Dundonnell Wind Farm

Year 3 Annual Report – Bat and Avifauna Management Plan Implementation

Prepared for Tilt Renewables

19 July 2024

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Biosis staff involved in this project were:

- Wyn Russell, Dr Inka Veltheim and Claire Tingate (Brolga and Peregrine Falcon field surveys)
- Julian Turner (mapping)
- Dr Inka Veltheim (quality assurance)

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The BAMP 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 to continue for the operational life of DDWF. It is a requirement of the BAMP and Condition 53 of the Planning Permit No. 105/23858 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 BAMP activities undertaken during the reporting year.

This report presents the findings of the third year (Year 3) of implementation of the BAMP at DDWF (November 2022 – October 2023). This report also presents an updated mortality estimate for Brolga, based on an updated analysis of all three years of data, in accordance with the BAMP.

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 Plan (BAMP) prepared by Brett Lane and Associates Pty Ltd (BL&A 2018).

The BAMP 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 BAMP commenced in November 2020. The results from the first two years of bird and bat monitoring are detailed in Biosis (2023a).

The current report contains the findings from the third year of implementing the actions and monitoring activities of the BAMP for DDWF.

The BAMP 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, 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 BAMP impact triggers.

The second annual report (Biosis 2023a) contains a full analysis of the first two years of data and includes estimates of annual mortalities of birds and bats occurring as a result of turbine collision, which was calculated by Symbolix. Data analysis and calculation of mortality estimates is not required for Year 3 of operation, and is therefore not included in the current report. The BAMP does, however, require mortality estimates to be calculated each year for Brolga, which has been undertaken on all three years of data and is presented in this report.

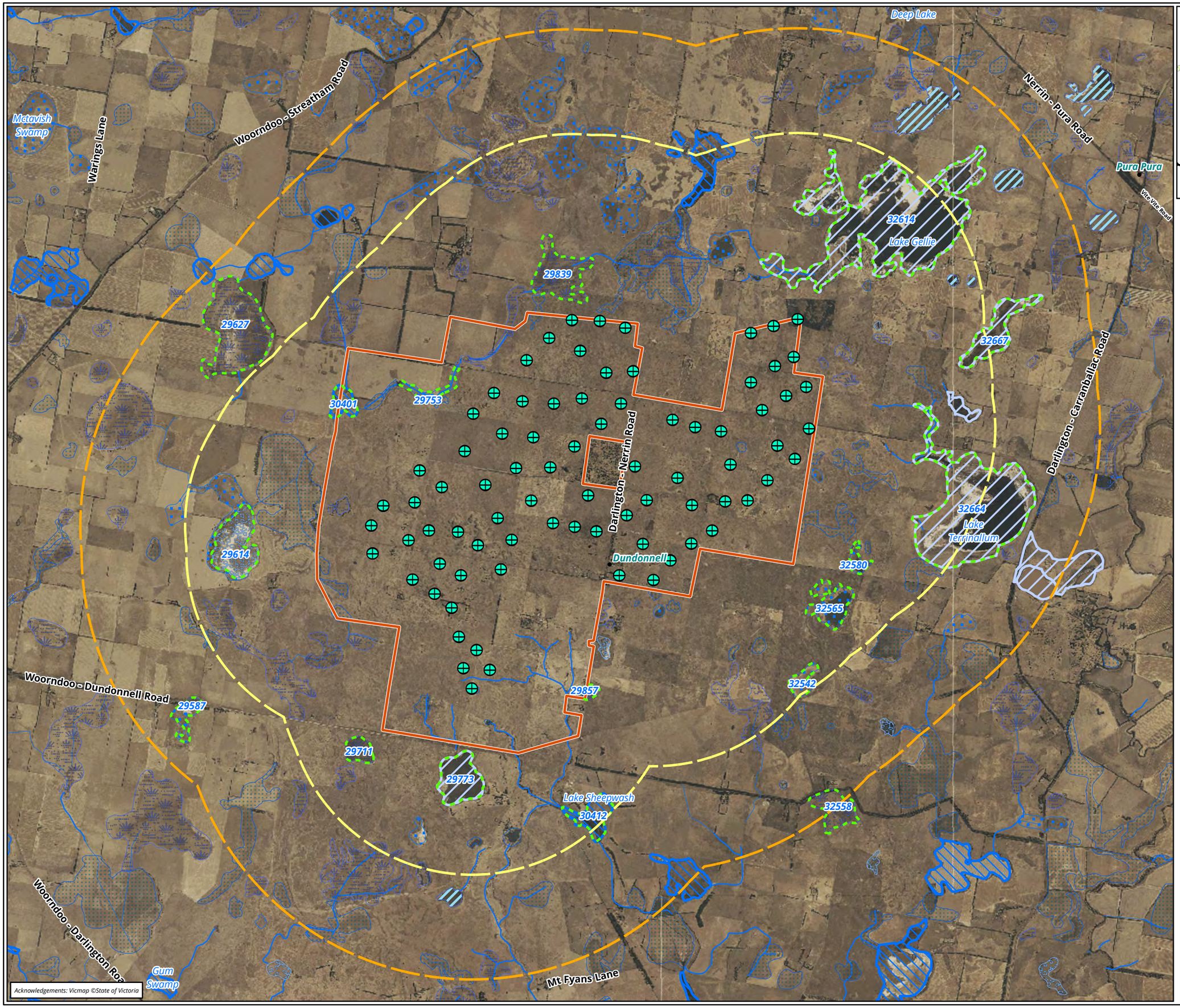
It is a requirement of the BAMP and Condition 53 of the Planning Permit that an annual report be prepared and submitted to the Victorian Department of Energy, Environment and Climate Action (DEECA, formerly DELWP) containing details of all BAMP activities undertaken during the reporting year. This report presents the findings of the third year (Year 3) of implementation of the BAMP at DDWF (November 2022 – October

2023). This report also presents an updated mortality estimate for Brolga, based on an updated analysis of all three years of data, in accordance with the BAMP.

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 1) during the Brolga flocking season (January to June), and within 3.2 kilometres during the breeding season (July to December). Survey wetlands were chosen by Biosis senior zoologists based on habitat quality, accessibility and past records of Brolga foraging, breeding and flocking (Table 1).

Three additional wetlands were incorporated into the survey plan after they were identified as suitable Brolga habitat 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 3 monitoring were conducted from November 2022 to October 2023, inclusive.

Table 1 Brolga utilisation survey wetlands, Year 3

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 3	Wetland type and Brolga use from years 1 and 2
A	29627	118	5km	None	Fresh water, shallow seasonal marsh, usually dry throughout year. • No Brolga activity in Year 1 or 2.
B	29614	112	3.2km	Two adults foraging in and around wetland.	Fresh water, shallow permanent lake. • Two adults foraging in Year 1. • Two adults foraging in Year 2. • Flock of 11 adult Brolgas foraging and roosting at wetland in Year 2.
C	29711	138	3.2km	No Brolgas seen at wetland during Year 3 surveys.	Fresh water, deep permanent lake. • Two adults foraging in Year 1. • No Brolga activity in Year 2.
D	29773	139	3.2km	Two adults and one fledged juvenile foraging in and around wetland.	Saline water, deep permanent lake. • No Brolga activity in Year 1 or 2.
E	30412	110	3.2 km 5 km	No Brolgas seen at wetland during Year 3 surveys.	Fresh water, shallow seasonal marsh, choaked with reeds. • No Brolga activity in Year 1. • Three adults foraging at wetland in Year 2.
F	32558	236	5km	• Two adults raised one chick in late	Fresh water, shallow seasonal marsh, usually dry from January – July based on Biosis DDWF

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 3	Wetland type and Brolga use from years 1 and 2
				2022 – early 2023 breeding season. • Two adults attempted to nest in late 2023 breeding season, however nest was flooded and abandoned.	surveys. • Two adults nested and fledged one chick in Year 1. • Two adults nested and raised two chicks in Year 2. • Three adults and two juveniles observed foraging at wetland in Year 2.
G	29857	602	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, small permanent lake. • No Brolga activity in Year 1. • Two adults and one juvenile foraging in adjacent paddock in Year 2.
H	32580	324	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, holding water year-round, likely spring-fed. • No Brolga activity in Year 1. • Flock of 21 foraging in adjacent paddock in Year 2.
I	32565	254	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, shallow permanent lake. • No Brolga activity in Year 1. • Three adults foraging in adjacent paddock during December 2022, Year 2.
J	32664	244	Both	• No Brolgas seen at wetland during Year 3 surveys.	Saline water, permanent spring-fed lake. • No Brolga activity in Year 1. • Up to two adults and one juvenile foraging at wetland in Year 2.
K	32667	243	Both	• No Brolgas seen at wetland during Year 3 surveys.	Saline water, shallow semi-permanent lake. • Two adults foraging in Year 1. • Two adults foraging in Year 2.
L	32614	239	Both	• Up to four adults (two pairs) foraging in and around wetland.	Lake Gellie. Saline water, deep permanent spring-fed lake with some shallow shore sections. • Seven adults foraging in Year 1. • Flock of 27 adults and 11 juveniles observed in April 2022, Year 2. • Flock of up to 42 observed by Landholder in May 2022, Year 2.
M		506	3.2km	• Two adults foraging in and around wetland.	
N	29839	326	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, shallow seasonal marsh. • No Brolga activity in Year 1.

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 3	Wetland type and Brolga use from years 1 and 2
O	30401	513	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, deep permanent dam. • No Brolga activity in Year 1 or 2.
P	29753	117	3.2km	• Two adults and one chick foraging together in north edge of wetland in late 2022 - early 2023.	Fresh water, shallow dam and seasonally flooded adjacent marshy paddock. • No Brolga activity in Year 1 or 2.
Q	32542	Not listed	3.2km	• Two adults nested and hatched two chicks in late 2022 – early 2023 breeding season. • Two adults nested in 2023 breeding season, however, nest was abandoned.	Fresh water, shallow seasonal marsh. • Two adult Brolgas nested and fledged one chick in Year 1. • Two adults nested and fledged one chick in Year 2.
R	29587	137	5km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, shallow dam and seasonally flooded adjacent marshy paddock. • Two adults nested and raised one chick in Year 1. • Two adults nested and raised one chick in Year 2. • Three adults and one juvenile foraging at wetland in Year 2.
S	33291	Not listed	3.2km	• No Brolgas seen at wetland during Year 3 surveys.	Fresh water, permanent dam. • Not surveyed in Year 1. • Two adults and one juvenile foraging at wetland in Year 2. Pair and juvenile from nest at nearby wetland Q.
T	32671	241	5km	• Two adults and one chick foraging in and around wetland in early Year 3. • Two adults nested in 2023 breeding season, however, nest was abandoned.	Fresh water, permanent dam. • Not surveyed in Year 1. • Up to three adults foraging throughout Year 2. • Flock of up to 26 observed in April 2022, Year 2.
U	32610	521	> 5km	No Brolgas seen at	Fresh water, seasonal dam.

Biosis Wetland ID	DEECA Wetland ID	BL&A (2018) Wetland ID	Buffer	Recorded Brolga use, Year 3	Wetland type and Brolga use from years 1 and 2
				wetland during Year 3 surveys.	• Not surveyed in Year 1. • Two adults nested and raised one chick in Year 2.

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 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 areas of deep water.
- 3: Deep water covering entire wetland, no/minimal areas of 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 breeding success, 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 3 is summarised in Table 2 below.

Table 2 Brolga utilisation survey schedule, Year 3

Survey month	Survey type	Survey date	Surveyor
November 2022	Breeding	2-4 November 2022 28-30 November 2022	Wyn Russell - Project Zoologist
December 2022	Breeding	29-30 December 2022	
January 2023	Flocking	24-25 January 2023	Claire Tingate - Project Zoologist
February 2023	Flocking	21-23 February 2023	
March 2023	Flocking	21-23 March 2023	
April 2023	Flocking	19-21 April 2023	Wyn Russell - Project Zoologist
May 2023	Flocking	17-19 May 2023	
June 2023	Flocking	8-9 June 2023	
July 2023	Breeding	19-21 July 2023	
August 2023	Breeding	16-18 August 2023	
September 2023	Breeding	13-15 September 2023	
October 2023	Breeding	5-6 October 2023	

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 2022 – March 2023. During these periods, in accordance with the BAMP, fortnightly surveys of Brolgas nesting, or with unfledged chicks were conducted, until all chicks fledged (i.e. breeding was deemed successful), or breeding was deemed to be unsuccessful. No Brolga breeding was detected within the 3.2 kilometre DDWF survey buffer between August and October 2023, though breeding was detected just outside this buffer and those nests were monitored during the standard monthly surveys to determine their success.

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 3 is summarised in Table 3 below.

Table 3 Brolga targeted breeding survey schedule, Year 3

Survey month	Survey wetlands	Survey dates	Surveyor
November 2022	R, Q, N and U (F inaccessible due to post-flood roadworks)	16/11/2022 – 17/11/2022	Claire Tingate – Project Zoologist
December 2022	F, N, Q, R, U	15/02/2022 – 16/2/2022	Wyn Russell - Project Zoologist
January 2023	F, L, N, Q, R, U	11/01/2023 – 12/01/2023	Claire Tingate – Project Zoologist
February 2023	F, R, Q, I, L, U	09/02/2023	Inka Veltheim - Senior Zoologist

Survey month	Survey wetlands	Survey dates	Surveyor
March 2023	F, L, Q, R, T, U, Tiverton property	09/03/2023 – 10/03/2023	Wyn Russell - Project Zoologist

2.3 Targeted flocking Brolga surveys

The BAMP outlines requirements of additional targeted surveys of any flocking Brolgas within the 5 kilometre DDWF buffer. Flocks are defined as a group of at least 10 Brolgas foraging and/or roosting together.

No Brolga flocks were recorded, or reported by local landholders during Year 3 monitoring, therefore no additional targeted flocking surveys were undertaken.

2.4 Peregrine Falcon breeding surveys

The BAMP 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 BAMP 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 at least once per month from July 2021 - December 2021 (Year 1 and 2), July 2022 – December 2022 (Year 2 and 3) and July 2023 – October 2023 (Year 3). 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 20 minutes, during which time the surveyor would walk through 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 3 is summarised in Table 4 below.

Table 4 Peregrine Falcon survey schedule, Year 3

Survey month	Survey dates	Surveyor
November 2022	02/11/2022 and 29/11/2022	Wyn Russell - Project Zoologist
December 2022	30/12/2022	
June 2023	09/06/2023	
July 2023	20/7/2023	
August 2023	17/08/2023	
September 2023	14/09/2023	
October 2023	06/10/2023	

2.5 Carcass search correction factor studies

2.5.1 Carcass persistence trials

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 BAMP, carcass persistence (scavenger) trials were proposed to be undertaken by people frequently checking placed carcasses. In November 2020, Biosis proposed to DEECA (formerly DELWP) that automated cameras be used instead, which have been found to have numerous advantages over the method outlined in the BAMP. 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 existing fence posts means that novel perch sites for scavenging birds are not introduced and obviates the problem for farm activities associated with putting them on new posts in paddocks or crops. The trials were carried out twice per year by Skylos Ecology, once each in autumn and in spring, and each trial lasted between 28 and 40 days. Table 5 presents the timing and number of trials (carcasses and cameras) utilised in Year 3 at DDWF.

Table 5 Number and timing (start dates) of carcass persistence trials during Year 3 at DDWF

Month	Number of trials
7 and 8 March 2023	20
6 April 2023	10
6 and 12 of September 2023	20
7 October 2023	10

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, a total of 60 carcasses were used, which consisted of the following carcass types:

- Bat – 3
- Bat proxy (mice) – 16
- Bird – 21, and

- Brolga proxy (turkeys) – 20

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.

2.5.2 Searcher efficiency trials

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 BAMP 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 104 carcasses were placed randomly by an independent observer, Emma Bennett of Elmoby Ecology, for the Year 3 searcher efficiency trials. A total of 29 bat carcasses, 31 bird carcasses and 44 Brolga proxy (turkey) carcasses/feather spots were placed randomly at turbines subject to monthly searches during March and September 2023. 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 6 presents the number, type and timing of searcher efficiency trials undertaken at DDWF during Year 3 of operation.

Table 6 Number and timing of searcher efficiency trials (binocular and dog) during Year 3 of operations at DDWF

Month	Number of binocular/human observer trials	Number of dog trials	Total
March 2023	24	24	**48**
September 2023	20	36	**56**
Total	**44**	**60**	**104**

2.6 Mortality monitoring

2.6.1 Routine carcass searches

All surveys for bird and bat collision mortalities were undertaken by experienced 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 BAMP (BL&A 2018), with substitutions made where health and safety or livestock/landholder access issues were encountered. The selection of turbines to be surveyed each month was undertaken randomly by BL&A (2018), with the additional inclusion of Turbine D03, 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 BAMP. This report provides details for the third year of carcass searches, undertaken between November 2022 and concluding in October 2023. Biosis (2023a) contains results for years 1 and 2 combined.

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. For the first three years of operational surveys at DDWF, the survey team and method has remained consistent, to ensure robustness of data and maximise accuracy for subsequent data analysis and mortality estimate calculations. 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 BAMP (BL&A 2018).

Detection dogs were used for the carcass search program, at approximately 20 metre 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 BAMP. In the first (standard) search of each month the area under each selected turbine was searched out to a 120 metre radius of the turbine base. In the second (pulse) search of each month the area out to 60 metre radius of the turbine base was searched. Table 7 presents the number of routine carcass searches (standard and pulse) undertaken each month for the first three years at DDWF.

All collision carcasses detected were documented and stored as per the BAMP. 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 Ecology, which is consistent with the requirements of the BAMP:

- 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 BAMP 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. 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. After Year 5, when routine carcass searching will no longer be required, binocular searches will be undertaken for all turbines.

In accordance with the results from the preferred Brolga survey method trial (Section 3.5 in Biosis (2021)), all Brolga mortality monitoring at the additional turbines was undertaken using binoculars to scan the entire area within 120 metres of each turbine. Table 7 presents the number of routine carcass searches (standard and pulse) undertaken each month for the first three years at DDWF, and also provides the total number of turbines subject to survey (either standard or Brolga). The specific turbines and total number of turbines varied each month due to access issues, such as avoiding lambing or works being undertaken on turbines.

Table 7 **Number and timing of routine carcass searches (standard and pulse) and Brolga binocular searches within the first three years at DDWF**

Date	Standard	Pulse	Brolga survey	Total # of turbines surveyed
November 2022	28	28	41	**69**
December 2022	28	28	48	**76**
January 2023	28	28	49	**77**
February 2023	28	28	49	**77**
March 2023	28	28	49	**77**
April 2023	28	28	49	**77**
May 2023	28	28	49	**77**
June 2023	26	26	40	**66**
July 2023	28	28	32	**60**
August 2023	28	28	49	**77**
September 2023	28	28	49	**77**
October 2023	28	28	49	**77**
Total	**334**	**334**	**553**	**NA**

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 BAMP) 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 BAMP 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

During the Brolga surveys, the observer was only able to survey a single wetland at a time, potentially missing Brolga activity at specific wetlands at certain times, such as early morning, midday and late afternoon and at times when Brolgas may be using non-wetland habitat away from the breeding or roosting wetlands. 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. Access was also restricted to some turbines due to construction works or active lambing (particularly in June and July 2023). Where this impacted carcass searches, replacement turbines were substituted in where possible. Roadworks and flooding restricted access to one wetland during Brolga targeted breeding surveys during November 2022, which is detailed in Section 3.2. The biosecurity decontamination station, which is required for turbines A01-A08, was out of service in November 2022 and July 2023, which meant those turbines could not be accessed for mortality surveys.

The Brolga mortality estimates for Year 3 were calculated by Symbolix. The statsistical method adopted entails a number of assumptions, which are detailed in Symbolix (2024) (Appendix 4).

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 three years 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 3 monitoring were undertaken from November 2022 to October 2023 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 3 monitoring. Brolgas were recorded foraging at 8 of the 21 wetlands and in adjacent paddocks (Figure 2). Pairs nested at four wetlands over the 2021/22 breeding season, and at three wetlands over the 2022/23 breeding season (Table 8 and Table 10). A range of common waterbirds were recorded regularly at all wetlands.

Table 8 Summary of Brolga, waterbird and raptor activity at survey wetlands, Year 3

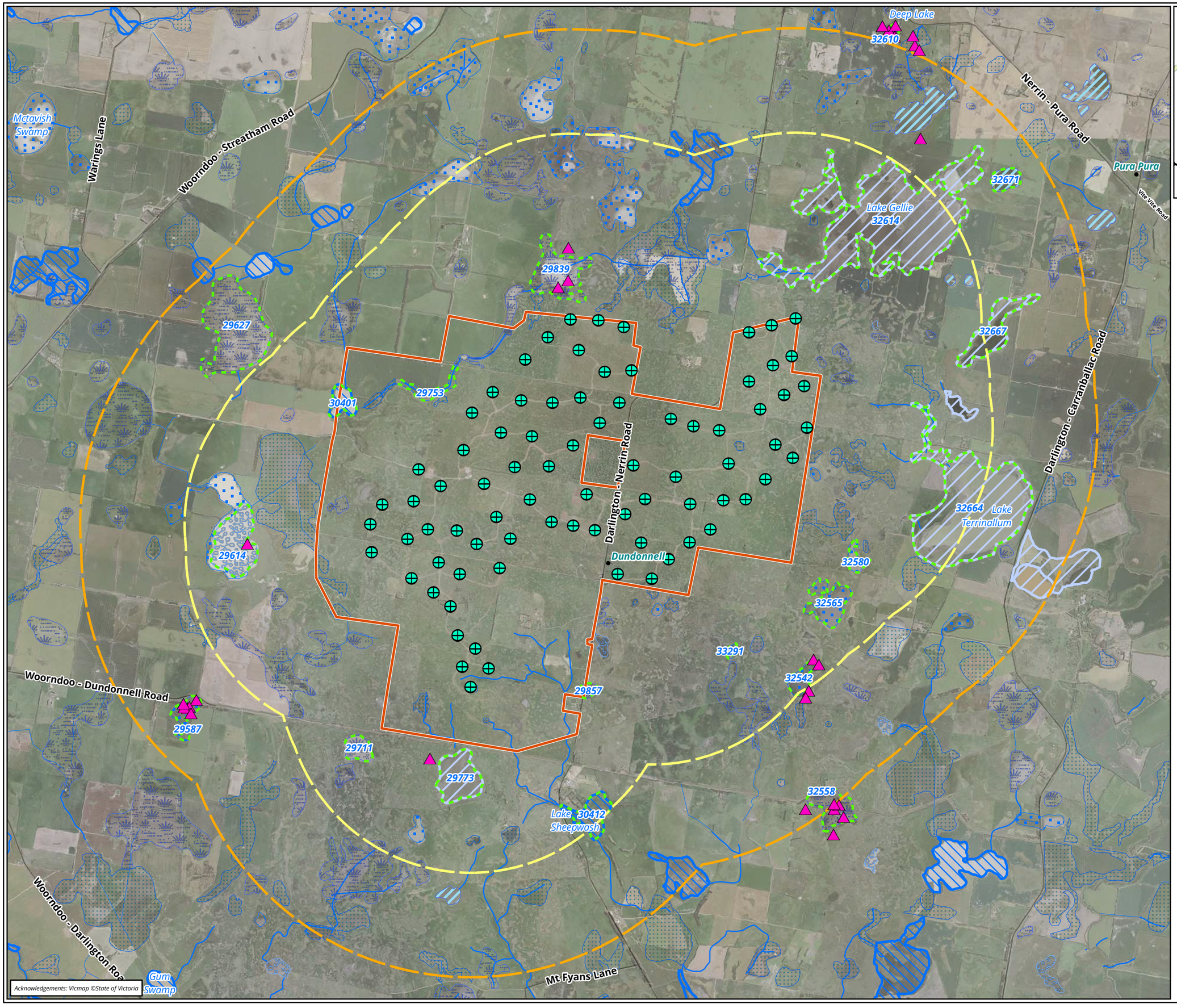
Wetland ID	Brolga activity and behaviour	Waterbirds and raptors recorded at wetland
A (29627)	No Brolgas seen at wetland during Year 3 surveys.	Straw-Necked Ibis, Australian White Ibis, Australian Shelduck
B (29614)	• **Early February 2023** – Landholder recorded two adults at wetland. • **22/02/2023** – Two adults foraging at edge of wetland. • **22/03/2023** – Two adults foraging at edge of wetland.	Black Swan, Pacific Black Duck, Silver Gull, White-faced Heron, Eurasian Coot, Masked Lapwing, Little Pied Cormorant, Hoary-headed Grebe, unidentified grebe spp.
C (29711)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Silver Gull, Pacific Black Duck, Hoary-headed Grebe, Pink-eared Duck, Masked Lapwing, Musk Duck, Chestnut Teal, Grey Teal
D (29773)	• **22/02/2023** – Two adults and one chick foraging together at northern edge of paddock. • **22/03/2023** – Two adults and one chick foraging in paddocks west of wetland. Chick large and fully fledged.	Black Swan, Silver Gull, Eurasian Coot, Masked Lapwing, Grey Teal, White-faced Heron, Australian Shelduck, Pacific Black Duck, Musk Duck, Chestnut Teal, unidentified grebe spp.
E (30412)	No Brolgas seen at wetland during Year 3 surveys.	Pacific Black Duck, Australian White Ibis, Australian Shelduck, Masked Lapwing, Australasian Swamphen, Straw-Necked Ibis, Silver Gull
F (32558)	• **03/11/2022** – One adult, foraging in western end of wetland. • **28/11/2022** – One adult, walking through paddock 300 m west of wetland. • **29/12/2022** – One adult sitting on nest in centre of wetland, one adult foraging in wetland. • **11/01/2023** – Two adults and one chick foraging in centre of wetland.	Black Swan, Australasian Swamphen, Brown Falcon, White-faced Heron, White-necked Heron, Little Pied Cormorant, Grey Teal, Pacific Black Duck

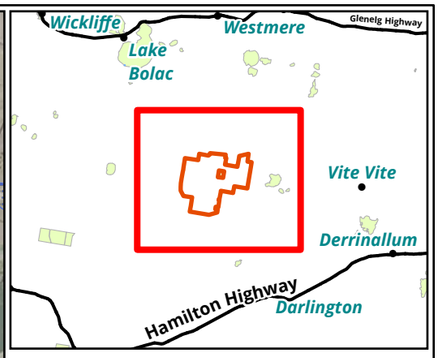
Wetland ID	Brolga activity and behaviour	Waterbirds and raptors recorded at wetland
	• **12/01/2023** – Two adults foraging at edge of wetland. No chick seen, but adults acting very wary, indicating that chick may be hidden. • **25/01/2023** - Two adults foraging in centre of wetland. No chick seen, but adults acting very wary, indicating that chick may be hidden. • **17/08/2023** – One adult sitting on nest in centre of wetland. Stood up, at least one egg visible. • **14/09/2023** – One adult foraging in grassland SW of wetland. Nest flooded and abandoned.	
G (29857)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, White-faced Heron, Wood Duck, Australasian Swamphen, Dusky Moorhen, Little Pied Cormorant, Grey Teal, Australasian Shoveler, Australian Shelduck, White-necked Heron, Chestnut Teal, Eurasian Coot, unidentified grebe spp.
H (32580)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Grey Teal, Little Pied Cormorant, Wood Duck, White-faced Heron, Masked Lapwing, White Ibis, Australasian Grebe, Chestnut Teal
I (32565)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Masked Lapwing, Silver Gull, Australasian Shoveler, Grey Teal, Masked Lapwing, Australasian Swamphen, Hoary-headed Grebe, Eurasian Coot, Australian Shelduck, Australian White Ibis, White-faced Heron, Chestnut Teal
J (32664)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Australian Shelduck, Grey Teal, Masked Lapwing, Silver Gull, White-faced Heron, Musk Duck, Chestnut Teal, Pink-Eared Duck, Eurasian Coot, Yellow-billed Spoonbill, unidentified grebe spp.
K (32667)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Silver Gull, Masked Lapwing, Hoary-headed Grebe, Chestnut Teal, Little Pied Cormorant, Australian Shelduck, White-faced Heron, Musk Duck, Grey Teal, Australasian Grebe, Eurasian Coot, Pink-eared Duck
L and M (32614)	• **24/01/2023** – Landholder observed approx. 6 adults at southern end of wetland in the morning. • **24/01/2023** – One adult seen flying over wetland, heading N-NE. • **09/02/2023** – Two pairs of adults, foraging separately around wetland. • **10/03/2023** – Two adults foraging together in paddock 300 m north of wetland.	Black Swan, Pacific Black Duck, Little Pied Cormorant, Silver Gull, Black Cormorant, Masked Lapwing, White-faced Heron, Musk Duck, Eurasian Coot, Australian Shelduck, White-necked Heron, Greater Grebe, Chestnut Teal, Grey Teal, Chestnut Teal

Wetland ID	Brolga activity and behaviour	Waterbirds and raptors recorded at wetland
N (29839)	• **11/01/2023** – Two adults foraging, resting and preening in grassland north of wetland. • **25/01/2023** – Two adults foraging, resting and preening on northern edge of wetland. • **22/02/2023** – Two adults foraging on edge of wetland. • **22/03/2023** – Two adults foraging together on northeast edge of wetland.	Black Swan, Masked Lapwing, Australasian Swamphen, White-faced Heron, Pacific Heron, Australian White Ibis, Great Egret, Black Cormorant
O (30401)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Australian Wood Duck, Australian Shelduck, Masked Lapwing, Eurasian Coot, Little Pied Cormorant, unidentified grebe spp.
P (29753)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Australian Shelduck, White-faced Heron, White-necked Heron, Little Pied Cormorant
Q (32542)	• **04/11/2022** – Two adults and one chick foraging together in north edge of wetland. • **17/11/2022** – One adult and one chick foraging together in grassland at SE corner of wetland. • **16/12/2022** – Two adults foraging together on northern hill overlooking wetland. Called when they noticed surveyor and flew to eastern side of wetland. No chick seen, but wary behaviour of adults indicated they potentially have one and hid it in tall grass. • **30/12/2022** – Two adults foraging together at northern end of wetland. Called when they noticed surveyor and walked into wetland. No chick seen, but wary behaviour of adults indicated they potentially have one and hid it in tall grass. • **11/01/2023** – Two adults and one fledged juvenile seen flying nearby within Tiverton property. • **09/02/2023** – Two adults and one fledged juvenile foraging in paddock south of wetland, outside predator proof fence.	Black Swan, Australasian Swamphen, Pacific Black Duck, Masked Lapwing, Wedge-tailed Eagle, White-faced Heron, Little Pied Cormorant, Gull-billed Tern, Grey Teal, White-necked Heron, Chestnut Teal, Great Egret, Whistling Kite, White-bellied Sea-eagle, Brown Falcon, Australasian Grebe
R (29587)	• **28/11/2022** – Two adults sitting and standing beside empty nest in SW flooded paddock section of wetland. • **29/11/2022** – One adult sitting on nest in flooded paddock section of wetland, one foraging in flooded paddock. • **15/12/2022** – One adult sitting on nest in flooded paddock section of wetland. • **16/12/2022** - One adult sitting on nest in flooded paddock section of wetland.	Black Swan, Pacific Black Duck, White-faced Heron, Masked Lapwing, Straw-necked Ibis, Australasian Swamphen, Australian Shelduck, Eurasian Coot, Silver Gull, Yellow-billed Spoonbill, White-necked Heron, unidentified grebe spp.

Wetland ID	Brolga activity and behaviour	Waterbirds and raptors recorded at wetland
	• **29/12/2022** - One adult sitting on nest in flooded paddock section of wetland, one foraging in flooded paddock. • **30/12/2022** - One adult sitting on nest in flooded paddock section of wetland, one foraging in flooded paddock. • **11/01/2023** – Two adults foraging together in eastern edge of wetland. Could not see chicks, but likely hidden in tall grass in wetland. • **12/01/2023** - Two adults foraging together at edge of wetland. Could not see chicks, but likely hidden in tall grass in wetland. • **25/01/2023** – Two adults and two chicks foraging together in southern end of wetland. Chicks quite small. Adults did not hide chicks. • **22/02/2023** – Two adults and two chicks foraging together in southern end of wetland. Whistling Kite landed in wetland approx. 20 m from group, adult brolgas displayed aggressing behaviour towards kite (opened and flapped wings). • **17/08/2023** – One adult sitting on nest in roadside section of wetland. • **14/09/2023** – Two adults foraging together in wetland. Nest empty and abandoned.	
S (33291)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Pacific Black Duck, Grey Teal, Eurasian Grebe, Masked Lapwing, Hoary-headed Grebe, Australasian Shoveler, White-faced Heron, Swamp Harrier
T (32671)	No Brolgas seen at wetland during Year 3 surveys.	Black Swan, Silver Gull, Eurasian Coot, Peregrine Falcon, unidentified grebe spp.
U (32610)	• **04/11/2022** – Two adults and one chick foraging together in paddock north of wetland. • **30/11/2022** – Two adults and one chick foraging together in paddock SE of wetland. Chick approx. 50-60% size of adults. • **16/12/2022** - Two adults and one chick foraging together in paddock SE of wetland. • **11/01/2023** - Two adults and one chick foraging and loafing together in paddock SE of wetland. • **24/01/2023** - Two adults and one chick foraging together in dry grassy section of wetland. • **22/02/2023** – Two adults and one chick roosting and foraging around northern edge of wetland. Adults feeding chick. • **09/02/2023** – Two adults and one chick, in wetland.	Black Swan, White-faced Heron, Whistling Kite, Masked Lapwing, Pacific Black Duck, Grey Teal, Australian White Ibis, Eastern Great Egret, White-necked Heron, Hoary-headed Grebe, Eurasian Coot, Chestnut Teal, Yellow-billed Spoonbill

Wetland ID	Brolga activity and behaviour	Waterbirds and raptors recorded at wetland
	• **09/03/2023** – Two adults and one chick foraging together on SE bank of wetland. • **10/03/2023** - Two adults and one chick foraging together on south edge of wetland. • **21/03/2023** - Two adults and one chick foraging together on eastern edge of wetland. • **17/08/2023** – One adult sitting on nest in middle of wetland. One adult foraging in paddock adjacent to wetland. Egret landing near nest disturbed nesting adult, which stood up off nest. Adult foraging flew over to partner in wetland. Two eggs seen in nest. • **14/09/2023** – Two adults foraging together in flooded paddock approx. 600 m ESE of wetland. Nest empty, but not flooded.	





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 3

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: 06 March 2023,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F2_Brolga_Wetlands
Location: P:\37800s\37873\Mapping\
37873_36297_33578_Dundonnell_Yr3.aprx

3.2 Targeted breeding Brolga survey results

Brolga breeding attempts were recorded during both the monthly Brolga utilisation monitoring program, and additional fortnightly targeted breeding Brolga surveys.

Brolgas were recorded nesting at four wetlands over Year 3 surveys (Table 10). Observations of breeding Brolgas within the 3.2 kilometre buffer zone triggered additional surveys over November 2022 – March 2023.

Two pairs were successful in hatching chicks in late Year 2 (wetland Q and U). Two other pairs had their first nests flooded in late Year 2, however, they both nested again in early Year 3, with one pair successfully hatching one chick (wetland F) and another pair hatching two chicks (wetland R).

Three pairs of Brolgas attempted to nest at wetlands F, R and U over the 2023 – 2024 breeding, however, all three abandoned their nests by September 2023, and no Brolgas were seen at known nesting wetlands in the final October 2023 survey of Year 3.

Table 9 below details the wetlands where Brolgas were recorded nesting during Year 1, 2 and 3 monitoring, and history of breeding use.

Table 9 Brolga breeding wetland description and prior nesting use

Survey wetland	Wetland description	Distance from DDWF property boundary	Historic and Year 1 and 2 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 over 2021/22 breeding season, with pair of adults and one juvenile observed in October 2021. • First breeding attempt in late Year 2 failed due to nest flooding in October 2022.
R (29587)	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 2021/22 (late Year 1 – early Year 2) breeding season, with pair of adults and one juvenile observed in October 2021. • Successful breeding attempt in late Year 2, with pair of adults and one juvenile observed in October 2022.
Q (32542)	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. • Successful breeding attempt in Year 2021/22 (late Year 1 – early Year 2) breeding season, with pair of adults and one juvenile observed in November 2021. • First breeding attempt in late Year 2 failed due to nest flooding in October 2022.

Survey wetland	Wetland description	Distance from DDWF property boundary	Historic and Year 1 and 2 Brolga breeding history at wetland
N (29839)	Large seasonally flooded marsh, surrounded by volcanic stony hills and large River Red Gums. Wetland tends to dry completely over summer-autumn months.	500 metres	• No recorded breeding history. Wetland was not included in targeted breeding surveys in Year 1. • First breeding attempt in late Year 2 failed due to nest flooding in October 2022.
U (32610)	Small dam with dense emergent vegetation, restored by landholder in early 2022 by damming eastern edge to allow water retention into summer.	5.1 kilometres	• Wetland was drained until restoration in early 2022. No recorded historic breeding use. Wetland was not included in targeted breeding surveys in Year 1. • Successful breeding attempt in late Year 2, with nesting concluded by October 2022 (pair of adults and one juvenile observed in January 2023).

Table 10 below summarises the Brolga breeding behaviour and outcomes at each survey wetland during Year 2 monitoring.

Table 10 Brolga breeding behaviour and success summary, Year 3

Survey month	Wetland F summary	Wetland Q summary	Wetland R summary	Wetland U summary
Year 1 and 2 Brolga breeding success summary				
2020 - 2021 breeding season (late Year 1 – early Year 2)	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.
Late Year 2 months	First nesting attempt in late Year 2 failed due to flooding.	Pair successfully hatched a chick in late Year 2 breeding season before nest was flooded.	First nesting attempt in late Year 2 failed due to flooding.	Pair successfully hatched a chick in late Year 2 before nest was flooded.
2022/2023 Breeding season (early Year 3)				
November 2022	One adult foraging at wetland.	Two adults and one chick, foraging in grasslands surrounding wetland.	Two adults, one nesting in wetland and one foraging in and around wetland.	Two adults and one chick, foraging in and around wetland. Chick approx. 50 – 60% size of adults by 31/11/2023.

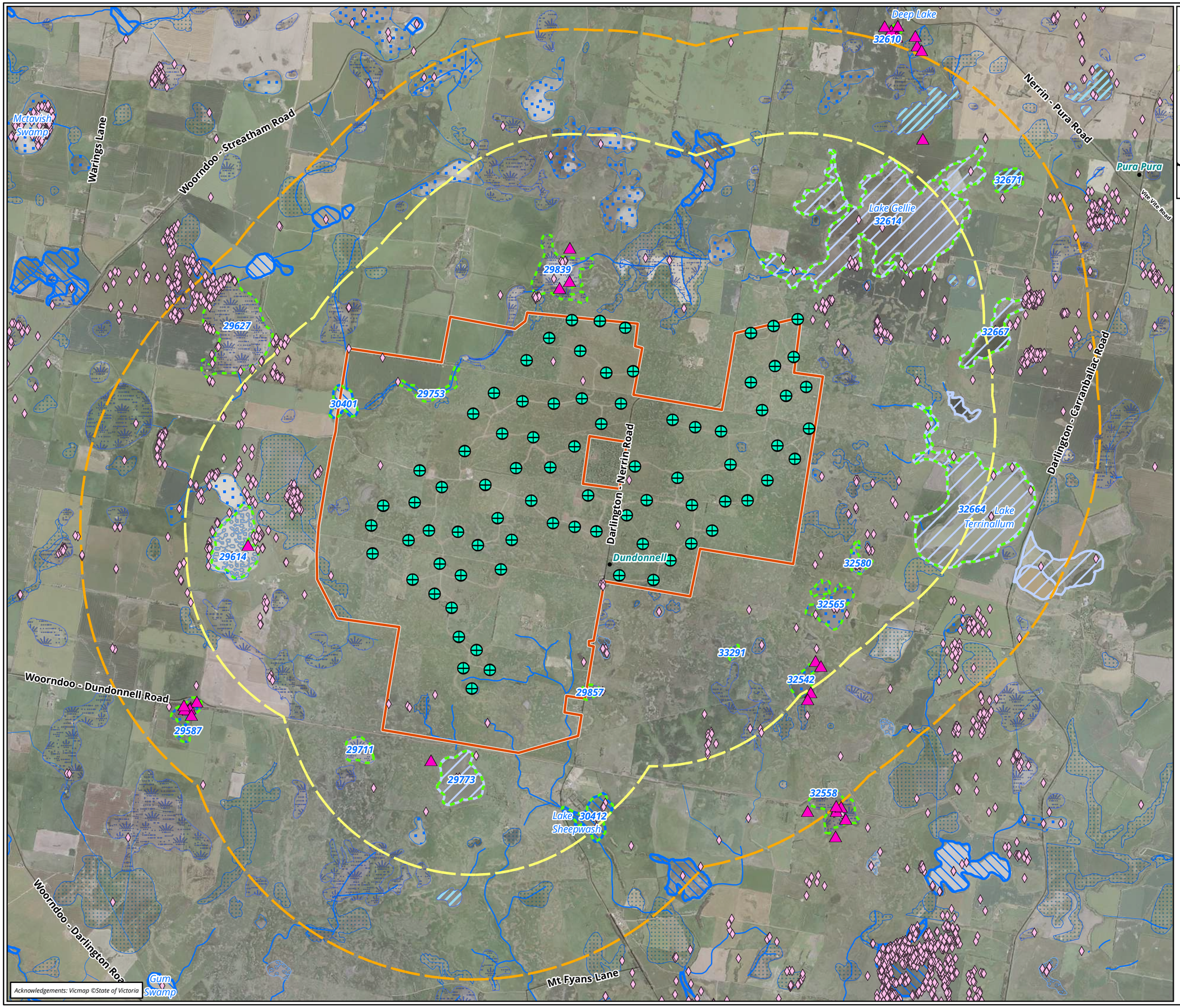
Survey month	Wetland F summary	Wetland Q summary	Wetland R summary	Wetland U summary
December 2022	Two adult brolgas, one nesting in wetland and one foraging in and around wetland.	Two adults seen foraging in and around wetland. No chick seen.		Two adults and one chick foraging together in paddock SE of wetland.
January 2023	Two adults and one chick foraging in wetland.	Two adults and one fledged juvenile seen flying near wetland.	Two adults and two chicks foraging in and around wetland.	Two adults and one chick roosting and foraging together in wetland.
February 2023	No brolgas seen at wetland.	Two adults and one fledged juvenile foraging in paddock south of wetland.		
March 2023		No Brolgas seen at wetland.	No Brolgas seen at wetland.	
2023/2024 breeding season (late Year 3)				
August 2023	One adult sitting on nest in wetland.	Two adults foraging in and around wetland.	One adult sitting on nest in wetland.	One adult sitting on nest in wetland, one foraging in wetland. Two eggs seen on nest.
September 2023	One adult foraging in wetland, nest flooded and abandoned.	No Brolgas seen at wetland.	One adult foraging in wetland, nest flooded and abandoned.	Two adults foraging in shallow flooded paddock approx. 600 m SE of wetland. Nest abandoned, but not flooded.
October 2023	No Brolgas seen at wetland.		No Brolgas seen at wetland.	No Brolgas seen at wetland.
Year 3 summary	• Successful breeding in late Year 2 – early Year 3 breeding season, one chick hatched by December 2022. • Unsuccessful breeding in late Year 3 breeding season, nest flooded in September 2023.	• Successful hatching of one chick in late Year 2 – early Year 3 season, October 2022. • No nesting attempt observed in late Year 3 breeding season.	• Successful breeding in late Year 2 – early Year 3 season, two chicks hatched by January 2023. • Unsuccessful breeding in late Year 3 breeding season, nest flooded in September 2023.	• Successful breeding in late Year 2 – early Year 3 season, one chick hatched by January 2023. • Unsuccessful breeding in late Year 3 breeding season, nest abandoned in September 2023.

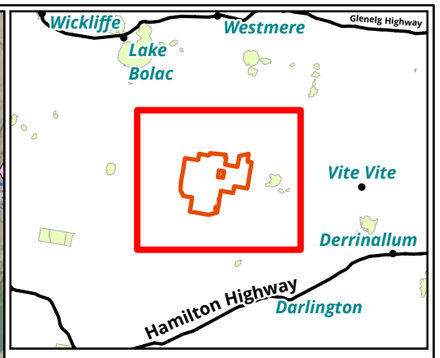
3.3 Targeted flocking Brolga survey results

No Brolga flocks were recorded within the DDWF study area during Year 3 monitoring, therefore no targeted flocking Brolga surveys were triggered.

Biosis (2023a) details the results of Brolga flocking within the DDWF study area for the first two years of operations at DDWF. No flocking activity was detected during Year 1, while three Brolga flocks were recorded within the DDWF study area during Year 2 monitoring, between November 2021 and April 2022 (Biosis 2023a). The flock movement and habitat use in Year 2 appeared largely driven by the availability and location of suitable roosting wetlands and foraging habitat (Biosis 2023a).

Figure 3 contains previous Biosis and VBA Brolga records for DDWF and the broader region. These records show widespread Brolga use of wetlands within the broader region throughout the year. Few records exist within the DDWF property boundary, aligning with post-construction Brolga utilisation, breeding and flocking survey results.





Legend

- Wind farm site boundary
- Turbine layout - 3.2 km buffer
- Turbine layout - 5 km buffer
- Turbine
- Brolga record (Biosis) - year 3 surveys
- 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 3 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: 02 May 2024,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F4_Brolga_PreCon_Utilization
Location: P:\37800s\37873\Mapping\
37873_36297_33578_Dundonnell_Yr3.aprx

3.4 Peregrine Falcon breeding survey results

Peregrine Falcon surveys were conducted at the Mount Fyans Wildlife Reserve during Year 3 from November 2022 – December 2023, and August – October 2023. Opportunistic surveys were conducted outside the breeding season in June and July 2023.

No Peregrine Falcons were recorded at the Mount Fyans Wildlife Reserve during any Year 3 surveys. No evidence of nesting activity was observed at the known Peregrine Falcon nest in the quarry within the western extent of the Mount Fyans Wildlife Reserve.

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 (Biosis 2023a). 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. No Peregrine Falcon carcasses were detected at DDWF during Year 3 of carcass monitoring.

Table 11 contains a summary of all results of Peregrine Falcon monitoring and carcass finds from DDWF.

Table 11 Peregrine Falcon monitoring summary

Survey month	Peregrine Falcon habitat utilisation and breeding behaviour summary
Year 1 and 2 survey summary	
• **July – October 2021:**	Pair of adults recorded at Mount Fyans Wildlife Reserve, utilising nest in face of quarry wall. Single Peregrine Falcon carcass recorded beneath Turbine B06 on 18 September 2021 (Biosis 2023a).
• **October – November 2021**	Adult pair observed at quarry, with one chick at mouth of nest. Chick with down feathers.
• **December 2021**	No Peregrine 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.
• **February 2022**	One adult seen briefly, flying above reserve, and perching in dead trees above quarry.
• **July – August 2022**	No Peregrine Falcons seen at Mount Fyans Wildlife Reserve. Single Peregrine Falcon carcass recorded beneath Turbine D05 on 29 August 2022 (Biosis 2023a).
• **September – October 2022**	One adult seen perched in dead trees above quarry and flying over quarry. No indication of nesting.
Year 3 survey summary	
• **2 November 2022**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **29 November 2022**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **30 December 2022**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **9 June 2023 (opportunistic survey)**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **20 July 2023 (opportunistic survey)**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **17 August 2023**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **14 September 2023**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **6 October 2023**	No Peregrine Falcons observed at Mount Fyans Wildlife Reserve.
• **Year 3 survey summary**	No Peregrine Falcons seen at Mount Fyans Wildlife Reserve during any Year 3 surveys. No evidence of Peregrine Falcon nesting at quarry within Mount Fyans Wildlife Reserve.

3.5 Carcass search correction factor study results

3.5.1 Carcass persistence trial

Four carcass persistence trials, with a total of 60 carcasses, were conducted by Skylos Ecology over two seasons in Year 3 (March/April 2023 and September/October 2023). Of the 60 carcasses used for these trials, a total of 17 were not removed by scavengers, which consisted of two bats or bat proxies, two birds and 13 Brolga proxies (turkeys). Table 12 displays the mean number of days each carcass type persisted for, along with the range (minimum and maximum number of days of carcass persistence). Year 3 carcass persistence rates for Brolga proxies (turkeys) was much higher in Year 3 compared to previous years. This influences the Brolga mortality estimate. There is no environmental or other factor that can explain this, however this pattern has been observed at other locations by Skylos Ecology, who have observed that turkey carcasses often persist for long periods if not scavenged within the first few days.

Table 12 Carcass persistence trial results, Year 3

Row Labels	Number used	Average no. of days of persistence	Minimum no. of days until scavenge	Maximum number of days until scavenge
Bat or bat proxy	19	4.7	0	32
Bird	21	7	0	37
Brolga Proxy	20	27.9	1	40

3.5.2 Searcher efficiency trial

Two searcher efficiency trials were undertaken during Year 3 monitoring at DDWF, which occurred in March and September 2023. A total of 104 carcasses were used during these trials, including 31 bird carcasses, 29 bat carcasses and 44 Brolga proxies (turkey).

A summary of the detection efficiencies is provided in Table 13. Searcher efficiency was 90% for bats, 100% for birds and 86% for Brolga proxies (using binocular searches). These results are presented as a preliminary summary; results will need to be used in statistical modelling at the end of Year 5 monitoring to correct for searcher efficiency. The searcher efficiency results for Year 3 show higher detection rates than earlier years, indicating that the survey team was becoming more efficient over time, which would improve confidence and accuracy of mortality estimates.

Table 13 Survey detection efficiencies for birds/bats and Brolga

Variable	Bats	Birds	Brolga
Number placed	29	31	44
Number found	26	31	38
Searcher efficiency	90%	100%	86%

3.6 Carcass search results

Carcass searches during Year 3 of operation at DDWF were conducted monthly from November 2022 to October 2023. A total of 668 searches were conducted (334 standard surveys, 334 pulse surveys) across a subset of approximately 28 turbines per month. During these surveys, a total of 136 bird/bat carcasses and 23 bird feather spots were recorded across approximately 29 species/species categories (Table 14). An additional 47 carcasses or feather spots were recorded incidentally during Year 3, including five additional species not recorded during routine searches, resulting in a grand total of 206 recorded mortalities across DDWF within the third year of operation (Table 14).

The most frequently recorded species during Year 3 were:

- Nankeen Kestrel (46 records)
- White-striped Free-tailed Bat (40 records)
- Australian Magpie (22 records)
- Brown Falcon (17 records)

Two threatened species were recorded during the carcass search program in Year 3, White-throated Needletail (two records) and Southern Bent-winged Bat (three records). These finds met the BAMP threatened species impact trigger and required further assessment and reporting to DEECA, which is summarised in Section 4. In accordance with the BAMP, all native bird and bat finds were reported to DEECA within 7 days of being detected.

Table 14 Carcass search program species summary years 1 and 2 combined (threatened species in bold text)

Species	Carcass finds	Feather spots	Incidental	Total
Bird				
Australasian Shelduck		1		**1**
Australian Hobby	1			**1**
Australian Magpie	9	5	8	**22**
Australian Spotted Crake	1			**1**
Baillon's Crake			1	**1**
Barn Owl			1	**1**
Brown Falcon	9	1	7	**17**
Buff-banded Rail		1		**1**
Crested Pigeon			1	**1**
Eastern Rosella		1		**1**
Eurasian Coot			1	**1**
Eurasian Skylark or Australian Pipit	1			**1**
Galah	2			**2**
Ibis sp.	1			**1**
Lorikeet or Rosella	1			**1**
Nankeen Kestrel	32	4	10	**46**
Pacific Black Duck			1	**1**
Raven sp.	6	1	1	**8**
Silvereye	1			**1**

Species	Carcass finds	Feather spots	Incidental	Total
Spotless Crake	1			**1**
Striated Pardalote	1			**1**
Stubble Quail	1			**1**
Sulphur-crested Cockatoo		1		**1**
Unidentifiable bird	3	7	6	**16**
Wedge-tailed eagle	3		5	**8**
Whistling Kite	1			**1**
White-faced Heron		1		**1**
White-throated Needletail	**2**			**2**
Bat				
Eastern False Pipistrelle	3			**3**
Gould's Wattled Bat	3			**3**
Large Forest Bat	1			**1**
Southern Bent-winged Bat	**3**			**3**
Unidentifiable bat	14		1	**15**
White-striped Free-tailed Bat	36		4	**40**
Total	**136**	**23**	**47**	**206**

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 14 Wedge-tailed Eagle flights (Table 15). No White-throated Needletail flights were recorded during Year 3 of incidental flight recording, which is consistent with the first two years (Biosis 2023a).

Table 15 Wedge-tailed Eagle incidental observation summary for third year of operation at DDWF

Month	Date	Time	Closest turbine/s	Number of birds	Estimated flight height (metres)	Description of behaviour
Nov-22	7/11/2022	9:23	H06	1	0 – 100	Circling flight
Dec-22	11/12/2022	6:22	E06, E07	2	20	Feeding on lamb carcass
Jan-23	4/01/2023	9:42	B01	1	20	Directional flying, north-north-west
Jan-23	9/01/2023	5:54	D07	1	20	Directional flying, west
Jan-23	9/01/2023	9:50	G07	1	0 – 50	Circling flight
Feb-23	6/02/2023	12:05	C13	1	0 – 200	Circling flight, active hunting
Feb-23	9/02/2023	7:10	C16	1	10	Directional flying, north
Feb-23	13/02/2023	11:08	H01	2	10 – 30	Circling flight
Mar-23	10/03/2023	11:40	F07	1	10 – 30	Circling flight
Apr-23	3/04/2023	11:15	D07	1	0 – 100	Circling flight
May-23	3/05/2023	8:35	B02	1	10 – 30	Directional flying, north
May-23	5/05/2023	9:29	G10	1	50 – 200	Circling flight, fending off magpies, then heading east

3.8 Brolga mortality monitoring

No Brolga carcasses were detected during Brolga mortality monitoring in Year 3 at DDWF.

Brolga monitoring (binocular searches) recorded an additional 33 bird carcasses/feather spots and four bats at the additional turbines surveyed, all of which were included in the overall carcass find results as incidental finds in Table 14.

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 BAMP at DDWF are summarised below.

- In accordance with the BAMP, any dead livestock found near turbines were reported by Skylos Ecology, as they are required to be removed by DDWF site personnel or landowners in accordance with the BAMP. Removal of livestock carcasses on other areas of the wind farm is to the discretion/action of the landholder. During Year 3, Skylos Ecology reported several instances of dead or dying livestock, which were reported to site personnel and also reported to Head of Health, Safety and Environment at Tilt Renewables. It was recommended by Skylos Ecology and Biosis that a clear procedure and points of contact be established to ensure dead and dying livestock near turbines are addressed promptly and ethically.
- No formal feral animal control program was undertaken during Year 3. Feral animal control is undertaken by each landowner on their property with an increased effort typically before lambing.
- Incidental records of feral animals on site are reported to DDWF staff. No incidental records were reported during Year 3, however it was noted that high fox activity was recorded by survey dogs with Skylos Ecology around Turbine F09.

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 BAMP for DDWF that statistical analyses of carcass search results and subsequent estimation of total mortalities is undertaken at the completion of two years and five years of wind farm operation, for all birds and bats. The analysis of the first two years was undertaken at the completion of Year 2 and is presented in the Year 2 Annual Report (Biosis 2023a). The next analysis of mortality estimates for all birds and bats is due to be completed at the completion of Year 5.

The BAMP also requires that a mortality estimate be calculated for Brolga each year. Symbolix was contracted to undertake this analysis for Brolga based on the first three years of monitoring data, and to produce a report on the methods and findings, which is provided as Appendix 4. Symbolix used the results of mortality monitoring, the correction factor studies (searcher efficiency and carcass persistence for Brolga proxies) as well as information about survey coverage, including carcass fall-zone, to calculate a cumulative estimate of Brolga mortality at DDWF for years 1 to 3, as well as Year 3 alone.

This section of the report provides a summary overview of the findings and conclusions made by Symbolix (2024). The full methods and results can be found at Appendix 4.

4.1 Brolga mortality estimates

During the first three years of operation of DDWF, a total of 1 Brolga carcass was found during formal surveys during Year 2 (Biosis 2023a). The single carcass was found in Year 2; no Brolga carcasses were found during Year 1 or Year 3.

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 in Year 2, as well as mortality search results, searcher efficiency rates, carcass persistence rates and survey effort for all three years, the estimated total mortality is approximately three Brolgas over the full survey period, and two Brolgas for Year 3 (Symbolix 2024). 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 BAMP, and against the Brolga Compensation Plan (Tilt Renewables 2019) is presented below, along with updated contextual information on the Victorian Brolga population.

4.1.1 Victorian Brolga population

The distribution of Brolga in Victoria extends from the State's north-east to the south-west, with little to no mixing between them based on GPS-tracking (Veltheim et al. 2022). 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.

4.1.2 Assessment against predicted mortalities

The single confirmed mortality of a Brolga at DDWF after three 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 BAMP for DDWF that statistical analyses of carcass search results and subsequent estimation of total Brolga mortalities is undertaken for each year of wind farm operation. Symbolix have calculated the mortality estimate for the first three years based on the found (one) carcass and accounting for searcher efficiency, carcass persistence and survey coverage. The calculations estimate that the mortality is around three Brolga lost over the first three years, which is higher than the annual predicted rate of 0.49 Brolga per year (BL&A 2018), but still within the losses accounted for within the Brolga Compensation Plan (19 Brolga over the 25 year life of the Project; Tilt Renewables 2019). 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 BAMP species impact triggers

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

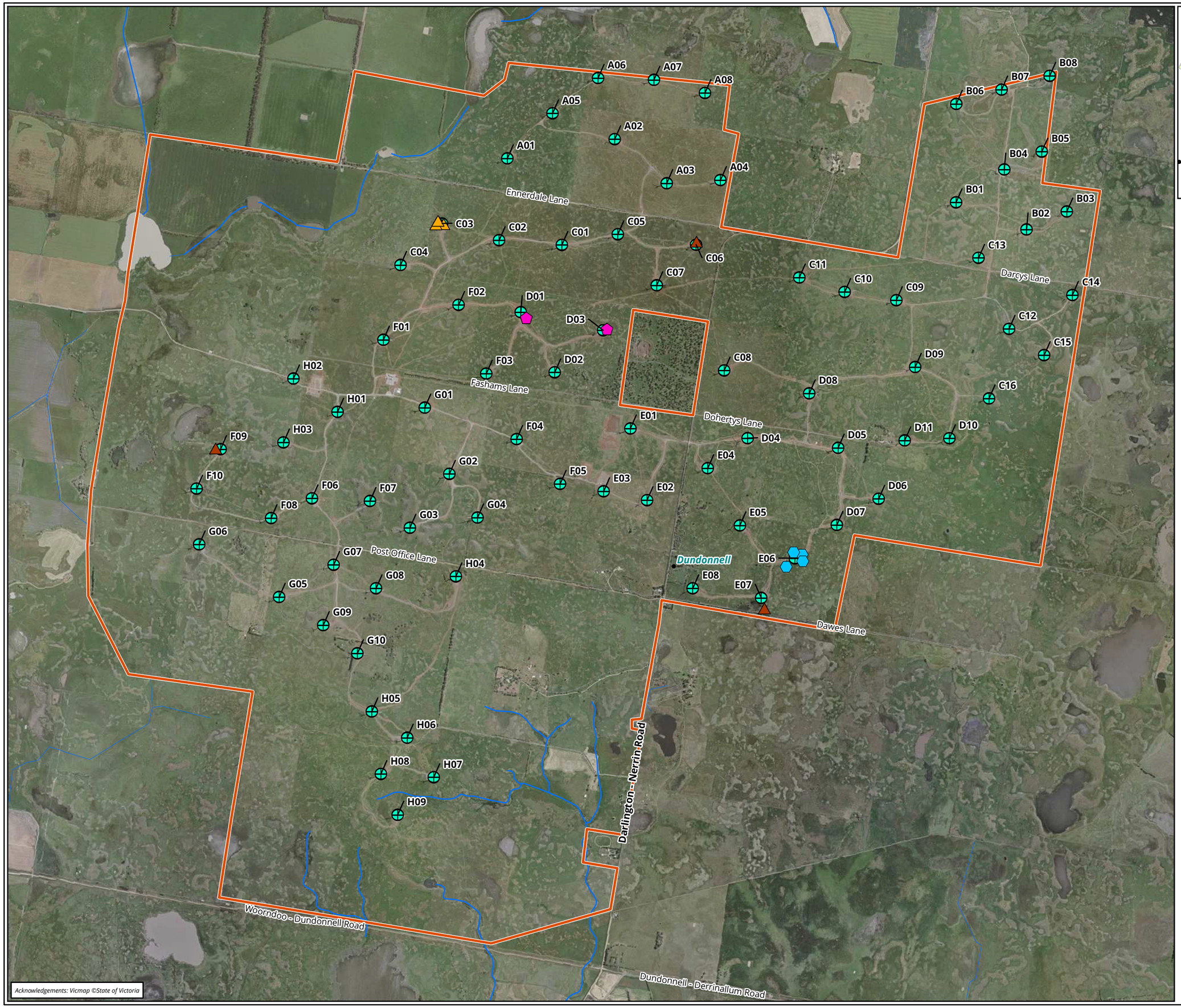
Impact trigger for threatened species: A threatened bird or bat species (or recognisable parts thereof) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Flora and Fauna Guarantee Act 1988* (FFG Act) (including Brolga) or on the Advisory List of Threatened 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 third year of operation at DDWF, a total of seven impact triggers were met, including five separate threatened species triggers for two species, and two non-threatened species impact trigger events. These impact trigger events for Year 3 are as follows:

- Southern Bent-winged Bat (threatened species) – three carcass finds (March, April and June 2023) at three turbines (F09, C06 and E07).
- White-throated Needletail (threatened species) – two carcass finds (March and April 2023) at two turbines (D01 and D03).
- Nankeen Kestrel (non-threatened species) – four carcass finds at the same turbine (E06) over two consecutive searches in May and June 2023.
- White-striped Free-tailed Bat (non-threatened species) – five carcasses found at the same turbine (C03) over two successive searches in March and April 2023.

In accordance with the BAMP, further assessment and reporting of these impact triggers was undertaken and submitted to DEECA. These assessments are summarised below, and the locations of all impact trigger finds for Year 3 of operation at DDWF are displayed in Figure 4.



Legend

- Wind farm site boundary
- Turbine
- White-throated Needletail - Impact trigger met
- White-striped Free-tailed Bat - Impact trigger met
- Nankeen Kestrel - Impact trigger met
- Southern Bent-wing Bat - Impact trigger met

Figure 4 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: 02 May 2024,
Checked by: WR, Drawn by: JPT, Last edited by: jturner
Layout: F5_BAM_Triggers
Location: P:\37800s\37873\Mapping\
37873_36297_33578_Dundonnell_Yr3.aprx

5.1 Southern Bent-winged Bat

Three Southern Bent-winged Bat carcasses were recorded during Year 3 of monitoring at DDWF, including one each in March 2023 (Turbine F09), April 2023 (Turbine C06) and June 2023 (Turbine E07). The species is listed as critically endangered under the EPBC Act and FFG Act.

An assessment was prepared and submitted that detailed available information regarding population numbers and an assessment of the possible effects on the regional population of the species (Biosis 2023b). The following text is extracted and summarised from that report.

5.1.1 Population scale and numbers

SBWB is an obligate cave-dwelling bat with a distribution across south-east South Australia and south-west Victoria. The total population of the SBWB was last estimated at 44,300 mature individuals (TSSC 2021). The population has declined by 67% since the mid-1990s, when the species was estimated to be 134,500, consisting of 122,500 from Naracoorte Bat Cave and 12,000 from Starlight Cave (Reardon 2001).

While a number of potential threats to the species have been identified, there is little empirical evidence on which to base one or more causes for the current decline. The most important factors for decline in south-west Victoria are likely to be destruction and disturbance of maternity and non-maternity roost sites, habitat clearance and wetland draining for agriculture, where the impact due to loss of foraging habitats may be significant (TSSC 2021; DEECA 2023). Agricultural practices such as pesticide spraying may also reduce prey species abundance (DELWP 2020). Windfarm developments are listed as a current and potential threat to SBWB in the conservation advice for the species (TSSC 2021), where it is noted that mortalities have been recorded at wind turbines (Moloney et al. 2019), however the population-level and cumulative impacts are currently unknown (TSSC 2021).

In 1963–1964, the Warrnambool population was estimated at 10,000–20,000 (Dwyer and Hamilton-Smith 1965), 12,000 in 2001 (Grant 2001 cited in Kerr and Bonifacio 2009) and 10,000–15,000 in 2004 (Grant and Reardon 2004 cited in Kerr and Bonifacio 2009). All estimates include juveniles (Kerr and Bonifacio 2009). The Warrnambool population was most recently estimated in 2020 at 17,000 to 18,000 mature adults and juveniles and approximately 3,000 pups (TSSC 2021). The maternity cave located near Portland has a smaller population, however, it seems to be proportionally a more successful breeding location with 97% of females at Portland giving birth to pups compared with 39% at the Warrnambool maternity cave (TSSC 2021).

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

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

Despite these limitations, applying the 1% 'rule' to the most recent estimate of adults within the Warrnambool population, a significant effect would constitute mortalities within the range of 170 to 180 adult SBWB.

5.1.2 Significance of effects

The pre-construction flora and fauna assessment for DDWF undertaken by BL&A (2015) recorded low numbers of SBWB calls. A total of four bat call surveys were undertaken in spring 2009, autumn 2011, summer/autumn 2013 and spring 2013, with SBWB only being detected in autumn 2011 and summer/autumn 2013 (BL&A 2015), which is consistent with the timing of the first two carcass finds in March and April 2023. No pre-construction microbat surveys were undertaken during winter. The BAMP concluded that the survey results indicated that the species was unlikely to be active in significant numbers in the area. The pre-construction flora and fauna assessment bat survey results (BL&A 2015), along with information on the species ecology and movements summarised above, suggest that the SBWB are more likely to be utilising the DDWF area in autumn, and may also utilise the area in winter, though some reduced activity at this time may occur due to individuals entering periods of torpor. This is consistent with the timing of all three SBWB carcass finds at DDWF.

The June 2023 SBWB carcass was discovered at Turbine E07, which is located along the south-eastern extent of DDWF. The previous two SBWB carcasses were found at Turbine F09 (March 2023) and Turbine C06 (April 2023), located in the west and central northern sections of DDWF respectively. There therefore appears to be no spatial pattern associated with the three SBWB carcass finds.

The SBWB carcass detected at DDWF in June 2023 is the third recorded mortality of this species since operational monitoring commenced at DDWF in November 2020. All three SBWB mortalities have occurred in the third year of operational monitoring. The BAMP (BL&A 2018) presents the results of a risk assessment for SBWB, which concluded that turbine strike at DDWF represented a 'moderate' risk to the species, as a result of the likelihood of turbine collision being assessed as 'likely', and the consequence of such an event being assessed as 'moderate'. Page 15 of the BAMP defines a 'likely' event as '*equally probable that the risk event could or could not occur in any year (50%)*', and a consequence of 'moderate' as '*moderate loss in numbers of individuals, leading to minor reduction in localised or regional population viability for between one and five years.*' While the detection of three adult SBWB carcasses within 28 months of monitoring is broadly consistent with the assessed likelihood in the BAMP of 'likely', these events are considered unlikely to result in a reduction in local or regional population viability for the species. The consequence rating is considered to be more consistent with the definitions for 'low' or 'negligible' (Table 4 of BL&A 2018), which is described as '*occasional*' or '*small numbers*' of losses *'but no reduction in local or regional population viability'*. The detection of three adult SBWB mortalities at DDWF is therefore not considered to be unexpected or in excess of what was presented in the approved BAMP (BL&A 2018).

Biosis consider that ongoing risk of collision is consistent with the assessment of risk in the approved BAMP for DDWF, and it is unlikely to lead to an unacceptable impact on the species at the broader population level based on current findings and information.

5.2 White-throated Needletail

Two White-throated Needletail carcasses were recorded during Year 3 of monitoring at DDWF, including one each in March 2023 (Turbine D01) and April 2023 (Turbine D03). The species is listed as vulnerable under the EPBC Act and under the FFG Act.

The White-throated Needletail is a trans-equatorial migrant, breeding in the Northern Hemisphere and flying south for the boreal winter. They depart breeding areas (eastern Siberia, north-eastern China and Japan) between August-October and travel south through China and Japan, migrating east of Borneo. White-throated Needletails usually arrive in Victoria from December onwards, with records peaking in March, and depart on their northward migration around April (Yamaguchi et al. 2021). White-throated Needletail are known to fly singly or in scattered flocks when migrating (Chantler 1999). Being largely an aerial species, they are almost

constantly on the move while in Australia and flight time extends for up to two hours after sunset and before sunrise (Tarburton 2021).

An assessment was prepared and submitted that detailed available information regarding population numbers and an assessment of the possible effects on the regional population of the species (Biosis 2023c). The following text is extracted and summarised from that report.

5.2.1 Population scale and numbers

In Australia, the population is a single entity with no recognisable subdivisions. It is therefore not possible to consider the population at the regional scale for this species. The global population size is unknown (DAWE 2021; BirdLife International 2023), however the *Action Plan for Australian Birds* (Garnet and Baker 2021) provides an Australian population estimate of 41,000 (20,000 – 61,000 with low reliability) and considers that the population is in decline. The '*Draft referral guideline for 14 birds listed as migratory species under the EPBC Act*' (DoE 2015) states that the population of White-throated Needletail is at least 10,000 individuals but probably fewer than 100,000. The largest flock recorded in Victoria included 50,000-100,000 birds in 1959, however it is believed there has been substantial population decline since then (Garnett and Baker 2021). Collision with wind turbines is identified as the major threat to the species in Australia (Garnett and Baker 2021; Tarburton 2021), and loss of breeding habitat in Eastern Siberia and Japan is considered a major threat at the global scale and to be largely responsible for the population decline that has been observed (Garnett and Baker 2021).

The *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (DoE 2015) provides thresholds for determining an 'ecologically significant proportion' of a population for White-throated Needletail, though it is noted that these guidelines were published before the species was listed as vulnerable under the EPBC Act, and may no longer be appropriate. The guidelines state that for species that aggregate in flocks, 1% of the population is considered internationally important and 0.1% is nationally important. These population percentages are used as upper and lower thresholds for determining the significance of impacts, with annual impacts to 1% of the population considered as a significant impact, and impacts above 0.1% triggering the need for additional research and/or mitigation. These draft guidelines utilise a population estimate of 10,000 individuals for White-throated Needletail to calculate annual population thresholds of 1% (100 birds) and 0.1% (10 birds), which is considered to be highly precautionary given the more recent population estimate of 41,000 provided by Garnett and Baker (2021).

The *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978* (DSE 2006) advise that a 'significant proportion' of a population of a threatened species within Victoria is '1 to 5 percent depending on the conservation status of the species' (page 7, DSE 2006). Both this and the *Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act*' (DoE 2015) indicate that an assessment of population-level impacts for the White-throated Needletail should consider thresholds of between 0.1% and 5% of the total population.

The conservation advice for White-throated Needletail (TSSC 2019) refers to evidence of wind farm mortalities documented at two wind farms in Tasmania by Hull et al (2013). This study documented a total of 11 collision records for the species at each of Bluff Point and Studland Bay Wind Farms, on the north-west coast of Tasmania (Hull et al 2013). Page 5 of the conservation advice for White-throated Needletail (TSSC 2019) refers to this study and states "*collision with wind turbines and overhead wires is of low severity and affects a small number of birds*." The carcass surveys that were conducted at these sites were undertaken at a greater frequency than at DDWF, but at fewer turbines. While not directly comparable, the reference to these results being of 'low severity' and 'small numbers' in the conservation advice for the species (TSSC 2019) appears to be broadly consistent with other documents referring to population thresholds of between 0.1% and 1%.

5.2.2 Significance of effects

The White-throated Needletail will forage above most habitats, but is most often recorded above wooded habitats, above partially cleared land, plantations or remnant vegetation at the edge of cleared land (TSSC 2019). Given the species' broad habitat associations and wide-ranging movements, it is considered that there is no clear change in local habitat conditions that could have increased, or continue to increase, the risk of White-throated Needletail turbine collision at DDWF. Both carcasses were found within 1 kilometre of the Mt Fyans Wildlife Reserve, which contains a small area of remnant woodland vegetation that the species may be more likely to forage over and around than cleared pasture, though this is uncertain.

These impact triggers represent the first two confirmed White-throated Needletail carcass finds at DDWF, however there were two potential but unconfirmed White-throated Needletail mortalities in March 2021, at Turbine H06 and Turbine C03 (Biosis 2023a). These finds were treated as White-throated Needletails and were reported in April 2021. This would bring the total carcass finds at DDWF for White-throated Needletail to four, since monitoring commenced in November 2020.

The pre-construction flora and fauna assessment for DDWF undertaken by BL&A (2015) did not record any White-throated Needletails within the DDWF area and assessed the habitat suitability as 'low', and the species 'unlikely' to occur. It concluded that any mortalities are likely to be very infrequent and unlikely to impact the overall population of the species significantly. The BAMP (BL&A 2018) includes a risk assessment for White-throated Needletail, which concludes that turbine strike at DDWF represents a 'low' risk to the species, as a result of the likelihood of turbine collision being assessed as 'likely', and the consequence of such an event being assessed as 'low'. Page 15 of the BAMP defines a 'likely' event as '*equally probable that the risk event could or could not occur in any year (50%)*', and a consequence of 'low' as '*repeated loss of small numbers of individuals but no reduction in local or regional population viability.*'

The find of four White-throated Needletails (two confirmed and two unconfirmed) at DDWF since operational monitoring commenced at DDWF in November 2020 is considered consistent with the risk assessment outlined in the BAMP. Four White-throated Needletail finds over two years represent 0.01% of the most recent population estimate of 41,000 provided in Garnett and Baker (2021). While actual mortalities are likely to be higher once corrected for survey coverage, searcher efficiency and carcass persistence, it is considered unlikely that White-throated Needletail mortalities at DDWF are significant at the population level.

For greater certainty, it is recommended that species-specific mortality estimates be calculated for White-throated Needletail during the next round of statistical analysis that is required for DDWF, which will be at the completion of the fifth year of operational monitoring (BL&A 2018). Mortality estimates should be presented as annual rates and/or in the context of the generational length for White-throated Needletail, which is 8.5 years (BirdLife International 2023). Any further White-throated Needletail carcass finds will continue to be reported and assessed as impact triggers in accordance with the requirements of the BAMP (BL&A 2018).

Biosis consider that ongoing risk of White-throated Needletail mortality at DDWF is consistent with the risk assessment outlined in the BAMP, and is unlikely to lead to an unacceptable impact on the species at the broader population level. Further action is not considered necessary at this stage. The timing of the two confirmed and two unconfirmed White-throated Needletail mortalities at DDWF coincides with a documented peak in numbers in Victoria around March. The species is not expected to be at any risk of turbine strike at DDWF while it is seasonally absent from at least late April to November.

5.3 Nankeen Kestrel

Four Nankeen Kestrel carcasses were recorded beneath Turbine E06 over two consecutive months (April and May 2023) during Year 3 of monitoring at DDWF. The species is a common species in Australia and is not

listed as threatened under state or Commonwealth legislation, however the detection of four carcasses at the same turbine over two consecutive months meets the BAMP definition for the non-threatened species trigger.

An assessment was prepared and submitted that detailed available information regarding population numbers and an assessment of the possible effects on the regional population of the species (Biosis 2023d). The following text is extracted and summarised from that report, with calculations updated based on the completed Year 3 dataset, where relevant.

5.3.1 Population scale and numbers

The Nankeen Kestrel is a common and widespread species occurring across virtually all habitats on mainland Australia, including alpine areas and urban areas. It is most common in open country with low and sparse vegetation cover, including agricultural land, where land clearing since European settlement has contributed to new feeding grounds in some areas, and is likely to have contributed to an expansion in distribution and numbers (BirdLife International 2023; Marchant and Higgins 1993). Nankeen Kestrels can be partially migratory, resident, dispersive or nomadic (Olsen & Olsen 1987).

Nankeen Kestrel numbers are known to fluctuate markedly in response to environmental conditions and prey abundance, and the species is subject to irruptions (Marchant and Higgins 1993). The species has been documented moving away from and/or declining in areas subject to drought and prolonged dry conditions, and conversely has been documented increasing in numbers following heavy rain (Marchant and Higgins 1993). Numbers are also known to increase substantially in response to increased prey resources. Nankeen Kestrels exhibit a generalist diet and feed on a range of large invertebrates and small vertebrates (Menkhorst et al. 2017). Nankeen Kestrels can increase in numbers in response to plagues of locusts and/or mice in agricultural areas (Marchant and Higgins 1993, Menkhorst et al. 2017).

The species is classified as least concern and is considered secure across its entire Australian distribution, which is due to its extremely large range and population size (BirdLife International 2023). There is no information on the number of individuals within the broader population, other than it is described as “extremely large” and likely to be increasing due to increased agricultural conversion and introduction of new prey species (BirdLife International 2023).

Captive Nankeen Kestrels have been documented breeding at one year of age (Marchant and Higgins 1993). Clutch sizes are typically 3-4. Higher clutch sizes of 7 and 8 have been recorded but are likely to represent two laying females or unusual activity/nest interference (Marchant and Higgins 1993). These life-history characteristics, along with the large population size, geographic distribution and increasing population trend suggest that Nankeen Kestrel populations are resilient and quick to recover, but may also be susceptible to boom and bust type cycles in response to seasonal and environmental variation.

5.3.2 Significance of effects

To date, there have been 86 Nankeen Kestrel carcasses found at DDWF since monitoring activities commenced in November 2020, inclusive of the four carcasses that activated the non-threatened species impact trigger in May 2023. A total of 30 carcasses were found during the first year of operation at DDWF, compared to 10 carcasses during the second year of operations (Biosis 2023a). A total of 46 carcasses were found during the third year of operational monitoring. Despite these numbers, the BAMP non-threatened species trigger has only been activated once for this species at DDWF. The species was the third most frequently recorded during carcass searches at DDWF for years 1 and 2 combined (Biosis 2023a), however was the most frequently recorded during Year 3 (Section 3.6). The majority (66%) of Nankeen Kestrel carcasses have been detected in

autumn and early winter, with 42% of all carcass finds occurring in either April or May, across all three years of operational monitoring. This suggests that the autumn/early winter period is likely to represent a peak in Nankeen Kestrel carcass finds at DDWF. These observed peaks, both in autumn and during 2021, also coincide with wetter than average conditions and documented increase in mice numbers in the broader region (MouseAlert 2023). Both factors are known to increase the numbers of Nankeen Kestrels in an area, as described above. The species was recorded during pre-construction surveys and assessments at DDWF (BL&A 2015) and is ubiquitous within the broader region.

Nankeen Kestrel carcasses have been documented at a number of Victorian wind farms that are subject to bird and bat monitoring. Moloney et al. (2019) collated mortality monitoring data from 15 Victorian wind farms for the period spanning from February 2003 to 2018, which documented a total of 54 Nankeen Kestrel carcass finds. The species was one of the most frequently encountered during wind farm mortality monitoring in Victoria, exceeded only by Australian Magpies and Wedge-tailed Eagles (Moloney et al. 2019). In addition, Nankeen Kestrels are the species most commonly struck by aircraft at Brisbane Airport (Leach 2013).

The Nankeen Kestrel is considered a common and widespread species, due to its ability to utilise a wide range of habitats and its occurrence across much of mainland Australia. Based on this information, we consider that Nankeen Kestrel collisions at Dundonnell Wind Farm will continue to occur, with peaks likely to occur in autumn/early winter months and/or in response to increasing mice/large invertebrate populations or plagues. Biosis consider that ongoing risk of collision is unlikely to lead to an unacceptable impact on the species at the broader population level, and thus that further action is not necessary at this stage. Mortality monitoring is to continue at DDWF for a total of five years, at which time the next round of mortality estimates will be calculated. It is recommended that additional anecdotal information on prey species abundance, particularly pest mice and insect numbers, is collated from site managers and farmers to better understand what factors may be contributing to seasonal and annual variation in Nankeen Kestrel mortality. Additionally, post mortem studies may be able to identify digested prey items, particularly during periods of prey eruption in autumn. This could confirm one potential causal factor in their collision risk profile.

5.4 White-striped Free-tailed Bat

Five White-striped Free-tailed Bat carcasses were recorded beneath Turbine C03 over two consecutive months (February and March 2023) during Year 3 of monitoring at DDWF. The species is a common endemic species in Australia and is not listed as threatened under state or Commonwealth legislation, however the detection of five carcasses at the same turbine over two consecutive months meets the BAMP definition for the non-threatened species trigger.

An assessment was prepared and submitted that detailed available information regarding population numbers and an assessment of the possible effects on the regional population of the species (Biosis 2023e). The following text is extracted and summarised from that report, with calculations updated based on the completed Year 3 dataset, where relevant.

5.4.1 Population scale and numbers

The White-striped Free-tailed Bat is a common and widespread species occurring across virtually all habitats in southern Australia, including alpine areas and urban areas. The species roosts in trees across their range either individually or in roosts of up to 20 individuals (Churchill 2008). The species was regularly recorded flying at heights above 50 metres in the pre-construction flora and fauna assessment for DDWF undertaken by BL&A (2015). White-striped Free-tailed Bats represent the majority of all bat carcass finds at wind farms across Victoria (Moloney et al 2019), and this has also been the case at DDWF (Biosis 2023a).

There have been a total of 99 White-striped Free-tailed Bat carcasses found at DDWF since monitoring activities commenced in November 2020, inclusive of the five carcasses that activated the non-threatened species impact trigger during Year 3. This includes 59 carcasses found during years 1 and 2 (Biosis 2023a) and 40 during Year 3 (Section 3.6). During Year 1, there was another non-threatened species impact trigger event for White-striped Free-tailed Bat in April and May 2021 as a result of four carcasses being found beneath Turbine E01 over the two consecutive months. This was reported to relevant authorities and the assessment undertaken determined that no further action was warranted (Biosis 2021).

The species is recognised as being in decline according to an IUCN assessment undertaken in July 2019 by Pennay (2019), however there is no information available on population numbers for the species. It is therefore not currently possible to differentiate between different population scales, nor assess the broader implications of the mortalities observed so far at Dundonnell Wind Farm. In the absence of population information, other wind farms provide additional and useful context to the mortalities observed. At one Victorian wind farm, Moloney et al. (2019) calculated mortality rates of 6.2 White-striped Free-tailed Bats per turbine per year, which equated to 397 individuals per year at that particular wind farm (location not specified). At Salt Creek Wind Farm, which is located within 10 kilometres of DDWF and consists of 15 turbines, 34 White-striped Free-tailed Bat carcasses were found from August 2019 to July 2020, which represented 63% of all microbat mortalities detected within that monitoring year (Biosis 2020). Mortality estimates have not been modelled separately for different microbat species and the findings from Salt Creek Wind Farm can't be directly compared with Moloney et al. (2019) findings. However, mortality surveys in August 2020 to July 2021 from Salt Creek Wind Farm indicate that annual mortality varies, as does the percentage of White-striped Free-tailed Bat carcasses found compared to other microbat species carcasses. During this survey period 21 White-striped Free-tailed Bat carcasses were found, which was 34% of all microbat carcasses found.

5.4.2 Significance of effects

Mortality estimates were undertaken at the completion of two years of monitoring at DDWF, the results of which are presented in Biosis (2023a). During the first two years of operation of DDWF, a total of 79 bat carcasses were found during formal surveys, 49 (62%) of which were White-striped Free-tailed Bats. 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 (Biosis 2023). The mortality estimates are calculated for all microbats, therefore it is not possible to extract a species-specific mortality estimate for White-striped Free-tailed Bat at DDWF, however the results for all microbats at DDWF do not appear to be unusual or unexpected when compared to results at Salt Creek Wind Farm and Maloney et al. (2019).

Most young White-striped Free-tailed Bats are weaned between mid-February and May (Churchill 2008). Given the addition of juveniles into the population between mid-February and May, these months are likely to represent periods of peak mortalities for wind farms in south-western Victoria. Data from DDWF suggests that a peak in mortality is occurring during this period, with March and April representing 28% and 54% of all White-striped Free-tailed Bat mortalities respectively, or 82% combined. Carcass finds drop away significantly outside these months, with February and May representing 4% and 12% respectively of all carcass finds for the species, therefore 98% of White-striped Free-tailed Bat carcasses have been found between February and May at DDWF. Similar patterns of higher mortalities in early to mid-autumn have been observed at the Salt Creek Wind Farm where the combined White-striped Free-tail Bat mortality for March and April was 54.8% from August 2019 to July 2020 (Biosis 2020),

White-striped Free-tailed Bats are not known to hibernate, and are thought to migrate from southern parts of their range during the cooler months, with very few records of the species occurring in Victoria from June to August (Churchill 2008). On the basis of this information, we consider that White-striped Free-tailed Bat collisions at Dundonnell Wind Farm are likely to occur regularly, but only during the period from September to April/May, with significant peaks occurring in March and April in association with the known weaning period.

The White-striped Free-tailed Bat is considered a common and widespread species, due to its ability to utilise a wide range of habitats and its occurrence across much of southern Australia. Despite this, collision with turbines is recognised as a localised threat to the species in south-western Victoria (Pennay 2019). Biosis consider that ongoing risk of collision is unlikely to lead to an unacceptable impact on the species at the broader population level, and thus that further action is not necessary at this stage. This is consistent with an assessment from Pennay (2019), which states that these localised impacts are unlikely to cause significant decline in the species overall population. Mortality monitoring is to continue at DDWF for a total of five years, at which time the next round of mortality estimates will be calculated.

6 Conclusion and recommendations

This report compiles the methods and findings from the third year of implementing the approved BAMP at DDWF, by detailing the findings from Year 3. Results and findings from Year 1 and 2 are presented in greater detail in Biosis (2023a), which also includes mortality estimates for all birds and bats. This section summarises the key findings of the third year of BAMP 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 third year of monitoring for breeding and flocking Brolgas, of which eight wetlands and surrounding paddocks were recorded being utilised by foraging Brolgas, and four wetlands were recorded being utilised by breeding Brolgas.

Of the four wetlands where Brolga breeding was recorded, two were within the 3.2 kilometre buffer of the wind turbines (wetlands Q and R), one was within the 5 kilometre buffer of the wind turbines (wetland F), and one was 5.1 kilometres from the wind turbines (wetland U). All four wetlands were subject to additional fortnightly breeding surveys during Year 3.

No Brolga flocks were recorded within the DDWF study area during Year 3 monitoring, therefore no targeted flocking Brolga surveys were triggered.

It is recommended that:

- Brolga utilisation monitoring is continued, in accordance with the BAM Plan.
- Additional wetlands within the survey buffer are included into the monthly Brolga utilisation monitoring schedule, when identified as suitable breeding or flocking habitat, or if restored after historic draining.
- Continue fortnightly Brolga breeding monitoring when breeding is observed or reported within the survey buffer, in accordance with the BAMP.
- Continue targeted flocking surveys when a flock is observed or reported within the survey buffer, in accordance with the BAM Plan, though flocking surveys should be undertaken in accordance with additional methods detailed in Biosis (2023a), which target dawn and dusk periods, and include mapping roosts, foraging areas and flights observed.

6.2 Peregrine Falcon monitoring

Monitoring at Mount Fyans Wildlife Reserve was undertaken during Year 3 of operation of DDWF. No Peregrine Falcons were recorded at the Mount Fyans Wildlife Reserve during any Year 3 surveys. No evidence of nesting activity was observed at the known Peregrine Falcon nest in the quarry within the western extent of the Mount Fyans Wildlife Reserve. Evidence of breeding Peregrine Falcons was last recorded at the site in December 2021, when a juvenile was observed being fed by an adult.

Two adult Peregrine Falcon carcasses have been recorded within the first three years at DDWF, one carcass during Year 1 and one during Year 2 (Biosis 2023a). No carcasses were detected in Year 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. Year 3 monitoring did not record any Peregrine Falcon activity at the reserve, further suggesting that the second carcass find in Year 2 was linked to the breeding pair at Mount Fyans Nature Reserve.

It is recommended that Peregrine Falcon monitoring continue at DDWF, in accordance with the BAM Plan and in conjunction with Brolga utilisation monitoring, to determine if a new breeding pair takes up the nesting site.

6.3 Brolga mortality monitoring

Brolga mortality monitoring was undertaken once per month at all accessible turbines during the third year 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.

No Brolga carcasses were detected during Brolga mortality monitoring in Year 3 at DDWF. To date, one Brolga carcass has been detected at DDWF in three years of monitoring (Biosis 2023a). Results from the third year of Brolga mortality monitoring were used to calculate an updated Brolga mortality estimate, which is presented in Section 4.1. Based on the single detected carcass in Year 2, as well as mortality search results, searcher efficiency rates, carcass persistence rates and survey effort for all three years, the estimated mortality is approximately three Brolgas over the full survey period, with around two lost during Year 3 (Symbolix 2024). This estimate is higher than the annual predicted rate of 0.49 Brolga per year (BL&A 2018), but still within the losses accounted for within the Brolga Compensation Plan (19 Brolga over the 25 year life of the Project; Tilt Renewables 2019). It is expected that as monitoring continues, the calculated mortality estimates will begin to 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 BAMP, and by utilising binocular searches as the preferred method.
- Investigate the use of other methods or techniques for surveying Brolga. For any different techniques or methods investigated, undertake a method trial to compare searcher efficiency rates.
- Undertake the next round of statistical analysis to produce Brolga mortality estimates at the completion of year 4, and reassess 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 third year of operational monitoring at DDWF. The carcass search program, and incidental observations, recorded a total of 206 bird/bat mortalities across approximately 34 bird species/species categories.

BAMP impact triggers were met for two threatened species (Southern Bent-winged Bat and White-throated Needletail) and two non-threatened species (White-striped Free-tailed Bat and Nankeen Kestrel). The latter two species were the most commonly recorded mortalities during the third year of monitoring with 46 and 40 recorded mortalities respectively, followed by Australian Magpie (22 records) and Brown Falcon (17 records).

The third year of operational monitoring at DDWF also included the completion of four carcass persistence trials and two searcher efficiency trials. These trials would ordinarily not be repeated again, however a recommendation has been made to undertake further searcher efficiency trials 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 4 and until Year 5, in accordance with the BAMP.
- Additional searcher efficiency 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 and impact trigger findings

Mortality estimates were undertaken for all birds and bats at the completion of Year 2, the results of which are detailed in Biosis (2023a). For Year 3, mortality estimates were only undertaken for Brolga, in accordance with the BAMP, which requires Brolga mortality estimates to be updated and provided each year. This report presents the results of the second mortality estimate undertaken for Brolga 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 three Brolgas over the first three years of operation at DDWF.

This report also presented impact trigger assessment findings for Year 3, which included a recommendation for species-specific mortality estimates be calculated for White-throated Needletail during the next round of statistical analysis that is required for DDWF at the completion of Year 5 monitoring. The impact trigger finding for Nankeen Kestrel also recommended that additional site-based observations are recorded on prey species eruptions, particularly pest mice and insects, to better understand factors contributing to seasonal and annual variation in Nankeen Kestrel mortalities.

Recommendations are therefore as follows:

- The next full statistical analysis for all birds and bats, incorporating the results of the correction factor studies, is to be undertaken at the completion of Year 5, as per the requirements of the BAMP.
- Brolga mortality estimates will be recalculated and reported each year, in accordance with the BAMP.
- Undertake species-specific mortality estimates for White-throated Needletail at the completion of Year 5.
- Record and collate site-based observations on prey species abundance, such as noting timing and duration of mice and insect eruptions.

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Appendix 1 Brolga utilisation survey detailed results

Table 16 Year 3 Brolga utilisation survey data, November 2022 – October 2023

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
November 2022											
02/11/2022	K (32667)	1035	1055	80	Nil	11.4	15.4	SW	3	2 Masked Lapwing, 6 Black Swan, 2 Silver Gull	
02/11/2022	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	
02/11/2022	T (32671)	1135	1145	80	Nil	11.9	9.9	SW	3	No Birds	
02/11/2022	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	
02/11/2022	N (29839)	1405	1450	90	Nil	12.6	18.4	SW	3	4 Black Swan (1 nesting), 2 Masked Lapwing	
02/11/2022	P (29753)	1520	1530	90	Nil	12.8	14.2	SW	1	No Birds	
03/11/2022	R (29587)	920	945	95	Nil	13.8	6.5	W	3	1 Black Swan (nesting)	
03/11/2022	F (32558)	1010	1045	95	Nil	14	4.3	W	2	1 Brolga (adult), 6 Black Swan (4 nesting)	Foraging in w edge of wetland.
03/11/2022	E (30412)	1055	1120	95	Nil	14.2	9.5	W	2	6 Australian White Ibis, 4 Pacific Black Duck	
03/11/2022	D (29773)	1125	1135	95	Nil	14.6	5.7	W	3	4 Silver Gull, 5 Black Swan	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
03/11/2022	C (29711)	1140	1155	95	Nil	14.3	7.3	W	3	7 Black Swan, 2 Silver Gull	
03/11/2022	G (29857)	1205	1215	95	Nil	14.7	11.9	SW	3	6 Black Swan (2 nesting)	
03/11/2022	B (29614)	1240	1355	95	Nil	14.5	11.6	SW	3	16 Black Swan	
03/11/2022	A (29627)	1440	1515	95	Nil	14.5	14.3	SW	1	6 Straw-Necked Ibis	
03/11/2022	O (30401)	1540	1605	95	Nil	14.3	8.5	SW	3	9 Pacific Black Duck	
04/11/2022	S (33291)	910	925	90	Nil	10.9	3.8	S	3	3 Black Swan, 4 Grey Teal	
04/11/2022	Q (32542)	940	1010	90	Nil	11.2	8	S	3	3 Brolgas (2 adults, 1 chick)	Foraging together on edge of wetland. Adults did not hide chick when they noticed I was observing.
04/11/2022	I (32565)	1025	1050	90	Nil	12.5	5.8	S	3	8 Black Swan, 4 Masked Lapwing, 4 Pacific Black Duck	
04/11/2022	H (32580)	1035	1045	90	Nil	14.6	6.2	S	3	8 Grey Teal	
04/11/2022	U (32610)	1120	1135	90	Nil	15.3	7	S	2	3 Brolgas (2 adults, 1 chick)	Foraging together on ne edge of wetland.
28/11/2022	F (32558)	1500	1525	95	Nil	16.6	13.4	NW	3	1 Brolga (adult, in adjacent paddock), 3 Black Swan (1 nesting), 4 Australasian Swamphen	One adult Brolga wandering alone in paddock 300 m w of wetland.
28/11/2022	R (29587)	1545	1600	100	Nil	16.4	7.6	NW	4	2 Brolga (adult), 2 Pacific Black Duck, 2 Black Swan	Pair sitting and standing beside nest in flooded paddock SSW of roadside wetland.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
29/11/2022	A (29627)	930	950	90	Nil	16.9	12.4	NE	1	No Birds	
29/11/2022	O (30401)	1010	1035	90	Nil	17.1	7.4	NE	3	4 Pacific Black Duck	
29/11/2022	R (29587)	1100	1110	95	Nil	17.3	6.7	NE	4	2 Brolga (adult)	One sitting on nest, one foraging in flooded paddock.
29/11/2022	C (29711)	1115	1125	95	Nil	17.8	6.4	NE	4	8 Silver Gull, 6 Black Swan	
29/11/2022	D (29773)	1130	1140	95	Nil	17.7	6.9	NE	4	12 Silver Gull	
29/11/2022	G (29857)	1150	1205	95	Nil	18.4	12.5	NE	4	1 Black Swan	
29/11/2022	Falcon Survey	1230	1320	95	Nil	17.6	8.8	NE	-	No Peregrine Falcons	
29/11/2022	N (29839)	1350	1420	95	Nil	19.3	9.9	NE	3	6 Australasian Swamphen, 2 Masked Lapwing, 4 Black Swan, 1 White-faced Heron	
29/11/2022	P (29753)	1440	1455	95	Nil	19.8	11.3	NE	1	2 Australian Shelduck	
29/11/2022	E (30412)	1515	1530	95	Nil	20.2	8.5	NE	2	8 White Ibis, 12 Straw-Necked Ibis	
29/11/2022	B (29614)	1610	1635	95	Nil	20.6	4.3	NE	3	25 Black Swan, 8 Pacific Black Duck	
30/11/2022	S (33291)	1010	1025	100	Nil	15.6	6.4	ESE	3	2 Black Swan, 4 Pacific Black Duck	
30/11/2022	Q (32542)	1045	1120	100	Nil	16.2	4.2	ESE	3	8 Black Swan, 6 Australasian Swamphen	
30/11/2022	I (32565)	1140	1205	100	Nil	16.7	7.9	ESE	3	16 Black Swan, 4 Masked Lapwing, 4 Silver Gull, 8 Pacific Black Duck	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
30/11/2022	H (32580)	1145	1205	100	Nil	17.1	11.2	SE	3	4 Grey Teal, 2 Black Swan, 1 Little Pied Cormorant	
30/11/2022	U (32610)	1225	1240	90	Nil	17.2	12.6	SE	3	3 Brolga (2 adult, 1 chick)	Foraging together in partially flooded paddock SE of wetland. Chick approx. 50-60% size of adults.
30/11/2022	J (32664)	1300	1325	90	Nil	18.3	7.6	SE	3	6 Black Swan, 8 Silver Gull, 4 Australian Shelduck	
30/11/2022	K (32667)	1340	1400	90	Nil	18.4	8.1	SE	3	4 Masked Lapwing, 13 Black Swan	
30/11/2022	L (32614)	1405	1430	90	Nil	19.9	5.3	SE	3	No Birds	
30/11/2022	T (32671)	1440	1450	90	Nil	20.5	6.5	SE	3	No Birds	
December 2022											
29/12/2022	R (29587)	1025	1200	50	Nil	17.5	3.4	NW	2	2 Brolga (adult), 1 White-faced Heron, 2 Masked Lapwing	One sitting on nest, one foraging in flooded paddock
29/12/2022	C (29711)	1210	1220	30	Nil	19.6	1.6	NW	3	No Brolgas	
29/12/2022	D (29773)	1225	1235	30	Nil	19.9	5.4	NW	3	No Brolgas	
29/12/2022	F (32558)	1250	1310	40	Nil	20.2	3.3	NW	2	2 Brolgas (adult), 2 Black Swan	One sitting on nest in middle of wetland, one foraging in wetland
29/12/2022	J (32664)	1320	1345	40	Nil	21.3	7.6	E	3	70 Black Swan, 6 Australian Shelduck, 12 Pacific Black Duck	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
29/12/2022	K (32667)	1350	1415	40	Nil	22.5	3.6	E	3	12 Black Swan, 4 Masked Lapwing	
29/12/2022	L (32614)	1425	1450	20	Nil	22.7	2.8	E	3	180 Black Swan	
29/12/2022	T (32671)	1455	1510	30	Nil	23.4	4.8	SE	4	No Birds	
29/12/2022	U (32610)	1525	1550	20	Nil	24.7	8.9	SE	4	No Brolgas	Brolgas may have been out of view in tall grass, or obscured among distant sheep and heat haze.
29/12/2022	P (29753)	1610	1625	50	Nil	25.6	12.9	SE	0	No Birds	
29/12/2022	N (29839)	1650	1720	50	Nil	25.3	6.8	SE	2	2 Masked Lapwing, 2 Black Swan	
29/12/2022	G (29857)	1745	1755	40	Nil	25.6	2.3	SE	3	6 Black Swan	
30/12/2022	R (29587)	945	950	100	Nil	20.9	7.6	NW	2	2 Brolga (adult)	One sitting on nest, one foraging in flooded paddock
30/12/2022	Q (32542)	1020	1110	100	Nil	21.1	4.6	NW	2	2 Brolga (adult), 6 Pacific Black Duck, 4 Masked Lapwing, 2 Black Swan, 2 Australasian Swamphen, 2 Wedge-tailed Eagle (perched on tree at north edge of wetland).	Foraging in n end of wetland, called when disturbed and wandered into wetland. No chick seen.
30/12/2022	I (32565)	1125	1155	100	Nil	22.6	5.3	NW	3	14 Black Swan, 6 Masked Lapwing, 2 Silver Gull	
30/12/2022	H (32580)	1135	1155	100	Nil	22.6	5.3	NW	3	1 Little Pied Cormorant, 4 Grey Teal, 2 Australian Shelduck, 2 Black Swan	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
30/12/2022	S (33291)	1215	1230	90	Nil	24.4	12.8	NW	3	4 Black Swan, 14 Pacific Black Duck, 2 Masked Lapwing	
30/12/2022	B (29614)	1255	1315	90	Nil	24.8	2.4	NW	3	28 Black Swan, 6 Pacific Black Duck	
30/12/2022	E (30412)	1340	1355	100	Nil	25.9	6.8	NW	2	15 Australian White Ibis, 6 Straw-Necked Ibis, 2 Silver Gull	
30/12/2022	A (29627)	1420	1440	80	Nil	26.4	11.1	NW	0	5 Straw-Necked Ibis	
30/12/2022	O (30401)	1505	1525	80	Nil	26.8	13.8	NW	3	2 Black Swan, 6 Pacific Black Duck, 2 Australian Wood Duck	
30/12/2022	Falcon Survey	1555	1635	80	Nil	24.7	9.4	NW	-	No Peregrine Falcons	
January 2023											
24/01/2023	U (32610)	1225	1250	90	Nil	24.4	15	SW	-	3 Brolga (2 adult, 1 chick), 2 Black Swan, 6 White-faced Heron, 1 Whistling Kite	Two adult Brolgas foraging with chick in dry section of wetland.
24/01/2023	T (32671)	1300	1315	80	Nil	25.1	15	WSW	-	2 Black Swan, 5 Silver Gull	
24/01/2023	L (32614)	1330	1355	90	Nil (Encroaching Storm)	25.5	19	WSW	-	1 Brolga (adult, flying overhead nearby), 4 unidentified grebe spp., 75 Silver Gull, 1 Black Cormorant, 20 unidentified duck spp., 2 Masked Lapwing, 395 Black Swan	One Brolga seen flying overhead near NE corner of wetland, flying NNE towards wetland 243. Landholder noted approx. 6 Brolgas using southern end at 7am this morning.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
24/01/2023	K (32667)	1430	1500	90	Nil	22.9	19	SW	-	2 Hoary-headed Grebe, 1 Masked Lapwing, 5 Chestnut Teal, 4 Little Pied Cormorant, 23 Australian Shelduck, 1 White-faced Heron, 3 Musk Duck, 4 Chestnut Teal, 4 Black Swan, 100 unidentified duck spp.	
24/01/2023	J (32664)	1510	1545	90	Nil	20.6	22	N	-	475 Black Swan, 35 Grey Teal, 67 Australian Shelduck, 5 Masked Lapwing, 1 White-faced Heron, 15 unidentified duck spp.,	
24/01/2023	F (32558)	1600	1630	90	Nil	21.1	13	NE	-	No Birds	Brolga pair and chick not seen.
25/01/2023	A (29627)	915	935	10	Nil	20.8	1.7	NE	-	No Birds	
25/01/2023	O (30401)	955	1015	10	Nil	23.6	2.5	NE	-	16 Australian Wood Duck, 26 Pacific Black Duck, 30 Australian Shelduck, 2 Masked Lapwing	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
25/01/2023	R (29587)	1050	1110	10	Nil	28.7	2.4	NE	-	4 Brolga (2 adult, 2 chicks), 2 Black Swan	2 adults and 2 chicks foraging near southern edge of wetland. Both chicks staying close to parents but not hiding when they spotted me. Chick size approx. top of body almost reaching underside of adults.
25/01/2023	C (29711)	1120	1130	10	Nil	29.8	6.4	NE	-	2 Silver Gull, 3 Pacific Black Duck	
25/01/2023	D (29773)	1130	1140	10	Nil	29.8	6.4	NE	-	110 Silver Gull, 125 Black Swan	
25/01/2023	E (30412)	1145	1155	30	Nil	28.3	21.5	NW	-	No Birds	
25/01/2023	G (29857)	1200	1210	50	Nil	29.8	12.6	NW	-	8 Pacific Black Duck, 1 White-faced Heron, 6 Black Swan, 8 Australian Wood Duck, 4 Australasian Swamphen, 3 unidentified grebe spp., 2 Dusky Moorhen	
25/01/2023	B (29614)	1230	145	50	Nil	29.5	11.5	NW	-	45 Silver Gull, 4 White-faced Heron, 5 Pacific Black Duck, 1 unidentified bird perched (likely cormorant), 25 unidentified duck spp. (small flock flew over)	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
25/01/2023	N (29839)	1400	1430	60	Nil	29.4	23.7	NW	-	2 Brolga (adult), 3 White-faced Heron, 2 Masked Lapwing	2 adult Brolga preening and foraging along n edge of wetland.
25/01/2023	P (29753)	1450	1500	60	Nil	29.6	6	WNW	-	No Birds	
25/01/2023	F (32558)	1515	1530	60	Nil	29.5	6	WNW	-	2 Brolga (Adult)	Adults foraging few meters apart toward middle of wetland. Chick not visible but tall grass and adults were wary, constantly looking up.
February 2023											
21/02/2023	U (32610)	1205	1235	20	Nil	20.1	9.4	ESE	-	2 Masked Lapwing, 22 Pacific Black Duck, 3 White-faced Heron, 1 Grey Teal	No sign of Brolga in wetland or surrounding paddocks.
21/02/2023	T (32671)	1255	1305	20	Nil	21.9	7.8	ESE	-	2 Black Swan	
21/02/2023	L (32614)	1320	1345	30	Nil	22.8	7.8	ESE	-	35 Silver Gull, 4 unidentified duck spp., 13 Black Swan, 2 Masked Lapwing, 1 Pacific Black Duck, 3 White-faced Heron.	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
21/02/2023	K (32667)	1355	1425	20	Nil	24.8	3.2	SE	-	24 White-faced Heron, 950 Grey Teal (two large flocks), 23 Black Swan, 29 Australasian Grebe, 1 Musk Duck, 5 Australian Shelduck, 8 unidentified grebe spp., 5 Pacific Black Duck, 2 Masked Lapwing	
21/02/2023	J (32664)	1455	1530	30	Nil	26.7	3.4	SE	-	378 Black Swan, 3 Australian Shelduck, 3 Musk Duck, 32 Pacific Black Duck, 2 Masked Lapwing, 44 Silver Gull	
21/02/2023	F (32558)	1540	1645	30	Nil	25.4	6.1	SE	-	No Birds	No Brolga in wetland or visible surrounding paddock. Two small pools of water with empty reed nests on se boundary of wetland.
22/02/2023	R (29587)	725	735	0	Nil	15	3.1	E	-	4 Brolga (2 adult, 2 chicks), 8 White-necked Heron, 5 Black Swan, 1 Straw-Necked Ibis, 1 Australasian Swamphen 2 White-faced Heron.	Brolga adults and chicks foraging together near southern edge of wetland. Whistling Kite landed just south of them 20m away, adult Brolga displayed aggressive behaviour toward kite (opened and flapped wings).
22/02/2023	F (32558)	745	815	0	Nil	15.1	3.4	E	-	1 Brown Falcon (perched on reed nest)	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
22/02/2023	E (30412)	835	845	0	Nil	17.2	8.2	E	-	No Birds	
22/02/2023	G (29857)	850	920	0	Nil	18.1	4.1	E	-	17 Masked Lapwing, 6 Black Swan, 23 Hoary-headed Grebe, 57 Pacific Black Duck (flock of 17 and 15 flew into wetland), 1 Little Pied Cormorant, 35 Australasian Shoveler, 17 Grey Teal	
22/02/2023	D (29773)	925	1025	10	Nil	19.7	3.1	ESE	-	3 Brolga (2 adult, 1 chick), 100 Silver Gull, 2 Eurasian Coot, 51 Black Swan, 7 unidentified duck spp. (likely Pacific Black Duck, perched on rocky bank but too far to see), 6 Masked Lapwing, 160 unidentified grebe spp. (low quality count), 50 Grey Teal	Brolga foraging close together along northern edge of wetland, in grassy paddock. Chick was moderate size, not hidden by adults though they were wary.
22/02/2023	C (29711)	1040	1050	30	Nil	23.4	5.6	SE	-	2 Pacific Black Duck, 2 Black Swan, 2 Silver Gull, 6 Hoary-headed Grebe	
22/02/2023	A (29627)	1115	1130	30	Nil	24.7	2.1	SE	0	No Birds	Wetland completely dry.
22/02/2023	O (30401)	1155	1215	30	Nil	26.2	3.9	NE	-	70 Australian Shelduck, 90 Australian Wood Duck, 7 Pacific Black Duck, 1 unidentified grebe spp.	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
22/02/2023	B (29614)	1335	1355	10	Nil	29.5	7.1	NE	-	2 Brolga (adult), 6 Black Swan, unidentified waterbirds (ducks or grebes).	Adult Brolgas foraging near grassy edge of wetland. Landholder recorded two adults two weeks ago in wetland.
22/02/2023	N (29839)	1425	1450	20	Nil	29.2	2.4	NE	-	2 Brolga (adult), 6 White-faced Heron, 1 White-necked Heron, 4 Australian White Ibis, 1 Great Egret	
22/02/2023	P (29753)	1515	1520	20	Nil	33.3	1.4	NE	-	No Birds	
22/02/2023	U (32610)	1535	1545	20	Nil	32.8	0.7	NE	-	3 Brolga (2 adult, 1 chick), 2 White-faced Heron, 2 Masked Lapwing	Two adult Brolga and chick roosting/foraging around edge of wetland. Adult feeding chick.
23/02/2023	Q (32542)	900	950	60	Nil	21.5	13.7	N	-	21 White-faced Heron, 30 Australasian Swamphen, 6 Little Pied Cormorant, 12 Masked Lapwing, 2 Black Swan	No sign of Brolga in wetland or surrounding paddocks, including southern arm where they were recorded two weeks prior.
23/02/2023	I (32565)	1020	1100	20	Nil	23.8	11.1	NE	-	10 Australasian Shoveler, 30 Grey Teal, 33 Pacific Black Duck, 6 Masked Lapwing, 19 Australasian Swamphen	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
23/02/2023	H (32580)	1120	1135	20	Nil	26.6	13.7	NE	-	3 Little Pied Cormorant, 6 Pacific Black Duck, 15 Australian Wood Duck, 1 White-faced Heron, 7 Masked Lapwing	
23/02/2023	S (33291)	1215	1225	10	Nil	27.7	7.4	NE	-	3 Masked Lapwing, 20 Hoary-headed Grebe, 35 Pacific Black Duck	
March 2023											
Mar-23 Land-holder Obs.	Tiverton Property	-	-	-	-	-	-	-	-	Adult Brolga pair and chick seen regularly near hay shed and homestead on Tiverton property, and near wetland S. One adult appeared to be limping slightly. Seen by landholder again on 24 March 2023 after surveys.	
21/03/2023	U (32610)	1150	1155	100	Nil	17.6	1.4	NE	0	3 Brolga (2 adult, 1 chick)	Brolga adults and chick foraging at the eastern edge of restored wetland
21/03/2023	T (32671)	1210	1225	100	Nil	18.6	3.9	NE	-	1 Peregrine Falcon (on fence post at wetland), 19 unidentified grebe spp., 5 Eurasian Coot	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
21/03/2023	L (32614)	1240	1315	100	Nil	19.8	4.8	NE	-	21 Musk Duck, 123 Eurasian Coot, 3 Grey Teal, 2 Masked Lapwing, 15 Little Pied Cormorant, 7 Black Cormorant, 55 Australian Shelduck (2 flocks flew overhead into wetland), 113 unidentified grebe spp., 43 Silver Gull, 30 unidentified duck spp., 25 Black Swan, 7 White-necked Heron, Approx. 150 unidentified duck/grebe spp. (could not ID clearly, estimate count)	
21/03/2023	K (32667)	1320	1410	100	Nil	23.9	1.8	NE	-	248 Chestnut Teal, 14 White-faced Heron, 26 Black Swan, 1 Australian Pelican (circling above), 295 Hoary-headed Grebe, 55 Grey Teal, 10 Australasian Grebe, 96 Eurasian Coot, 14 Pink-Eared Duck, 6 Musk Duck, 232 Australian Shelduck, 1 Little Pied Cormorant, 5 Masked Lapwing	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
21/03/2023	J (32664)	1440	1515	100	Nil	24.5	1.5	NE	-	35 Chestnut Teal, 400 Black Swan, 60 Australian Shelduck, 300 unidentified grebe spp., 2 Masked Lapwing, 14 Pink-Eared Duck, 6 Musk Duck, 5 Australasian Shoveler, 400 Eurasian Coot, 9 White-faced Heron, 500 unidentified grebe spp. (too far to ID), 67 Silver Gull, 15 Grey Teal	
21/03/2023	F (32558)	1525	1545	90	Nil	22.8	2.6	NE	-	No Birds	No sign of Brolga, no water visible in wetland though green vegetation in middle suggests it's still wet
22/03/2023	R (29587)	830	850	20	Nil	13.3	0	-	-	7 White-necked Heron, 2 Masked Lapwing	No sign of Brolgas in wetland or visible surrounding paddocks, some water and old reed nest still present. Checked day prior (21.03.23) and no Brolga either.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
22/03/2023	C (29711)	855	915	40	Nil	15.7	0	-	-	7 Pink-Eared Duck, 31 Black Swan, 3 Masked Lapwing, 12 Grey Teal, 37 Australian Shelduck, 33 Pacific Black Duck, 4 Musk Duck, 21 Eurasian Coot, 20 Hoary-headed Grebe, 11 Silver Gull, 3 Chestnut Teal	
22/03/2023	D (29773)	920	955	40	Nil	19.7	1.1	E	-	3 Brolga (2 adult, 1 chick), 49 Black Swan, 22 White-faced Heron, 25 unidentified duck spp., 480 unidentified grebe spp. (predominately Hoary-headed Grebe but some unable to clearly ID), 70 Australian Shelduck, 18 Pacific Black Duck, 43 Grey Teal, 6 Masked Lapwing, 10 Eurasian Coot, 5 Musk Duck, 37 Silver Gull, 60 Chestnut Teal, 180 identified duck spp. (on far edge of wetland likely Pacific Black Ducks Or teal spp.)	Two adult Brolga and chick moving through paddocks just west of the wetland. Chick large and fully fledged. Moved south away from me, seen in same area as last month.
22/03/2023	E (30412)	1005	1020	80	Nil	19.8	2.8	NE	-	2 Australian Shelduck (flew into wetland)	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
22/03/2023	N (29839)	1045	1105	80	Nil	21.2	2.5	NE	-	2 Brolga (adult), 1 White-faced Heron	Two adult Brolga foraging together at ne edge of wetland.
22/03/2023	P (29753)	1130	1135	80	Nil	22.3	1.3	NE	-	No Birds	
22/03/2023	A (29627)	1210	1225	80	Nil	22.4	3.6	E	0	No Birds	
22/03/2023	O (30401)	1245	1300	40	Nil	24.1	4.8	E	-	230 Pacific Black Duck, 18 Australian Shelduck, 2 Eurasian Coot	
22/03/2023	G (29857)	1345	1415	40	Nil	26.4	3.8	NE	-	19 Eurasian Coot, 12 Masked Lapwing, 145 Pacific Black Duck, 8 White-faced Heron, 2 Australasian Swamphen, 15 Australasian Grebe, 25 Hoary-headed Grebe, 6 Black Swan, 4 Australian Shelduck, 30 Chestnut Teal, 1 White-necked Heron, 3 Australasian Shoveler	
22/03/2023	B (29614)	1430	1450	70	Nil	28.1	1.7	NE	-	2 Brolga (adult), 7 White-faced Heron, 450 unidentified duck spp. (heat haze extreme unable to ID), 35 Black Swan	Adult Brolga foraging near edge of wetland, same area seen a month ago.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
23/03/2023	Q (32542)	915	935	100	Nil - Storm Passed Just Before Survey	15.9	3.8	SSW	-	21 Masked Lapwing, 160 Australasian Swamphen, 2 White-faced Heron	
23/03/2023	I (32565)	955	1010	90	Nil - Encroaching Storm	18.3	3.2	ESE	-	136 Grey Teal, 5 Hoary-headed Grebe, 6 Masked Lapwing, 31 unidentified duck sppp. (Pacific Black Duck, or teal spp., too far to ID),	
23/03/2023	H (32580)	1015	1030	90	Nil - Encroaching Storm	20.4	1.4	WSW	-	19 Pacific Black Duck, 4 Little Pied Cormorant, 2 Australian Shelduck, 15 Chestnut Teal, 2 Masked Lapwing, 1 Australian White Ibis, 50 Australasian Grebe	
23/03/2023	S (33291)	1100	1120	90	Light Drizzle	19.2	3.2	E	-	4 Masked Lapwing, 1 White-necked Heron, 1 White-faced Heron, 1 Black Swan, 100 Pacific Black Duck, 95 Eurasian Coot, 3 Australasian Shoveler, 15 Grey Teal, 20 Chestnut Teal, 5 Hoary-headed Grebe	
April 2023											

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
19/04/2023	K (32667)	1100	1120	50	Nil	14.4	15.3	W	4	8 Black Swan, 20 Grey Teal, 2 White-faced Heron	
19/04/2023	L (32614)	1125	1150	50	Nil	15.4	14.2	W	4	4 Great-crested Grebe, 80 Pacific Black Duck, 40 Grey Teal, 2 Little Pied Cormorant	
19/04/2023	T (32671)	1155	1210	60	Nil	15.6	7.6	SW	4	No Birds	
19/04/2023	U (32610)	1220	1235	60	Nil	15.1	8.4	SW	2	2 White-faced Heron	
19/04/2023	N (29839)	1310	1335	40	Nil	15.8	9.3	SW	1	5 Australasian Swamphen, 2 White-faced Heron	
19/04/2023	P (29753)	1355	1410	40	Nil	16.1	13.8	W	0	No Birds	
19/04/2023	J (32664)	1435	1500	60	Nil	15.9	6.1	W	3	36 Black Swan, 4 Australian Shelduck, 18 White-faced Heron, 45 Pacific Black Duck	
20/04/2023	A (29627)	940	1000	70	Nil	13.8	3.2	W	0	No Birds	
20/04/2023	O (30401)	1015	1030	80	Nil	14.5	6.8	W	3	2 Pacific Black Duck, 2 Black Swan, 1 Little Pied Cormorant	
20/04/2023	R (29587)	1105	1140	90	Nil	16.1	8.8	W	2	4 Straw-Necked Ibis, 9 Australian Shelduck, 13 White-faced Heron, 1 White-necked Heron, 120 Pacific Black Duck, 4 Masked Lapwing, 36 Black Swan	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
20/04/2023	C (29711)	1150	1200	90	Nil	16.8	7.9	W	3	6 Pacific Black Duck	
20/04/2023	D (29773)	1210	1225	90	Nil	17.2	6.5	W	3	32 Black Swan	
20/04/2023	E (30412)	1235	1250	90	Nil	17.2	9.5	W	1	4 White Ibis	
20/04/2023	F (32558)	1305	1330	90	Nil	17.6	8.1	W	0	No Birds	
20/04/2023	G (29857)	1400	1420	80	Nil	16.9	12.3	W	3	4 Black Swan, 2 Australian Shelduck, 6 Pacific Black Duck, 2 Chestnut Teal	
20/04/2023	B (29614)	1500	1610	80	Nil	17.2	15.8	W	2	18 Black Swan, 6 Pacific Black Duck, 4 Eurasian Coot, 5 unidentified grebe spp.	
21/04/2023	Q (32542)	1010	1030	70	Nil	12.7	6.4	SE	1	130 Australasian Swamphen	
21/04/2023	I (32565)	1050	1130	70	Nil	13.3	7.3	SE	1	30 Black Swan, 24 Eurasian Coot, 4 Australian Shelduck	
21/04/2023	H (32580)	1100	1120	80	Nil	14.2	5.5	SE	3	2 Little Pied Cormorant, 6 Chestnut Teal, 2 Australian Shelduck	
21/04/2023	S (33291)	1150	1215	80	Nil	14.8	5.6	SE	2	300 Eurasian Coot, 7 White-faced Heron, 19 Chestnut Teal	
May 2023											

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
May-23 Landholder Observation	Tiverton Property	-	-	-	-	-	-	-	-	Adult Brolga pair and fedged juvenile From Q (32542) still foraging together in property and at grainlines.	
May-23 Landholder Observation	Roadside Wetland Near Wetland G	-	-	-	-	-	-	-	-	Up to 4 Brolgas (adult), 2 appeared to be roosting on one night	
17/05/2023	K (32667)	1110	1150	60	Nil	13.2	11.4	SE	4	4 Black Swan, 3 Eurasian Coot, 2 Masked Lapwing	
17/05/2023	L (32614)	1200	1230	60	Nil	13.2	12.4	SE	4	2 Masked Lapwing, 60 Eurasian Coot, 40 Chestnut Teal, 2 Black Swan, 1 Little Pied Cormorant	
17/05/2023	T (32671)	1240	1250	40	Nil	13.6	6.5	SE	4	No Birds	
17/05/2023	U (32610)	1300	1335	40	Nil	13.5	8.9	SE	1	5 Pacific Black Duck	
17/05/2023	N (29839)	1410	1450	40	Nil	14.1	4.3	SE	2	12 Australasian Swamphen, 2 Masked Lapwing	
17/05/2023	P (29753)	1510	1525	70	Nil	14.3	15.7	SE	0	2 Australian Shelduck	
17/05/2023	J (32664)	1545	1620	70	Nil	14.9	13.3	SE	3	30 Black Swan, 20 Eurasian Coot, 20 Australian Shelduck	
18/05/2023	A (29627)	935	955	30	Nil	12.6	4.3	NE	1	4 Australian Shelduck, 8 Australian White Ibis	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
18/05/2023	O (30401)	1015	1050	30	Nil	12.4	9.6	NE	3	4 Black Swan, 2 Australian Shelduck	
18/05/2023	R (29587)	1220	1250	45	Nil	14.2	3.8	NE	2	105 Black Swan, 4 White Ibis, 22 Eurasian Coot, 180 Australian Shelduck	
18/05/2023	C (29711)	1255	1310	60	Nil	14.5	6.2	NE	3	4 Black Swan, 2 Eurasian Coot	
18/05/2023	D (29773)	1315	1330	60	Nil	14.3	5.3	NE	3	2 Silver Gull, 6 Black Swan	
18/05/2023	E (30412)	1335	1355	60	Nil	14.6	2.1	NE	2	No Birds	
18/05/2023	F (32558)	1405	1415	60	Nil	14.8	6.4	NE	0	No Birds	
18/05/2023	G (29857)	1425	1435	60	Nil	14.6	61	NE	3	6 Black Swan, 4 Eurasian Coot, 2 unidentified grebe spp.	
18/05/2023	B (29614)	1510	1610	60	Nil	15.1	8.9	NE	2	23 Black Swan, 16 Australian Shelduck, 4 White-faced Heron	
19/05/2023	Q (32542)	1030	1105	80	Nil	11.6	2.6	W	1	80 Australasian Swamphen	
19/05/2023	I (32565)	1115	1140	80	Nil	12.4	6.6	W	2	8 Black Swan, 6 Pacific Black Duck	
19/05/2023	H (32580)	1120	1135	80	Nil	13.4	7.8	W	3	1 Little Pied Cormorant, 6 Pacific Black Duck, 2 Black Swan	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
19/05/2023	S (33291)	1145	1205	80	Nil	13.8	3.2	W	2	4 Black Swan, 250 Eurasian Coot, 6 unidentified grebe spp., 4 Masked Lapwing, 6 White-faced Heron	
June 2023											
08/06/2023	K (32667)	1035	1050	90	Nil	13.1	12.4	NW	3	12 Black Swan, 4 Masked Lapwing, 2 White-faced Heron	Recent heavy rain, 25mm
08/06/2023	L (32614)	1055	1115	90	Nil	12.9	16.8	NW	4	23 Black Swan, 45 Eurasian Coot, 1 Little Pied Cormorant, 20 Chestnut Teal,	
08/06/2023	T (32671)	1120	1125	100	Nil	13.2	22.2	NW	4	2 Black Swan, 3 Eurasian Coot	
08/06/2023	U (32610)	1135	1150	100	Nil	13.4	16.4	NW	1	3 White-faced Heron, 4 Pacific Black Duck, 2 White Ibis	
08/06/2023	N (29839)	1235	1300	100	Nil	13.3	19.9	NW	2	4 Masked Lapwing, 6 Australasian Swamphen	
08/06/2023	P (29753)	1325	1330	90	Nil	13.3	13.2	NW	0	No Birds	
08/06/2023	J (32664)	1400	1435	90	Nil	13.6	14.6	NW	4	20 Black Swan, 2 White-faced Heron, 8 Australian Shelduck, 4 Grey Teal, 10 Eurasian Coot	
08/06/2023	F (32558)	1455	1510	70	Nil	13.2	15.9	NW	0	No Birds	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
08/06/2023	E (30412)	1530	1545	70	Nil	12.9	19.4	NW	1	6 White Ibis, 3 White-Faced Heron	
08/06/2023	D (29773)	1600	1615	70	Nil	13.1	21.6	NW	4	2 Black Swan, 8 Silver Gull	
08/06/2023	C (29711)	1625	1640	70	Nil	12.7	25.4	NW	4	No Birds	
08/06/2023	R (29587)	1655	1720	80	Nil	12.6	26.8	NW	4	28 Black Swan, 8 Eurasian Coot	
09/06/2023	G (29857)	935	945	70	Nil	10.2	22.1	NW	3	8 Black Swan, 4 Pacific Black Duck, 2 unidentified grebe spp.	
09/06/2023	Q (32542)	1020	1050	70	Light Rain	10.9	22.3	NW	2	60 Australasian Swamphen, 1 White-faced Heron, 2 Masked Lapwing, 4 Black Swan	
09/06/2023	I (32565)	1105	1135	80	Light Rain	11.2	20	NW	1	6 Black Swan, 2 Pacific Black Duck, 6 Masked Lapwing	
09/06/2023	H (32580)	1115	1130	80	Light Rain	11.5	19.5	NW	3	1 Little Pied Cormorant, 3 Black Swan, 6 Grey Teal	
09/06/2023	S (33291)	1150	1205	80	Light Rain	12.1	17.4	NW	3	80 Eurasian Coot, 6 unidentified grebe spp., 4 Masked Lapwing, 2 Black Swan, 3 White-faced Heron	
09/06/2023	B (29614)	1240	1315	70	Nil	12.2	22.9	NW	2	14 Black Swan, 4 Australian Shelduck, 6 White-faced Heron, 6 Eurasian Coot	
09/06/2023	A (29627)	1405	1420	70	Nil	12.5	17.3	NW	0	No Birds	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
09/06/2023	O (30401)	1435	1450	70	Nil	12.3	15.4	NW	3	2 Black Swan	
July 2023											
19/07/2023	K (32667)	1110	1135	100	Light Rain	7.1	8.4	NNW	3	6 Black Swan, 2 Masked Lapwing,	
19/07/2023	L (32614)	1145	1230	100	Light Rain	8.2	7.5	NNW	5	2 Black Swan, 18 Eurasian Coot	
19/07/2023	T (32671)	1240	1255	90	Nil	9.3	13.5	NW	4	No Birds	
19/07/2023	U (32610)	1315	1340	90	Nil	10.8	16.4	N	1	2 Black Swan, 2 Pacific Black Duck	
19/07/2023	N (29839)	1415	1445	90	Nil	11.6	11.4	N	2	4 Australasian Swamphen	
19/07/2023	P (29753)	1500	1520	100	Nil	12.3	17.4	NNE	1	No Birds	
19/07/2023	J (32664)	1545	1630	100	Nil	12.2	16.9	NNE	4	22 Black Swan, 8 Grey Teal, 4 Australian Shelduck, 6 Eurasian Coot, 2 Silver Gull	
20/07/2023	A (29627)	945	1000	100	Light Rain	8.1	24.1	N	0	No Birds	
20/07/2023	O (30401)	1020	1040	100	Light Rain	7.9	18.6	N	4	No Birds	
20/07/2023	R (29587)	1125	1150	100	Light Rain	8.4	21.2	N	4	18 Black Swan (2 nesting), 4 Eurasian Coot, 2 Australasian Swamphen, 3 Silver Gull	
20/07/2023	C (29711)	1200	1215	100	Light Rain	8.7	15.6	N	4	No Birds	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
20/07/2023	D (29773)	1225	1250	100	Nil	9.2	15.9	N	4	4 Silver Gull, 2 Black Swan	
20/07/2023	E (30412)	1315	1335	100	Nil	8.9	16.2	N	2	4 White Ibis, 2 Pacific Black Duck, 2 Masked Lapwing	
20/07/2023	F (32558)	1350	1410	100	Nil	9.3	9.8	N	1	2 Black Swan, 2 Australasian Swamphen, 1 White-faced Heron	
20/07/2023	G (29857)	1430	1445	100	Light Rain	9.5	18.6	NE	3	4 Black Swan, 6 Eurasian Coot	
20/07/2023	B (29614)	1520	1545	100	Light Rain	9.7	17.3	NE	2	8 Black Swan, 4 Masked Lapwing, 18 Eurasian Coot, 2 unidentified grebe spp.	
21/07/2023	Q (32542)	1020	1045	80	Nil	7.6	6.5	NW	2	10 Black Swan (5 nesting), 54 Australasian Swamphen, 2 Masked Lapwing, 1 White-faced Heron	
21/07/2023	I (32565)	1105	1145	80	Nil	8.2	7.9	NW	2	8 Black Swan, 4 Masked Lapwing, 4 Silver Gull, 8 unidentified grebe spp.	
21/07/2023	H (32580)	1120	1135	70	Nil	8.5	3.5	NW	3	5 Black Swan, 12 Grey Teal	
21/07/2023	S (33291)	1150	1220	70	Nil	9.8	9.4	NW	3	2 Brolga (adult, flying overhead), 2 Black Swan, 2 Masked Lapwing, 6 Pacific Black Duck, 8 Eurasian Coot	Brolgas seen in flight, flying west over Tiverton property, landing out of sight towards wetland G.
August 2023											

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
16/08/2023	J (32664)	1340	1420	60	Nil	13.6	9.4	NE	3	27 Black Swan, 1 Musk Duck, 14 Australian Shelduck, 4 White-faced Heron, 60 Pacific Black Duck, 2 unidentified grebe spp.	
16/08/2023	N (29839)	1455	1520	60	Nil	14.3	15	NE	1	4 Masked Lapwing, 2 White-faced Heron, 2 Black Swan, 4 Australian White Ibis	
16/08/2023	B (29614)	1500	1540	60	Nil	14.4	13	NE	2	18 Black Swan, 2 Masked Lapwing, 1 White-faced Heron, 18 Pacific Black Duck	
17/08/2023	R (29587)	1000	1050	80	Nil	11.5	18.4	N	4	1 Brolga (adult), 2 Black Swan, 18 Pacific Black Duck, 1 unidentified grebe spp., 8 Australian Shelduck	Sitting on nest in deep section of wetland immediately adjacent to roadside.
17/08/2023	E (30412)	1100	1115	90	Nil	11	16.5	N	2	2 Australian White Ibis, 12 Australasian Swamphen	
17/08/2023	K (32667)	1140	1150	90	Nil	10.8	21	N	4	2 Black Swan, 8 Eurasian Coot	
17/08/2023	L (32614)	1155	1210	100	Nil	10.4	25.4	N	4	6 Eurasian Coot	
17/08/2023	T (32671)	1215	1220	100	Nil	10.3	24.6	N	4	No Birds	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
17/08/2023	U (32610)	1225	1235	100	Nil	9.9	32.1	N	2	2 Brolga (adult), 1 Eastern Great Egret	One sitting on nest in west edge of wetland, two eggs seen when Brolga stood up when disturbed by egret taking flight. One foraging in paddock, flew short distance when partner called after being disturbed off nest by egret.
17/08/2023	P (29753)	1250	1255	100	Light Rain	10	22.1	N	2	1 Black Swan (nesting)	
17/08/2023	F (32558)	1340	1355	100	Light Rain	7.8	28	N	1	1 Brolga (adult), 30 Australasian Swamphen, 1 Black Swan (nesting)	Sitting on nest in middle of wetland, stood up, at least one egg seen.
17/08/2023	A (29627)	1440	1455	100	Nil	8.3	27	N	0	No Birds	
17/08/2023	O (30401)	1510	1530	100	Nil	8.5	22	N	3	2 Black Swan	
18/08/2023	Q (32542)	950	1030	80	Nil	9	19	SW	2	8 Black Swan (3 nesting, 3 empty nests), 6 Masked Lapwing, 6 Australasian Swamphen, 18 Pacific Black Duck	
18/08/2023	I (32565)	1040	1120	80	Nil	9.2	16	SW	2	7 Black Swan, 14 Pacific Black Duck, 4 Masked Lapwing, 1 White-faced Heron, 2 White Ibis	
18/08/2023	H (32580)	1055	1110	80	Nil	9.6	13	SW	3	2 Little Pied Cormorant, 3 Black Swan, 6 Grey Teal	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
18/08/2023	S (33291)	1130	1150	70	Nil	9.6	21	SW	3	8 Black Swan, 4 Eurasian Coot, 8 unidentified grebe spp., 24 Pacific Black Duck	
18/08/2023	D (29773)	1210	1220	70	Nil	10.1	24	SW	3	2 Black Swan, 2 Silver Gull, 24 Eurasian Coot	
18/08/2023	C (29711)	1225	1235	70	Nil	12.4	17	SW	3	No Birds	
September 2023											
13/09/2023	A (29627)	1320	1340	50	Nil	16.9	9.9	N	0	6 Australian White Ibis	
13/09/2023	O (30401)	1355	1420	50	Nil	17.4	12	N	3	2 Black Swan, 4 Pacific Black Duck	
13/09/2023	J (32664)	1515	1540	60	Nil	17.7	14.3	N	3	2 Yellow-billed Spoonbill, 24 Black Swan, 18 Pacific Black Duck, 15 unidentified grebe spp., 4 Australian Shelduck, 1 White-faced Heron	
13/09/2023	N (29839)	1600	1625	60	Nil	17.9	7.6	N	0	No Birds	
14/09/2023	R (29587)	900	920	40	Nil	19.1	18.4	N	4	2 Brolga (adult), 6 White-necked Heron, 4 Black Swan	Foraging in wetland. Nest abandoned.
14/09/2023	C (29711)	925	935	60	Nil	19.4	15	N	4	No Birds	
14/09/2023	D (29773)	940	950	70	Nil	20.2	16.6	N	4	12 Black Swan, 5 Silver Gull, 18 Eurasian Coot	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
14/09/2023	F (32558)	1005	1030	80	Nil	20.6	14.9	N	3	1 Brolga (adult), 7 Black Swan, 1 White-necked Heron, 35 Australasian Swamphen, 1 White-faced Heron, 1 Little Pied Cormorant, 20 Grey Teal, 6 Pacific Black Duck	Foraging in grassland SW of wetland. Nest flooded/abandoned.
14/09/2023	L (32614)	1045	1055	90	Nil	21	16.3	N	4	6 Eurasian Coot	
14/09/2023	K (32667)	1105	1125	90	Nil	21.1	7.3	N	4	8 Eurasian Coot, 5 Hoary-headed Grebe	
14/09/2023	T (32671)	1130	1135	90	Nil	21	13.7	N	4	15 Black Swan	
14/09/2023	U (32610)	1145	1155	80	Nil	21.6	9.2	N	3	2 Brolga (adult), 3 Black Swan (1 Nesting) 1 White-necked Heron, 35 Hoary-headed Grebe, 6 Pacific Black Duck, 3 White-faced Heron, 16 Eurasian Coot	Foraging in adjacent shallow wetland. Flooded paddock, approx. 600 m ese of wetland. Nest empty, but not flooded.
14/09/2023	P (29753)	1220	1235	80	Nil	21.7	8	N	1	2 Black Swan 3 White-faced Heron, 2 Little Pied Cormorant, 1 White-necked Heron	
14/09/2023	B (29614)	1400	1440	80	Nil	24.3	18.6	N	3	2 Little Pied Cormorant, 18 Eurasian Coot, 5 Hoary-headed Grebe, 8 Pacific Black Duck	
14/09/2023	G (29857)	1500	1515	80	Nil	23.9	7.4	N	3	2 Black Swan, 40 Eurasian Coot, 2 Australian Shelduck	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
14/09/2023	E (30412)	1525	1540	90	Nil	23	16	N	2	18 Australasian Swamphen, 1 White-necked Heron, 2 Australian White Ibis	
15/09/2023	S (33291)	1010	1030	30	Nil	16.4	16.6	NW	2	2 Black Swan, 1 White-faced Heron, 50 Hoary-headed Grebe, 80 Eurasian Coot, 12 Pacific Black Duck	
15/09/2023	Q (32542)	1100	1125	30	Nil	17.3	14.3	NW	2	2 Brolga (adult), 84 Australasian Swamphen, 15 Black Swan (3 adults, 1 nesting, 13 young chicks), 4 Masked Lapwing , 2 Gull-Billed Tern, 430 Grey Teal, 1 White-necked Heron, 20 Pacific Black Duck, 5 Chestnut Teal	
15/09/2023	I (32565)	1140	1220	40	Nil	18.2	12.7	NW	2	3 Masked Lapwing, 4 Black Swan, 10 Pacific Black Duck	
15/09/2023	H (32580)	1150	1210	20	Nil	19.1	13.8	NW	3	6 Black Swan, 6 Grey Teal, 1 Little Pied Cormorant	
October 2023											
Oct-23 Landholder Observation	Tiverton Property	-	-	-	-	-	-	-	-	2 Brolga (adult)	Foraging in paddock north of wetland G.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
05/10/2023	K (32667)	1000	1025	70	Nil	8.9	17.3	NW	3	2 Silver Gull, 2 Masked Lapwing	
05/10/2023	L (32614)	1035	1055	70	Nil	8.8	14.3	NW	4	18 Eurasian Coot, 2 Black Swan, 6 unidentified grebe spp.	
05/10/2023	T (32671)	1105	1115	70	Nil	9.2	11.6	NW	4	8 Black Swan	
05/10/2023	U (32610)	1130	1145	50	Nil	9.4	9.4	NW	3	1 Yellow-billed Spoonbill, 18 Hoary-headed Grebe, 5 Pacific Black Duck, 1 Great Egret, 6 Eurasian Coot, 3 Black Swan (1 nesting)	No Brolgas seen. Nest abandoned.
05/10/2023	N (29839)	1220	1245	50	Nil	10.6	9.4	NW	0	No Birds	
05/10/2023	P (29753)	1310	1320	40	Nil	13.1	15.4	NW	1	2 Australian Shelduck	
05/10/2023	J (32664)	1340	1400	60	Nil	14.7	17.7	NW	3	2 Yellow-billed Spoonbill, 14 Black Swan, 2 Australian Shelduck, 25 Pacific Black Duck, 8 unidentified grebe spp.	
05/10/2023	F (32558)	1420	1440	60	Nil	15.1	21.4	NW	1	5 Black Swan, 4 Pacific Black Duck, 28 Australasian Swamphen, 1 White-faced Heron, 22 Grey Teal	No Brolgas seen. Nest abandoned.
05/10/2023	E (30412)	1500	1515	60	Nil	15.2	24.1	NW	2	8 Australasian Swamphen, 18 White Ibis, 2 Straw-Necked Ibis	

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
05/10/2023	D (29773)	1530	1545	60	Nil	16.2	22.2	NW	4	3 Black Swan, 5 Eurasian Coot	
05/10/2023	C (29711)	1555	1610	70	Nil	15.9	25.6	NW	4	2 Silver Gull, 4 Black Swan	
05/10/2023	R (29587)	1620	1650	70	Nil	16.4	21.6	NW	4	5 Black Swan, 5 Pacific Black Duck, 1 Yellow-billed Spoonbill	No Brolgas seen. Nest abandoned.
06/10/2023	Q (32542)	1010	1030	80	Nil	9.6	8.3	SW	1	45 Australasian Swamphen, 2 White-faced Heron, 6 Pacific Black Duck, 1 Great Egret	
06/10/2023	I (32565)	1050	1135	80	Nil	10.2	11.2	SW	1	1 Great Egret, 4 Black Swan, 2 Masked Lapwing, 4 Eurasian Coot	
06/10/2023	H (32580)	1105	1125	80	Nil	10.9	7.4	SW	3	4 Black Swan, 2 Little Pied Cormorant	
06/10/2023	S (33291)	1155	1215	90	Light Rain	11.4	7.6	S	3	6 Pacific Black Duck, 2 unidentified grebe spp.	
06/10/2023	B (29614)	1240	1310	90	Light Rain	11.7	14.2	S	3	2 Black Swan, 25 Eurasian Coot, 6 Pacific Black Duck, 4 unidentified grebe spp.	
06/10/2023	G (29857)	1435	1445	100	Light Rain	12.6	17.4	S	3	6 Black Swan, 4 Eurasian Coot, 2 Pacific Black Duck	
06/10/2023	A (29627)	1530	1545	100	Light Rain	12.7	20.2	S	0	No Birds	
06/10/2023	O (30401)	1610	1635	100	Light Rain	13.3	18.6	S	3	No Birds	

Appendix 2 Brolga breeding survey detailed results

Table 17 Year 3 Brolga breeding season survey data, November 2022 – October 2023

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
November 2022											
16/11/2022	N (29839)	1215	1305	50	Nil	16.8	4.1	SSE	3	6 Black Swan , 1 White-faced Heron, 1 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, Masked 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
17/11/2022	Q (32542)	950	1100	80	Nil	15.1	1.3	SSW	4	2 Brolga (1 adult and 1 chick), 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),	Brolga adult and chick foraging in grasslands near wetland on the se corner, close to predator proof fence line

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
17/11/2022	F (32558)	-	-	-	-	-	-	-	-	Road closed, no access to wetland.	-
December 2022											
15/12/2022	F (32558)	1240	1320	60	Nil	16.3	5.6	SW	2	6 Black Swan (2 nesting)	
15/12/2022	R (29587)	1340	1410	60	Nil	17.2	7.8	SW	3	1 Brolga (adult), 2 Black Swan, 2 Pacific Black Duck	Sitting on nest in flooded paddock section of wetland
15/12/2022	N (29839)	1445	1530	75	Nil	17.4	8.2	SW	3	4 Black Swan, 2 Masked Lapwing	
16/12/2022	Q (32542)	1030	1120	80	Nil	15.2	5.3	S	2	2 Brolga (adults, likely with 1 chick hidden), 6 Black Swan (3 Nesting)	Foraging on northern hill overlooking wetland, near windmill. Saw me before I saw them, called, and flew to eastern side of wetland, likely leaving chick hidden in tall grass.
16/12/2022	R (29587)	1145	1200	80	Nil	16.9	12.3	S	3	1 Brolga (adult), 2 Black Swan, 2 Pacific Black Duck, 1 White-faced Heron	Sitting on nest in flooded paddock section of wetland
16/12/2022	F (32558)	1220	1240	70	Nil	17.7	6.1	S	3	6 Black Swan (2 nesting)	
16/12/2022	U (32610)	1310	1325	60	Nil	18.2	7.6	S	3	3 Brolga (2 adult, 1 chick), 2 Masked Lapwing, 3 Black Swan	Foraging together in flooded paddock approx 200m se of wetland.
January 2023											

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
11/01/2023	N (29839)	1200	1300	0	Nil	26.6	6	W	2	2 Brolga, 2 White-faced Heron	Two adult Brolgas foraging in grassland to north. Adults resting and preening, some foraging behaviour, then spotted me and slowly walked east.
11/01/2023	U (32610)	1350	1430	10	Nil	29.2	7.5	W	2	3 Brolga, 6 Black Swan, 1 Masked Lapwing	2 adult Brolga and 1 chick resting / foraging in grassland to the south east. Chick was approx. two thirds the size of the adults. 5 Black Swan chicks sitting on old Brolga nest.
11/01/2023	F (32558)	1450	1510	10	Nil	32.5	3.1	W	2	3 Brolga	2 adults and 1 chick foraging towards centre of wetland. All ducked down when the car stopped on the side of the road nearby. Chick was approx. half the size of the adults.
11/01/2023	R (29587)	1525	1600	10	Nil	32	2.1	W	2	2 Brolga, 1 White-faced Heron, 5 Black Swan (2 adults, 3 chicks)	2 adults foraging in grassland in south eastern section of wetland. Could not see chick but likely hidden in dense grass, one adult open and closed beak as if calling but didn't hear from my view point.
12/01/2023	Q (32542)	940	1100	10	Nil	21.4	3.9	SW	1	4 Masked Lapwing, 1 Pacific Black Duck	No Brolga observed. Checked northern wetlands twice (waiting 20min between), and main wetland. Two adults with chick seen flying around Tiverton yesterday 11/1/23 but banded chick not confirmed.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
12/01/2023	R (29587)	1140	1230	0	Nil	25.4	3.8	SW	2	2 Brolga, 5 Black Swan (2 adults, 3 chicks)	2 adult Brolgas foraging around edge of wetland. Spotted me but continued to forage close together initially, later moved ~5m apart and 1 adult preening, then moved back side by side and continued foraging together. Regularly looking up and occasionally around. Chick likely to be hidden.
12/01/2023	F (32558)	1240	1250	0	Nil	26.9	3.5	SW	2	2 Brolga	2 adults approx. 20m apart in tall grass. Chick not visible. Wary behaviour mostly up and alert with car on side road.
12/01/2023	L (32614)	1310	1325	0	Nil	28.5	1.5	SW	3	270 Black Swan, 12 Silver Gull	
February 2023											
09/2/2023	F (32558)	1030	11:05	1	Nil	19.7	1.8	NE	0	1 White-faced Heron, 1 Australian Magpie	No brolgas.
09/2/2023	R (29587)	1030	12:20	0	Nil	23.9	11.1	W	3	4 Brolga (2 adult, 2 chicks), 4 Black Swan (one nesting), 4 White-faced Heron	Foraging in wetland, chicks about 6 weeks old, following adults closely. One sat down in water, got up and kept following the 2 adults and other chick. Short downy tail, feathers developed on the back.
09/2/2023	Q (32542)	Appro x 1400	1539	0	nil	28.4	11.1	WSW	2-3	3 Brolga (2 adults, 1 juvenile – band on right leg: orange on top, orange	3 Brolgas seen at 2:51:00 PM, 1 adult alert, 1 adult foraging, 1 juvenile sitting. Juvenile fledged - on southern side of predator proof

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
										bottom)south of wetland), 34 Australasian Swamphen, 11 White-faced Heron, 2 Black Swan, 1 White-bellied Sea-Eagle, 7 Chestnut Teal, 4 Masked Lapwing, 4 Little Pied Cormorant, 3 Australasian Grebe, 1 Swamp Harrier, 1 Brown Falcon	fence. Juvenile has a bit of red on top of head still and a bit of orange on the base of the bill. All three seen foraging during the observation period, within a green area of a paddock with cattle.
09/2/2023	I (32565)	1613	1619	0	nil	28.4	11.1	WSW	4	17 Grey teal, 5 Pacific Black Duck, 3 Chestnut Teal, 2 Australian Magpie, 2 Raven spp. (no call - no spp. ID)	
09/2/2023	F (32558)	1715	1740	0	nil	28.4	11.1	WSW	1-2	No waterbirds.	
09/2/2023	L (32614)	1810	1826	0	nil	26.7	18.5	SW	4	4 Brolga (2 separate adult pairs)	No notes on behaviour.
09/2/2023	U (32610)	1910	1915	0	nil	25.6	25.39	SW	4	3 Brolga (2 adults, 1 juvenile - band on right leg; orange top, white bottom)	Brolgas in wetland. No detailed observations, to minimise disturbance.
March 2023											
09/3/2023	U (32610)	1245	1310	80	Nil	16.4	13.9	SW	2	3 Brolga (2 adult, 1	Foraging together on se bank of

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
										juvenile)	wetland U.
09/3/2023	F (32558)	1335	1400	80	Nil	17.3	13.2	SW	0	No Birds	
09/3/2023	R (29587)	1430	1455	80	Nil	17.8	15.8	SW	1	5 Black Swan, 2 Australasian Swamphen	
10/3/2023	R (29587)	910	925	100	Nil	18.4	16.6	NW	1	6 Black Swan, 4 Australasian Swamphen	
10/3/2023	Tiverton Property	950	955	100	Nil	14.9	3.6	NW	-	2 Brolga (Adult)	Brolgas seen behind hayshed in paddock north of wetland s. Both took flight, landing out of sight approx 1km SW of wetland S.
10/3/2023	S (33291)	1015	1045	100	Nil	14.9	3.6	NW	2	120 Chestnut Teal, 6 Masked Lapwing, 1 Swamp Harrier, 2 White-faced Heron	
10/3/2023	Q (32542)	1105	1140	100	Nil	15.2	3.9	NW	1	80 Australasian Swamphen, 14 Masked Lapwing, 1 White-faced Heron	
10/3/2023	R (29587)	1225	1300	100	Nil	15.6	6.3	NW	1	4 Black Swan, 2 Australasian Swamphen	
10/3/2023	F (32558)	1330	1345	100	Nil	16.1	3.8	NW	0	No Birds	
10/3/2023	L (32614)	1400	1425	100	Nil	16.2	1.4	NW	4	2 Brolga (adult), 2 Black Swan, 36	Foraging together on paddock 300m north of wetland L.

Survey Date	Wetland ID	Start Time	End Time	Cloud Cover %	Rainfall	Air Temp	Wind Speed (km/h)	Wind Direction	Wetland Status	Species Observed	Brolga Behaviour
										Chestnut Teal	
10/3/2023	U (32610)	1445	1505	100	Nil	16.4	5.6	NW	2	3 Brolga (2 adult, 1 juvenile)	Foraging together on south bank of wetland U.

Appendix 3 Peregrine Falcon breeding season survey detailed results

Table 18 Year 3 Peregrine falcon breeding season survey data, November - December 2022, June - October 2023

Survey date	Start time	End time	Peregrine falcons observed?	Cloud cover %	Rainfall	Air temp	Wind speed (km/h)	Wind direction
2/11/2022	1250	1335	No Peregrine falcons	90	Nil	12.7	4.2	SW
29/11/2022	1230	1320	No Peregrine falcons	95	Nil	17.6	8.8	NE
30/12/2022	1555	1635	No Peregrine falcons	80	Nil	24.7	9.4	NW
9/6/2023 (opportunistic survey)	1510	1530	No Peregrine falcons	70	Nil	12.1	9.7	NW
20/7/2023 (opportunistic survey)	1610	1700	No Peregrine falcons	100	Light rain	10.1	13.2	NE
17/8/2023	1310	1330	No Peregrine falcons	100	Light rain	8.6	30	N
14/9/2023	1250	1340	No Peregrine falcons	80	Nil	25	12	N
6/10/2023	1335	1420	No Peregrine falcons	90	Light rain	12.2	11.8	S

Appendix 4 Symbolix report

symbolix

Dundonnell Wind Farm Mortality Estimate - Year 3

Prepared for Biosis, 30 April 2024, Ver. 0.9 - For review

This report outlines an analysis of Brolga mortality at Dundonnell Wind Farm from 2020-10-15 to 2023-10-10. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials from November 2020 to September 2023.
- Scavenger loss rates – estimated from trials from November 2020 to October 2023
- Mortality estimates - based on surveys at 80 turbines, from 2020-11-15 to 2023-10-10

1 Available data

Turbine data, mortality survey data, and adjunct survey data was provided by Biosis.

Brolga parameters were sourced from Veltheim (2018).

1.1 Data cleaning

Carcass finds (formal), incidental finds, searcher efficiency, scavenger efficiency data:

- Unidentifiable/unknown birds were recoded to “Unidentified Bird”
- Unidentifiable/unknown bats were recoded to “Unidentified Bat”
- Capitalisation and hyphenation made consistent

Scavenger efficiency:

- Carcasses listed as “Bat Proxy” were recoded to “House Mouse” (T. Lyten, *pers. comms*)

Otherwise, data was used as provided by Biosos.

2 Statistical 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 estimators project the number of found carcasses (C) up to the number of actual mortalities (M). They should account for:

- The probability a carcass will be detected by the searcher (p)
- The probability a carcass is not lost to scavenge or decay prior to the search (r)
- The probability a carcass falls within the searched area (a)
- The fraction of turbines searched (f)

Most mortality estimators, e.g. (M. M. Huso 2011), can be conceptualised as a ratio estimator

$$\hat{M} = \frac{C}{\hat{p} \cdot \hat{r} \cdot \hat{a} \cdot f} \tag{1}$$

with the terms in the denominator providing a "boost factor" to the number of carcasses found, C.

However, a limitation of analytical methods is estimating r 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. Additionally, ratio estimators cannot handle the cases when zero carcasses are found, as zero multiplied by any number still gives zero.

To address this, Symbolix have developed a Monte Carlo algorithm. We have used this method for mortality estimates at over forty 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 survey protocol, and sampling from empirical distributions for scavenge loss and searcher efficiency. In this way, we directly sample the probability a carcass was lost before the survey, negating the need to calculate r analytically each time.

We then estimate how many carcasses were truly generated, 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 (number of carcasses found).

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).

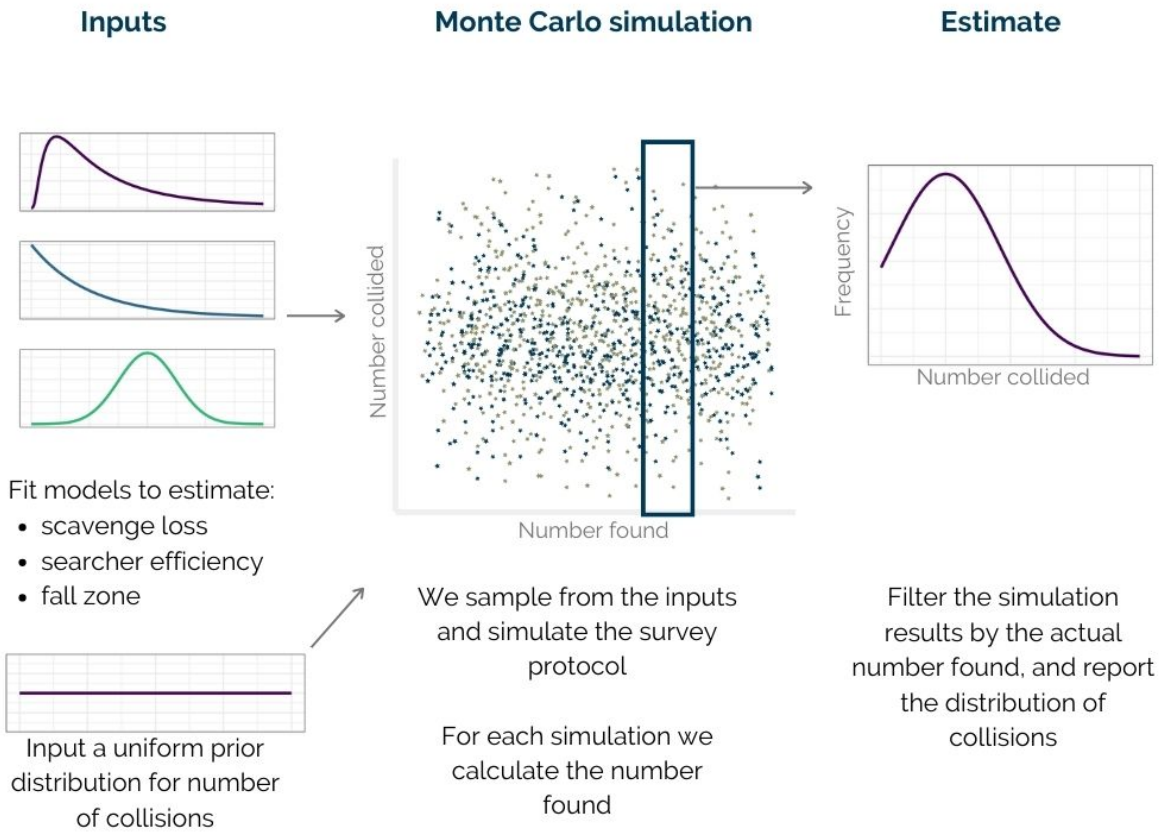

Figure 1: Overview of how the mortality estimation works.

The following sections outline how we estimate p, r and a. C is given by the field observation data, and f is defined by the survey design.

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

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.

The carcass searches provide the C and f terms in Section 2.

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.

100% of turbines were searched at Dundonnell. In the Monte Carlo algorithm, we explicitly simulate the survey design. The proportion of turbines sampled (f) is therefore accounted for in the simulation.

Table 1: Number of surveys per month.

Date	Brolga Survey	Pulse	Standard
2020 Nov	52	28	28
2020 Dec	51	27	27
2021 Jan	52	28	28
2021 Feb	50	28	28
2021 Mar	50	28	28
2021 Apr	50	28	28
2021 May	51	28	28
2021 Jun	53	26	26
2021 Jul	51	28	28
2021 Aug	50	28	28
2021 Sep	51	28	28
2021 Oct	52	28	28
2021 Nov	52	28	28
2021 Dec	52	28	28
2022 Jan	58	28	32
2022 Feb	46	28	32
2022 Mar	52	28	20
2022 Apr	52	28	28
2022 May	42	28	28
2022 Jun	43	28	28
2022 Jul	50	27	28
2022 Aug	75	28	56
2022 Sep	28	28	
2022 Oct	52	28	44
2022 Nov	31	28	12
2022 Dec	48	28	28
2023 Jan	49	28	28
2023 Feb	49	28	28
2023 Mar	49	28	28
2023 Apr	49	28	28
2023 May	49	28	28
2023 Jun	40	26	26
2023 Jul	32	28	28
2023 Aug	49	28	28
2023 Sep	49	28	28
2023 Oct	49	28	28

3.1.2 Carcass finds

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

Table 2: Carcasses found during formal surveys. Brolga highlighted.

Species	Bat	Bird	Feather Spot
Australian Hobby		1	
Australian Magpie		18	22
Australian Magpie (probable)			2
Australian Shelduck			1
Australian Spotted Crake		1	
Australian White Ibis			2
Black-shouldered Kite		1	
Brolga		**1**	
Brown Falcon		23	2
Brown Falcon (probable)		1	
Brown Goshawk		1	
Buff-banded Rail			1
Common Barn Owl		4	5
Common Starling		3	
Corvid sp.		11	
Dusky Moorhen		1	
Eastern Rosella (probable)			1
European Goldfinch		4	
Fantail sp.		1	
Finch sp.		1	
Galah		4	
Grey Fantail		1	
Ibis sp.		2	
Little Button-quail		1	
Musk Lorikeet		1	
Nankeen Kestrel		39	7
Nankeen Kestrel (probable)		2	1
Painted Button-quail		1	
Peregrine Falcon		1	
Raven sp. (probable)			1
Rock Dove			1
Rosella species			1
Silvereye		2	
Skylark sp.		1	
Sparrow sp.		1	
Spotless Crake		1	
Straw-necked Ibis		6	6
Striated Pardalote		3	

Table 2: Carcasses found during formal surveys. Brolga highlighted. *(continued)*

Species	Bat	Bird	Feather Spot
Stubble Quail		3	
Sulphur-crested Cockatoo			1
Unidentified Bird		10	21
Unidentified Passerine		2	1
Unknown Parrot		1	
Wedge-tailed Eagle		10	
Whistling Kite		1	
Whistling Kite (probable)		1	
White-faced Heron (probable)			1
White-throated Needletail		2	1
Eastern False Pipistrelle	2		
Eastern False Pipistrelle (probable)	1		
Gould's Wattled Bat	5		
Gould's Wattled Bat (probable)	2		
Grey-headed Flying-fox	1		
Large forest bat (probable)	1		
Southern Bent-winged Bat	3		
Unidentified Bat	37		
Wattled Bat sp.	2		
White-striped Free-tailed Bat (probable)	7		
White-striped Freetail Bat	76		
White-striped Freetail Bat (probable)	2		

A number of carcasses were also found incidentally. They are reported for completeness in Table 3.

Table 3: Incidental carcass finds.

Species	Number found
Australian Magpie	28
Baillon's Crake (TBC)	1
Brown Falcon	23
Brown Falcon (probable)	1
Common Barn Owl	11
Common Starling	4
Corvid sp.	4
Crested Pigeon	1
Eurasian Coot	1
Fantail sp.	1
Galah	1
Gould's Wattled Bat	2
Grey-headed Flying-fox	3
Lesser Long-eared Bat	1
Nankeen Kestrel	36
Nankeen Kestrel (probable)	1
Pacific Black Duck	1
Pallid Cuckoo	2
Peregrine Falcon	1
Skylark sp.	1
Straw-necked Ibis	4
Unidentified Bat	4
Unidentified Bird	17
Wedge-tailed Eagle	17
Whistling Kite	1
White-striped Freetail Bat	14
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 Field methods

The searcher efficiency data is sourced from trials conducted from November 2020 to September 2023. Carcasses were laid out, and a trained detection dog (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 carcasses or 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).

For the dog trials, birds (80 replicates), and bats (87 replicates) were used. For the human/binocular trials Brolga (carcasses and feather spots, 34 replicates) and Brolga proxies (Turkeys, 61 replicates) were used (Table 4).

Table 4: Count by species class and observer used during the detection trials.

Species type	Binoculars	Dog	Human
Bat		87	
Bird		80	13
Brolga Feather Spot	10		11
Turkey (Brolga Proxy)	61		

3.2.2 Statistical methods

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.

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.

3.2.3 Results

For binocular based surveys, the most parsimonious model of searcher efficiency models was the "intercept-only" model (i.e. all carcasses have the same expected searcher efficiency). For dog surveys, the parsimonious model was split by bat/bird. Brolga detection efficiencies are modelled separately due to the different search method.

The expected searcher efficiency for birds (by dogs) is 99%, with a 95% confidence interval of [93%, 100%]. The expected searcher efficiency for brolgas (by humans using

binoculars) is 81%, with a 95% confidence interval of [72%, 88%].

We do not use the Bat estimate in this report, as it only concerns Brolga.

Table 5: Detection efficiencies for Bats, Birds and Brolgas.

Variable	Bats (Dog)	Birds (Dog)	Brolga (Binocular)
Number found	79	79	77
Number placed	87	80	95
Mean detectability proportion	0.91	0.99	0.81
Detectability lower bound (95% CI)	0.83	0.93	0.72
Detectability upper bound (95% CI)	0.96	1	0.88

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 Section 2.

3.3.1 Field methods

Scavenger efficiency trials were conducted from November 2020 to September 2023. The trials ran over approximately 40 days. In total, 59 brolga proxy (turkey) carcasses were used. Trials used cameras in order to record exact times of scavenge events.

We note that general bird and bat proxies were also used, but are not considered in this report.

3.3.2 Statistical 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, ∞] (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).

3.3.3 Results

Figure 2 shows the survival curve fitted to the brolga proxy carcasses. The survival curve (smooth solid line for fitted regression curve, jagged step function for empirical removal rate) 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 brolga carcass removal via scavenge is 18.2 days, with a 95% confidence interval of [11, 30.6] days.

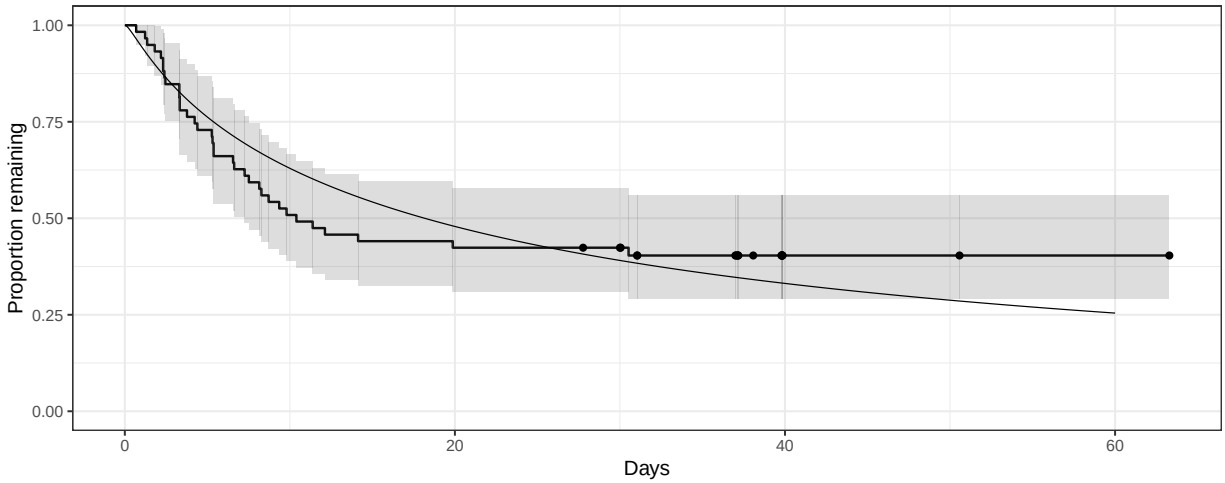

Figure 2: Empirical survival curve of Brolga (the step function), with 95% confidence intervals shaded. The smooth curve presents the fitted model.

Note: while we chose to aggregate all carcasses, there was evidence that the carcass persistance rate of the Brolga Proxies was much faster in the third year (median scavenge time of approx. 40 days) verses the first two years (median times approx. 10 days). This requires review and discussion of the most appropriate way forward, as the scavenger rate strongly influences the mortality estimation.

3.4 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 Section 2.

3.4.1 Fall zone simulation - methods

We generated a carcass fall-zone distribution for brolgas, given the turbine size at the wind farm.

The fall-zone distribution is the end result of the simulation method detailed in Hull and Muir (2010). The simulation method is a ballistics model describing animal strikes by turbine blades.

3.4.2 Coverage factor calculation - methods

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.

3.4.3 Simulation inputs

Table 6 displays the dimensions and RPM of the turbines at Dundonnell Wind Farm while Table 7 shows the bird and bat physical parameters used. These are input into the fall zone simulation.

Turbine specifications were provided by Biosis. Brolga parameters were sourced from Veltheim (2018).

Table 6: Turbine specifications for Dundonnell Wind Farm.

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

Table 7: Brolga size parameters.

Species	Mass (kg)	Min. area (sq m)	Max. area (sq m)
Brolga	7.46	0.1	0.475

3.4.4 Results

Figure 3 displays the simulation results, given the factors specified above. We display the cumulative density function (CDF) on the y axis versus the distance from turbine on the 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 78% of Brolga carcasses to fall within 140m of the turbine.

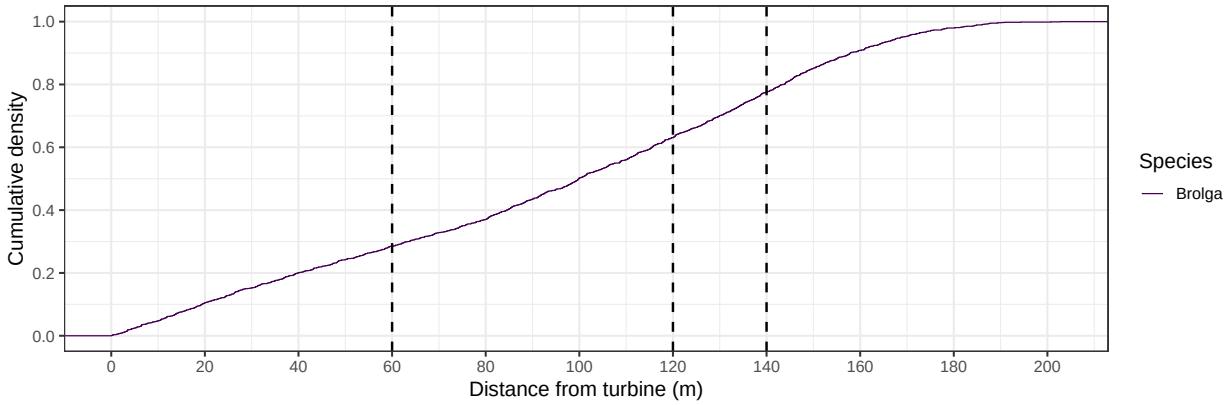

Figure 3: Cumulative distribution function of the fall zone simulation output for Brolga. Vertical lines indicate the Pulse, Standard, and Brolga survey radii.

Once the fall zone distribution is calculated, we generate a "coverage factor". The coverage factor represents the expected proportion of carcasses which fall within the searched area, given the search protocol.

On average, we assume that 61% of Brolga strikes will land within the searched area.

4 Mortality estimate

With estimates for scavenge loss, searcher efficiency, and survey coverage, we converted the number of Brolga carcasses detected, into an estimate of overall mortality at Dundonnell Wind Farm from 2020-10-15 to 2023-10-10, as well an estimate for the Year 3 (2022-10-11 to 2023-10-10).

The mortality estimation is done via a Monte Carlo algorithm. We used 25000 simulations, 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 available to strike bats and birds.
- 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 from 2020-10-15 (approximately one month from the first survey), until the final surveyed date (2023-10-10).
- Brolgas are on-site at all times during this period.
- Brolgas 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 being involved in a collision / mortality.
- We took scavenge loss and searcher efficiency rates as outlined above.
- We assumed a log-normal scavenge shape.
- 80 turbines (100% of the farm) were surveyed (96% of the turbines were surveyed in Year 3). Turbines were searched out to a 120 metre radius for standard surveys, a 60 metre radius for follow-up pulse surveys, and a 140 metre radius for the binocular-based Brolga surveys, in accordance with the supplied survey data.
- The coverage factor was 61% for Brolgas.

4.1 Brolga

During the three years of surveys, one Brolga was found during formal surveys. The resulting (median) estimate of total mortality is 3 Brolgas lost on site over the three year period. The (median) estimate of mortality in Year 3 is 2 Brolgas.

We note that during Year 3, no Brolga carcasses were found. Therefore, we have no evidence that Brolgas were struck during this period (as opposed to Years 1-2, where we *did* have evidence Brolgas were struck). As the mortality estimator has an assumption that at least one bird was struck, the Year 3 estimate is likely biased high (i.e. a conservative estimate).

Table 8 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 3 Brolgas, and are 95% confident that fewer than 8 individuals were lost, in the three year period.

Table 8: Percentiles of estimated total Brolga losses in the three years of surveys.

Model	0%	50% (median)	90%	95%	99%	99.9%
Cumulative (3 years combined)	1	3	7	8	12	16
Year 3	1	2	5	6	9	13

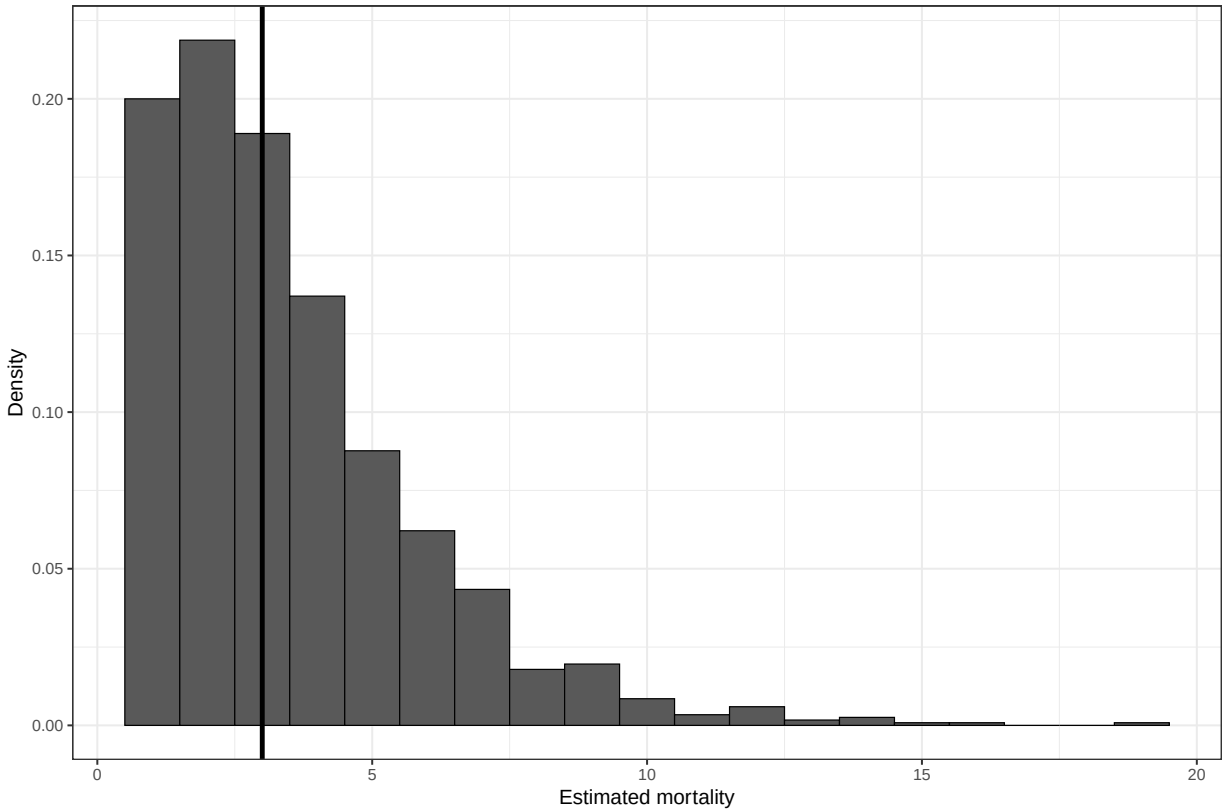

Figure 4: Histogram of the total losses distribution (brolgas). The black solid line shows the median.

Note: The cumulative (3 year) estimate in this report is lower than the 2-year estimate from the previous report (Symbolix 2023). This is driven by the change in the scavenger efficiency rate estimate.

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