggers
Location: P:\36200s\36297\Mapping\
36297_33578_Dundonnell_Yr2.aprx

5.1 Brolga

A single Brolga carcass was detected beneath turbine H09 on 5 October 2022 during visual binocular searches undertaken by Skylos Ecology for the monthly Brolga mortality monitoring. The carcass find was notified to DEECA on Thursday 6 October 2022, within the 2-day timeframe specified in the BAM Plan impact trigger for threatened species, and a follow up investigation was undertaken by Biosis to determine the likely cause of death and the likelihood of further occurrences. Following an inspection by Biosis, the carcass was taken for an independent necropsy by the University of Melbourne, which was requested and commissioned by DEECA.

5.1.1 Investigation of the carcass

The Brolga carcass detected by Skylos Ecology consisted of two wings and a large feather scatter, suggesting that the carcass had been scavenged. Following the detection of the two wings, additional searching was undertaken by Skylos Ecology on foot, and with the assistance of dogs, in an attempt to locate other parts of the carcass. Two legs were subsequently detected, however the head could not be located. It is likely that a scavenger, most likely a fox, had removed the head and body and carried them away.

The carcass was frozen and then delivered to Dr Inka Veltheim, a Senior Zoologist at Biosis and a Brolga subject matter expert. The carcass was inspected in an attempt to find any evidence of blunt trauma or other signs that could assist in understanding the cause of death. However, this assessment was significantly limited by the absence of the body, neck and head.

Upon inspection of the carcass, the wings and legs showed no evidence to help determine a cause of death, such as bone breakage, cuts or scrapes (such as I. Veltheim has observed on carcasses previously found from powerline or fence collisions). No obvious signs of blunt trauma were detected, however there was evidence of teeth or claw marks, which is likely to be from scavenging activity, post mortem. The carcass inspection also included an assessment of the plumage to determine age and sex, if possible. The plumage of the carcass was assessed as that of a juvenile bird, likely from the 2021 breeding season.

Given the location of the carcass (approximately 90 metres from a turbine) and numerous feathers, and the absence of other likely collision risks such as powerlines in the immediate vicinity of the area, it is considered most probable that the cause of death was turbine strike and that it occurred at turbine H09. The feather scatter found in the immediate vicinity of the wings is also suggestive that the carcass was encountered by scavenger/s at that location, rather than dragged there from another location.

At the request of DEECA, the carcass was taken to the University of Melbourne in Werribee for an independent necropsy to be undertaken, which concluded that the cause of death was undetermined (Appendix 6).

5.1.2 Investigation of the site and local context

In accordance with Section 8.1.2 (Decision-making framework of an impact trigger for threatened species) of the BAM Plan, further investigation was undertaken to identify any particular risk behaviours that could have led to the collision and an evaluation of the likelihood of further collisions.

The carcass was discovered approximately 90 metres from wind turbine H09, which is the southern-most wind turbine at DDWF. On 7 October 2022, Biosis zoologist Wyn Russell undertook a site assessment of the area to gather preliminary contextual information to understand potential on-going collision risk for Brolgas in the vicinity of turbine H09. This included:

- assessing the proximity of the turbine to any wetlands and their current condition
- looking for individuals and nests within these wetlands

- assessing and accounting for the presence of all individuals of known breeding pairs within the radius of the BAM Plan required breeding surveys
- a search for other structures that can pose potential mortality risks to Brolga, such as the presence of powerlines and the met mast approximately 400 metres from turbine H09.

From 18 – 20 October 2022, Biosis zoologists Inka Veltheim and Wyn Russell undertook further site assessments and targeted dusk/dawn Brolga surveys in the vicinity of turbine H09 to assess the potential ongoing risk to Brolga at the location. This included:

- an assessment of potential foraging and nesting habitat within the surrounding landscape
- a dusk survey on the night of 18 October
- dawn surveys on the morning of 19 and 20 October

All known pairs of Brolgas within the DDWF Brolga breeding survey buffer were surveyed and accounted for during monthly surveys immediately after the carcass was recorded (5 – 7 October 2022 surveys). During the dawn surveys at H09, a Brolga pair were heard calling approximately 3 kilometres to the south-west, which was likely to have been the breeding pair then known to be nesting at a wetland at the southern end of Veals Lane (wetland R). These observations are consistent with the assessment of the carcass being a juvenile bird, and not an adult currently nesting within the DDWF Brolga breeding survey buffer.

Two seasonally flooded wetlands were recorded within the vicinity of Turbine H09, as well as flooded low-lying areas with water, *Juncus* and large numbers of frogs within 100 metres of Turbine H09. These are likely to be the result of recent high rainfall and are not numbered DEECA wetlands. There were no signs of foraging, roosting or nesting Brolgas at any seasonal wetlands or flooded areas in the vicinity of Turbine H09 (i.e. no feathers, nests or footprints). No flying, roosting or foraging Brolgas were recorded within the immediate vicinity of Turbine H09 during the site inspections or the dawn/dusk surveys.

Widespread flooding throughout the region has caused a 'boom' of frogs and foraging habitat, while also flooding out nesting wetlands, potentially leading to increased movements of Brolgas as they forage throughout areas that are usually dry, and search for suitable nesting habitat. Wet conditions associated with the La Nina weather system that has been present for the past three years are predicted to end next summer, with the return of an El Nino weather system which will result in warmer, drier conditions, and possibly reduced Brolga activity at some wetlands within the study area. Ongoing Brolga monitoring and carcass searches will determine the impact this changing weather system has on Brolga activity and mortality.

Fencelines are located within 50 metres of Turbine H09 which consist of stone walls and barbed wire. These were searched by the two observers walking up and down the fencelines, with no Brolga feathers found on or near them. It is therefore considered unlikely that the Brolga died as a result of collision with these fences. There were no powerlines within the vicinity of Turbine H09, therefore ruling out collision with a powerline as a cause of death.

Other potential causes of death include disease and predation, though these are considered highly unlikely. There is no information on diseases or pathogens in wild Brolgas, and the independent necropsy did not record any evidence to suggest this was likely. Similarly, the site-based assessment undertaken by Biosis found no evidence that Brolgas are or were utilising habitat in the vicinity of the carcass find, therefore it is also considered unlikely that the individual was predated upon while using those habitats.

Given the location of the carcass (approximately 90 metres from a turbine) and numerous feathers, and the absence of other likely collision risks such as powerlines in the immediate vicinity of the area, it is considered most likely that the cause of death was turbine strike and that it occurred at the location of Turbine H09. The feather scatter found in the immediate vicinity of the wings is also suggestive that the carcass was encountered

by scavenger/s at that location, rather than dragged there from another location. A summary of all potential causes of mortality and an assessment of their likelihood is provided in Table 17 below.

Table 17 Summary of potential Brolga mortality sources at Turbine H09 and an assessment of likelihood

Potential cause of mortality	Assessment	Likelihood
Collision with powerline	There were no powerlines within the vicinity of Turbine H09, therefore ruling out collision with a powerline as a cause of death.	Highly unlikely
Collision with fenceline	The site-based assessment undertaken by Biosis included a search around existing fencelines. No feathers were found on or near these fencelines. It is therefore considered unlikely that the Brolga died as a result of collision with a fence.	Unlikely
Disease	There is no information on diseases or pathogens in wild Brolgas, and the independent necropsy did not record any evidence to suggest this was likely, though it is acknowledged that there was unlikely to be enough soft tissue material to test for this. The necropsy result was undetermined.	Unlikely
Predation	The site-based assessment undertaken by Biosis included a search around existing standing water in the area surrounding the turbine. No feathers, nests or footprints were found in these areas, suggesting that it is unlikely that these areas were being utilised by Brolga. It is also considered unlikely that a Red Fox or other potential predator would take a fully-sized Brolga. It is therefore considered unlikely that the individual was predated upon while using those habitats.	Unlikely
Collision with turbine	The carcass was found approximately 90 metres from Turbine H09 and comprised wings, legs and numerous feathers. The feather scatter found in the immediate vicinity of the wings suggests that the carcass was encountered by scavenger/s at that location, rather than dragged there from another location. In the absence of evidence to suggest predation, disease or collision with another structure, the cause of death is considered most likely to be a result of collision with Turbine H09.	Most likely

5.1.3 Victorian Brolga population information

The impact trigger assessment for the Brolga carcass find entailed a review of the status of the Victorian Brolga population, which is provided below. The distribution of Brolga in Victoria extends from the State's north-east to the south-west. Published information on the Victorian Brolga population estimates that it consists of 600–650 individuals, with 500–550 of these within the south-west and 50–100 within the north-east of the state (White 1987). More recent surveys have aimed at a better and more comprehensive understanding of Brolga numbers in south-west Victoria, through undertaking systematic same-day counts. In 2013, 907 individuals were counted during the annual count (SWIFFT 2021) at Victorian and South Australian flocking areas. GPS tracking has shown that Brolgas move between sites in south-west Victoria and South Australia and are part of

the same population. The number of breeding pairs is estimated to be 200-250 (SWIFFT 2021). South-west Victoria thus incorporates the core range of the Victorian brolga population and the area occupied by the species includes breeding and locations at which Brolgas congregate during the non-breeding season.

5.1.4 Assessment against predicted mortalities

The single confirmed mortality of a Brolga at DDWF after two years of operation is within the range of mortalities projected to occur by Collision Risk Modelling (0-2 after one year and 1-9 after ten years; BL&A 2018). It is a requirement of the BAM Plan for DDWF that statistical analyses of carcass search results and subsequent estimation of total mortalities is undertaken after two years of wind farm operation. Symbolix have attempted to calculate the mortality estimate based on the found (one) carcass and accounting for searcher efficiency, carcass persistence and survey coverage. As the estimates are calculated from a single actual carcass find, the reliability and accuracy of this estimate is low. It is expected that as Brolga monitoring continues, the calculated mortalities will more closely align with the predicted cumulative mortalities presented in the Brolga Compensation Plan for DDWF (Tilt Renewables 2019).

5.1.5 Conclusion and recommendations

The independent necropsy undertaken by University of Melbourne as requested by DEECA (formerly DELWP) concluded that the cause of death was undetermined. Based on the additional assessments undertaken by Biosis of the Brolga carcass and site-based information from Turbine H09, it is considered that turbine strike is the most probable cause of death. The individual is likely to have been a juvenile bird from the 2021 breeding season, that may have been dispersing or using the local area for foraging. Based on tracking studies undertaken by Veltheim et al (2022), it is possible that the juvenile originated from a local natal site or was dispersing from breeding sites further to the east. Information from the site assessment indicates that habitat in the vicinity of Turbine H09 has no characters making it particularly attractive to Brolgas and thus that there is no reason to expect that Brolga strikes there are likely to be a regular occurrence. As a consequence, no specific mitigation measures are apparent, and none are proposed. The find confirms that the preferred method for Brolga mortality searches (visual searches) is successful at detecting Brolga carcasses.

It is therefore recommended to continue Brolga monitoring as well as undertaking further correction factor studies to improve the confidence and accuracy in subsequent mortality estimates. Concurrently, it is recommended that additional methods be considered and trialled to improve searcher efficiency and carcass persistence. The BAM Plan requires that Brolga mortality estimates are recalculated each year, therefore the next Brolga mortality estimate will be calculated and presented in the Year 3 Annual Report.

6 Conclusion and recommendations

This report compiles the methods and findings from the first two years of implementation of the approved BAM Plan at DDWF, by detailing the findings from Year 2, and summarising the results from Year 1 which are presented in greater detail in Biosis (2022). This section summarises the key findings of the first two years of BAM Plan implementation and recommendations for ongoing bird and bat monitoring at DDWF.

6.1 Brolga utilisation monitoring

A total of 21 wetlands were surveyed during the first two years of monitoring for breeding and flocking Brolgas, of which 16 wetlands and surrounding grassland were recorded being utilised by foraging Brolgas, and five wetlands were recorded being utilised by breeding Brolgas.

Of the five wetlands where Brolga breeding was recorded, two were within the 3.2 kilometre buffer of the wind turbines, two were within the 5 kilometre buffer of the wind turbines, and one was 5.1 kilometres from the wind turbines. All five wetlands were subject to additional fortnightly breeding surveys. Successful fledging of chicks was recorded at three wetlands over the 2021/2022 breeding season.

Three instances of flocking were recorded during Year 2 monitoring. Flocks of up to 38 individuals were recorded foraging and roosting at wetlands within the 3.2 kilometre buffer of the wind turbines. Flock movement appeared largely driven by availability of suitable roosting habitat and recently harvested grain crops.

Therefore, it is recommended that:

- Brolga utilisation monitoring is continued into Year 3, in accordance with the BAM Plan.
- Additional wetlands within the survey buffer are added to the monthly Brolga utilisation monitoring schedule, when identified as habitat, or if restored after historic draining.
- Additional fortnightly Brolga breeding monitoring has continued into Year 3 of monitoring and will continue until breeding behaviour ceases.
- Continue targeted flocking surveys when a flock is observed or reported within the survey buffer, in accordance with the BAM Plan.

6.2 Peregrine Falcon monitoring

Monitoring at Mount Fyans Wildlife Reserve was undertaken for the first two years of operation of DDWF, which confirmed the presence of a breeding pair of Peregrine Falcons in 2021 (year 1). The pair were monitored monthly until the single chick fledged in December 2021. 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. Monitoring during the 2022/2023 season only recorded a single adult on three occasions. No breeding attempt was recorded.

Two adult Peregrine Falcon carcasses have been recorded within the first two years at DDWF, one carcass during year 1 and one during year 2. The carcass find in Year 1 appeared to be unrelated to the breeding pair at the reserve due to the fact that two adults and their chick were all observed at the nest site following this find. Only one adult Peregrine Falcon was recorded at the former nesting site at Mount Fyans Wildlife Reserve from July-December 2022, and no breeding attempt was recorded. This suggests that the Peregrine

Falcon carcass find in August 2022 could have been one of the adult birds that successfully bred at the site the previous season.

Therefore, it is recommended that:

- Peregrine Falcon monitoring to continue into Year 3 monitoring at DDWF, in accordance with the BAM Plan, and in conjunction with Brolga breeding monitoring.

6.3 Brolga mortality monitoring

Brolga mortality monitoring was undertaken once per month at all turbines during the first two years of operation at DDWF. Binocular searches were undertaken as the preferred method for all turbines that were not already being surveyed as part of the routine carcass searching which is required for a subset of turbines for the first five years. One Brolga carcass was detected during the first two years of monitoring. The carcass was detected using the visual (binocular) search method, which confirms the preferred method is capable of detecting mortalities of this species.

The single confirmed mortality of a Brolga at DDWF after two years of operation is within the range of mortalities projected to occur by Collision Risk Modelling (0-2 after one year and 1-9 after ten years; BL&A 2018). As the estimates are calculated from a single actual carcass find, the reliability and accuracy of this estimate is low, as discussed in Section 5.1.4. It is expected that as Brolga monitoring continues, the calculated mortalities will more closely align with the predicted cumulative mortalities presented in the Brolga Compensation Plan for DDWF (Tilt Renewables 2019). Additional methods should also be considered and trialled to improve searcher efficiency and carcass persistence, which would further improve the accuracy of future mortality estimates.

In summary, the following is recommended:

- Brolga mortality monitoring to continue in accordance with the BAM Plan, and by utilising binocular searches as the preferred method.
- Undertake additional searcher efficiency trials and carcass persistence trials to improve the reliability of future mortality estimates.
- Investigate the use of other methods or techniques for surveying Brolga, and undertake a method trial to determine if searcher efficiency can be increased using different techniques or methods.
- Undertake the next round of statistical analysis to produce Brolga mortality estimates at the completion of year 3, and assess the results against the Brolga Compensation Plan for DDWF.

6.4 Bird and bat carcass search program and correction factor studies

A program of monthly carcass searches was successfully undertaken during the first two years of operational monitoring at DDWF. The carcass search program, and incidental observations, recorded a total of 361 bird/bat mortalities across approximately 42 species/species categories. BAM Plan impact triggers were met for three threatened species (Brolga, Grey-headed Flying-fox and possible White-throated Needletail) and one non-threatened species (White-striped Free-tailed Bat). The latter species was the most commonly recorded carcass during two years of monitoring, closely followed by Australian Magpie and Nankeen Kestrel.

The first two years of operational monitoring at DDWF also included the completion of five carcass persistence trials and five searcher efficiency trials. These trials would ordinarily not be repeated again, however a recommendation has been made to undertake further trails to increase the accuracy and reliability of mortality estimates, particularly for Brolga. Recommendations therefore are as follows:

- Carcass search program is to continue into Year 3 and until Year 5, in accordance with the BAM Plan.
- Additional searcher efficiency trials and carcass persistence trials are to be undertaken to maintain and potentially increase the reliability and accuracy or mortality estimates calculated via statistical analysis, which will next be undertaken at the completion of year 5.

6.5 Mortality estimates

This report presents the results of the first mortality estimates calculated for DDWF. It was found that, based on actual carcass finds, searcher efficiency, carcass persistence and survey effort, that there was a total site loss of around 564 bats (based on 79 actual finds), around 926 birds (based on 146 actual finds) and around five Brolgas (based on one actual find).

- The next statistical analysis, incorporating the results of the correction factor studies, is to be undertaken at the completion of Year 5, as per the requirements of the BAM Plan.
- Brolga mortality estimates will be recalculated and reported each year, in accordance with the BAM Plan.

7 References

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Appendices

Appendix 1 Brolga utilisation survey detailed results

Table A1.2 Year 2 Brolga utilisation season survey data, November 2021 – October 2022

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
November 2021											
17/11/2021	R (29587)	930	945	70	nil	15.2	3.7	N	-	2 Brolga; 2 Australasian Swamphen; 1 Whiskered Tern; 1 Masked Lapwing; 3 Black Swan; 1 White-faced Heron	Foraging together in paddock south of wetland
17/11/2021	C (29711)	950	1015	70	nil	15.1	4.2	N	-	7 Grey Teal	
17/11/2021	D (29773)	1020	1040	75	nil	15.4	6.3	NE	-	72 Black Swan; 28 Eurasian Coot; 12 Pacific Black Duck	
17/11/2021	E (30412)	1130	1140	30	nil	18.5	2.4	N	-	No Waterbirds	
17/11/2021	F (32558)	1145	1230	25	nil	18.3	2.6	N	-	3 Brolga (2 Adults; 1 Juvenile); 1 Whiskered Tern; 1 Australasian Swamphen	Foraging together on south edge of wetland
17/11/2021	J (32664)	1245	1305	40	nil	19.2	4.8	N	-	17 Black Swan; 27 Australian Shelduck; ~600 Banded Stilt; ~200 Eurasian Coot	
17/11/2021	L (32614)	1315	1340	80	nil	19.3	3.6	N	-	~1800 Black Swan; 160 Eurasian Coot	
17/11/2021	M (32614)	1340	1350	80	nil	19.1	3.2	N	-	34 Black Swan; 8 Eurasian Coot	
17/11/2021	K (32667)	1400	1430	80	nil	19	2.8	N	-	2 Masked Lapwing; 3 Black Swan	
18/11/2021	I (32565)	930	1020	100	light rain	13.5	8.9	NNE	-	41 Whiskered Tern; 3 White-faced Heron; 3 Australasian Swamphen; 2 Swamp Harrier	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
										(Both Swooping Swamphens together In wetland)	
18/11/2021	H (32580)	1025	1050	100	light rain	13.6	4.2	NNE	-	2 Little Pied Cormorant; 2 Black Swan; 4 Pacific Black Duck	
18/11/2021	Q (32542)	1110	1135	100	nil	14.4	4.3	NE	-	4 Australasian Swamphen; 6 Whiskered Tern	
18/11/2021	N (29839)	1215	1235	100	nil	15.7	7.5	NE	-	6 Black Swan; 2 White-faced Heron	
18/11/2021	B (29614)	1250	1325	90	nil	15.9	14.2	NE	-	22 Pacific Black Duck; 2 Black Swan	
18/11/2021	G (29857)	1335	1350	90	nil	16	12.1	NE	-	2 White-faced Heron	
18/11/2021	O (30401)	1410	1425	90	nil	15.4	8.2	N	-	6 Grey Teal; 2 Pacific Black Duck	
18/11/2021	P (29753)	1440	1505	90	nil	15.9	6.9	N	-	No waterbirds	
December 2021											
6/12/2021	J (32664)	1450	1515	15	nil	30.1	11.8	NW	-	Approx. 700 Banded Stilt; 70 Pink-Eared Duck; 30 Pacific Black Duck; 12 Australian Shelduck; 4 Black Swan; 14 Eurasian Coot;	
6/12/2021	F (32558)	1525	1550	15	nil	31.1	4.8	NW	-	2 Australasian Swamphen; 2 Brolga (Adult)	Foraging together in tall grass in south-west corner of wetland. Juvenile may have been with them, but hidden in tall grass.
6/12/2021	E (30412)	1555	1610	20	nil	29.5	4.9	NW	-	No birds	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
6/12/2021	D (29773)	1615	1630	25	nil	29.4	5.6	NW	-	79 Black Swan; 8 Silver Gull; 16 Eurasian Coot	
6/12/2021	C (29711)	1635	1645	30	nil	29.2	3.2	NW	-	6 Pacific Black Duck	
6/12/2021	R (29587)	1650	1700	30	nil	28.9	8.4	NW	-	4 Masked Lapwing; 3 Black Swan; 1 Australasian Swamphen; 1 White-necked Heron;	
7/12/2021	G (29857)	900	915	100	light rain	12.2	12.8	S	-	3 Black Swan; 1 White-faced Heron; 1 Australian Shelduck; 4 Eurasian Coot	
7/12/2021	B (29614)	930	1000	100	light rain	13.5	7.7	S	-	6 Black Swan; 18 Pacific Black Duck	
8/12/2021	O (30401)	1030	1100	80	nil	12.8	6	S	-	4 Pacific Black Duck; 1 White-faced Heron	
8/12/2021	P (29753)	1115	1140	80	nil	13.1	12.2	S	-	No birds	
8/12/2021	N (29839)	1305	1325	80	nil	14	8.2	S	-	No birds	
8/12/2021	F (32558)	1350	1615	80	nil	14.6	7.7	S	-	3 Brolga (2 Adult; 1 Juvenile)	Foraging together in south edge of wetland
9/12/2021	Q (32542)	1010	1025	100	nil	12.9	16.8	S	-	3 Brolga (2 Adult; 1 Juvenile); 2 Swamp Harrier; 7 Australasian Swamphen;	Foraging together in wetland, Adults opening wings and walking at group of 5 Swamphens that were getting close to Brolga chick.
9/12/2021	I (32565)	1115	1230	100	nil	13.2	18.4	S	-	3 White-faced Heron; 7 Masked Lapwing	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
9/12/2021	H (32580)	1130	1230	100	nil	13.4	22.7	S	-	1 Australian Shelduck; 1 Little Pied Cormorant	Lots of sheep in paddock north of wetland where flock of Brolga were previously seen foraging.
9/12/2021	L and M (32614)	1305	1330	100	nil	15	21.8	S	-	Approx. 900 Black Swan; 6 Australian Shelduck; 28 Eurasian Coot; 35 Hoary-headed Grebe	
9/12/2021	K (32667)	1345	1415	100	nil	15.2	22.2	S	-	7 Black Swan; 6 Masked Lapwing; 8 Pacific Black Duck	
January 2022											
13/01/2022	J (32664)	1150	1220	50	nil	29.6	6.2	E	-	8 Australian Shelduck; 14 Black Swan; 2 Little Pied Cormorant	
13/01/2022	F (32558)	1235	1255	50	nil	30.1	4.5	E	-	No birds. Wetland largely dry and covered in dry grass.	
13/01/2022	E (30412)	1300	1325	70	nil	30.3	9.8	E	-	No birds	
13/01/2022	D (29773)	1330	1330	80	nil	30.5	8.8	NE	-	32 Black Swan; 4 Silver Gull; 27 Pacific Black Duck	
13/01/2022	C (29711)	1335	1355	85	light rain	30.9	6.5	NE	-	7 Pacific Black Duck; 6 Australian Shelduck; 14 Silver Gull	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
13/01/2022	R (29587)	1405	1430	90	light rain	31.3	14.8	E	-	3 Brolga (2 adult; 1 Juvenile); 19 Australasian Swamphen; 7 Australian White Ibis; 1 White-faced Heron; 6 Straw-necked Ibis;	Foraging on southern edge of flooded paddock. Juvenile approx. 90% size of adults. Appeared somewhat disturbed by smoke from nearby grass fire.
13/01/2022	G (29857)	1440	1450	90	nil	30.7	7	E	-	25 Black Swan; 60 Australian Shelduck; 1 Australian Pelican; 2 Masked Lapwing; 30 Eurasian Coot	
14/01/2022	B (29614)	1510	1535	90	nil	29.8	6.3	E	-	17 Black Swan; 24 Australian Shelduck	
14/01/2022	N (29839)	1555	1610	90	nil	28.6	9	E	-	2 White-faced Heron	
14/01/2022	I (32565)	945	1020	20	nil	26.3	7.7	N	-	2 Masked Lapwing; 2 Black Swan; 5 Pacific Black Duck	
14/01/2022	H (32580)	1025	1040	50	nil	27.6	8.9	N	-	1 Little Pied Cormorant	
14/01/2022	Q (32542)	1110	1140	60	nil	27.4	13.4	N	-	12 Australasian Swamphen; 4 Masked Lapwing; 2 Straw-necked Ibis;	
14/01/2022	L and M (32614)	1305	1335	80	nil	28.6	11.9	N	-	120 Black Swan	
14/01/2022	K (32667)	1345	1400	80	nil	29.5	9	N	-	6 Black Swan; 2 Masked Lapwing	
14/01/2022	A (29627)	1435	1445	80	nil	29.6	9.5	N	-	No Birds	
14/01/2022	O (30401)	1455	1520	70	nil	30.2	15.5	N	-	6 Pacific Black Duck; 2 Australian Wood Duck; 1 White-faced Heron	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
14/01/2022	P (29753)	1545	1605	50	nil	29.9	14.8	N	-	No birds	
February 2022											
Approx. 1 week before 10/02/2022	Landholder observation. South of Lake Gellie (wetland L, 32614)									3 Brolga	Foraging in paddocks and around wetland.
7/02/2022	Landholder observation. Wetland S (33291)									3 Brolga (2 Adult; 1 Juvenile)	Tiverton pair and juvenile feeding on grain in paddock west of wetland Q in early morning.
9/02/2022	Landholder observation. Tiverton property, wetland Q									3 Brolga (2 Adult; 1 Juvenile)	Tiverton pair and juvenile feeding on grain in paddock west of wetland Q in early morning.
9/02/2022	F (32558)	1130	1145	90	nil	24.3	3.8	SW	0	No birds	
9/02/2022	I (32565)	1200	1225	80	nil	25.5	4.3	SW	3	No birds	
9/02/2022	H (32580)	1225	1255	80	nil	25.9	6	SW	3	6 Pacific Black Duck	
9/02/2022	Q (32542)	1315	1335	80	nil	26	7.8	SW	2	No birds	
9/02/2022	S (33291)	1430	1455	15	nil	27.8	13.4	W	3	3 Brolga (2 Adult; 1 Juvenile); 3 Black Swan; 1 White-faced Heron; 56 Pacific Black Duck; 6 Masked Lapwing; 2 Swamp Harrier (circling over wetland; swooping Masked Lapwings)	Foraging together in paddock approx. 100m south-west of wetland
9/02/2022	E (30412)	1505	1515	25	nil	27.4	12.3	W	2	No birds	
9/02/2022	D (29773)	1600	1615	25	nil	27.5	14.2	W	3	2 Silver Gull; 57 Black Swan	
9/02/2022	C (29711)	1620	1630	30	nil	27.8	14.9	W	3	63 Australian Shelduck; 17 Black Swan; 2 Masked Lapwing	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
9/02/2022	R (29587)	1635	1655	30	nil	27.7	12.6	W	2	3 Brolga (2 Adult; 1 Juvenile); 1 White-necked Heron; 3 White-faced Heron; 6 Masked Lapwing;	Foraging together in centre of mostly dry wetland.
10/02/2022	G (29857)	1000	1010	90	nil	18.6	7.7	SW	3	No birds	
10/02/2022	J (32664)	1030	1115	90	nil	18.9	9.7	SW	3	68 Black Swan; 220 Eurasian Coot; 120 Australian Shelduck;	
10/02/2022	B (29614)	1325	1430	75	nil	22.1	7.3	SW	2	11 Brolgas (**FLOCKING SURVEY TRIGGER**); 61 Black Swan; 415 Australian Shelduck; 45 Pacific Black Duck; 20 White-faced Heron; 40 Silver Gull; 1 Little Eagle	Foraging together in paddock east of wetland. when disturbed, flock flew to north back of wetland.
10/02/2022	N (29839)	1530	1600	70	nil	22	11.7	SW	3	12 Eurasian Coot; 2 Yellow-billed Spoonbill	
10/02/2022	P (29753)	1610	1620	65	nil	21.9	4.3	SW	0	No birds	
11/02/2022	K (32667)	1010	1025	100	nil	17.9	10.6	SE	3	2 Brolga (Adult); 48 Black Swan; 4 Masked Lapwing; 6 Silver Gull; 3 White-faced Heron.	Foraging together in southern end of wetland
11/02/2022	L and M (32614)	1030	1045	100	nil	18.2	16.7	SE	3	15 Black Swan; 25 Pacific Black Duck	
11/02/2022	South of Lake Gellie (L, 32614)	1055	1105	100	nil	18.1	12.3	SE	3	No Birds	
11/02/2022	A (29627)	1130	1155	100	nil	19.2	7.6	SE	0	No Birds	
11/02/2022	O (30401)	1215	1235	100	nil	19.1	14.9	SE	3	6 Pacific Black Duck	
March 2022											
8/03/2022	F (32558)	1025	1045	100	light rain	16.4	24.3	SE	0	No Birds	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
8/03/2022	Lake Barnie Bolac	1120	1205	100	nil	17	20.8	SE	3	46 Black Swan; 16 Pacific Black Duck; 5 Silver Gull	
8/03/2022	E (30412)	1215	1230	100	nil	17.2	17.5	SE	1	No Birds	
8/03/2022	D (29773)	1240	1250	90	nil	17.5	26.5	S	3	65 Black Swan; 4 Eurasian Coot; 16 Pacific Black Duck; 8 Silver Gull	
8/03/2022	C (29711)	1300	1310	90	nil	17.4	26.8	S	3	24 Black Swan; 8 Eurasian Coot; 2 Silver Gull	
8/03/2022	R (29587)	1315	1420	80	nil	17.9	22.2	S	1	2 Black Swan; 1 White-faced Heron; 2 Masked Lapwing	First week where no Brolga were observed. Chick may have fledged, or family may be foraging in adjacent paddock out of sight.
8/03/2022	G (29857)	1430	1435	70	nil	18.2	21.5	S	3	6 Black Swan	
8/03/2022	J (32664)	1445	1500	70	nil	18.8	18.5	S	3	1 Brolga; 320 Australian Shelduck; 6 Masked Lapwing; 11 Black Swan	Sitting on NW edge of lake, stood up briefly, then sat back down.
9/03/2022	S (33291)	1010	1045	60	nil	14.4	13.5	SE	3	2 Black Swan; 3 Wedge-tailed Eagle (perched overlooking wetland); 6 Pacific Black Duck; 6 Masked Lapwing; 1 Australasian Swamphen; 3 Brolga (2 adult; 1 large juvenile)	Flying over wetland from west to east, landing out of sight towards wetland Q
9/03/2022	Q (32542)	1100	1125	60	nil	16.3	12	SE	0	No Birds	
9/03/2022	I (32565)	1140	1220	50	nil	17.1	15.6	SE	0	3 Brolga; 2 Australasian Swamphen	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
9/03/2022	H (32580)	1200	1220	50	nil	17.5	17.8	SE	3	1 Little Pied Cormorant; 6 Pacific Black Duck	
9/03/2022	R (29587)	1420	1435	50	nil	18.9	12.2	SE	1	3 Brolga (2 adult; 1 juvenile); 2 Masked Lapwing	Sitting together in tall grass at west end of wetland near partially full dam. Family stood up and started foraging together around dam. Juvenile approx. 90% size of adults
9/03/2022	L and M (32614)	1505	1530	40	nil	21	16.6	S	3	2 Pacific Black Duck; 2 Black Swan	
9/03/2022	K (32667)	1540	1600	40	nil	20.7	18.9	S	3	5 Masked Lapwing	
10/03/2022	A (29627)	940	1000	80	nil	15.2	16.4	S	0	No birds	
10/03/2022	O (30401)	1025	1045	60	nil	15.8	13.2	S	3	6 Wood Duck; 1 White-faced Heron; 2 Pacific Black Duck	
10/03/2022	P (29753)	1105	1120	60	nil	16.2	15.1	S	0	No birds	
10/03/2022	N (29839)	1230	1250	60	nil	17.2	17.4	S	1	2 Masked Lapwing	
10/03/2022	B (29614)	1325	1405	60	nil	17.8	13.6	S	1	6 Pacific Black Duck	
21/03/2022	Landholder observation. Lake Gellie area (wetlands L and M)									20 Brolga	Roosting on SE edge of lake, flew off when disturbed.
April 2022											
12/04/2022	E (30412)	1210	1225	60	nil	16.9	19.6	S	1	3 Brolga (adult size; too far to tell if one was a juvenile)	Foraging together on edge of wetland
12/04/2022	R (29587)	1235	1300	65	nil	16.7	8.4	S	0	3 Pacific Black Duck	No Brolga, usual group may have been the ones

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											sighted at wetland 110
12/04/2022	A (29627)	1330	1345	55	nil	19.6	3.5	S	0	No birds	
12/04/2022	O (30401)	1355	1415	50	nil	20.2	6.2	S	3	26 Australian Shelduck; 2 Black Swan; 1 White-faced Heron; 12 Chestnut Teal	
12/04/2022	P (29753)	1435	1450	50	nil	21.2	12.2	S	0	No birds	
12/04/2022	N (29839)	1540	1610	40	nil	20.6	13.7	S	0	No birds	
13/04/2022	S (33291)	1030	1050	40	nil	16.3	9.1	E	3	3 Brolga (2 adult; 1 juvenile); 13 Masked Lapwing; 32 Pacific Black Duck; 12 Hoary-headed Grebe; 1 White-faced Heron	Foraging together
13/04/2022	Q (32542)	1155	1215	60	nil	17.4	8.3	E	0	No birds	
13/04/2022	H (32580)	1240	1310	55	nil	21.2	3.4	E	3	14 Australian Wood Duck; 1 White-faced Heron; 32 Chestnut Teal; 9 Pacific Black Duck; 6 grebe sp..; 1 Australian White Ibis; 32 Australian Shelduck	
13/04/2022	I (32565)	1245	1310	55	nil	21.2	3.4	E	0	23 raven sp.; no waterbirds	
13/04/2022	G (29857)	1325	1330	55	nil	22.4	8.6	E	1	3 Black Swan	
13/04/2022	F (32558)	1335	1340	55	nil	22.6	9	E	0	No birds	
13/04/2022	J (32664)	1345	1350	50	nil	22.6	7.7	E	3	6 Australian White Ibis; 1 White-faced Heron	
13/04/2022	L and M (32614)	1400	1435	50	nil	23.1	12.2	E	3	8 Black Swan; 2 Pacific Black Duck	
13/04/2022	K (32667)	1445	1510	50	nil	22.9	11.9	E	1	6 Masked Lapwing; 7 Black Swan	
13/04/2022	T (32671)	1520	1540	60	nil	23.4	6.5	E	3	No birds	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
13/04/2022	E (30412)	1610	1620	60	nil	23.6	6.9	E	1	No birds	
13/04/2022	Lake Barnie Bolac	1625	1635	60	nil	22.6	12.5	E	3	No Brolga	
13/04/2022	B (29614)	1650	1700	70	nil	21.4	16.9	E	0	No birds	
13/04/2022	L (32614)	1730	1840	70	nil	17.7	4.8	E	3	12 Brolga (adult sized) **(FLOCKING SURVEY TRIGGER)**	First seen 17:45, 7 foraging together in unburnt sheep grazing paddock north of lake. 18:20, heard multiple calls from NE out of sight. 18:23, 5 Brolga flew in from NE, joining 4 from group of 7 flying to join them in NE point of lake to roost. 3 from group of 7 flew to NW centre of lake to roost.
14/04/2022	L (32614)	600	730	80	nil	7.9	2.8	N	3	12 Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
14/04/2022	T (32671)	740	1015	80	nil	8.2	3.9	N	3	26 Brolga (4 juvenile)	Foraging together on ridge SW of wetland. group walked west over ridge, 22 flew approx. 300m, 10m above ground, across foraging area at 8:57. 26 flew from foraging site to north of Lake Gellie for midday roost at 9:04. 7 flew from north Lake Gellie at 9:41, picking up 7 foraging in paddock north Lake Gellie on their way, all 14 landed in NW edge of Lake Gellie.
14/04/2022	505	1025	1040	80	nil	9.7	4.3	N	1	No Birds; Brolga Feathers next to wetland	
14/04/2022	520	1100	1125	80	nil	10.4	3.7	N	3	No birds; Brolga feather in paddock east of wetland	
April 2022											
4/05/2022	L and M (32614)	1245	1305	95	nil	14.1	9.7	W	3	32 Black Swan; 8 Australian Shelduck	
4/05/2022	J (32664)	1315	1325	95	nil	14.2	12.4	W	3	No Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
4/05/2022	F (32558)	1335	1350	95	nil	13.9	10	W	0	5 Brolga (3 adults; 2 juveniles with grey heads)	Foraging to get on SE hill overlooking dry wetland. 2 Adults calling and displaying
4/05/2022	E (30412)	1355	1405	90	nil	14.5	7.3	W	1	No birds	
5/05/2022	L (32614)	1045	1100	10	nil	11.2	9.2	WSW	3	55 Black Swan	
5/05/2022	J (32664)	1105	1110	10	nil	11.4	6.4	WSW	3	2 Brolga (1 adult; 1 juvenile); 23 Silver Gull; 40 Australian Shelduck; 6 White-faced Heron; 30 Black Swan; 200 Pacific Black Duck	Foraging together along N bank of lake
5/05/2022	P (29753)	1125	1135	10	nil	12.3	3.9	WSW	0	No birds	
5/05/2022	G (29857)	1145	1150	20	nil	12.8	8.4	SW	3	3 Black Swan; 6 Australian Shelduck	
5/05/2022	B (29614)	1205	1220	30	nil	13.2	5.2	SW	1	6 Australian Shelduck; 2 Black Swan	
5/05/2022	D (29773)	1245	1255	35	nil	13.1	5.3	SW	3	48 Black Swan; 6 Pacific Black Duck	
5/05/2022	C (29711)	1300	1310	35	nil	13.4	4	S	3	18 Silver Gull; 8 Pacific Black Duck	
5/05/2022	R (29587)	1325	1350	40	nil	13.7	2.9	S	1	3 Brolga (2 adult; 1 new-near juvenile); 1 White-faced Heron; 2 Masked Lapwing	Family roosting at nest used during last breeding season. Standing/sitting on nest and next to it. Foraging in tall green grass within dry wetland area. Juvenile approx.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											90% size of adults, grey head.
5/05/2022	A (29627)	1430	1445	40	nil	13.6	2.8	S	0	No birds	
5/05/2022	O (30401)	1500	1510	50	nil	13.6	4.4	S	3	8 Pacific Black Duck; 1 White-faced Heron; 2 Masked Lapwing	
5/05/2022	L (32614)	1640	1820	70	nil	12.1	2.2	WSW	3	48 Black Swan. Several Brolga (heard)	No Brolga visible at start of survey. Heard several Brolga calling at 1755 from NE of lake, out of sight.
6/05/2022	S (33291)	1005	1030	30	nil	11.5	4.1	NNW	2	2 Black Swan; 2 Australian Shelduck; 16 Pacific Black Duck; 8 Chestnut Teal; 10 Hoary-headed Grebe	
6/05/2022	Q (32542)	1110	1150	40	nil	1.8	5	NNW	0	1 White-faced Heron	
6/05/2022	I (32565)	1220	1300	30	nil	12	5.5	NW	0	No birds	
6/05/2022	H (32580)	1230	1300	20	nil	12.2	12.3	NW	3	2 Australian Shelduck; 1 White-faced Heron	
6/05/2022	N (29839)	1335	1350	20	nil	12.6	7.8	NW	0	No birds	
6/05/2022	K (32667)	1415	1430	20	nil	13.2	7.5	NW	2	2 Black Swan; 2 Masked Lapwing; 6 Silver Gull	
June 2022											
Approx 2 weeks prior to 6/6/2022	Landholder observation. Lake Gellie area (wetland L and M)									42 Brolga	Foraging in paddock North of wetland 239, around wetland 241.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
2/06/2022	J (32664)	1255	1320	100	nil	12.3	8.5	NW	3	12 Black Swan; 18 Pacific Black Duck; 160 Chestnut Teal; 25 Silver Gull	
2/06/2022	F (32558)	1330	1345	100	nil	12.2	4	NW	0	No birds	
2/06/2022	E (30412)	1355	1410	100	nil	12.4	3.2	NW	2	No birds	
2/06/2022	D (29773)	1420	1430	100	nil	11.7	6.5	NNW	3	12 Black Swan; 8 Silver Gull; 4 Eurasian Coot	
2/06/2022	C (29711)	1435	1445	100	nil	11.7	4.4	NNW	3	123 Black Swan; 8 Pacific Black Duck	
2/06/2022	R (29587)	1500	1540	100	nil	11.5	4.6	NNW	0	3 Brolga (2 adult; 1 juvenile)	Foraging together in paddock approx. 100m north of wetland, across road.
2/06/2022	A (29627)	1605	1620	100	nil	11.3	7.3	NNW	0	No birds	
2/06/2022	O (30401)	1635	1650	100	nil	10.4	6.8	NNW	3	2 Australian Wood Duck; 7 Pacific Black Duck; 2 Masked Lapwing; 1 White-faced Heron	
3/06/2022	R (29587)	930	940	100	nil	10.6	12.4	N	0	4 Brolga (3 adult; 1 juvenile)	Foraging together in dry green grass in wetland.
3/06/2022	G (29857)	950	955	100	nil	11.2	10.1	N	3	32 Black Swan	
3/06/2022	Q (32542)	1025	1050	100	nil	11.1	11.5	N	0	No birds	
3/06/2022	I (32565)	1110	1125	100	nil	11.6	8.9	N	1	2 Masked Lapwing	
3/06/2022	H (32580)	1115	1125	95	nil	11.8	8.5	N	3	1 White-faced Heron; 5 Australian Shelduck	
3/06/2022	S (33291)	1135	1155	90	nil	12,4	12.1	N	3	1 Brolga (Adult); 2 Australian Shelduck; 5 Masked Lapwing; 2 Black Swan	Foraging by itself on east bank of wetland

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
3/06/2022	N (29839)	1230	1250	70	nil	14.3	14.4	N	0	No birds	
3/06/2022	P (29753)	1310	1325	70	nil	14.4	11	N	0	No birds	
3/06/2022	K (32667)	1345	1405	60	nil	14.3	9.9	N	1	4 Masked Lapwing	
3/06/2022	L and M (32614)	1415	1505	60	nil	14.6	13.4	N	3	2 Black Swan; 6 Pacific Black Duck	
3/06/2022	T (32671)	1510	1520	60	nil	15.2	13.2	N	3	No birds	
3/06/2022	B (29614)	1555	1635	50	nil	15.4	6.8	N	1	30 Black Swan; 8 Pacific Black Duck; 2 Silver Gull	
July 2022											
4/07/2022	A (29627)	1410	1425	50	nil	12.7	7.4	SE	0	No birds	
4/07/2022	O (30401)	1450	1505	40	nil	13.1	13	SE	3	1 White-Faced Heron; 12 Pacific Black Duck; 2 Australian Shelduck	
4/07/2022	P (29753)	1530	1540	40	nil	12.1	11.7	SE	0	No birds	
5/07/2022	G (29857)	1020	1025	15	nil	12	8.8	SE	1	8 Black Swan	
5/07/2022	S (33291)	1040	1110	15	nil	12	9.4	SE	3	2 Black Swan; 1 White-faced Heron; 2 Australian Shelduck; 12 Hoary-headed Grebe; 2 Australian Wood Duck.	3 new large reed nests, only 2 swans. New perimeter fence.
5/07/2022	Q (32542)	1120	1130	15	nil	12.3	6.5	SE	0	No birds	
5/07/2022	I (32565)	1150	1220	20	nil	12.2	5.8	SE	0	No birds	
5/07/2022	H (32580)	1200	1220	20	nil	13.1	5.5	SE	3	2 Pacific Black Duck	
5/07/2022	B (29614)	1250	1315	25	nil	13.2	2.3	SE	1	40 Black Swan; 2 Pacific Black Duck	
5/07/2022	E (30412)	1350	1400	25	nil	13.2	7.4	SE	1	2 Silver Gull	
5/07/2022	D (29773)	1405	1415	25	nil	13.6	7.9	SE	3	8 Black Swan; 2 Silver Gull	
5/07/2022	C (29711)	1420	1425	25	nil	13.6	6	SE	3	12 Black Swan; 8 Silver Gull	
5/07/2022	R (29587)	1430	1450	25	nil	13.3	5.6	SE	0	2 Masked Lapwing	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
5/07/2022	G (29857)	1500	1520	25	nil	12.5	4.3	SE	1	8 Black Swan; 3 Brolga (2 adult; 1 juvenile)	Brolga foraging together in roadside paddock just north of wetland.
5/07/2022	F (32558)	1540	1555	25	nil	12.3	4	SE	0	No birds	
6/07/2022	L and M (32614)	955	1035	50	nil	9.9	5.5	NE	3	4 Black Swan	
6/07/2022	K (32667)	1045	1105	50	nil	10.2	6.7	NE	2	2 Masked Lapwing; 2 Black Swan	
6/07/2022	T (32671)	1120	1130	50	nil	10.8	7	NE	3	No birds	
6/07/2022	J (32664)	1145	1210	50	nil	11	7.9	NE	3	45 Black Swan; 20 Chestnut Teal; 8 Pacific Black Duck; 2 Masked Lapwing	
6/07/2022	N (29839)	1240	1305	50	nil	12.2	5.2	NE	0	No birds	
August 2022											
Early August 2022	Landholder observation. Wetland F (32558)									2 Brolga (Adult)	Pair foraging/potentially nesting in small damp grassy patch north of wetland. No nest found in area on 16/08/2022
15/08/2022	F (32558)	1350	1420	100	nil	12	18.4	SW	0	No birds	
15/08/2022	A (29627)	1550	1615	100	nil	12.2	22.3	SW	0	No birds	
15/08/2022	O (30401)	1635	1655	100	nil	11.8	16.7	SW	3	2 Pacific Black Duck	
16/08/2022	S (33291)	1025	1055	80	Light rain	10.5	23.3	SW	3	2 Black Swan; 6 Australian Shelduck; 12 Pacific Black Duck; 2 Masked Lapwing	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
16/08/2022	I (32565)	1110	1145	80	Light rain	10.7	19.7	SW	1	4 Black Swan; 6 Masked Lapwing; 4 Silver Gull	
16/08/2022	H (32580)	1120	1135	80	nil	11.9	16.4	SW	3	2 Pacific Black Duck	
16/08/2022	Q (32542)	1155	1230	80	nil	12.1	16.9	SW	1	2 Brolga (adult)	One foraging, one sitting in tall grass in wetland, then stood up to forage with partner
16/08/2022	G (29857)	1250	1310	70	nil	11.8	13	SW	2	18 Black Swan; 1 White-faced Heron; 4 Pacific Black Duck	
16/08/2022	J (32664)	1420	1455	70	nil	12.3	14.3	SW	3	70 Black Swan; 8 Australian Shelduck; 4 Masked Lapwing	
16/08/2022	N (29839)	1535	1550	70	nil	12.4	14.8	SW	0	No birds	
16/08/2022	P (29753)	1620	1630	70	nil	11.9	15.3	SW	0	No birds	
17/08/2022	R (29587)	950	1020	100	nil	10.3	17	N	1	2 Black Swan	
17/08/2022	C (29711)	1030	1050	100	nil	10.8	18.4	N	3	14 Black Swan; 8 Silver Gull; 4 Pacific Black Duck	
17/08/2022	D (29773)	1055	1115	100	nil	11.1	20.1	N	3	23 Black Swan; 8 Silver Gull	
17/08/2022	E (30412)	1125	1140	100	nil	10.9	22.1	N	2	No birds	
17/08/2022	B (29614)	1225	1300	100	nil	11.5	20.4	N	1	280 Black Swan; 12 Australian Shelduck	
17/08/2022	K (32667)	1330	1355	100	nil	12.3	17.8	N	1	6 Black Swan; 2 Masked Lapwing	
17/08/2022	L and M (32614)	1405	1430	100	nil	12.2	18.9	N	3	30 Black Swan; 4 Grey Teal	
17/08/2022	T (32671)	1435	1450	100	nil	11.7	19.3	N	3	2 Brolga (adult); 6 Black Swan	Foraging together in adjacent paddock

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
September 2022											
7/09/2022	J (32664)	1345	1405	80	nil	17.5	9	N	3	30 Black Swan; 100 Banded Stilt; 4 Silver Gull; 2 Eurasian Coot; 40 Grebe sp.; 2 Australian Pelicans (flying 200m west of wetland; 60m above ground). 14 Little Black Cormorant; 1 Little Pied Cormorant; 2 Australasian Swamphen; 6 Black Swan (upper fresh spring section)	
7/09/2022	F (32558)	1410	1425	90	nil	18.4	1	NE	1	1 White-faced Heron; 2 Masked Lapwing; 1 reed nest in middle of wetland.	
7/09/2022	E (30412)	1435	1440	90	nil	17.6	18.3	E	2	50 Silver Gull; 1 Australian White Ibis; 8 Straw-necked Ibis; 1 Australasian Swamphen; 2 Pacific Black Duck	
7/09/2022	N (29839)	1550	1620	90	nil	18.5	10.7	E	2	2 Brolga (adult); 1 Yellow-billed Spoonbill; 2 White-necked Heron; 4 Masked Lapwing; 2 Black Swan (one on nest); 2 empty reed nest; 2 Australasian Swamphen	Foraging together in wetland, getting swooped by masked lapwing
7/09/2022	P (29753)	1640	1645	90	nil	18.5	10.7	E	0	1 Australian Shelduck	
7/09/2022	R (29587)	1655	1705	85	nil	17.7	6.4	NE	3	2 Brolga (adult)	1 foraging on roadside, one sitting on nest in roadside wetland, got off as we drove up. Foraging Brolga

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											flew 20m to wetland.
8/09/2022	C (29711)	925	935	100	nil	15	12.6	NE	4	32 Banded Stilt; 1 Silver Gull; 8 Welcome Swallow (above wetland); 6 Australian Wood Duck	
8/09/2022	D (29773)	940	950	100	nil	15	9.7	NE	4	36 Black Swan; 4 Silver Gull; 108 Australasian Grebe	
8/09/2022	S (33291)	1025	1040	100	nil	14.7	15.8	NE	4	50 Australasian Grebe; 20 Chestnut Teal; 1 Black Swan (on nest); 1 empty reed nest; 2 Australian Shelduck; 6 Pacific Black Duck; 2 Masked Lapwing	
8/09/2022	H (32580)	1110	1130	100	nil	13	17.1	NE	3	50 Teal sp.; 4 Chestnut Teal; 6 Masked Lapwing; 50 Australasian Grebe	
8/09/2022	I (32565)	1110	1150	100	light rain	13.7	17.1	NE	2	47 Black Swan (1 on nest in west section); 10 Masked Lapwing; 4 Silver Gull; 3 Pacific Black Duck; Chestnut Teal	
8/09/2022	Q (32542)	1230	1255	100	light rain	13.6	17.2	NE	2	2 Brolga (adult); 20 Australasian Swamphen	One sitting on nest in east of wetland, 2 eggs, stood up and quickly walked south when it noticed us. One foraging S of wetland, seen flying between foraging points.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
8/09/2022	U (32610)	1345	1400	100	nil	13.9	6.4	NE	2	1 Brolga (Adult)	Sitting on nest, 2 eggs, stood up and flew into nearby field when disturbed
8/09/2022	A (29627)	1520	1530	100	nil	14.5	8.4	NE	0	1 Pacific Black Duck	
8/09/2022	O (30401)	1540	1555	100	nil	14.5	8.4	NE	4	3 Pacific Black Duck; 1 Little Pied Cormorant	
9/09/2022	G (29857)	955	1005	10	nil	15.5	7.7	NNE	3	7 Black Swan (4 nesting); 4 Australian Grebe	
9/09/2022	L (32614)	1025	1035	20	nil	15.4	8.9	N	3	130 Black Swan (6 nesting); 22 Little Pied Cormorant; 2 Little Black Cormorant; 4 Australian Pelicans; 8 Silver Gull; 20 Duck sp.	
9/09/2022	K (32667)	1045	1055	70	nil	15.3	13.4	NE	3	56 Black Swan; 1 Pacific Black Duck; 10 Silver Gull; 2 Masked Lapwing	
9/09/2022	T (32671)	1100	1105	60	nil	15	6.6	NE	3	No birds. 1 empty reed nest in NE edge of wetland	
October 2022											
4/10/2022	J (32664)	1055	1125	90	nil	11.6	15.2	SE	3	8 Black Swan; 12 Pacific Black Duck	
4/10/2022	F (32558)	1150	1235	90	nil	11.8	16.4	SE	2	6 Black Swan (3 nesting); 1 adult Brolga (nesting)	Sitting on nest in middle of wetland
4/10/2022	E (30412)	1250	1310	90	nil	12.5	16.3	SE	2	18 Straw-necked Ibis; 2 Australian White Ibis; 2 Australasian Swamphen	
4/10/2022	D (29773)	1320	1335	90	nil	13.1	9.2	SE	3	4 Black Swan; 26 Silver Gull; 6 Pacific Black Duck	
4/10/2022	C (29711)	1345	1400	100	nil	13.6	14.2	S	3	8 Black Swan; 6 Silver Gull	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
4/10/2022	R (29587)	1410	1515	100	nil	14.8	18.9	S	2	2 Brolga; 5 Black Swan (1 nesting); 6 Australasian Swamphen	Foraging together in flooded paddock west of main roadside wetland. Nest in roadside wetland somewhat flooded
5/10/2022	R (29587)	945	1050	70	nil	10.6	22.1	E	2	5 Black Swan (1 nesting); 2 Black Kite (circling over wetland and landing in reeds); 1 Australasian Grebe; 2 Pacific Black Duck; 4 Australasian Swamphen	No Brolga observed at wetland or surrounding paddocks
5/10/2022	G (29857)	1105	1120	70	nil	11.8	16.4	E	3	9 Black Swan (4 nesting); 4 Eurasian Coot; 2 Silver Gull	
5/10/2022	B (29614)	1150	1245	80	nil	12.1	14.5	E	2	26 Black Swan	
5/10/2022	P (29753)	1455	1515	80	nil	12.8	23.8	E	1	2 Australian Shelduck	
5/10/2022	N (29839)	1540	1635	80	nil	13.9	24.2	E	2	4 Black Swan (1 nesting); 2 Australasian Swamphen; 2 Whiskered Tern	No Brolga seen, nest from last survey totally covered in water
6/10/2022	R (29587)	950	1035	80	nil	13.1	8.4	NE	2	1 Australasian Grebe; 5 Black Swan (1 nesting); 7 Australasian Swamphen; 2 Silver Gull	No Brolga observed at wetland or surrounding paddocks
6/10/2022	F (32558)	1055	1120	80	nil	15.6	12	NE	2	1 Brolga (adult); 7 Black Swan (4 nesting)	
6/10/2022	K (32667)	1145	1205	80	nil	17.2	16.3	NE	3	4 Masked Lapwing	
6/10/2022	L (32614)	1215	1250	80	nil	18.4	18.2	NE	3	120 Black Swan (4 nesting); 6 Pacific Black Duck; 4 Grebe sp.	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
6/10/2022	T (32671)	1300	1320	80	light rain	18.8	16.7	N	3	No birds	
6/10/2022	A (29627)	1435	1455	90	light rain	19.3	21.5	N	0	No birds	
6/10/2022	O (30401)	1510	1540	90	light rain	19.1	23.3	N	3	6 Pacific Black Duck; 1 Little Pied Cormorant	
7/10/2022	R (29587)	930	945	90	nil	12.8	4.9	NW	2	1 Australasian Grebe; 5 Black Swan (1 nesting); 6 Australasian Swamphen; 4 Silver Gull; 1 White-faced Heron	No Brolga observed at wetland or surrounding paddocks
7/10/2022	S (33291)	1010	1025	90	nil	13.2	8.3	NW	3	4 Black Swan; 12 Pacific Black Duck; 1 White-faced Heron; 4 Masked Lapwing	
7/10/2022	Q (32542)	1040	1110	90	nil	13.4	11.6	NW	3	3 Brolga (2 adult; 1 chick); 2 Australasian Swamphen	Foraging in west edge of wetland together. Chick following adults closely, adults did not hide chick when they noticed me.
7/10/2022	I (32565)	1110	1120	90	light rain	13.8	11.6	NW	2	6 Black Swan (1 nesting); 8 Pacific Black Duck; 6 Masked Lapwing	
7/10/2022	H (32580)	1120	1130	90	light rain	14.2	11.8	NW	3	8 Grey Teal; 1 Little Pied Cormorant; 2 Black Swan	
7/10/2022	U (32610)	1150	1205	90	light rain	14.4	13.7	NW	3	2 Brolga (adult); 2 Black Swan; 2 Masked Lapwing	Foraging together in NW edge of wetland.
November 2022 (Year 3 monitoring)											
2/11/2022	K (32667)	1035	1055	80	nil	11.4	15.4	SW	3	2 Masked Lapwing; 6 Black Swan; 2 Silver Gull	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
2/11/2022	L (32614)	1105	1130	80	nil	11.6	11.5	SW	3	90 Black Swan (3 nesting); 6 Pacific Black Duck; 1 Little Pied Cormorant	
2/11/2022	T (32671)	1135	1145	80	nil	11.9	9.9	SW	3	No birds	
2/11/2022	J (32664)	1200	1235	90	nil	12.1	15.2	SW	3	25 Black Swan; 18 Pacific Black Duck; 4 Australian Shelduck; 6 Grey Teal; 2 Masked Lapwing	
2/11/2022	N (29839)	1405	1450	90	nil	12.6	18.4	SW	3	4 Black Swan (1 nesting); 2 Masked Lapwing	
2/11/2022	P (29753)	1520	1530	90	nil	12.8	14.2	SW	1	No birds	
3/11/2022	R (29587)	920	945	95	nil	13.8	6.5	W	3	1 Black Swan (Nesting)	
3/11/2022	F (32558)	1010	1045	95	nil	14	4.3	W	2	6 Black Swan (4 nesting); 1 Brolga (adult)	Foraging in W edge of wetland by itself
3/11/2022	E (30412)	1055	1120	95	nil	14.2	9.5	W	2	6 Australian White Ibis; 4 Pacific Black Duck	
3/11/2022	D (29773)	1125	1135	95	nil	14.6	5.7	W	3	4 Silver Gull; 5 Black Swan	
3/11/2022	C (29711)	1140	1155	95	nil	14.3	7.3	W	3	7 Black Swan; 2 Silver Gull	
3/11/2022	G (29857)	1205	1215	95	nil	14.7	11.9	SW	3	6 Black Swan (2 nesting)	
3/11/2022	B (29614)	1240	1355	95	nil	14.5	11.6	SW	3	16 Black Swan	
3/11/2022	A (29627)	1440	1515	95	nil	14.5	14.3	SW	1	6 Straw-necked Ibis	
3/11/2022	O (30401)	1540	1605	95	nil	14.3	8.5	SW	3	9 Pacific Black Duck	
4/11/2022	S (33291)	910	925	90	nil	10.9	3.8	S	3	3 Black Swan; 2 Australasian Grebe; 4 Grey Teal	
4/11/2022	Q (32542)	940	1010	90	nil	11.2	8	S	3	3 Brolga (2 adults; 1 chick)	Foraging together on N edge of wetland. Adults did not hide chick when

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											they noticed I was observing.
4/11/2022	I (32565)	1025	1050	90	nil	12.5	5.8	S	3	8 Black Swan; 4 Masked Lapwing; 4 Pacific Black Duck	
4/11/2022	H (32580)	1035	1045	90	nil	14.6	6.2	S	3	8 Grey Teal	
4/11/2022	U (32610)	1120	1135	90	nil	15.3	7	S	2	3 Brolga (2 adults; 1 chick)	Foraging together on NE edge of wetland

Appendix 2 Brolga targeted breeding surveys detailed results

Table A2.1 Year 2 Brolga breeding season survey data, November 2021 – October 2022, Year 2

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
November 2021 – First additional survey											
1/11/2021	Q (32542)	-	-	-	-	-	-	-	-	3 Brolga (2 adult; 1 chick)	Foraging together in wetland.
8/11/2021	R (29587)	1050	1240	100	nil	15.4	4.5	W	-	2 Brolga (adult); 7 Australasian Swamphen; 7 Black Swan; 1 Swamp Harrier (flying above wetland)	Both foraging together in wetland, no chick or eggs seen in nest.
8/11/2021	F (32558)	1250	1340	100	nil	17.3	6.2	W	-	3 Brolga (2 adults; 1 juvenile)	Foraging together in wetland.
8/11/2021	R (29587)	1350	1630	90	nil	17.8	4.2	N	-	2 Brolga (adult); 7 Australasian Swamphen; 7 Black Swan; 1 Swamp Harrier (flying above wetland)	Foraging together in paddock west of wetland.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
9/11/2021	Q (32542)	910	1100	5	nil	13.1	10.5	N	-	1 Whiskered Tern; 6 Australasian Swamphen; 1 Swamp Harrier; 2 Pacific Black Duck; 2 White-faced Heron	
9/11/2021	R (29587)	1120	1250	40	nil	18.5	2.2	NW	-	2 Brolga (adult); 4 Great Egret; 8 Australasian Swamphen; 2 Little Pied Cormorant (basking on Brolga nest); 8 Black Swan;	Foraging together in northern paddock adjacent to wetland.
9/11/2021	F (32558)	1300	1350	80	nil	17.3	3.8	N	-	3 Brolga (2 adults; 1 juvenile); 4 Australasian Swamphen	Foraging together in wetland.
November 2021 – Second additional survey											
15/11/2021	Landholder observation. Wetland Q (32542)									3 Brolga (2 adult; 1 chick)	
23/11/2021	Landholder observation. Wetland I (32565)									21 Brolga **(Flocking Survey Trigger)**	Flocking. Foraging together in western flooded section of wetland.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
24/11/2021	Landholder observation. Wetland I (32565)									18 Brolga **(Flocking Survey Trigger)**	Flocking. 16 foraging together in western shallow flooded section of wetland. 2 foraging together away from flock (appeared somewhat distressed, may be pair from Wetland R (29587))
24/11/2021	R (29587)	1100	1330	60	nil	22.1	2.8	NE	-	3 Brolga (2 adults; 1 small chick); 4 Australasian Swamphen; 4 White-faced Heron	Foraging together in north-west section of wetland.
24/11/2021	F (32558)	1345	1610	80	nil	25.6	4.5	W	-	3 Brolga (2 adults; 1 juvenile); 2 Australasian Swamphen	Juvenile approx. 80% size of adults.
25/11/2021	F (32558)	950	1035	100	nil	13.6	7.8	N	-	4 White-faced Heron; 12 Masked Lapwing; 2 Pacific Black Duck; 1 Whiskered Tern	
25/11/2021	H (32580)	1035	1105	100	nil	14.1	2.4	N	-	2 Little Pied Cormorant; 2 Black Swan	
25/11/2021	Q (32542)	1115	1330	100	nil	15.5	5.1	N	-	2 Australasian Swamphen	
December 2021 – First additional survey											

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
7/12/2021	R (29587)	1030	1335	100	light rain	14.1	13.4	S	-	3 Brolga (2 adult; 1 chick); 1 White-necked Heron; 1 White-faced Heron; 5 Masked Lapwing; 6 Black Swan; 8 Australian White Ibis; 3 Australasian Swamphen	Foraging together in paddock west of wetland, along windbreak. Chick approx. 25% size of adults.
7/12/2021	F (32558)	1440	1605	90	nil	18.8	17.9	W	-	3 Brolga (2 adult; 1 juvenile)	Foraging together in centre of wetland
9/12/2021	Q (32542)	905	1010	100	nil	12.6	14.2	S	-	3 Brolga (2 adult; 1 juvenile); 2 Swamp Harrier; 2 Australasian Swamphen	Foraging together in wetland. Adults hid chick almost instantly after I came over the hill and walked away from it. Adults walked back to chick after I hid behind a bush. Juvenile approx. 50% size of adults
December 2021 – Second additional survey											
22/12/2021	F (32558)	1135	1315	15	nil	20.8	5.1	W	0	1 White-faced Heron	
22/12/2021	R (29587)	1330	1545	5	nil	21.6	6.4	SE	2	3 Brolga (2 adult; 1 juvenile); 10 Australasian Swamphen (9 adult; 1 juvenile)	Foraging together in paddock along treeline, then walking to southern edge of wetland area. Juvenile approx. 50% size of adult

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
23/12/2021	F (32558)	935	1245	0	nil	19.3	3.7	S	0	1 Brolga heard	Heard Brolga calling from south of wetland at 1025 and 1120.
23/12/2021	Q (32542)	1315	1510	5	nil	24.6	8.5	S	2	3 Brolga (2 adult; 1 juvenile); 6 Australasian Swamphen	Foraging together in north-east of wetland
January 2022 – First additional survey											
4/01/2022	F (32558)	1125	1325	90	nil	20.6	13	SW	0	3 Australasian Swamphen; 1 Swamp Harrier (perched on ground in middle of dry wetland)	
4/01/2022	R (29587)	1340	1605	90	nil	24.5	9.2	S	2	3 Brolga (2 adult; 1 juvenile); 8 Australasian Swamphen; 12 Straw-necked Ibis; 2 White-faced Heron; 1 White-necked Heron; 1 Brown Falcon; 9 Australian White Ibis	Foraging together in tall grass south of wetland. Chick approx. 60% size of adults
5/01/2022	Q (32542)	940	1055	100	drizzle	16.5	9.8	S	2	1 Yellow-billed Spoonbill; 6 Masked Lapwing; 1 White-faced Heron; 13 Australasian Swamphen; 6 Straw-necked Ibis	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
January 2022 – Second additional survey											
20/01/2022	F (32558)	1130	1245	0	nil	26.4	9.7	E	0	No birds.	
20/01/2022	R (29587)	1345	1545	0	nil	29.2	15.5	SE	1	3 Brolga (2 adult; 1 juvenile); 20 Australian White Ibis; 3 Straw-necked Ibis; 3 White-faced Heron; 26 Australasian Swamphen	One adult and juvenile foraging together in paddock south of wetland, then walked to south edge of wetland. Other adult in paddock appeared to be trying to get through the farm fence to get into the wetland, walking repeatedly into and along the fence and appearing slightly distressed. Juvenile approx. 80% size of adults and noticeably grey head.
21/01/2022	Q (32542)	1030	1235	0	nil	26.7	7.2	NE	1	3 Brolga (2 adult; 1 juvenile); 38 Australasian Swamphen; 7 Masked Lapwing. wetland drying out; outer 20m of wetland is dry.	Foraging in NE of wetland. One adult and Juvenile together, other adult approx. 80m away from them. After moving survey position, all three walked up bank of wetland, then took off together at 1220, circling above wetland to gain height, then flying north. Juvenile took flight first

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
21/01/2022	F (32558)	1255	1315	0	nil	29.3	5.4	NE	0	No birds. Wetland almost entirely dry	
21/01/2022	R (29587)	1325	1610	0	nil	29.5	8.9	NE	1	3 Brolga (2 adult; 1 juvenile); 24 Australasian Swamphen; 12 Australian White Ibis	Foraging together on southern edge of wetland. Juvenile approx. 80% size of adults and has black primary flight feathers.
February 2022 – First additional survey											
Week of 1/2/2022	Landholder observation. Tiverton Property									3 Brolga (2 adult; 1 juvenile)	Feeding on spilled grain near farm laneway. When disturbed, Juvenile took flight, followed by adults.
3/02/2022	F (32558)	1120	1200	100	light rain	15.5	8	SE	0	No birds.	
3/02/2022	R (29587)	1345	1600	100	nil	17.3	4.9	S	1	3 Brolga (2 adult; 1 juvenile); 2 White-faced Heron; 1 Masked Lapwing; 1 Little Pied Cormorant; 13 Australasian Swamphen. Wetland drying out; only a 10m square patch of open water left in flooded paddock.	Foraging together in grass of recently dry west end of flooded paddock. Juvenile approx. 90% size of adult.
4/02/2022	F (32558)	1155	1230	90	nil	20.2	7.4	SW	0	No birds.	
September 2022											

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
20/09/2022	U (32610)	1240	1320	70	nil	15.4	13.4	SW	1	1 Brolga (adult)	Sitting on nest in wetland. Stood up and walked out of sight in wetland when it noticed me.
20/09/2022	N (29839)	1350	1445	70	nil	16.2	10.1	SW	2	1 Brolga; 2 Black Swan; 2 Masked Lapwing	Sitting on nest in middle of wetland
20/09/2022	R (29587)	1520	1550	80	nil	15.9	4.4	SW	2	2 Brolga	One sitting on nest, one foraging in wetland
21/09/2022	R (29587)	920	950	100	nil	11.3	7.6	W	2	2 Brolga	One sitting on nest, one foraging in wetland
21/09/2022	Q (32542)	1035	1220	100	nil	13.8	15.8	W	2	1 Brolga; 18 Australasian Swamphen; 6 Pacific Black Duck	Sitting on nest in wetland.
October 2022											
18/10/2022	F (32558)	1845	1850	0	nil	19.4	6.5	NE	3	2 Brolga; 6 Black Swan (4 nesting)	Foraging together in wetland. Brolga nest in middle of wetland mostly flooded, small 60cm square patch above water
18/10/2022	Turbine H09 area **(Additional survey post Brolga carcass find)**	1920	2020	0	nil	19.6	8.3	NE	-	No Brolga seen	Marginal foraging habitat and poor nesting habitat close to turbine H09. Lots of frogs in recently flooded drainage lines.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
19/10/2022	Turbine H09 area **(Additional survey post Brolga carcass find)**	605	900	0	nil	9.6	4.3	NNE	-	No Brolgas.	No Brolga seen at Turbine H09 area. Pair of Brolgas heard calling several kilometres away, WSW, likely at wetland R. At the same time Brolgas were heard calling while in flight, NW of H09.
19/10/2022	N (29839)	930	1010	0	nil	12.4	7.3	NNE	3	7 Black Swan; 12 raven sp.; 2 White-faced Heron; 4 Masked Lapwing	2 Brolga heard approx. 2.5km ESE of wetland. 1 seen foraging next to wetland 800m E of wetland.
19/10/2022	Q (32542)	1210	1300	0	nil	14.8	5	SSE	4	3 Brolga (2 adult; one chick); 2 Black Swan; 11 Pacific Black Duck and 14 chicks; 2 Australasian Swamphen	Foraging together in shallow grassy edge of wetland, east side.
19/10/2022	B (29614)	1335	1400	0	nil	15.5	12.3	SE	3	2 Brolga; 4 Black Swan	Foraging in paddock 1.5km NE of wetland.
19/10/2022	G (29857)	1425	1430	0	nil	19.2	11.4	SE	3	4 Black Swan	
19/10/2022	R (29587)	1445	1520	0	nil	19.6	8.6	SE	3	2 Black Swan (1 nesting); 1 White-faced Heron; 2 Australasian Swamphen	Empty Brolga nest next to road

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
20/10/2022	Roadside east of Turbine H09 area	605	830	0	nil	8.7	7.5	SE	-	No Brolgas	No Brolgas seen or heard.
20/10/2022	R (29587)	850	920	0	nil	12.1	8	SE	3	2 Black Swan (1 nesting); 4 Australasian Swamphen; 2 Australian Grebe	
20/10/2022	F (32558)	950	1020	0	nil	15	6.4	SE	3	6 Black Swan (4 nesting)	No Brolga seen although 2 were seen two days previously
20/10/2022	U (32610)	1055	1110	0	nil	16.3	11.5	E	3	2 Brolga; 2 Masked Lapwing	Foraging together in flooded grass at edge if wetland
16/11/2022	N (29839)	1215	1305	50	nil	16.8	4.1	SSE	3	6 Black Swan; 1 White-faced Heron; 1 Little Black Cormorant	
16/11/2022	R (29587)	1415	1445	80	nil	13.2	11.1	SE	3	1 Black Swan (nesting); 2 Pacific Black Duck	Empty Brolga nest next to road
16/11/2022	U (32610)	1600	1620	80	nil	17.2	4.5	SE	3	2 Black Swan; 1 Masked Lapwing; 3 Chestnut Teal	Brolga nest in centre of wetland empty, looks disrupted, lapwing in nest at the time of the survey
17/11/2022	R (29587)	900	910	80	nil	11.7	2.5	SE	3	2 Pacific Black Duck; 2 Black Swan (nesting)	Pair of Pacific Black Ducks were occupying empty Brolga nest

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
17/11/2022	Q (32542)	950	1100	80	nil	15.1	1.3	SSW	4	4 Black Swan; 1 Chestnut Teal; 3 Australasian Swamphen; 2 Pacific Black Duck; 1 Pied Cormorant; 1 Whistling Kite (flying over/circling at start of survey); 2 Brolga (1 adult and 1 chick)	Brolga adult and chick foraging in grasslands near wetlands on the SE corner, close to predator proof fence line
17/11/2022	F (32558)	Road closed, no access									

Appendix 3 Brolga targeted flocking surveys detailed results

Table A3.1 Targeted Brolga flocking survey data, Year 2

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
30/11/2021	Landholder observation. Wetlands L (32614) and K (32667)									No Brolgas	No Brolga seen recently
3/13/2021	Landholder observation. Wetland H (32580)									17 Brolga	Saw 17 Brolga foraging at the lake "a few weeks ago" (did not know exact date)
30/11/2021	C (29711)	1300	1310	20	nil	32.7	4.2	NNW	-	8 Black Swan	
30/11/2021	D (29773)	1310	1320	20	nil	32.9	6.5	NNW	-	60 Black Swan, 40 Silver Gull	
30/11/2021	E (30412)	1320	1325	20	nil	32.8	4	NNW	-	No waterbirds	
30/11/2021	30416	1330	1335	20	nil	32.6	4.2	NW	-	No waterbirds	
30/11/2021	Lake Barnie Bolac	1335	1340	20	nil	32.4	2.9	NW	-	90 Black Swan, 8 Australian Shelduck, 8 Banded Stilt, 12 Silver Gull, 30 Hoary-headed Grebe	
30/11/2021	33411	1350	1400	20	nil	32.2	8.6	NW	-	No waterbirds	
30/11/2021	F (32558)	1405	1410	20	nil	30.3	4.9	NW	-	No waterbirds	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
30/11/2021	G (29857) and wetland just north of G (29857)	1415	1420	25	nil	31.1	11	NW	-		
30/11/2021	I (32565)	1430	1535	25	nil	30.8	14.7	WNW	-	36 Masked Lapwing, 7 White-faced Heron, 6 Banded Stilt, 7 Black Swan, 7 Pacific Black Duck, 8 Australian Wood Duck (2 adults, 6 chicks), numerous small white flocking birds flying over shallow wetland No Brolga	
30/11/2021	H (32580)	1535	1550	25	nil	30.4	18	WNW	-	6 Australian Shelduck, 1 Little Pied Cormorant, 6 Pacific Black Duck	
30/11/2021	Q (32542)	1615	1720	30	nil	29.9	12.8	WNW	-	2 Brolga, 7 White-faced Heron, 1 Wedge-tailed Eagle	Foraging in east side of wetland. At 1420 the two adults were seen flying just above wetland chasing away a Wedge-tailed Eagle. After chasing the eagle away they started foraging on the SE edge of the wetland
1/12/2021	J (32664) and 234	450	630	80	nil	16.8	12.8	N	-	No Brolga	
1/12/2021	G (29857)	830	835	-	nil	20.9	11.1	N	-	No Brolga	
1/12/2021	E (30412)	840	845	-	nil	21	11	N	-	No Brolga	
1/12/2021	30416	850	900	-	nil	21.6	14.2	N	-	No Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
1/12/2021	Lake Barnie Bolac	905	915	-	nil	22.8	13	N	-	No Brolga	
1/12/2021	33411	925	940	-	nil	22.6	14.2	N	-	No Brolga	
1/12/2021	J (32664)	955	1030	-	nil	23.2	15.6	N	-	No Brolga	
1/12/2021	C (29711)	1300	1310	-	nil	23.2	13.8	N	-	No Brolga	
1/12/2021	D (29773)	1315	1325	-	nil	22.9	7.8	N	-	No Brolga	
1/12/2021	E (30412)	1330	1340	-	nil	23.8	12.1	NW	-	No Brolga	
1/12/2021	30416	1345	1350	-	nil	23.7	11.9	NW	-	No Brolga	
1/12/2021	Lake Barnie Bolac	1355	1400	-	nil	24	11.7	NW	-	No Brolga	
1/12/2021	33411	1420	1435	-	nil	23.9	8.4	W	-	No Brolga	
1/12/2021	F (32558)	1440	1455	-	nil	24.4	9.4	W	-	No Brolga	
1/12/2021	32648	1510	1525	-	nil	24.8	9.1	SW	-	No Brolga	
1/12/2021	J (32664)	1530	1540	-	nil	24.9	7.9	SW	-	No Brolga	
1/12/2021	G (29857)	1550	1555	-	nil	25.6	8	SW	-	No Brolga	Survey included small roadside wetland just to the north
1/12/2021	D (29773)	1605	1620	-	nil	24.2	10.2	SW	-	No Brolga	
1/12/2021	C (29711)	1620	1630	10	nil	23.7	7.7	SW	-	No Brolga	
1/12/2021	29894	1910	1915	25	nil	22.1	5.7	S	-	No Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
1/12/2021	I (32565) and H (32580)	1925	2115	20	nil	21.8	7.4	S	-	8 Brolga (adults)	8 adult Brolga foraging approx. 300m north of wetland 324 in grazed paddock with sheep as I arrived. 3 of the individuals were opening their wings and jumping together at 8:18. At 8:24, 3 Brolgas that were hidden behind trees on the east bank of wetland H were seen flying north, the 8 foraging then took off after them. 5 of the 8 were seen flying a few hundred meters NNE and landing out of sight just behind a hill. At 8:30, 2 Brolga were seen flying NW from wetland H to the shallow muddy section of wetland I. Brolga could be heard calling at wetland I until 8:45. 5 Brolga were seen standing in the mudflats of wetland I at 8:55. The 5 Brolga at the mudflats flew NNE at 9:14, towards the wetland where the west went, calling while they flew, just as the last of the light was fading.
2/12/2021	I (32565) and H (32580)	455	700	-	fog	13.2	4.8	NW	-	1 Brolga (adult)	Did not see any Brolga flying out from suspected roosting wetland, however morning was very foggy so they may have been obscured. 1 adult Brolga, foraging on north

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											bank of wetland H at 6:42, did not see it fly in.
2/12/2021	I (32565) and H (32580)	700	1030	30	nil	14.9	8.6	NW	-	3 Brolga (adult)	1 adult Brolga foraging on north side of wetland 324, slowly walking further north through paddock. walked out of view over rocky rise at 8:30. No Brolga in wetland 264. 3 adult Brolga seen at 8:53 approx. 400m north of wetland 324 foraging in paddock and slowly walking closer to wetland, stopping to forage in area where the 8 were seen last night. Did not see them fly in.
2/12/2021	I (32565) and H (32580)	1100	1230	70	nil	17.9	2.1	SW	-	No Brolga, must have left between 1030 and 1100.	
2/12/2021	F (32558)	1245	1255	80	nil	18.4	5.8	SW	-	3 Brolga (2 adult, 1 juvenile)	Foraging together in NW corner of wetland right next to road. Walked back into centre of the wetland after I drove past. Juvenile around 80% size of adult, yellow head
2/12/2021	J (32664)	1305	1400	80	nil	19	9.8	SW	-	No Brolga	
2/12/2021	32703	1420	1425	80	nil	19.5	12.7	SW	-	No Brolga	
2/12/2021	K (32667)	1430	1505	80	nil	21.2	16.5	SW	-	No Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
2/12/2021	J (32664) and 32651	1905	2120	100	nil	15.5	10.1	S	-	11 Brolga, 2 Wedge-tailed Eagle	Brolga heard calling from towards wetland 324/243 at 820. 2 WTE seen perching on and flying just above a small rocky hill 100m NE of survey point. 11 Brolga flew in a flock from around wetland 324 north at 2030 towards wetland 243, landing just over hill NNE of survey point, approx. 50m above the ground. Walked to wetland 248, no Brolga at wetland at 855.
3/12/2021	J (32664) and 32651	450	815	40	nil	-	-	SW	-	No Brolga	
3/12/2021	F (32558)	840	920	15	nil	16	5.3	SW	-	3 Brolga (2 adult, 1 juvenile around 80% size of adult, yellow head)	Foraging together in S edge of wetland.
3/12/2021	J (32664) and 32651	1000	1140	80	nil	19.1	5.9	SW	-		Heard multiple Brolga calls from towards wetland 324 at 1045
3/12/2021	Lake Barnie Bolac	1145	1205	60	nil	24.8	9.4	WSW	-	No Brolga	
10/02/2022	B (29614)	1930	2125	5	nil	20.4	5.4	SW	2, shallow water over most of wetland	13 Brolga (adults)	Dusk survey. 1 foraging in paddock NNE of wetland from 1930 to 2052. 9 roosting in W side of wetland from 2045, did not see or hear them fly in. 3 more observed roosting in SSW end of wetland at 2050, did not see or hear them fly

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											in. 12 total roosting in wetland at of survey.
11/02/2022	B (29614)	615	940	15	nil	8.9	4.9	SE	2, shallow water over most of wetland	15 Brolga (adults) observed. Dawn survey. 6:15 – 15 Brolga in wetland (10 in group on W side, 3 in group south, 2 in group SW). 6:45 – group of 10 started spreading out and foraging in west side of wetland. 7:18 – Group of 10 started foraging on west bank of wetland, partially obscured by tall reeds. 7:35 – Group of 3 out of sight. Group of 2 and group of 10 foraging on bank of lake. 7:55 – Group of 2 foraging in tall grain crops SW of wetland. Continued to forage there until end of survey. 7:55 – group of 10 now down to 9 individuals, foraging on W bank. Did not see where or when one left. 7:57 – group of 9 took flight, flew low over wetland and circled over crops west of wetland. 2 individuals landed in crops, remaining 7 landed at S end of wetland. 8:25 – group of 7 flew to meet the 2 individuals that landed in the crops west of wetland. All started to forage together in crops. 8:37 – 3 Brolga flew into wetland from SSW of wetland. 50m above ground. Appeared to be the group of 3 that were lost sight of at 7:35. Started foraging together on south bank of wetland. 9:40 – End of survey. Group of 9 foraging in crop west of wetland. Group of 2 foraging in crops SW of wetland. Group of 3 foraging on south bank of wetland.	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
19/02/2022	Landholder observation. B (29614)	-	-	-	-	-	-	-	-	3 Brolga	roosting in lake in the evening
22/02/2022	Lake Barnie Bolac	1225	1240	10	nil	19.8	11.4	SE	3	No Brolga	
22/02/2022	B (29614)	1340	1400	5	nil	20.2	7.1	SE	1	No Brolga	
22/02/2022	D (29773)	1420	1425	5	nil	20.4	8	SE	3	No Brolga	
22/02/2022	C (29711)	1430	1435	5	nil	20.4	8.4	SE	3	No Brolga	
22/02/2022	R (29587)	1440	1520	5	nil	22.8	6.8	SE	1, mostly dry, one small dam still partially full	3 Brolga (2 Adult, 1 Juvenile)	Preening and sitting together in shade of tree next to small dam with last of the standing water. Juvenile approx. 90% size of adults.
22/02/2022	J (32664)	1540	1600	0	nil	26.4	4.1	SE	3	2 Brolga (Adult)	Sitting together in grass on NW bank of lake.
22/02/2022	L and M (32614)	1610	1620	0	nil	26.3	7.6	SE	3	No Brolga	
22/02/2022	T (32671)	1625	1630	0	nil	26.4	9	SE	3	No Brolga	
22/02/2022	B (29614)	1940	2120	60	nil	21.3	14.4	S	1	No Brolga	Dusk survey.
23/02/2022	Lake Barnie Bolac	1130	1145	5	nil	28.9	2.2	NW	3	No Brolga	
23/02/2022	J (32664)	1200	1215	5	nil	29.6	1.8	NW	3	No Brolga	
23/02/2022	L and M (32614)	1225	1240	5	nil	30.1	3.2	NW	3	No Brolga	
23/02/2022	K (32667)	1250	1315	5	nil	31.2	1.3	NW	3	No Brolga	

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
23/02/2022	T (32671)	1325	1330	0	nil	31.4	2.2	SE	3	No Brolga	
23/02/2022	L and M (32614)	1935	2140	80	nil	25.4	9.1	SW	3	No Brolga	Dusk survey.
24/02/2022	Lake Barnie Bolac	605	800	50	nil	16.2	11.6	S	3	No Brolga	Dawn survey.
24/02/2022	R (29587)	920	940	10	nil	19.4	15.4	S	1, mostly dry, one small dam still partially full	3 Brolga (2 Adult, 1 Juvenile)	Foraging together near dam in West end of wetland
24/02/2022	S (33291)	1010	1025	5	nil	21.2	12.7	S	3	No Brolga	
24/02/2022	Q (32542)	1040	1115	5	nil	22.8	9.9	S	0	No Brolga	
24/02/2022	I (32565)	1145	1240	5	nil	24.1	13.5	S	0	No Brolga	
24/02/2022	H (32580)	1200	1240	5	nil	24.7	14.3	S	3	No Brolga	
25/02/2022	J (32664)	600	645	70	nil	15.8	6	SW	3	No Brolga	Dawn survey.
25/02/2022	F (32558)	650	825	60	nil	16.4	7.8	SW	0	No Brolga	
25/02/2022	A (29627)	850	915	40	nil	18.4	9.2	S	0	No Brolga	
25/02/2022	O (30401)	930	945	40	nil	18.7	12.4	S	3	No Brolga	
19/04/2022	L (32614)	1445	1505	95	light rain	14.7	6.2	SW	3	10 Brolga (9 adult, 1 juvenile)	Foraging in groups of 2-4 in ploughed paddock north of lake.
19/04/2022	32628	1525	1530	90	nil	14.6	9	SW	3	15 Brolga (adult)	Foraging together in paddock just south of wetland. Took flight when disturbed, 13 landed in NW section

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
											of Lake Gellie, 2 flew north and landed out of sight in paddocks.
19/04/2022	L (32614)	1600	1630	75	nil	14.7	7.6	SW	3	33 Brolga	Flock flew in from NE of wetland at 1620 with flock of Australian Shelduck. Landed in N section of lake.
19/04/2022	L (32614)	1710	1720	70	nil	14.8	8.2	SW	3	31 Brolga	20 foraging on NW edge of lake. 2 foraging in paddock north of lake. 9 flew from NW at 1710, approx. 20m above ground.
19/04/2022	L (32614)	1740	1810	75	nil	14.2	5.5	SW	3	24 Brolga	Foraging in ploughed paddocks N of lake. Between 9 seen at 1740, 12 seen at 1755, 23 seen at 1810 with 1 additional lone bird on SW edge of lake. 23 flew from paddocks N of lake to NW edge of lake at 18:12 to roost, joining lone bird. Sun below horizon at time of flight.
20/04/2022	L (32614)	605	920	100	foggy, light rain	13.2	13.8	W	3	No Brolga	Dawn survey. Too much fog and rain to see Brolga on roost, or flying off from roost
20/04/2022	L (32614)	920	935	100	foggy, light rain	14.6	14.2	W	3	2 Brolga	Foraging together in paddock NE of lake.
20/04/2022	L (32614)	1000	1020	100	foggy, light rain	14.9	16.8	W	3	8 Brolga	6 Foraging together in ploughed paddock NE of lake. 2 flying low (3m) over lake, from SW bank to paddock NW of lake, out of sight.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
20/04/2022	L (32614)	1030	1035	100	foggy, light rain	14.9	16.8	W	3	17 Brolga	Foraging in groups in ploughed paddock north of lake. 7 NW of lake, 3 N of lake, 7 NE of lake.
20/04/2022	L (32614)	1050	1115	100	foggy	15	9.6	W	3	7 Brolga	Foraging around 'pond' at NE of lake. No other Brolga viable around lake, pond, or surrounding paddocks.
20/04/2022	32628	1120	1130	95	nil	15.3	7.4	SW	3	No Brolga	
20/04/2022	32672	1150	1155	95	light rain	-	-	-	3	No Brolga	
20/04/2022	J (32664)	1215	1220	95	nil	-	-	-	3	No Brolga	
20/04/2022	L (32614)	1520	1530	85	nil	17.3	8.2	WSW	3	5 Brolga	foraging in group of 2 and 3 on West edge of lake in muddy bay
20/04/2022	L (32614)	1550	1620	75	nil	17.2	7.3	WSW	3	23 Brolga (1 new year juvenile)	17 foraging together on NE edge and bank of lake, 6 foraging together in NE 'pond'.
21/04/2022	L (32614)	805	1030	100	nil	14.6	8.8	S	3	24 Brolga	Foraging in ploughed, burnt wheat crop paddock N of lake. Flock walking across paddock while foraging, often breaking into small groups and pairs.
21/04/2022	L (32614)	1040	1105	100	nil	15.7	11.7	S	3	24 Brolga	Foraging in ploughed, burnt wheat crop paddock N of lake. Flock walking across paddock while foraging, often breaking into small groups and pairs. 21 flew into NW side of lake at 11:06 to roost.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
21/04/2022	L (32614)	1105	1400	100	nil	15.4	4.8	S	3	36 Brolga	Up to 33 roosting in NW of lake, some moving out of sight behind rocks/shrubs. 3 foraging in paddock N of lake for most of survey. Around 1300 half of flock had walked back to northern paddocks to forage. by 1350, most had moved/flown out of sight. Last 4 flew to NE paddock out of sight by 1400
21/04/2022	L (32614)	1530	1630	100	nil	16.4	9.1	SSE	3	38 Brolga (11 juvenile, 2 Of which have fully grey heads)	All roosting/foraging together in shallow water/mud on NW side of lake at start of survey. over next 30mins, spread out east along edge of lake. by 1600 all viable Brolga were foraging in paddock just N of lake. At around 1615, 15 took flight from paddock and flew N, then E, and back S, landing out of sight behind hills, near where Inka and Wyn had first seen the flock on the grazed hill last week. Flight approx. 25m above ground. 8 still visible foraging in paddock N of lake at time of flight.
21/04/2022	L (32614)	1710	1735	100	nil	14.7	9.2	S	3	28 Brolga	17 Foraging in ploughed burnt wheat crop paddock NW of lake, 11 took off from group at start of survey and flew East, landing out of sight behind hills NE of lake.

Survey date	Wetland ID	Start time	End time	Cloud cover %	Precipitation	Air temp	Wind speed (km/h)	Wind direction	Wetland status	Species observed	Brolga behaviour
21/04/2022	T (32671)	1740	1745	100	nil	13.7	9.9	S	3	3 Brolga	Foraging in paddock south of wetland.
21/04/2022	L (32614)	1750	1825	100	nil	13.6	4.3	S	3	22 Brolga	5 Foraging together in ploughed burnt wheat crop N of lake. Lost sight of 5 by 1800. 22 seen roosting in NW section of lake at 1810, still present at end of survey.
22/04/2022	L (32614)	610	1035	100	nil	13.8	6	SW	3	20 Brolga	First seen roosting in NW section of wetland. 4 flew off to paddock NE of lake, out of sight at 7:10. 16 slowly walked from lake to burnt wheat paddock N of wetland at 7:20. 16 seen foraging in paddocks N of wetland until 10:05 when 12 flew from paddocks back to lake for midday roost. Remaining 4 flew to meet main group in wetland at 1010.

Appendix 4 Peregrine Falcon breeding season survey detailed results

Table A4.1 Year 2 Peregrine Falcon breeding season survey data, November 2021 - October 2022

Survey date	Start time	End time	Cloud cover %	Precipitation	Ait temp ©	Wind speed (km/h)	Wind direction	Species observed	Falcon behaviour
15/11/2021	1045	1115	60	nil	15.8	3.4	NE	3 Peregrine Falcon (2 adults, 1 juvenile with mostly adult feathers), Galahs, Australian Magpies	Adults perched on trees overlooking quarry. Juvenile perched on quarry wall just outside nest
7/12/2021	1340	1425	90	nil	18.8	7.9	S	2 Peregrine Falcon, 1 Brown Falcon, 1 Australian Magpie	No falcons visible at quarry on arrival. Adult flew in calling loudly, juvenile (adult size with light brown breast feathers) then came out of nest in quarry wall and flew up to meet adult in a tree. Adult gave juvenile a small mammal that it was carrying. Juvenile flew off to another tree (notably, landed in the middle of a tree with a dense canopy while adults tend to perch in dead trees with no leaves). Adult then noticed me and circled overhead calling loudly, continuing to follow me until I left quarry area.
4/02/2022 Additional opportunistic survey	1030	1105	80	nil	19.8	6.2	SW	1 Peregrine Falcon	Seen briefly, flying above reserve and perched above quarry nest site. Left soon after. Remains of 2 dead Straw-necked Ibis and 2 Australian Magpies found in quarry.
4/07/2022	1310	1340	50	nil	11.9	7.4	W	Numerous Galahs and Australian Magpies. 2 Australian Shelduck	NA

Survey date	Start time	End time	Cloud cover %	Precipitation	Ait temp ©	Wind speed (km/h)	Wind direction	Species observed	Falcon behaviour
15/08/2022	1430	1515	100	nil	12.3	8.9	SW	Numerous Galahs and Australian Magpies. 2 Australian Shelduck	NA
7/09/2022	1450	1525	90	nil	17.4	9	NE	1 Peregrine Falcon	Perched in dead tree above quarry throughout entire survey, did not appear perturbed by obvious presence of surveyor, indicating lack of nesting partner.
5/10/2022	1320	1430	80	nil	11.3	14.5	E	1 Peregrine Falcon	Perched in dead tree above quarry throughout entire survey, did not appear perturbed by obvious presence of surveyor, indicating lack of nesting partner.
19/10/2022	1100	1130	0	nil	13.8	6.3	E	1 Peregrine Falcon	Seen briefly, flying though SW corner of reserve.
2/11/2022 (Year 3 survey)	1250	1335	90	nil	12.7	4.2	SW	No falcons	NA
29/11/2022 (Year 3 survey)	1230	1320	95	nil	17.6	8.8	NE	No falcons	NA
30/12/2022 (Year 3 survey)	1555	1635	80	nil	24.7	9.4	NW	No falcons	NA

Appendix 5 Symbolix Report on Mortality Estimates

symbolix

Dundonnell Wind Farm Mortality Estimate - Year 2

Prepared for Biosis, 7 March 2023, Ver. 1.1

This report outlines an analysis of the mortality data collected at Dundonnell Wind Farm from 2020-11-15 to 2022-10-11. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in November 2020, April 2021, October 2021, April 2022 and October 2022
- Scavenger loss rates – consisting of trials in November 2020, March 2021, April 2021, October 2021, March 2022, April 2022 and October 2022
- Mortality estimates - based on monthly surveys at 80 turbines, from 2020-11-15 to 2022-10-11

1 Available data

Survey data was collected and provided by Skylos Ecology[1]. A brief summary of the data is provided below, and the ultimate focus of this report is a discussion of the potential mortality.

Turbine parameter data was provided by Tilt Renewables.

Species archetype data was taken from Hull and Muir (2010) (bat and bird archetypes) and Veltheim (2018) (brolga).

1.1 Data cleaning

Survey data:

- Survey `A08SF11-15-21`'s turbine was updated to `A09`

Carcass finds data:

- Unidentifiable/unknown birds were recoded to "Unknown Bird"
- Unidentifiable/unknown bats were recoded to "Unknown Bat"
- Capitalisation and hyphenation made consistent

Searcher efficiency data:

[1] 20220112 SYMBOLIX FINAL Dundonnell Survey Excel - YEAR 1 and 2 - OCTOBER 2022 - Biosis.xlsx

- All Turkey carcasses were classified as a Brolga Proxy

Scavenger rate data:

- Carcass T5's date last seen was updated to be 2021-04-12

2 Methodology overview

Mortality through collision is an ongoing environmental management issue for wind facilities. Different sites present different risk levels; consequently different sites have different monitoring requirements. In order to estimate the mortality loss at a given site (in a way that is comparable with other facilities) we must account for differences in survey effort, searcher and scavenger efficiency. We used a Monte Carlo method to achieve this.

Best practice (M. M. Huso 2011) requires an estimator of the form:

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \tag{1}$$

where

- $\hat{M}_{ij}$ is the estimated mortalities at turbine i during search j
- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i r_{ij} p_{ij} \tag{2}$$

- a_i is the fraction of total carcasses within the searched area (note this is *not* the same as the fraction of area searched)
- r_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j
- p_{ij} is the probability that an existing carcass will be detected by the searcher

The following sections outline how we estimate $\hat{\mathbf{a}}$, $\hat{\mathbf{r}}$ and $\hat{\mathbf{p}}$. $\mathbf{C}$ is given by the field observation data.

Our final task is to estimate $\hat{M}$ for each group of turbines and species.

One limitation of analytical methods is estimating r_{ij} when the time between surveys is not constant. In Australia, it is common for the time between searches to vary due to seasonal changes in effort or the use of a pulsed design in which the turbine is searched monthly with a return visit a few days later.

To allow for survey protocols with non-standard intervals, we developed a Monte Carlo algorithm. We have used this method for annual estimates at over a dozen wind farms in Australia to date.

Monte Carlo methods (Sawilowsky (2003), Ripley (1987)) simulate a large set of possible survey results, by simulating the actual sampling protocol and sampling from the empirical distributions for scavenge loss and searcher efficiency. In this way, we can directly sample the probability a carcass was lost before the survey, negating the need to calculate r_{ij} analytically each time.

We can then estimate how many carcasses were truly in the field, given the range of searcher and scavenger efficiencies, the survey frequency and coverage, and the true "found" details. After many simulations, we can estimate the likely range of mortalities that could have resulted in the recorded survey outcome.

This method has been benchmarked against analytical approaches (M. M. Huso (2011), Korner-Nievergelt et al. (2011)). Its outputs are equivalent but it is able to robustly model more complex survey designs (e.g. pulsed surveys, rotating survey list).

Figure 1 provides an overview of the methodology. A detailed explanation can be found in Stark and Muir (2020).

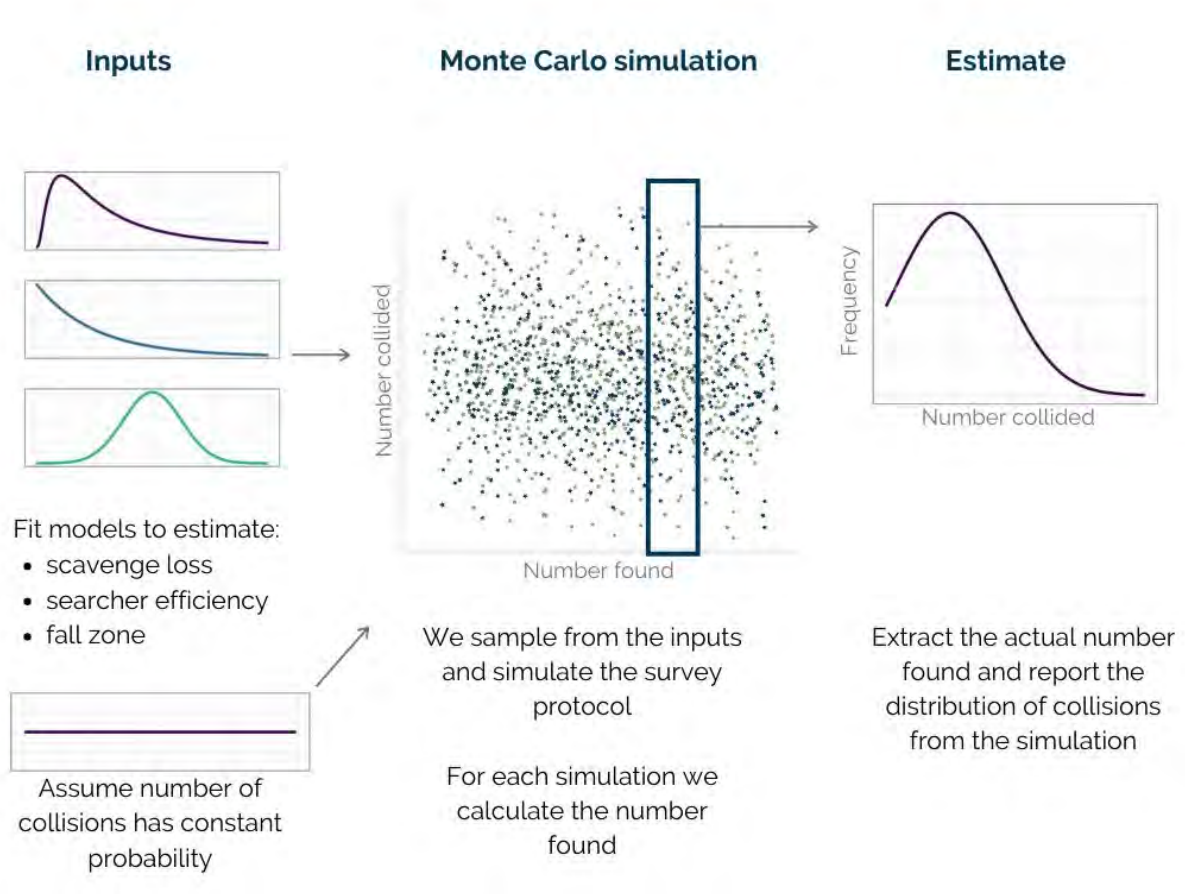

Figure 1: Overview of how the mortality estimation works.

3 Analysis and modelling

The survey program consisted of carcass searches, and adjunct scavenger and detection trials. We summarise the methods, field data and analysis results for each below.

3.1 Carcass search data

Carcass searches for birds and bats were undertaken by scent dog, with a trained handler. For brolgas specifically, a search was conducted with human surveyors using binoculars. Both surveys were conducted in accordance with Sections 5 and 7 of Brett Lane & Associates (2018).

The carcass searches provide the C term of Equation (1).

3.1.1 Survey effort

The mortality estimate was based on a dated list of turbine surveys. The survey frequency is summarised in Table 1. All 80 turbines were selected, with approximately 28 being surveyed by dogs, and approximately 52 surveyed by humans with binoculars (with some overlap in selected turbines and changes from month to month).

For dog based surveys, turbines were selected to be surveyed twice each month with one "Standard" survey out to 120m and one "Pulse" survey out to 60m. Human binocular surveys conducted searches out to 140m once a month for each selected turbine.

Table 1: Number of surveys per month. Note: September 2022's surveys were held at the end of August.

Date	Standard	Pulse	Brolga Survey
2020 Nov	28	28	52
2020 Dec	27	27	51
2021 Jan	28	28	52
2021 Feb	28	28	50
2021 Mar	28	28	50
2021 Apr	28	28	50
2021 May	28	28	51
2021 Jun	26	26	53
2021 Jul	28	28	51
2021 Aug	28	28	50
2021 Sep	28	28	51
2021 Oct	28	28	52
2021 Nov	28	28	52
2021 Dec	28	28	52
2022 Jan	32	28	58
2022 Feb	32	28	46
2022 Mar	20	28	52
2022 Apr	28	28	52
2022 May	28	28	42
2022 Jun	28	28	43
2022 Jul	28	27	50
2022 Aug	56	28	75
2022 Sep		28	28
2022 Oct	28	28	42

3.1.2 Carcass finds

The breakdown of found carcasses per species are summarised in Table 2.

Table 2: Carcasses found during formal surveys over two years.

Species	Bat	Bird	Feather Spot
Australian Magpie		9	18
Australian Magpie or Magpie-lark		0	1
Australian White Ibis		0	2
Barn Owl		4	5
Black-shouldered Kite		1	0

Table 2: Carcasses found during formal surveys over two years. *(continued)*

Species	Bat	Bird	Feather Spot
Brolga		1	0
Brown Falcon		15	1
Brown Goshawk		1	0
Common Starling		3	0
Dusky Moorhen		1	0
European Goldfinch		4	0
Fantail/Wagtail		1	0
Galah		2	0
Gould's Wattled Bat	4		
Goulds or Chocolate Wattled Bat	2		
Grey Fantail		1	0
Grey-headed Flying-fox	1		
Ibis sp.		1	0
Introduced finch sp. (Goldfinch or Greenfinch)		1	0
Little-button quail		1	0
Musk Lorikeet		1	0
Nankeen Kestrel		9	4
Painted Buttonquail		1	0
Peregrine Falcon		1	0
Raven sp.		5	0
Rock Dove		0	1
Rosella sp.		0	1
Silvereye		1	0
Skylark or pipit		1	0
Sparrow sp.		1	0
Straw-necked Ibis		6	6
Striated Pardalote		2	0
Stubble Quail		2	0
Unknown Bat	23		
Unknown Bird		8	15
Wedge-tailed Eagle		7	0
Whistling Kite		1	0
White-striped Freetail Bat	49		
White-throated Needletail		0	1

A number of carcasses were also found incidentally. While these can't be included in the formal mortality estimate, we report them for completeness in Table 3.

Table 3: Incidental finds.

Species	2020	2021	2022
Australian Magpie	1	16	4
Barn Owl	1	7	2
Brown Falcon	3	10	4
Common Starling	1	1	2
Fantail/Wagtail			1
Galah		1	
Gould's Wattled Bat	1	1	
Grey-headed Flying-fox		3	
Lesser Long-eared Bat		1	
Nankeen Kestrel		21	6
Pallid Cuckoo		1	1
Peregrine Falcon			1
Raven sp.	1		2
Skylark	1		
Straw-necked Ibis	1	3	
Unknown Bat		2	1
Unknown Bird		7	3
Wedge-tailed Eagle	5	5	2
Whistling Kite	1		
White-striped Freetail Bat		7	3
White-throated Needletail		1	

3.2 Searcher efficiency

The aim of searcher efficiency trials is the quantify the effectiveness of observers, at finding carcasses. They provide the p term in Equation (2).

3.2.1 Methods

The searcher efficiency data is sourced from trials conducted through the survey period. Carcasses were laid out in accordance to the specification in Section 5.2.5 of Brett Lane & Associates (2018). Trained detection dogs (with a human handler) searched for the carcasses using the same protocol as the main mortality survey. If the carcass was found, "success" was

recorded, else "failure" was the dog missing the carcass.

For the binocular surveys, brolga carcass proxies (Turkeys and feather spot clumps) were laid out according to the specification in Sections 5.2.5 and 7.2 of Brett Lane & Associates (2018).

We estimated searcher efficiency by fitting binomial generalised linear models (GLMs). The optimal model was determined, guided by the small-sample Akaike Information Criterion (Anderson and Burnham 2004), otherwise known as the AICc.

3.2.1.1 AIC model selection The theory of AIC is deep and complex, and beyond the scope of this report. However, to summarise, AIC is a method for choosing the best approximating model of the "truth". For each model we fit to the data, we calculate the AIC. We compare the differences in AIC between models, which in turn informs us of the weight of evidence for that particular model.

AIC is not the same as significance testing. We do not aim to state anything is significant at the 5% level, instead we aim to find a good model fit for the data. Additionally, we also consider two other principles guiding model selection. They are parsimony (a simpler model is preferable to a more complex model), and application (for example, it's all well and good to find that cloud cover affects detection rates, but it's not feasible to incorporate cloud cover into a mortality estimate).

AICc is a modification of AIC, which is appropriate for smaller sample sizes.

3.2.2 Results

Searcher efficiency trials were conducted in November 2020, April 2021, October 2021, April 2022 and October 2022; see Table 4.

The detectability trials used bird (49 replicates) and bat (58 replicates) carcasses along with Brolga proxies (Turkeys, 51 replicates) (Table 5).

Table 4: Number of trials conducted on each detection survey month.

Observer type	Month	Number of trials
binocular	2020 Nov	27
binocular	2021 Apr	10
binocular	2022 Apr	14
dog	2021 Apr	38
dog	2021 Oct	28
dog	2022 Apr	20
dog	2022 Oct	21

Table 5: Count of species types used during the detection surveys.

Species type	Observer type	Number of records
brolga proxy	binocular	51
bat	dog	58
bird	dog	49

For both dog and binocular based surveys, the most parsimonious models of searcher efficiency models were the "intercept-only" model (i.e. all carcasses have the same expected searcher efficiency). Therefore, bird and bat detection efficiencies are aggregated in the following mortality estimate. Brolga detection efficiencies are treated separately due to the different search method.

Table 6: Detection efficiencies for birds/bats, and Brolga.

Variable	Bats and Birds	Brolgas
Number found	101	39
Number placed	107	51
Mean detectability proportion	0.94	0.76
Detectability lower bound (95% CI)	0.88	0.63
Detectability upper bound (95% CI)	0.98	0.87

3.3 Scavenger efficiency

In order to accurately estimate mortality, we must account for carcass loss to scavengers. Scavenger trials are performed to quantify the time until a carcass is completely lost as a result of scavenger activity, which is the r term in (2).

Trials used motion sensitive cameras in order to record exact times of scavenge events, accordance with Section 5.2.4 and 7.2 of Brett Lane & Associates (2018) for regular and Brolga specific trials respectively.

3.3.1 Methods

Survival analysis (Kaplan and Meier (1958), Kalbfleisch and Prentice (2011)) was used to determine the distribution of time until complete loss from scavenge (or decay). Survival analysis was required to account for the fact that we do not necessarily know the exact time of scavenge loss, only an interval in which the scavenge event happened. For example, any carcass which is unscavenged at the end of the trial, has its scavenge event in the interval $[x, \infty]$ (where x is the length of the trial).

By performing survival analysis we can estimate the time until carcass loss after a given length of time, despite these unknowns.

We fit parameterised models to analyse significant factors influencing time to scavenge (carcass species type etc), and to find the most appropriate distribution to fit the time-to-loss curve (e.g. log-normal, exponential).

Time to carcass loss is influenced by the parameters discussed above and the distribution of the loss curve we fit to the data (M. M. P. Huso, Dalthorp, and Korner-Nievergelt 2015). The choice of loss function is important because it should capture the behaviours and relative time dependence of the various scavengers. Generally, the best distribution is the log-normal distribution (Stark and Muir 2020).

3.3.2 Results

Scavenger efficiency trials were conducted in November 2020, March 2021, April 2021, October 2021, March 2022, April 2022 and October 2022 (Table 7) at Dundonnell Wind Farm. The trials ran over approximately 30 days. In total, 40 bird carcasses and 14 bat carcasses were used, plus 39 turkeys were used as proxies for Brolga, and 26 mice carcass data were used as bat proxies (Table 8).

Table 7: Scavenger trial timing.

Month	Number of trials
2020 Nov	10
2021 Mar	20
2021 Apr	9
2021 Oct	30
2022 Mar	10
2022 Apr	20
2022 Oct	20

Table 8: Species types for scavenger trials.

Species type	Number of records
Bat	14
Bat Proxy	26
Bird	40
Brolga Proxy	39

We fit separate curves to Birds (general), Brolga, and Bats.

We note that the Bat cohort comprised of both Bats (White-striped Freetails) and Bat Proxies (mice). At Dundonnell Wind Farm, the behaviour of the WSFT was very different from that

of the mice, with the WSFT having an unusually large median carcass persistence rate of approximately 30 days. In Victoria, the expected carcass persistence for bats is generally less than 5 days (Stark and Muir 2020), which is what the mouse scavenger rate agrees with. We have therefore combined Bats and Bat Proxies in the modelling.

Figure 2 shows a survival curve fitted to the different cohorts. The survival curve (smooth solid line for fitted, step function for empirical) shows the estimated proportion of the set remaining at any given time. The shaded portions are the 95% confidence intervals on the estimate.

Under these assumptions, the median time to total loss via scavenge is 4.9 [2, 9.8] days for bats, 8.3 [4, 18.9] days for birds, and 10.5 [7, 16.8] days for brolgas. The numbers in square brackets give the 95% confidence interval.

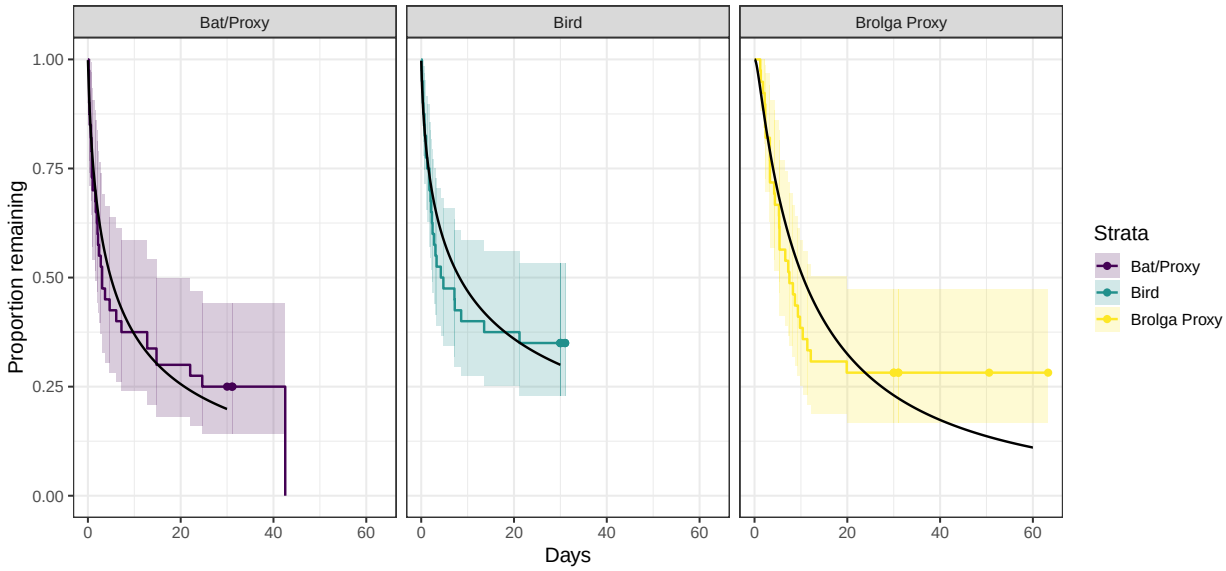

Figure 2: Empirical survival curve (the step function), with 95% confidence interval shaded. The smooth curve presents the fitted model.

3.4 Proportion of turbines searched

In the Monte Carlo algorithm, we explicitly simulate the survey design. The proportion of turbines sampled is therefore explicitly accounted for in the simulation (in this case it's 100% anyway).

3.5 Coverage factor

The coverage factor estimates the probability that, given a carcass falls at a searched turbine, that the carcass falls within the searched area. This contributes to the a term in Equation (2)

3.5.1 Methods

We generated a carcass fall-zone distribution for each species class, given the turbine size at the wind farm. The percentage of the fall zone not covered by the survey area, provides a correction factor in the mortality estimate. Because carcasses that fall outside the searched area have a zero probability of being detected by a survey, the likelihood of landing in this region is essential to understanding the relationship between detections and actual losses.

The fall-zone estimate is the end result of the calculation detailed in Hull and Muir (2010).

3.5.2 Results

Table 9 displays the dimensions and RPM of the turbines at Dundonnell Wind Farm, while Table 10 shows the bird physical parameters used. These are input into the fall zone simulation.

Table 9: Turbine specifications for the wind farm.

Rotor Diameter (m)	Tower Height (m)	RPM
150	114	12

Table 10: Bird archetype parameters.

Species type	Archetype	Mass (kg)	Min. area (sq m)	Max. area (sq m)
Bat	Gould's Wattled Bat	0.014	0.0028	0.014
Bird	Raven	0.680	0.0450	0.100
Large Bird	Brolga	7.500	0.1000	0.475

Figure 3 displays the simulation results for birds, bats and brolgas, given the factors specified above. We display the cumulative density function (CDF) on the y axis versus the distance from turbine (x axis). for each species type. The CDF describes the expected proportion of carcass which fall less than or equal to a certain distance from the turbine. For example, we see that we expect about 53% of Bird carcasses to fall within 60m of the turbine, and about 99% of Bird carcasses to fall within 120m of the turbine.

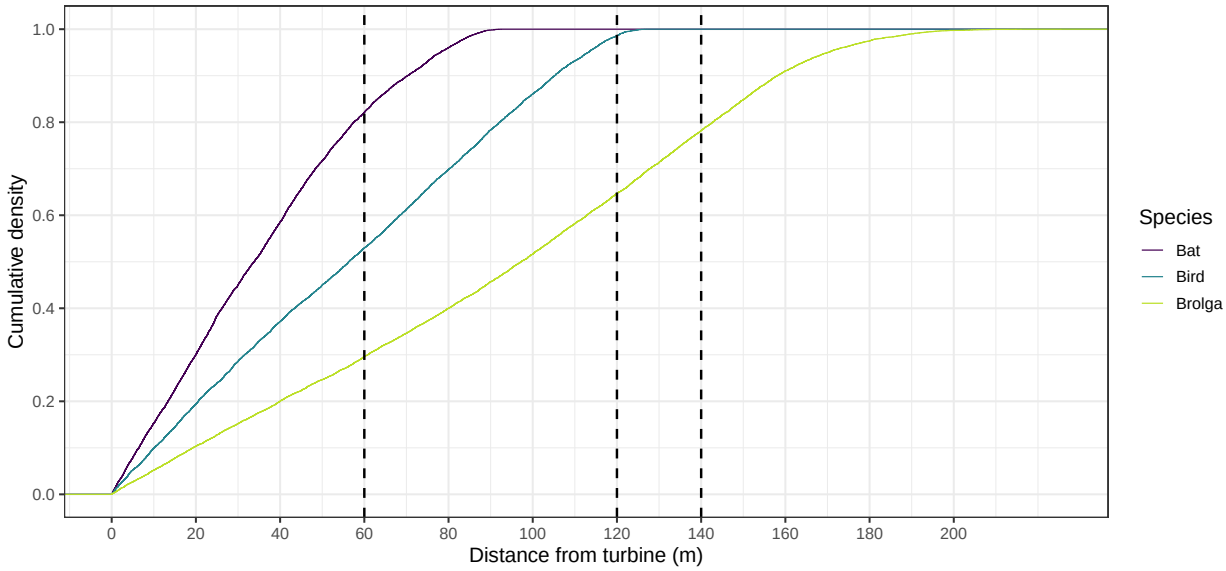

Figure 3: Cumulative distribution function of the fall zone simulation output for birds and bats. Vertical lines indicate relevant survey radii.

Once the fall zone distribution is calculated, we generate a "coverage factor" for each species type. The coverage factor represents the proportion of carcasses which fall within the searched area.

On average, we assume that the survey coverage of bird fall zone is 53% for pulse surveys out to 60m and 99% for standard surveys out to 120m. The coverage of the bat fall zone is 82% for pulse surveys and 100% for standard surveys. For brolga, the coverage is 30% for pulse surveys, 65% for standard surveys, and 78% for the binocular surveys out to 140m.

4 Mortality estimate

With estimates for scavenge loss, searcher efficiency, and survey coverage, we then converted the number of bat, bird, and Brolga carcasses detected into an estimate of overall mortality at Dundonnell Wind Farm from 2020-10-15 to 2022-10-11 (we allow for collisions to occur up to a month prior to the first survey).

The mortality estimation is done via a Monte Carlo algorithm. We used 25000 simulations for bats, 25000 for birds, and 25000 for brolgas, with the survey design simulated each time. Random numbers of virtual mortalities were simulated, along with the scavenge time and searcher efficiency (based on the measured confidence intervals). The proportion of virtual carcasses that were "found" was recorded for each simulation. Finally, those trials that had the same outcome as the reported survey detections were collated, and the initial conditions (i.e. how many true losses there were) reported on.

The model assumptions are listed below:

- There were 80 turbines on site.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 1 for a summary).
- Mortalities were allowed to occur up to a month before the initial survey (2020-11-15) and until the final surveyed date (2022-10-11).
- Birds (including Brolga) are on-site at all times during this period.
- Bats are on-site at all times during this period.
- Bats and birds that are struck are immediately replaced (i.e. strikes one day do not affect the chance of strikes the next).
- We have used the standard practice of assuming that all carcasses and all feather spots (regardless of size or composition) are attributable to the wind turbines.
- Finds are random and independent, and not clustered with other finds.
- There was equal chance of any turbine individually being involved in a collision / mortality.
- We took scavenge loss and search efficiency rates as outlined above.
- We assumed a log-normal scavenge shape.
- 39 turbines were surveyed for birds, bats and Grey Headed Flying Foxes, and were searched out to a 120 metre radius, in accordance with the supplied survey data.
- 64 turbines were surveyed with binoculars for brolgas specifically[2], and were searched out to a 140m radius, in accordance with the supplied survey data.
- The coverage factors were taken to be those stated in Section 3.5.2.

Bat and bird mortality estimates have been run using only the dog-based survey data (Standard and Pulse surveys), while the brolga mortality estimate has been run using both the binocular and dog based survey data.

[2]Note: some turbines were searched both with binoculars, and dogs.

4.1 Bats

During the full period of surveys a total of 79 bats were found during formal surveys, with 46 bats found in Year 1, and 33 in Year 2. The resulting (median) estimate of total mortality is 564 bats lost on site over the full survey period. Our estimate of bat mortality in Year 1 is 348, and for Year 2 it is 241. Note: due to simulation variation, the Year 1 and Year 2 estimates do not equal the overall estimate.

Table 11 and Figure 4 display the percentiles of the distributions, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 564 bats over the full survey period, and are 95% confident that fewer than 754 individuals were lost. During Year 1 the total loss was around 348 and we're 95% confidence that less than 490 were found. During Year 2 the total loss was around 241 with 95% confidence that less than 347 were found.

Table 11: Percentiles of estimated total bat losses, over each survey period.

Survey Period	0%	50% (median)	90%	95%	99%	99.9%
Cumulative	333	564	683	754	785	786
Y1	207	348	465	490	620	680
Y2	150	241	330	347	445	510

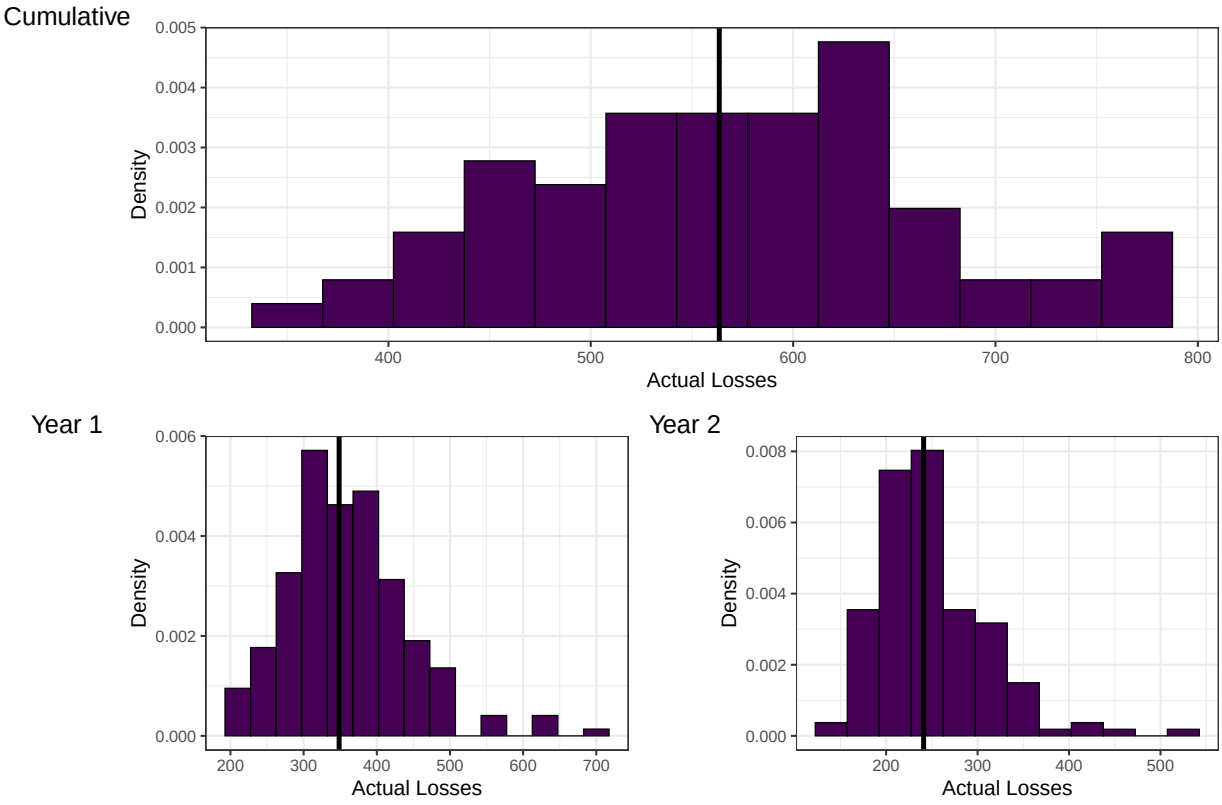

Figure 4: Histogram of the total losses distribution (bats). The black solid line shows the median.

4.2 Birds

During the full period of surveys a total of 146 birds were found during formal surveys, with 67 birds found in Year 1, and 79 in Year 2. The resulting (median) estimate of total mortality is 926 birds lost on site over the full survey period. Our estimate of bird mortality in Year 1 is 418, and for Year 2 it is 485.

Table 12 and Figure 5 display the percentiles of the distributions, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 926 birds over the full survey period, and are 95% confident that fewer than 1381 individuals were lost. During Year 1 the total loss was around 418, and we are 95% confident that less than 660 birds were lost. During Year 2 the total loss was around 485 individuals are we are 95% confidence that less than 701 were lost.

Table 12: Percentiles of estimated total bird losses, over each survey period.

Survey Period	0%	50% (median)	90%	95%	99%	99.9%
Cumulative	653	926	1222	1381	1562	1566
Y1	287	418	570	660	724	746
Y2	326	485	633	701	806	975

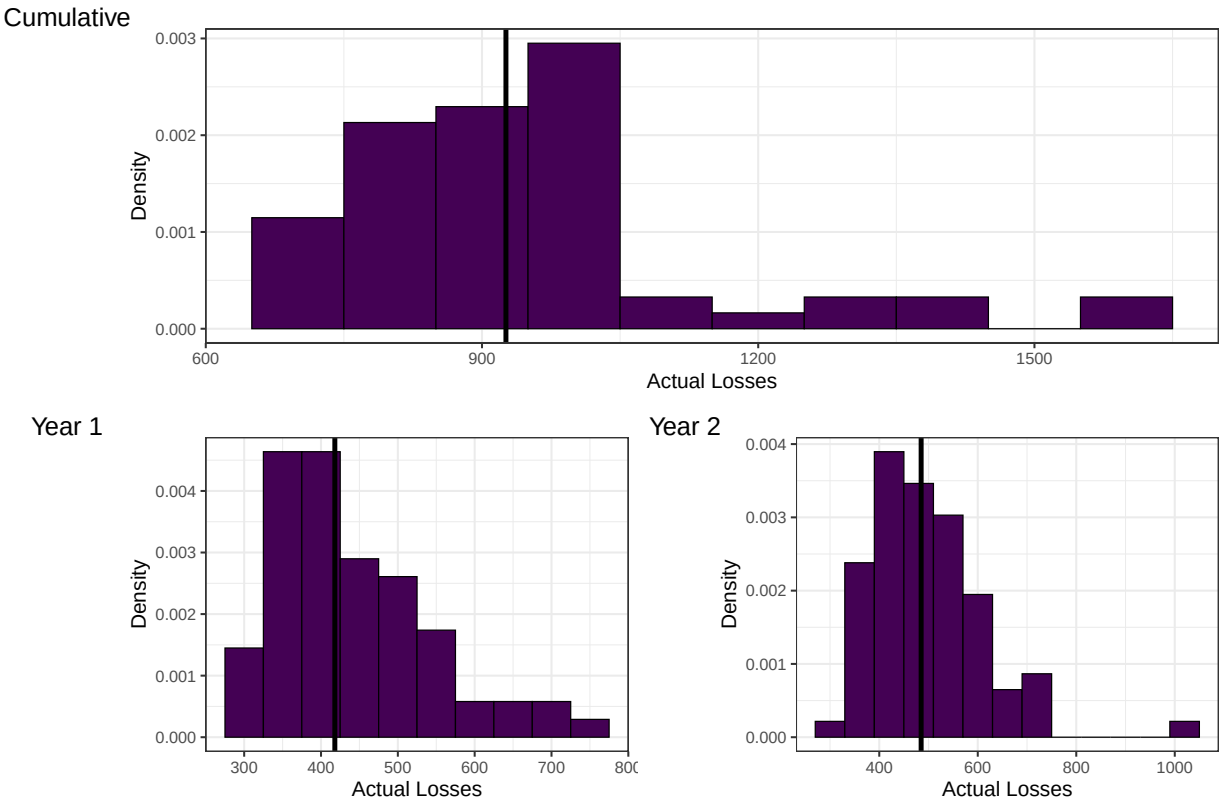

Figure 5: Histogram of the total losses distribution (birds). The black solid line shows the median.

4.3 Brolgas

During the full period of surveys a total of one brolga was found during formal surveys, with zero brolgas found in Year 1, and one in Year 2. The resulting (median) estimate of total mortality is five brolgas lost on site over the full survey period, two during Year 1 and four during Year 2.

We note that during Year 1, no brolga carcasses were found. Therefore, we have no evidence that brolga were struck during this period (as opposed to Year 2, where we *do* have evidence brolga were struck). As the mortality estimator has an inherent assumption that at least one bird was struck, the Year 1 estimate is likely biased high (i.e. a conservative estimate).

Table 13 and Figure 6 display the percentiles of the distributions, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around five brolgas over the full survey period, and are 95% confident that fewer than 14 individuals were lost. During Year 1 we estimate the total loss was around two with 95% confidence that less than 10 were lost. During Year 2 the we estimate the total loss was around four with 95% confidence that less than 15 were lost.

Table 13: Percentiles of estimated total brolga losses over each survey period.

Survey Period	0%	50% (median)	90%	95%	99%	99.9%
Cumulative	1	5	11	14	20	26
Y1	1	2	7	10	15	22
Y2	1	4	11	15	20	31

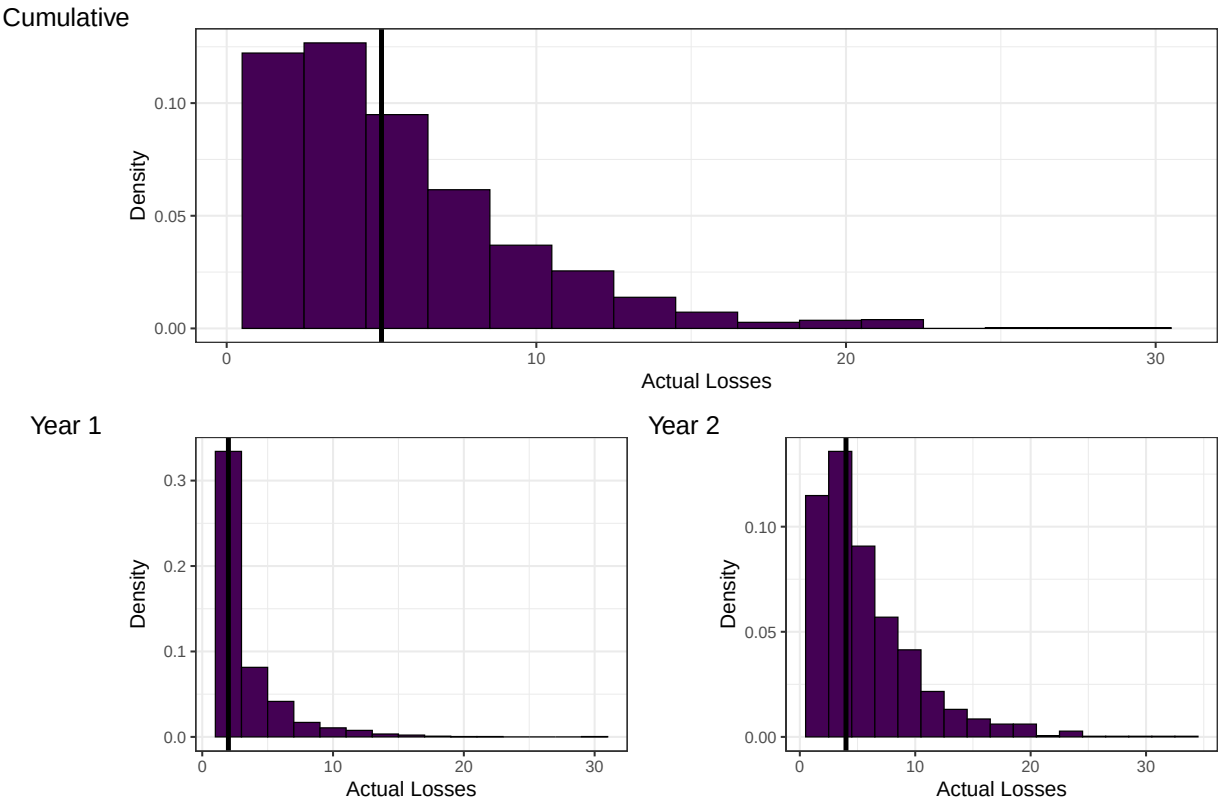

Figure 6: Histogram of the total losses distribution (brolgas). The black solid line shows the median.

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Appendix 6 Brolga necropsy report (University of Melbourne)

Case Report *ID: 1111-22*

FVAS - Veterinary Anatomic Pathology

FVAS - Veterinary Anatomic Pathology
250 Princes Highway
Werribee Victoria 3030
Phone: (03) 8001 2562
Email: anat-vet@unimelb.edu.au

Submission Date: 27/10/2022
Completed Date: 14/11/2022
Pathology Number: 1111-22
Submitting Client: DELWP
Submitting Contact: Adam Williams

Owner Details:

DELWP

Phone:

Email:

Patient Details:

Name: Brolga

Patient #:

Animal Type: Wildlife

Species/Breed: Brolga

Age: 0y 0m

Sex: Female

Completed Report

Clinical History:

The Brolga carcass detected on 5 October 2022 consisting of two wings and a large feather scatter, indicating the carcass had been scavenged. The two legs were subsequently detected. Head could not be located. The scavenger, most likely a fox, has removed the head. Initial ecologist inspection showed no evidence to help determine a cause of death, such as bone breakage, cuts, or scrapes. Given the location of the carcass 90m from the wind turbine, and the absence of other likely collision risks considered most probable that the cause of death was a turbine strike. Feather scatter found in the immediate vicinity of the wings suggests the carcass was encountered by scavenger/s at that location, rather than dragged there from another location.

Gross Pathology:

The post-mortem examination performed on 27th of October at 3.30 pm and concluded at 4.00 pm. The subject was presented as five separate body parts with minimal dried soft tissue attached. The tissues were poorly preserved and were severely scavenged and desiccated.

Examination of both legs revealed intact tarsometatarsus and toes with no evidence of injury or inflammation. The ventral half of the tibiotarsus was intact, and the dorsal half is devoid of any skin, but partially covered with a small number of brown, dried fibers and tendons. No fracture was evident in the femur, no skin was present, and was overlain with a small amount of dried soft tissue. The synsacrum was devoid of any soft tissue, the left pubic bones were attached to the synsacrum and the right one was loosely attached to the femur with dried soft tissues.

The carpometacarpus was intact with feathers attached. There was no evidence of injury to the feathers on both wing. The humerus and parts of the scapula were present and devoid of any soft tissue.

No other body parts were received.

Histopathology:

Not performed.

Morphological Diagnosis:

Severely scavenged carcass

Comments:

Received multiple extremities for necropsy. No soft tissue was present in the submitted specimen. No fractures were evident in the long bones of the legs and wings. The feathers were intact. The cause of death is undetermined.

Pathologist:

Smitha Rose Georgy (BVSc MVSc PhD MANZCVS Diplomate ACVP)
Senior Lecturer in Veterinary Pathology