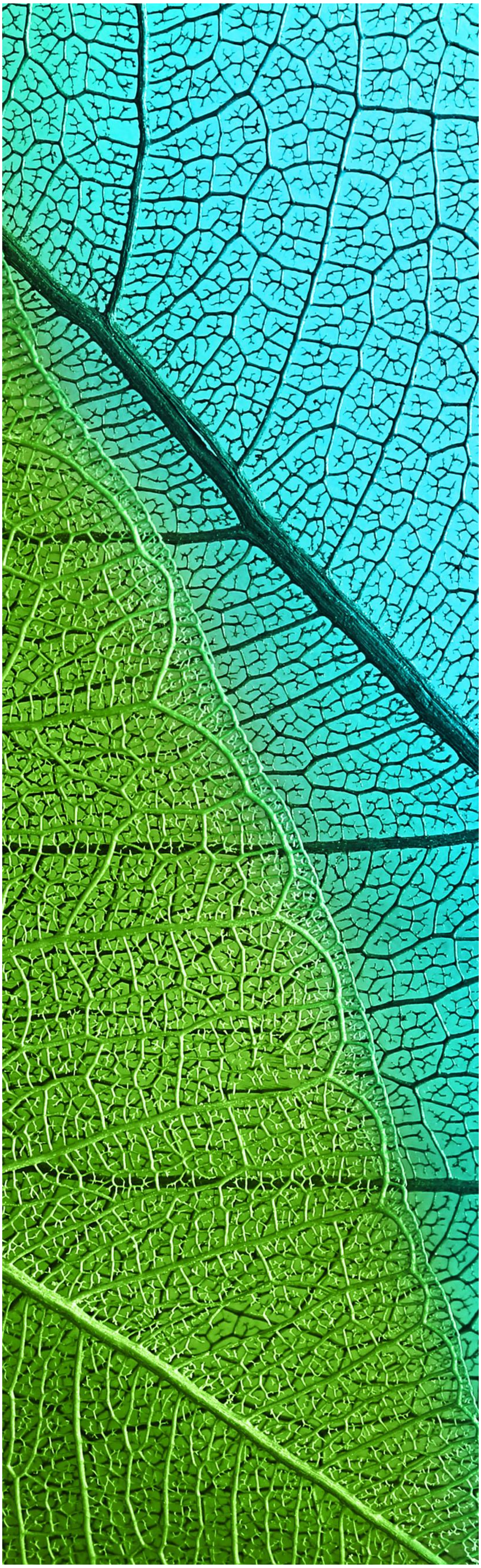

Murra Warra Wind Farm

Implementation of the Bird and Avifauna Management Plan - 2 Year Monitoring Report

Prepared for Murra Warra Project Co Pty Ltd

June 2022
Report No. 19049.1 (14.1)

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1. Introduction

The Murra Warra Wind Farm (MWWF), located near Horsham in the Wimmera Bioregion of Western Victoria (VIC), received planning approval for 116 turbines and associated infrastructure development (Horsham Permit No. PA1600127 and Yarriambiak Permit No. PA1600128). The wind farm is approximately 10 kilometres north-east of Murra Warra, 32 kilometres north of Horsham and 25 kilometres east of Dimboola.

Under the planning approval; Conditions 56, 57 and 58 for PA 1600127A and Conditions 57,58 and 59 for PA 1600128B57 detail the requirement for the development and implementation of a 'Bat and Avifauna Management Plan' (BAMP) for MWWF, which was approved in August 2017 (Biosis 2017).

RES Australia Ltd engaged Nature Advisory Pty Ltd to implement the BAMP for stage 1 of the wind farm, comprising 61 turbines.

The purpose of this 24-month monitoring report is to summarise the implementation and progress of the monitoring program and provide any conclusions and recommendations for future bat and bird impact monitoring and management.

The 24-month monitoring program has included:

- Monthly carcass searches under 20 fixed random turbines,
- Carcass persistence trials and searcher efficiency trials,
- Incidental raptor monitoring.

Section 3.5 of the BAMP outlines that at the completion of the 24-month monitoring program, the report will include:

- *"Tabulated results of searches and incidental finds for all bird and bat collisions (carcasses & feather spots), including results for turbines fitted with aviation warning lighting and details of any operation of the lighting during the reporting period.*
- *Estimated total of annual mortalities for all listed species detected in carcasses searches.*
- *Results of all bird and bat monitoring investigations."*

This report addresses the above points in the following sections:

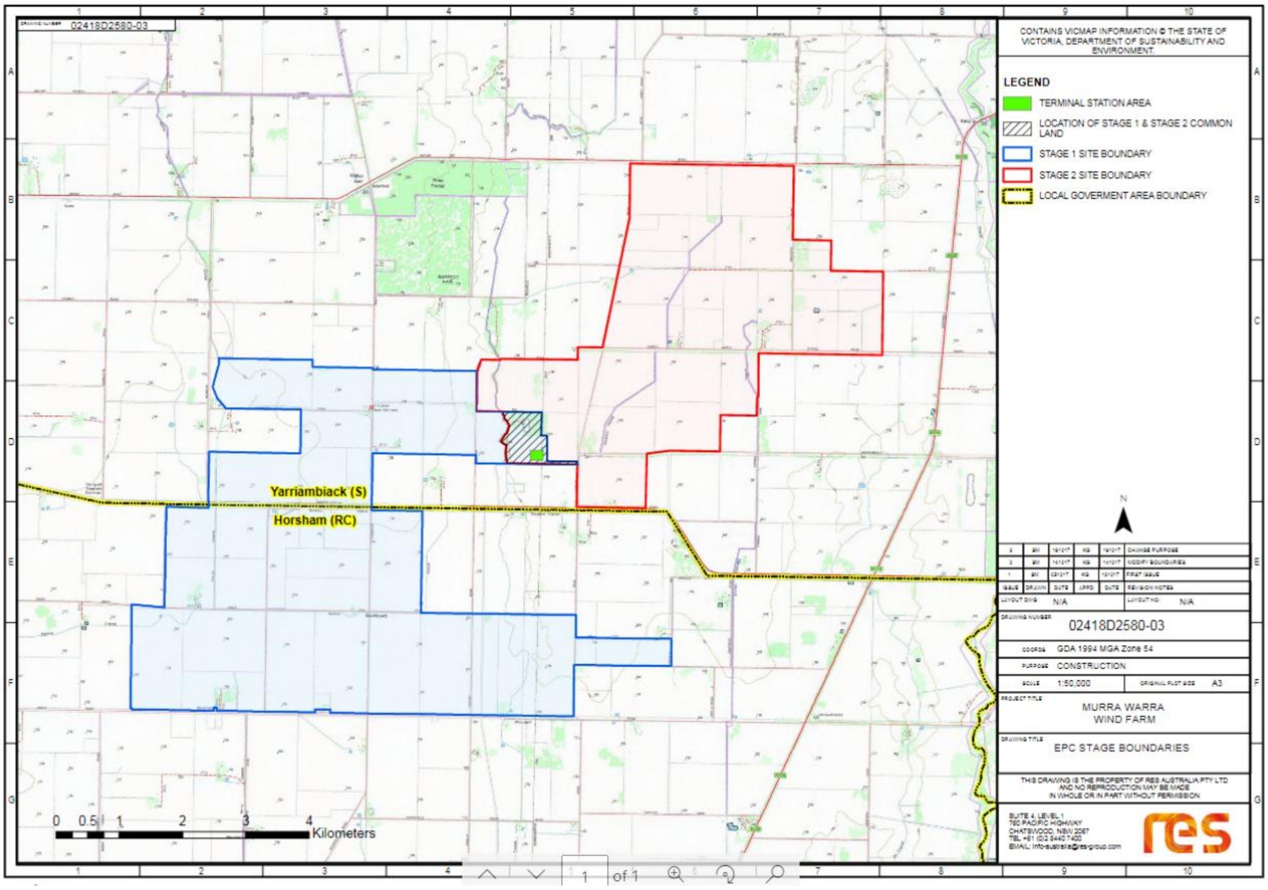
Section 2: the methods of the postconstruction utilisation programs, including Raptor surveys and mortality monitoring program.

Section 3: Presents results of monitoring programs.

Section 4: Provides discussion of results and presents recommendations.

This BAMP implementation and reporting has been carried out by Eamon O'Meara (Zoologist and Dog Handler), Andrew McVinish (Zoologist and Dog Handler), Liz Browne (Zoologist and Dog Handler), Amy Tipton (Zoologist and Dog Handler), Clinton Schipper (Zoologist and Dog Handler), Jackson Clerke (Senior Ecologist and Project Manager), Bernard O'Callaghan (Director) and Brett Lane (Principal Consultant).

Figure 1: Murra Warra Wind Farm location



2. Methodology

The following section summarises the methods from Section 3.2 of the BAMP; Turbine collision carcass searches and trials.

2.1. Mortality monitoring

The MWWF BAMP outlined a mortality monitoring regime designed to determine the impact on birds and bats from collision with operating wind turbines. To enable a statistically robust analysis to be undertaken, a fixed randomly selected 33% of turbines were searched for the duration of the monitoring program. Monitoring began in March 2020 and was undertaken monthly under 20 of MWWF's 61 turbines. The total anticipated area searched each month equalled 50.82ha across 20 turbines.

Turbines were selected randomly at the commencement of the program for monitoring taking into consideration OH&S issues which must be avoided such as search areas falling onto public roads. The selected turbines are provided in Table 1 below.

Table 1: Mortality search selected turbines

Selected Murra Warra turbines									
15	21	29	30	40	53	66	103	151	154
158	161	190	195	198	214	216	217	220	224

Scent detection dogs have been found to be more efficient at detecting carcasses than humans (Mathews et al 2013, Paula et al 2011) and as such, this was the primary detected method used for the duration of the mortality monitoring program. Each turbine was searched to a radius of 90 metres by an experienced dog handler working with "Kitty" or "Gir", Nature Advisory's specially trained detection dogs. The search method consisted of the handler walking at approximately 20 metre spaced transects across the radius into the direction of the wind (where possible) and directing the highly trained scent detection dog to search both sides of each transect. The dog's position was tracked in real time via a hand-held GPS unit linked to a GPS tracking collar fitted to the dog. Weather observations and information related to the searches were recorded for each search on data sheets in the field.

It is assumed that any dead bird, bat or feather spot (ten or more wing or tail feathers), detected beneath a turbine has died as a result of collision or interaction with a turbine, unless there are obvious signs of another cause of death (e.g., shot). A feather spot is assumed to be a carcass that has been scavenged by a scavenger, such as a fox, leaving only feathers. For any carcass of feather spot found the following variables were recorded in a pre-prepared pro-forma:

- GPS position, distance and compass bearing of the carcass from the wind turbine tower;
- Species, age, number, sex (if possible);
- Signs of injury and estimated date of strike; and
- Weather details at the time of detection.

Upon discovery each carcass or feather spot, the searcher:

- Photographed the carcass in situ;
- Removed it from site to avoid re-counting; and

- Stored the carcass in a freezer at the site office so the identification could be verified or used later in searcher efficiency and scavenger trials (Section 2.3 & 2.4). before collection and storage at a freezer on site.

In addition, any carcasses found by wind farm staff or at turbines not included in the selected turbines have been recorded as incidental finds and the same data is collected.

The location and area of the turbines searched are shown in Figure 2.

Figure 2: Mortality search selected turbines

Project: Murra Warra Wind Farm
Client: RES Australia Pty Limited
Date: 12/08/2022

● Turbines
90m search radius

N

Metres
0 600

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Limitations

During the spring and summer months of the monitoring period the cropping land surrounding the turbines at MWWF saw significant growth and yields following high levels of seasonal rain in the region. This limited the ability of the zoologist and scent detection dog to undertake full searches of the entire radius under certain turbines due to; the presence of snakes inhabiting the cropped areas presenting an unacceptable risk to dog and handler, dense cropping impeding movement and access, and crop stubble presenting risk to the dog when at eye level.

Instead, an alternative search area of just the hardstands and access roads were monitored during months where there was significant crop growth. This reduced search area will be accounted for through in the mortality estimates (Section 3.1).

The scent detection dog was injured during December 2020, and therefore could not attend the monthly carcass searches. Instead searches of the hardstands were conducted by Eamon O'Meara on foot.

Monthly carcass searches were not conducted in March 2021 and July 2021 due to the risk of Covid 19 transmission to on site and lockdown restrictions in Melbourne.

2.2. Incidental raptor monitoring

Although not a requirement of the MWWF BAMP, Zoologists from Nature Advisory recommended raptor monitoring be conducted in conjunction with the carcass monitoring program due to detected raptor mortality. Incidental raptor observations were made while carcass searchers were traversing the wind farm site and searching under turbines. Raptors were observed with binoculars, on foot and from vehicles.

Data recorded included:

- Species, number, age and sex (if known) of all raptors
- Date and time of day
- Time and duration of flight
- Number of birds
- Direction of flight
- Height above ground
- Flight behaviour of the bird (e.g., flapping, circling, soaring, hovering, foraging, perched etc.)

Limitations

Incidental raptor surveys were not conducted from March 2021 – September 2021.

2.3. Carcass persistence trial

Carcass persistence trials were undertaken to determine the probability of scavenge loss at a given time, and the nature of scavenge removal (e.g., an early peak in activity, or activity that peaks after carcasses have been in place for a period). It is important to ascertain the rate at which carcasses are removed by scavengers to create a correction factor for later estimation of total carcasses generated (Section 3.5).

Section 3.2.7 of the BAMP details the process for carcass persistence trials. The approach detailed in the BAMP places carcass in the search area and then an observer comes back regularly to check on whether the carcass has been scavenged.

A modified methodology has been adopted for the scavenger trials where a motion sensor camera is used to monitor scavenger activity taking place, which can provide more accurate timing of scavenging and also identify scavengers. Each trial was located within the vicinity of operating turbines and within the search radius if possible. Turbines used were the same as those used for mortality searches.

To determine the scavenging rates on birds and bats, three size categories of carcasses were used (small, medium, and large). Where carcasses of the species of concern could not be found, a similar sized substitute has been used. The aim has been to use ten carcasses of each size category during each scavenger trial, or 20 per year per size category. In practice this has not been feasible as 10 solely 'large birds' could not be sourced. Sourcing unprocessed (not gutted, plucked, cleaned) poultry, for example, is illegal and would also not be an accurate representation of naturally occurring, fallen carcasses under turbines. Therefore, a mix of small bird and bat and medium birds was employed for each trial.

The motion sensor cameras were attached to trees or fence posts approximately 3-4 metres away from each placed carcass. The camera recorded any scavenging activity on a 32 GB SD card. The placement of the carcass was reviewed at each deployment to ensure that the carcass is appropriately in the frame of the camera before being left in the field.

The carcass was left for a period of 30 days after which the camera and SD card were collected, and scavenging activity reviewed. If the carcass remained after this time, it was assumed that the carcass was not scavenged. The information recorded captured the exact time and date and provided a photograph of which scavenger, if any, took the carcass.

Limitations

Limitations to the trial included less successful deployments of carcasses than required by the BAMP. This was related to the theft or removal of some remote motion sensor cameras that were not recovered, and equipment malfunction which resulted in lost or corrupted data.

Additionally, there was difficulty in sourcing enough useable carcasses during the 24-month monitoring period, as most carcasses found during the monitoring program were decomposed and unusable for scavenging purposes. Mostly substitute carcasses had to be used for bats in the form of black mice (difficult to find, as most pet supply stores stock white mice) and birds were supplemented with Common Mynah (*Acridotheres tristis*) carcasses. Common Mynahs are a pest species introduced to Australia and carcasses were sourced from a community group that undertakes an eradication program. Sourcing enough of these and transporting them to MWWF proved difficult during Covid-19 lockdowns and restriction periods.

While these limitations are regrettable, the lower numbers of scavenger data collected did not undermine the viability of data collected on scavenging rates as a correction factor presented in Section 3.5 and Appendix 1.

As acknowledged in the methods above, carcass persistence trials were intended to be undertaken seasonally to determine differences in scavenger activity and rates. This could not be reasonably achieved over the monitoring program, again due to Covid-19 restrictions on movement and persons attending sites and across the state of Victoria. A such, most of the program took place in summer.

A publicly available study by Symbolix (2020) has shown that there was no significant difference between scavenger rates at 10 different wind farms in Victoria between seasonal trials and therefore this approach was not predicted to affect the viability of the correction factor as part of the mortality estimates.

2.4. Searcher efficiency trial

In addition to the carcass persistence trial correction factor described above, the searcher efficiency must also be considered. It is not expected that searchers will find every carcass that falls on the ground under the turbine. Therefore, the average efficiency of searchers is tested to determine at what rates they will find birds and bats on the found during a given search. This is then used a correction factor in mortality estimates.

Twenty carcasses were placed randomly within the 90-metre search radius of around five or six of the turbines to be searched. These carcasses were a range of birds or bats found at the Murra Warra site or a similar substitute (e.g., Common Mynah or mice).

An ecologist from Nature Advisory not involved in monthly searches placed all carcasses ahead of the searcher arriving at a turbine and the search team was not aware of the positions. A blind trial was not considered necessary as the detection dog is unaware of the trial taking place as opposed to any other search activity. GPS coordinates were taken for each placed carcass to ensure that each was not confused with an actual find. Upon completion of each search the search team informed the carcass placer what they had found, and the placer returned to each turbine to determine what they had found or missed.

The BAMP states that four searcher efficiency trials will be conducted over the two-year monitoring period, two trials when grass height is short and two when grass height is long. Trials were conducted in May 2020, October 2020, May 2021, and January 2022.

2.5. Mortality estimates

A mortality estimate based on carcass monitoring data, and scavenger and efficiency trials as correction factors, has been undertaken by statistical data analysis consultancy Symbolix. Full methods and results for this are found in Appendix 1.

The modelling extrapolates mortality data based on data recorded by Nature Advisory, and presented in this report, across the entire site in an effort to establish impacts on birds and bats the site is potentially having.

3. Results

This section provides and summary of results for all monitoring activity and trials undertaken during the monitoring program.

3.1. Mortality monitoring

Over the 24-month monitoring period, a total of 134 carcasses were detected. This consisted of 33 bird carcasses, 88 bat carcasses, 10 feather spots and three incidental finds. A summary of results is shown in Table 2. Detailed results of the carcass searches are shown in Appendix 2.

In the first 12 months of the mortality searches 71 mortalities were detected. This consisted of one incidental find detected by wind farm staff, 19 bird carcasses, 51 bat carcasses, and one feather spot. In the second year, 62 mortalities were detected consisting of 15 bird carcasses, 37 bat carcasses, nine feather spots, and one incidental find.

Table 2: Summary of 24-month monitoring results

Season	Month	Bird	Bat	Feather spot	Incidental	Total mortalities
Autumn	Mar-20	1	7	0	1	9
	Apr-20	4	16	0	0	20
	May-20	3	10	0	0	13
Winter	Jun-20	3	0	0	0	3
	Jul-20	0	0	0	0	0
	Aug-20	1	1	0	0	2
Spring	Sep-20	2	0	0	0	2
	Oct-20	0	1	0	0	1
	Nov-20	0	1	1	0	2
Summer	Dec-20	0	0	0	0	0
	Jan-21	3	7	0	0	10
	Feb-21	1	8	0	0	9
Autumn	Mar-21					
	Apr-21	1	8	1	1	11
	May-21	0	10	0	0	10
Winter	Jun-21	2	1	0	0	3
	Jul-21					
	Aug-21	0	0	1	1	2
Spring	Sep-21	2	3	0	0	5
	Oct-21	2	0	3	0	5
	Nov-21	3	1	4	0	8
Summer	Dec-21	1	4	0	0	5
	Jan-22	1	4	0	0	5
	Feb-22	2	1	0	0	3
Autumn	Mar-22	0	2	0	0	2
	Apr-22	1	3	0	0	4
	Totals	33	88	10	3	134

Figure 3 below demonstrates mortality results by month and season consecutively.

In the first two years of monitoring autumn saw the highest mortalities, driven primarily by bat mortality which spiked in April 2020 and May 2021. Mortality averaged less than four bats per month, ranging between zero (during winter) to a high of 16 in a single month.

Bird mortality was more consistent across the monitoring period averaging just over one mortality a month, ranging between zero to four.

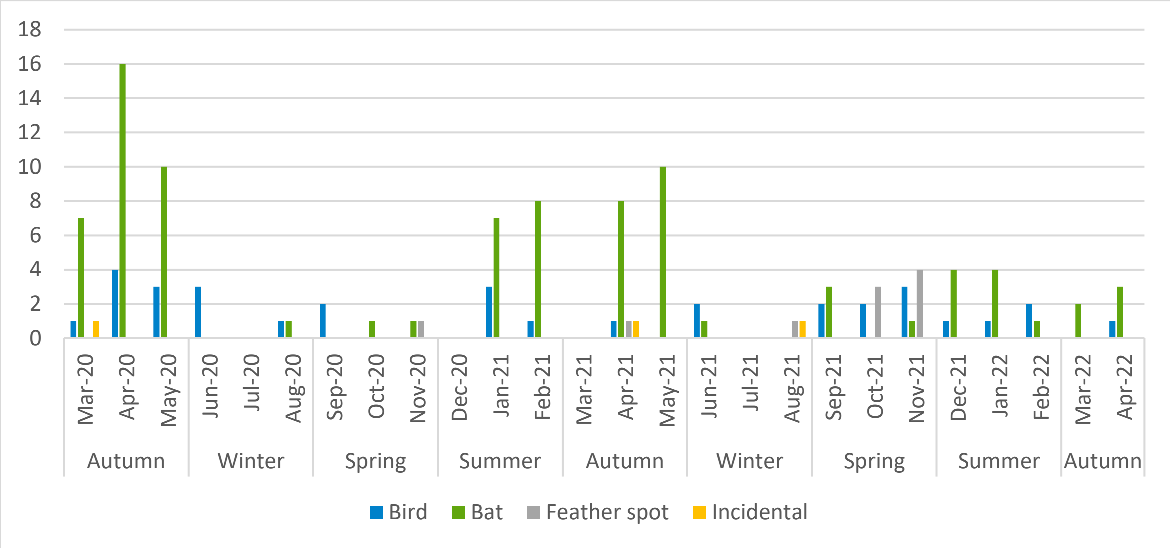

Figure 3: Monthly mortalities

Bat mortality alone made up 66.4% of mortalities found. A total of four species of bats were identified as mortalities. One individual specimen could only be identified to genus level and an additional seven individuals could not be identified even to genus due to advanced decomposition or scavenging leading to a lack of identifying features remaining.

White-striped Freetail Bat held the highest mortality rate with 36 individuals detected over 24 months making up 40.4% of bat mortality and 26.9% of all mortality (birds, bats, and feather spots) combined. Southern Freetail Bat held the second highest mortality of the bats with 26 mortalities, followed by Gould's Wattled Bat with 18 mortalities. Seven individual bat specimens were detected that could not be identified to family or species level due to the state of decomposition and damage, leaving no identification features. Table 3 shows the total bat mortality per species.

Table 3: Total bat mortality over 24 months

Common name	Scientific name	Total mortalities	% Total of bat mortalities	% Total of all mortalities
White-striped Freetail Bat	*Austronomus australis*	36	40.4	26.9
Southern Freetail Bat	*Mormopterus planiceps*	26	29.2	19.4
Gould's Wattled Bat	*Chalinolobus gouldii*	18	20.2	13.4
Unknown Bat sp.	*NA*	7	7.9	5.2
Chocolate Wattled Bat	*Chalinolobus morio*	1	1.1	0.7
Wattled Bat sp.	*Chalinolobus Sp.*	1	1.1	0.7
				66.4

The turbines responsible for the highest bat mortalities were Turbines 151 and 154 in the north of the wind farm. These turbines both recorded 11.4% of the bat mortalities with 10 mortalities each. These are followed by Turbine 217, which is in the south of the site, with 9.1%, and turbine 158, which is nearby Turbines 151 and 154, with 8%. Table 4 shows bat mortalities at each turbine.

Table 4: Bat mortalities per turbine

Turbines	Bat mortalities	% Total
151	10	11.4
154	10	11.4
217	8	9.1
158	7	8.0
40	5	5.7
15	5	5.7
220	4	4.5
214	4	4.5
224	4	4.5
30	4	4.5
198	4	4.5
21	4	4.5
190	3	3.4
103	3	3.4
29	3	3.4
195	3	3.4
66	2	2.3
53	2	2.3
216	2	2.3
161	1	1.1

Birds made up 33.6% of all mortalities (including carcasses, feather spots, and incidentals) consisting of 13 species. Three individuals could only be identified to genus level and four individuals could not be identified due to decomposition and a lack of identifying features.

Nankeen Kestrel held the highest mortality rate with 12 mortalities, making up 26.7% of bird mortalities and 9% of overall mortalities. This was followed by Brown Falcon and Common Starling which 7 mortalities each, making up 15.6% of bird mortalities. Table 5 shows the total bird mortalities over the 24-month monitoring period at MWWF.

Table 5: Total bird mortality over 24 months

Common name	Scientific name	Total mortalities	% Total of bird mortalities	% Total of all mortalities
Nankeen Kestrel	*Falco cenchroides*	12	26.7	9.0
Brown Falcon	*Falco berigora*	7	15.6	5.2
Common Starling	*Sturnus vulgaris*	7	15.6	5.2
Unknown Bird sp.	*NA*	4	8.9	3.0
Barn Owl	*Tyto alba*	3	6.7	2.2
Australasian Pipit	*Anthus novaeseelandiae*	2	4.4	1.5
Raven sp.	*Corvid sp.*	2	4.4	1.5
Wedge-tailed Eagle	*Aquila audux*	2	4.4	1.5
Australian Magpie	*Cracticus tibicen*	1	2.2	0.7
Currawong sp.	*Strepera sp.*	1	2.2	0.7
Eurasian Skylark	*Alauda arvensis*	1	2.2	0.7
European blackbird	*Turdus philomelos*	1	2.2	0.7
Grey Fantail	*Rhipidura phasiana*	1	2.2	0.7
Grey Shrike-thrush	*Colluricincla harmonica*	1	2.2	0.7
				33.6

Turbine 158, in the north of the wind farm, had the highest bird mortality with five in total. This was followed by Turbines 66, 29, 198, and 21, which are mostly in the south of the wind far, with four mortalities each. Table 6 shows bird mortalities at each turbine.

Table 6: Bird mortalities per turbine

Turbines	Bird mortalities	% Total
158	5	11.6
66	4	9.3
29	4	9.3
198	4	9.3
21	4	9.3
103	3	7.0
214	3	7.0
30	3	7.0
217	2	4.7
224	2	4.7
195	2	4.7
15	2	4.7
151	1	2.3
154	1	2.3
161	1	2.3
53	1	2.3
220	1	2.3
190	0	0.0
216	0	0.0
40	0	0.0

3.2. Incidental raptor monitoring

During the incidental raptor surveys a total of five species were observed (Table 7). Nankeen Kestrel was observation the most often with 12 observations in total, followed by Whistling Kite with five. Swamp Harrier and Black falcon, two threatened raptor species that were listed in the BAMP as being recorded within 10km of MWWF, were not observed during the 24-month monitoring program.

Table 7: Incidental raptor summary

Common name	Scientific name	Total observations
Nankeen Kestrel	*Falco cenchroides*	12
Whistling Kite	*Haliastur sphenurus*	5
Black-shouldered Kite	*Elanus axillaris*	3
Brown Falcon	*Falco berigora*	3
Wedge-tailed Eagle	*Aquila audax*	2

The highest number of raptors observed at any given time was five Whistling Kites. No nest observations have been made to date. No raptors were recorded flying at heights within the Rotor-Swept-Area (RSA) (between 67–211 metres above ground). Results of incidental raptor observation are displayed in Table 8.

Table 8: Incidental raptor observations

Species	Date	Time	No	Height (m)	Behaviour
Black-shouldered Kite	12/03/2020	11:39	2	5	Foraging
Whistling Kite	12/05/2020	14:03	5	10	Soaring
Brown Falcon	14/05/2020	12:05	1	15	Foraging
Wedge-tailed Eagle	8/09/2020	9:44	2	0	Resting
Nankeen Kestrel	9/09/2020	12:06	1	1	Resting
Nankeen Kestrel	6/10/2020	8:10	2	1	Flapping
Brown Falcon	7/10/2020	9:42	1	50	Foraging
Black-shouldered Kite	5/10/2021	9:30	1	20	Hovering/Flapping
Nankeen Kestrel	6/10/2021	13:22	2	15	Flapping/Soaring
Brown Falcon	16/11/2021	14:22	1	30	Perching
Nankeen Kestrel	17/11/2021	9:30	1	15	Soaring/foraging
Nankeen Kestrel	14/12/2021	6:32	1	20	Flapping
Nankeen Kestrel	14/12/2021	6:40	1	20	Flapping
Nankeen Kestrel	11/01/2022	10:00	1	20	Hovering / Hunting
Nankeen Kestrel	12/01/2022	8:57	1	10	Flying/Perching
Nankeen Kestrel	8/02/2022	11:52	1	1	Perching
Nankeen Kestrel	7/03/2022	12:00	1	20	Foraging

3.3. Searcher efficiency trial

Four trials were undertaken during May 2020, October 2020, May 2021, and January 2022.

In the May 2020 trial Kitty achieved 85% efficiency, 95% in October 2020, and 95% in May 2021, with an average of 91.6%. In the January 2022 trial Gir achieved 95%.

There did not appear to be a difference in the scent detection canines' ability to detect different size classes of carcass; with two medium carcasses missed compared to four small carcasses missed during the trial in total.

Table 9: Searcher efficiency trial results May 2021 and October 2020

Date:	14/05/2020 - Kitty				Date:	5/10/2020 - Kitty			
Turbine	Carcass	Size	Distance (m)	Found	Turbine	Carcass	Size	Distance (m)	Found
158	Australian Magpie	Medium	27	1	151	Brown Falcon	Medium	52	1
	Chocolate Wattled Bat	Small	56	1		White-striped Freetail Bat	Small	33	1
	Nankeen Kestrel	Medium	23	1		Bat sp.	Small	45	1
15	White-striped Freetail Bat	Small	16	1		Nankeen Kestrel	Medium	54	1
	Nankeen Kestrel	Medium	3	1		White-striped Freetail Bat	Small	12	1
	Southern Freetail Bat	Small	32	0	154	House Sparrow	Small	8	1
40	Nankeen Kestrel	Medium	2	1		White-striped Freetail Bat	Small	15	1
	Gould's Wattled Bat	Small	66	0		White-striped Freetail Bat	Small	44	1
	Long-billed Corella	Medium	22	1		Nankeen Kestrel	Medium	66	1
214	White-striped Freetail Bat	Small	50	1		Brown Falcon	Medium	59	1
	Nankeen Kestrel	Medium	79	1	158	Gould's Wattled Bat	Small	13	1
	White-striped Freetail Bat	Small	83	1		Gould's Wattled Bat	Small	33	1
103	Nankeen Kestrel	Medium	51	1		Brown Falcon	Medium	56	1
	White-striped Freetail Bat	Small	76	1		Brown Falcon	Medium	57	1
	Australasian Pipit	Small	37	0		White-striped Freetail Bat	Small	66	1
220	White-striped Freetail Bat	Small	55	1	161	Australian Magpie	Medium	43	1
	Brown Falcon	Medium	10	1		Bat sp.	Small	38	1
	White-striped Freetail Bat	Small	22	1		Southern Freetail Bat	Small	4	1
190	Quail sp.	Medium	11	1		Nankeen Kestrel	Medium	54	0
	White-striped Freetail Bat	Small	24	1		Quail sp.	Medium	75	1
			Efficiency	85%				Efficiency	95%

Table 10: Searcher efficiency results May 2021 and January 2022

Date:	5/05/2021 - Kitty				Date:	11/01/2021 - Gir			
Turbine	Carcass	Size	Distance (m)	Found	Turbine	Carcass	Size	Distance	Found
161	Brown Falcon	Medium	79	1	103	Common mynah	Medium	73	1
	White-striped Freetail Bat	Small	46	1		Common mynah	Medium	55	1
	Nankeen Kestrel	Medium	71	1		Common mynah	Medium	30	1
66	Australian Magpie	Medium	54	1	190	Common mynah	Medium	73	1
	White-striped Freetail Bat	Small	15	1		Common mynah	Medium	51	1
	White-striped Freetail Bat	Small	58	1	216	Common mynah	Medium	19	1
53	Brown Falcon	Medium	83	1		Common mynah	Medium	27	1
	Nankeen Kestrel	Medium	57	1		Common mynah	Medium	86	1
	White-striped Freetail Bat	Small	18	1		Common mynah	Medium	24	1
	White-striped Freetail Bat	Small	47	1		Bat sp.	Small	40	1
42	Nankeen Kestrel	Medium	25	1	214	Common mynah	Medium	81	0
	Brown Falcon	Medium	50	1		Common mynah	Medium	38	1
	White-striped Freetail Bat	Small	29	1		Common mynah	Medium	28	1
	White-striped Freetail Bat	Small	66	1		Common mynah	Medium	90	1
30	Nankeen Kestrel	Medium	62	1	217	Common mynah	Medium	60	1
	Australasian Pipit	Small	42	0		Common mynah	Medium	43	1
	White-striped Freetail Bat	Small	8	1		Common mynah	Medium	90	1
15	Nankeen Kestrel	Medium	29	1		Common mynah	Medium	70	1
	Gould's Wattled Bat	Small	42	1		Bat sp.	Small	20	1
	White-striped Freetail Bat	Small	50	1		Common mynah	Medium	50	1
			Efficiency	95%				Efficiency	95%

3.4. Carcass persistence trial

In total 67 carcasses were deployed. Of these, 14 deployments failed to yield useable data. This was the result of equipment malfunction and theft or removal of cameras in the field. 53 deployments were successful. Fortunately, this was enough to generate robust scavenger data, which are present in Section 3.5 and Appendix 1.

Carcass size consisted of 33 medium carcasses and 20 small carcasses. Red Fox was the most common scavenger recorded by the motion sensor cameras. Results of the carcass persistence trial are shown in Table 11

Where the scavenger is described as event missed, this refers to the actual photograph of a scavenging event not being recorded. In this instance, it is assumed that the next photograph of the carcass not being in frame anymore was the scavenging event. The date is taken from this. This method would not be less accurate than the original method of checking carcasses each day, or every three – five days as outlined in the BAMP.

Where data is described as missing, this was a failure in data collection by zoologists assessing data. This did not affect scavenging rate assessment.

Table 11: Carcass persistence trial results

Species	Carcass Size	Placement Date	Placement time	Days in the field	Scavenge time	Turbine	Scavenger
Common Mynah	Medium	10/01/2022	14:40	1	-	15	NA
Common Mynah	Medium	12/01/2022	8:12	1	11:47	15	Data missing
Mouse	Small	10/01/2022	15:02	2	23:59	21	Data missing
Common Mynah	Medium	10/01/2022	14:52	6	0:03	21	Data missing
Mouse	Small	10/01/2022	15:30	2	1:29	198	Data missing
Mouse	Small	12/01/2022	9:30	0.5	18:37	198	Data missing
Common Mynah	Medium	10/01/2022	15:30	1	9:49	198	Data missing
Common Mynah	Medium	12/01/2022	9:25	2	5:42	198	Data missing
Mouse	Small	11/01/2022	10:20	1	1:04	220	Data missing
Mouse	Small	11/01/2022	10:26	3	10:49	220	Data missing
Common Mynah	Medium	11/01/2022	10:50	1	23:13	216	Data missing
Mouse	Small	11/01/2022	10:55	1	21:46	216	Data missing
Common Mynah	Medium	11/01/2022	13:10	7	0:04	103	Data missing
Mouse	Small	11/01/2022	13:20	7	0:15	103	Data missing
Common mynah	Medium	11/01/2022	13:40	3	5:06	224	Data missing
Mouse	Small	11/01/2022	14:05	4	5:21	224	Data missing
Common Mynah	Medium	11/01/2022	14:28	3	2:01	29	Data missing
Mouse	Small	11/01/2022	15:20	3	11:42	30	Data missing
Mouse	Small	11/01/2022	15:15	1	3:24	30	Data missing
Common Mynah	Medium	12/01/2022	7:20	3	2:00	154	Data missing
Common Mynah	Medium	12/01/2022	7:30	0.5	10:42	154	Data missing
Mouse	Small	1/02/2022	15:10	2	6:57	103	Raven
Mouse	Small	1/02/2022	15:20	1	4:20	103	Unidentifiable
Mouse	Small	1/02/2022	15:40	1	2:50	220	Red Fox
Mouse	Small	1/02/2022	15:50	1	8:10	220	Magpie
Mouse	Small	1/02/2022	16:10	1	18:35	216	Magpie
Mouse	Small	1/02/2022	16:20	2	6:15	216	Unidentifiable

Species	Carcass Size	Placement Date	Placement time	Days in the field	Scavenge time	Turbine	Scavenger
Mouse	Small	1/02/2022	16:50	2	1:30	224	Red Fox
Nankeen Kestrel	Medium	2/02/2022	9:40	0.5	22:01	154	Red Fox
Nankeen Kestrel	Medium	2/02/2022	9:45	1	4:26	154	Red Fox
Brown Falcon	Medium	2/02/2022	10:20	1	8:28	15	Wedge-tailed Eagle
Nankeen Kestrel	Medium	2/02/2022	10:50	0.5	22:51	21	Red Fox
Australian Pipit	Small	2/02/2022	11:05	0.5	22:58	21	Red Fox
White-striped Freetail Bat	Small	2/02/2022	11:20	1	1:30	198	Red Fox
Brown Falcon	Medium	2/02/2022	11:30	1	1:24	198	Wedge-tailed Eagle and Red Fox
Brown Falcon	Medium	2/02/2022	12:05	0.5	21:06	30	Red Fox
Mouse	Small	2/02/2022	12:15	1	9:54	30	Raven sp.
Common Mynah	Medium	24/02/2022	10:08	0.5	23:11	15	Red Fox
Common Mynah	Medium	23/02/2022	16:15	1	23:15	21	Red Fox
Common Mynah	Medium	23/02/2022	16:29	0.5	-	21	NA
Common Mynah	Medium	24/02/2022	10:45	2	17:06	198	Event missed
Common Mynah	Medium	23/02/2022	13:58	3	20:52	220	Feral cat
Common Mynah	Medium	23/02/2022	14:10	1	22:52	220	Feral cat
Common Mynah	Medium	23/02/2022	15:03	2	2:16	216	Red Fox
Common Mynah	Medium	23/02/2022	15:09	2	4:56	216	Red Fox
Common Mynah	Medium	23/02/2022	14:25	2	21:05	103	Red Fox
Common Mynah	Medium	23/02/2022	14:33	4	3:19	103	Red Fox
Common Mynah	Medium	23/02/2022	14:46	7	13:13	103	Brown Falcon
Common Mynah	Medium	23/02/2022	15:56	2	-	224	NA
Common Mynah	Medium	23/02/2022	15:29	0.5	23:26	29	Event missed
Common Mynah	Medium	23/02/2022	15:43	2	4:07	29	Red Fox
Common Mynah	Medium	24/02/2022	8:50	1	1:29	154	Red Fox
Common Mynah	Medium	24/02/2022	8:45	0.5	22:31	154	Red Fox

3.5. Mortality estimates

The 24-months of monitoring data, including carcass search program, scavenger trials and efficiency trials data, was provided to Symbolix for analysis and estimation of potential mortality extrapolated across the entire wind farm site. The full analysis, including methods and results, is provided in a report in Appendix 2 and summarised below.

3.5.1. Searcher efficiency

There was no evidence that searcher efficiency differed between the trials. There was also no evidence that searcher efficiency differed between birds and bats or observer. Bird and bat detectability is 92%, with a 95% confidence interval of [84%, 97%].

3.5.2. Scavenging data

Survival analysis was used to determine the average time until complete loss from scavenging.

The median time to total loss via scavenge is 1.3 days, with a 95% confidence window of [1, 1.7] days.

3.5.3. Bat mortality

Based on the detected carcasses and measure detectability and scavenge rate, it is expected that there was a potential site loss of around 5373 bats over the survey period, and are 95% confident that fewer than 7223 individuals were lost.

Assuming all model assumptions hold, the true total number of bat losses in year one was significantly higher than the number of losses in year two.

3.5.4. Bird mortality

Based on the detected carcasses and feather spots and measured detectability and scavenge rate, we expect that there was a potential site loss of around 3281 birds over the survey period, and are 95% confident that fewer than 3672 individuals were lost.

Assuming all model assumptions hold, the true total number of bird losses in year one was significantly lower than the number of losses in year two.

Limitations

In evaluating the potential impact of the wind farm, an important consideration is that all mortality estimators have an inherent assumption that there is an unlimited supply of carcasses to be found, i.e., that the number of individuals killed by turbines does not reduce the local population present. In particular an upper limit was not applied on the number of bats that could be onsite, and the assumption was made that bats were present all year round.

The ecological feasibility of this assumption must be accounted for when using these results to evaluate overall ecological impact. In this case; it was assumed that all carcasses that fall under the turbines have been scavenged within 1.3 days and so searchers are unlikely to detect them, substantially raising potential estimates to levels. This is discussed further in Section 4.

4. Discussion and recommendations

The 24-month monitoring program did not record any mortality of threatened species.

Bird mortalities totalled 45 and was primarily made up of species common to farmland environments across Victoria. Nankeen Kestrel was the most commonly detected bird carcass and made up 26.7% of bird mortality. This was followed by Brown Falcon and Common Starling, with 15.6% and 15.6% respectively. Common Starling is an introduced pest species and is not considered further. Nankeen Kestrel and Brown Falcon are common raptor species that are widespread throughout Australia (Birdlife Australia 2022, Marchant & Higgins 1993) and both have been frequently recorded as mortalities across many Victorian wind farms (Moloney et al. 2019, Smales 2012, Symbolix 2020). These raptors often fly at RSA height while foraging over open areas, such as farmland, and therefore are susceptible to collision with wind turbines. During incidental raptor surveys Nankeen Kestrel was the most observed species.

Bat mortalities totalled 89 and peaked typically April or May in the first two years of monitoring. Mortalities were comprised primarily of White-striped Freetail Bat, Southern Freetail Bat, and Gould's Wattled Bat, which made up 40.4%, 29.2%, and 20.2% of bat mortalities respectively. A number of studies (Moloney et al. 2019, Smales 2012, Symbolix 2020) have identified that these species are commonly impacted by wind farm operations and that White-striped Freetail and Gould's Wattled Bat in particular are over-represented as mortalities across many wind farms. Observations by Nature Advisory (unpublished data) at various wind farms in other parts of these species' range are consistent with these findings. This is related to the foraging behaviour of all three microbat species which causes them to fly within RSA height in pursuit of high-flying insects (Churchill 2008). This unfortunately brings these species into collision with turbines.

In regards to the mortality estimates; the very low carcass persistence rate recorded has substantially raised potential mortality estimates to levels that, while are statistically possible based on results, are unlikely to be ecologically possible. Actual observed mortality for birds was 45 and was extrapolated to a statistically possible 3281 over 24 months, and bats was 88 and extrapolated to a statistically possible 5373. For example; Nankeen Kestrel made up 26% of bird mortality which could be expected to mean that up to an estimated 853 individuals were potentially killed over 24 months. Given that the highest number of Nankeen Kestrel's observed incidentally using the wind farm site during a single survey period was two, this seems highly unlikely.

For microbats, it is known that White-striped Freetail Bat can have up to 25 individuals per colony (although up to 300 can be found in the case of maternity colonies) and roost primarily in mature tree hollows (Churchill 2008). While it is unknown how many colonies occur within the footprint of MWWF or within the maximum daily foraging distance (20km (Rhodes and Catteral 2008)), it is unlikely that there is sufficient habitat around Murra Warra and the broader region for which a significant proportion is used for agriculture (60% of land is used specifically for broad acre cropping (Agriculture Victoria 2019)) to support the number of colonies that could result in the estimated mortality of 5373 for bats. Approximately 40% of mortality was of White-striped Freetail bat which could be expected to mean up to 2149 of the species were killed, would require up to 86 non-maternity colonies to be within foraging range of the wind farm. While this may be plausible, it is unlikely that any colonies would be travelling 20 kms in a night to MWWF, given the uniformity of the agricultural landscape in the Murra Wurra region.

Such low carcass persistence rates may be related to the use of substitute carcasses (i.e., mice and Common Mynahs) which are not necessarily reflective of species available to scavengers under turbines, or in the case of mice; what scavengers would be seeking regularly, and may be more attractive to potential scavengers than microbats and other bird species. Another factor may be the necessary deploying of carcasses repeatedly over one season in a limited area, which may have resulted in attracting scavengers to the site due to scavenging opportunities being available for extended periods, thus resulting in much higher scavenging activity. However, there may just be very high scavenger activity at MWWF.

A such; the mortality estimates in this case may not be appropriate to use as an assessment tool for impacts at MWWF. The discussion below is therefore based on observed mortality and literature review of population information. Recommendations are provided in the sections below.

In terms of impacts, Brown Falcon population is thought to be stable, although local declines have been reported in some agricultural areas due to poisoning and lack of breeding sites (Marchant and Higgins 1993). It is estimated that the total Australian breeding population in the 1990s was 225,000 pairs (Marchant and Higgins 1993), however more recent estimations could not be found. Given its apparent large population and established widespread occurrence; Brown falcon mortality at MWWF is unlikely to have had a significant impact on this species, or cause an ongoing reduction in population to the species.

The Nankeen Kestrel population is also thought to be stable, however current population estimates are not available (Birdlife Australia 2022). Nankeen Kestrel occupy most landscape systems throughout Australia but favour open agricultural areas (Marchant & Higgins 1993), such as those that occur at MWWF and surrounds. The species is known to respond to increases in food resources, such as plague events, by producing large numbers of offspring (Hobbs 1971). Local dispersal may be influenced by events that affect prey availability, for example; heavy rain events, drought conditions, bushfires, and plagues of mice or locusts (Brooker et al. 1979, Hayward & Macfarlane 1971, Marchant & Higgins 1993). According to Nature Advisory zoologists on site monthly, there were an abundance of field mice present on site. This would provide substantial foraging resources to Nankeen Kestrel, which would account for the species being to most frequently observed raptor, and unfortunately, having the highest mortality. However, given this information, it is unlikely that such a common and widespread species well adapted to farmland environments, the most common environment in the region, would be significantly impacted by the mortality recorded at MWWF during the 24 months, or cause a long-term decline in its population.

Other birds detected were of common and widespread species detected in low numbers that would not suggest any significant impacts occurring to any populations from MWWF.

Population estimates for White-striped Freetail Bat, Southern Freetail Bat, and Gould's Wattled Bat are not available and would be extremely difficult to establish, given the species cryptic and widespread natures. White-striped Freetail Bat and Gould's Wattled Bat commonly occupy a broad range of habitats around Australia and Southern Freetail Bat occurs commonly across western Victoria and throughout areas of New South Wales and South Australia (Churchill 2008). It is not expected that the observed mortality levels observed at MWWF would constitute a significant impact to the overall population level of any of these species, given that they occur across the majority of Australia and a variety of habitats. Additionally, the direct mortality levels observed over the monitoring period is lower than many other wind farms monitored by Nature Advisory across south eastern Australia (Nature Advisory unpublished data). However, as that population levels of these species are not understood, the actual impact of this level of mortality on the species is unknown.

MWWF staff reported that there is no aviation lighting on any turbines, so this was not factored into mortality analysis or estimates.

4.1. Recommendations

Considering the discussion above, it is recommended that any further monitoring and mitigation measures focus on raptors and microbat species.

4.1.1. Bird risk reduction measures

As per Section 3.6 of the BAMP; MWWF is primarily a crop farm however, removal of carrion from underneath turbines in paddocks used for stock grazing is recommended to continue for the life of the wind farm. Additionally, stock should not be feed grain within 200 metres of turbines (subject to land holder agreement) as this may attract parrots.

MWWF should continue to work with landholders over the life of the project to minimise the attractiveness of the site to raptors, parrots, and other species of birds.

4.1.2. Carcass search program

Two years of mortality search data have provided a useful baseline set of data to gain an understanding of the impact that the wind farm is having on bird and bat species in the region. Extension of the formal carcass monitoring program is not recommended.

4.1.3. Incidental monitoring

Incidental reporting of carcasses by MWWF staff should continue. MWWF staff should continue to photograph and store any carcasses found by staff under turbines as per the BAMP. This will continue to provide some indication of ongoing impacts to birds and bat at the wind farm.

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Appendix 1: Symbolix report

Murra Warra Wind Farm Mortality Estimate - Years 1 and 2

Prepared for Nature Advisory, 24 May 2022, Ver. 1.0

This report outlines an analysis of the mortality data collected at the Murra Warra Wind Farm from 2020-03-10 to 2022-04-12. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in May 2020, October 2020, May 2021, January 2022
- Scavenger loss rates – consisting of trials in January 2022 and February 2022
- Mortality estimates - based on monthly surveys at 20 turbines, from 2020-03-10 to 2022-04-12

The data was collected and provided by Nature Advisory and is analysed "as-is." A brief summary of the data is provided below, and the ultimate focus of this report is a discussion of the potential mortality.

Available data

The data analysed was collected, verified and provided to us from Nature Advisory[1].

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 simulation to achieve this.

The analysis used survey data to estimate the average time to scavenge loss and searcher efficiency (and related confidence intervals). The algorithm then simulated different numbers of virtual mortalities. We could then estimate how many carcasses were truly in the field, given the range of searcher and scavenger efficiencies, and the survey frequency and coverage, and

[1] 19049.1 Murra Warra Wind Farm mortality data for Symbolix (2).xlsx

the true “found” details. After many simulations, we can estimate the likely range of mortalities that could have resulted in the recorded survey outcome.

This method has been benchmarked against analytical approaches (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).

Searcher efficiency

Four searcher efficiency trials were held (2020-05-14, 2020-10-05, 2021-05-05, 2022-01-11). A range of bird sizes were used, including the Common Mynah, Australian Magpie, and Brown Falcon. Generally, White-striped Freetail bats were used in the bat efficiency trials, but a small number of other species (e.g. Gould’s Wattled Bat) were also used.

AICc selection (Burnham and Anderson 2002) found no evidence that searcher efficiency differed between the two trials, bats and birds, or observer; therefore, the model best describing was an aggregated “intercept-only” model. Therefore, bird and bat detection efficiencies are aggregated in the following mortality estimate.

Table 1 summarises the result.

Detectability is 92%, with a 95% confidence interval of [84%, 97%].

Table 1: Detection efficiencies for all carcass.

Variable	Value
Number found	74
Number placed	80
Mean detectability proportion	0.92
Detectability lower bound (95% confidence interval)	0.84
Detectability upper bound (95% confidence interval)	0.97

Note - 19 carcass search surveys (out of 478 total) used human surveyors (the rest used dogs - see Table 2). The detection trials used dogs only. Given the low proportion of human searches (4%) we’ve used the dog searcher efficiency as a proxy for human searcher efficiency. The argument is, despite the (likely) lower human searcher efficiency, human searchers undertook so few surveys compared to dogs, that it won’t majorly affect the result. This likely over-estimates searcher efficiency (and thus slightly under-estimates mortality).

Scavenger efficiency

Scavenger efficiency trials were conducted in 2022 Jan, 2022 Feb. Motion capture cameras were used to determine time of scavenge.

Survival analysis (Kaplan and Meier (1958)) was used to determine the average time until complete loss from scavenge. Survival analysis was required to account for the fact that we do not know the exact time of scavenge loss, only an interval in which the scavenge event happened. By performing survival analysis we can estimate the average survival percentage after a given length of time, despite these unknowns.

AICc selection suggested that the most parsimonious model was one that does not differentiate between birds and bats. We thus have treated them as a single group in the mortality estimate.

Figure 1 shows a survival curve fitted to the combined cohort of bat and bird. The survival curves (solid line) shows the estimated proportion of the sets remaining at any given time. The shaded portions are the 95% confidence intervals on the estimates. For example, we see that we expect around 0% to 13% of carcasses to remain after ten days with the expectation being around 2%.

Under these assumptions, the median time to total loss via scavenge is 1.3 days, with a 95% confidence window of [1, 1.7] days.

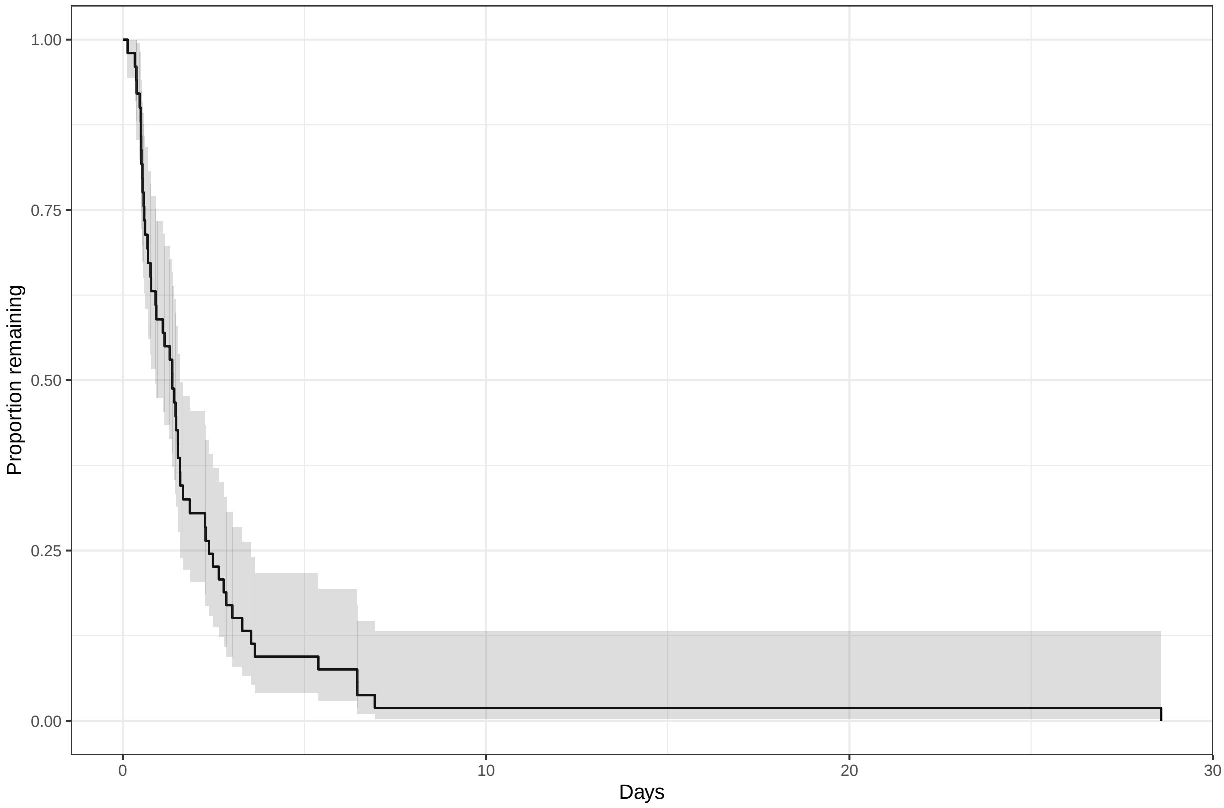

Figure 1: Combined survival curves for birds and bats, with 95% confidence interval shaded.

Mortality projection inputs

Carcass search data

The mortality estimate was based on a dated list of turbine surveys. The survey frequency is summarised in Table 2. 20 turbines were selected at the start of the project, and surveyed once each month. All twenty were surveyed out to a radius of 90 metres where feasible; however, due to accessibility issues, for some months only the hardstand and access roads were surveyed (Table 3).

This drop in search area is accounted for in the mortality estimate. As a brief summary: for every survey, we calculated the proportion of the fall zone surveyed (estimates of the fall zone distribution were generated via the simulation method of Hull and Muir (2010)). The fall zone distribution was converted into a spatial distribution centred at the turbine, and cast onto the actual hardstand / roads surveyed[2]. Each survey's fall zone coverage was then combined into an average "coverage factor."

[2] Provided as shape files by Nature Advisory - `19049_turbine_locations.shp` and `19049_limited_search_area.shp`.

Table 2: **Number of surveys per month (and surveyor type).**

Date	Surveyor	N
March 2020	Dog	20
April 2020	Dog	20
May 2020	Dog	20
June 2020	Dog	20
July 2020	Dog	20
August 2020	Dog	20
September 2020	Dog	20
October 2020	Dog	20
November 2020	Dog	20
December 2020	Human	19
January 2021	Dog	20
February 2021	Dog	20
April 2021	Dog	20
May 2021	Dog	20
June 2021	Dog	20
August 2021	Dog	20
September 2021	Dog	20
October 2021	Dog	20
November 2021	Dog	20
December 2021	Dog	20
January 2022	Dog	19
February 2022	Dog	20
March 2022	Dog	20
April 2022	Dog	20

Table 3: Harstand-only surveys.

Date	Turbine
November 2020	All surveyed
December 2020	All surveyed
September 2021	195
October 2021	66, 161, 195, 216, 217, 224
November 2021	66, 161, 195, 216, 217, 224
December 2021	66, 161
February 2022	195
March 2022	195
April 2022	195

Mortality estimate

Mortality estimation – methodology

With estimates for scavenge loss and searcher efficiency we then converted the number of bat and bird carcasses detected into an estimate of overall mortality at Murra Warra Wind Farm from 2020-02-10 to 2022-04-12 (we allow for collisions to occur up to a month prior to the first survey).

The mortality estimation is done via Monte-Carlo simulation. 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 complete set of model assumptions are listed below.

- There were 61 turbines on site.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 2 for a summary).
- Mortalities were allowed to occur up to a month before the initial survey (2020-03-10) and until the final surveyed date (2022-04-12).
- Birds are on-site at all times during this period.
- Bats are on-site at all times during this period.
- Finds are random and independent, and not clustered with other finds.
- There was equal chance of any turbine individually being involved in a collision / mortality.
- We assumed a log-normal scavenge shape.
- We took scavenge loss and search efficiency rates as outlined above.
- 20 turbines were selected at random to be surveyed, and were searched out to a 90 metre radius where possible (sometimes only the hardstand was searchable). We estimated the "coverage factor" for the survey – i.e. the total fall zone surveyed for birds and bats (using estimates from Hull and Muir (2010)). We calculated that the coverage factor was 76% for birds and 96% for bats.

Mortality projection results

After running the simulation we investigated the distribution of mortalities that could have resulted in the actual numbers found during the surveys. The breakdown of found carcasses per species are summarised in Table 4.

Table 4: Carcasses found during formal surveys over two years.

Species	Bat	Bird	Feather Spot
Australasian Pipit	0	2	0
Australian Magpie	0	0	1
Barn Owl	0	2	1
Bat spp	2	0	0
Brown Falcon	0	7	0
Chocolate wattled Bat	1	0	0
Common Starling	0	5	2
Corvid sp Featherspot	0	0	1
Currawong Sp	0	0	1
Eurasian Skylark	0	1	0
European blackbird	0	1	0
Freetail Bat sp.	1	0	0
Gould's Wattled Bat	18	0	0
Grey Fantail	0	1	0
Grey Shrike-thrush	0	1	0
Nankeen Kestrel	0	11	1
Raven Sp	0	1	0
Southern Freetail Bat	25	0	0
Unknown Bat	5	0	0
Unknown Bird	0	1	3
Wattled bat Sp.	1	0	0
White-striped Freetail Bat	35	0	0

Table 5: Carcasses found during formal surveys in the first year.

Species	Bat	Bird	Feather Spot
Brown Falcon	0	5	0
Corvid sp Featherspot	0	0	1
Freetail Bat sp.	1	0	0
Gould's Wattled Bat	9	0	0
Grey Shrike-thrush	0	1	0
Nankeen Kestrel	0	11	0
Southern Freetail Bat	20	0	0
Unknown Bird	0	1	0
White-striped Freetail Bat	21	0	0

Table 6: Carcasses found during formal surveys in the second year.

Species	Bat	Bird	Feather Spot
Australasian Pipit	0	2	0
Australian Magpie	0	0	1
Barn Owl	0	2	1
Bat spp	2	0	0
Brown Falcon	0	2	0
Chocolate wattled Bat	1	0	0
Common Starling	0	5	2
Currawong Sp	0	0	1
Eurasian Skylark	0	1	0
European blackbird	0	1	0
Gould’s Wattled Bat	9	0	0
Grey Fantail	0	1	0
Nankeen Kestrel	0	0	1
Raven Sp	0	1	0
Southern Freetail Bat	5	0	0
Unknown Bat	5	0	0
Unknown Bird	0	0	3
Wattled bat Sp.	1	0	0
White-striped Freetail Bat	14	0	0

Bat mortality estimate – results

Both years

During the two years of surveys a total of 88 bats were found during formal surveys (Table 4). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 5373 and a median of 5372 bats lost on site over the twenty-four months.

Table 7 and Figure 2 display the percentiles of the distribution, to show the confidence interval in this average.

Based on the detected carcasses and measured detectability and scavenge rate, we expect that there was a total site loss of around 5373 bats over the survey period, and are 95% confident that fewer than 7224 individuals were lost.

Table 7: Percentiles of estimated total bat losses over the two years of survey period.

0%	50% (median)	90%	95%	99%	99.9%
3352	5372	6566	7224	7675	8521

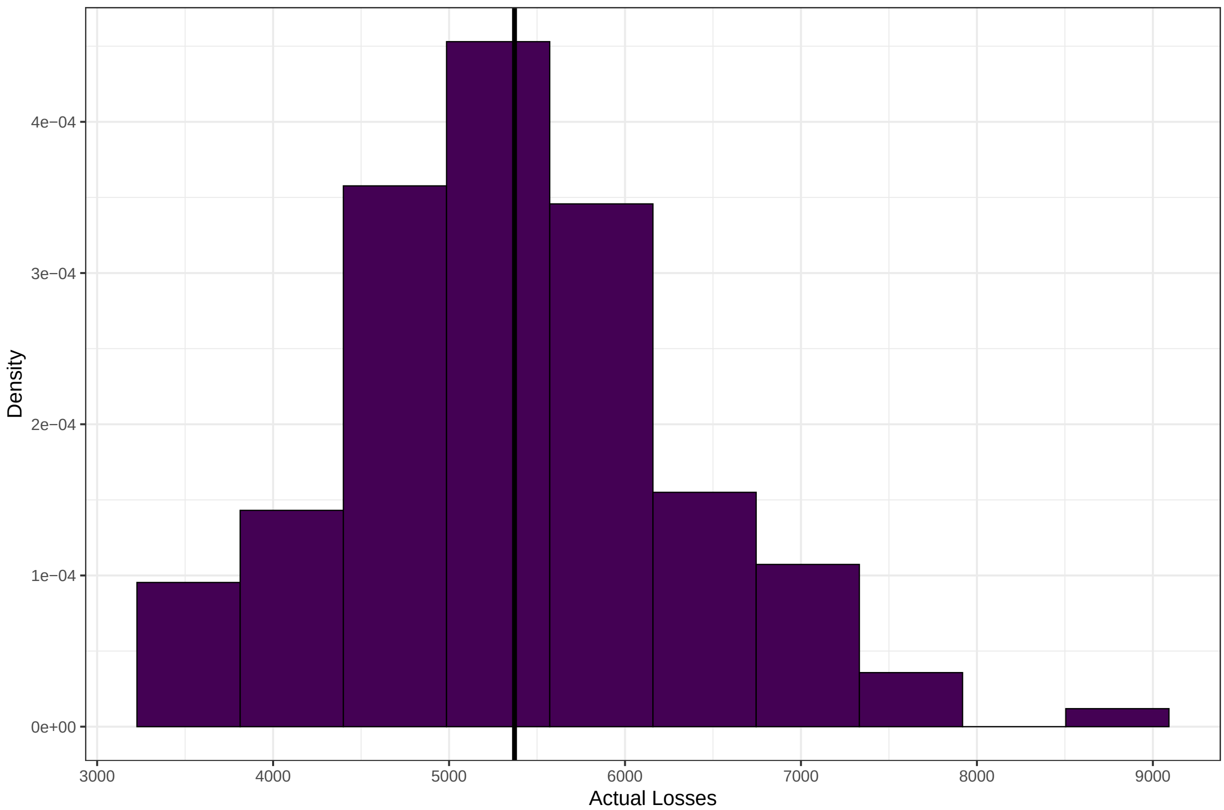

Figure 2: Histogram of the total losses distribution (bats), given 88 were detected on-site. The black solid line shows the median.

Year 1

During the first year of surveys a total of 51 bats were found during formal surveys (Table 5). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 2849 and a median of 2803 bats lost on site over first year.

Table 8 and Figure 3 display the percentiles of the distribution, to show the confidence interval in this average.

Based on the detected carcasses and measured detectability and scavenge rate, we expect that there was a total site loss of around 2849 bats in the first year, and are 95% confident that fewer than 3839 individuals were lost.

Table 8: Percentiles of estimated total bat losses over the first year of survey.

0%	50% (median)	90%	95%	99%	99.9%
1560	2803	3530	3839	4387	4906

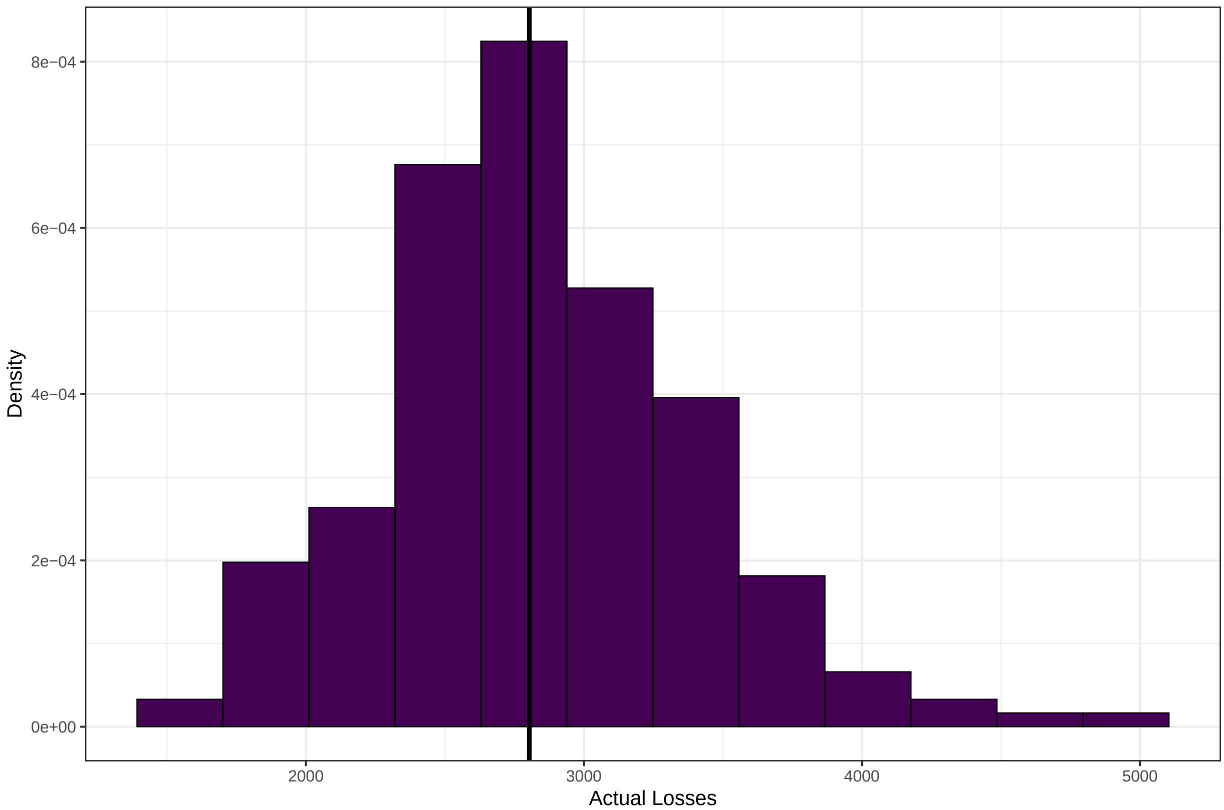

Figure 3: Histogram of the first year losses distribution (bats), given 51 were detected on-site. The black solid line shows the median.

Year 2

During the second year of surveys a total of 37 bats were found during formal surveys (Table 6). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 2211 and a median of 2145 bats lost on site over the second year.

Table 9 and Figure 4 display the percentiles of the distribution, to show the confidence interval in this average.

Based on the detected carcasses and measured detectability and scavenge rate, we expect that there was a total site loss of around 2211 bats in the second year, and are 95% confident that fewer than 3159 individuals were lost.

Table 9: Percentiles of estimated total bat losses over the second year of survey.

0%	50% (median)	90%	95%	99%	99.9%
1098	2145	2853	3159	3585	4340

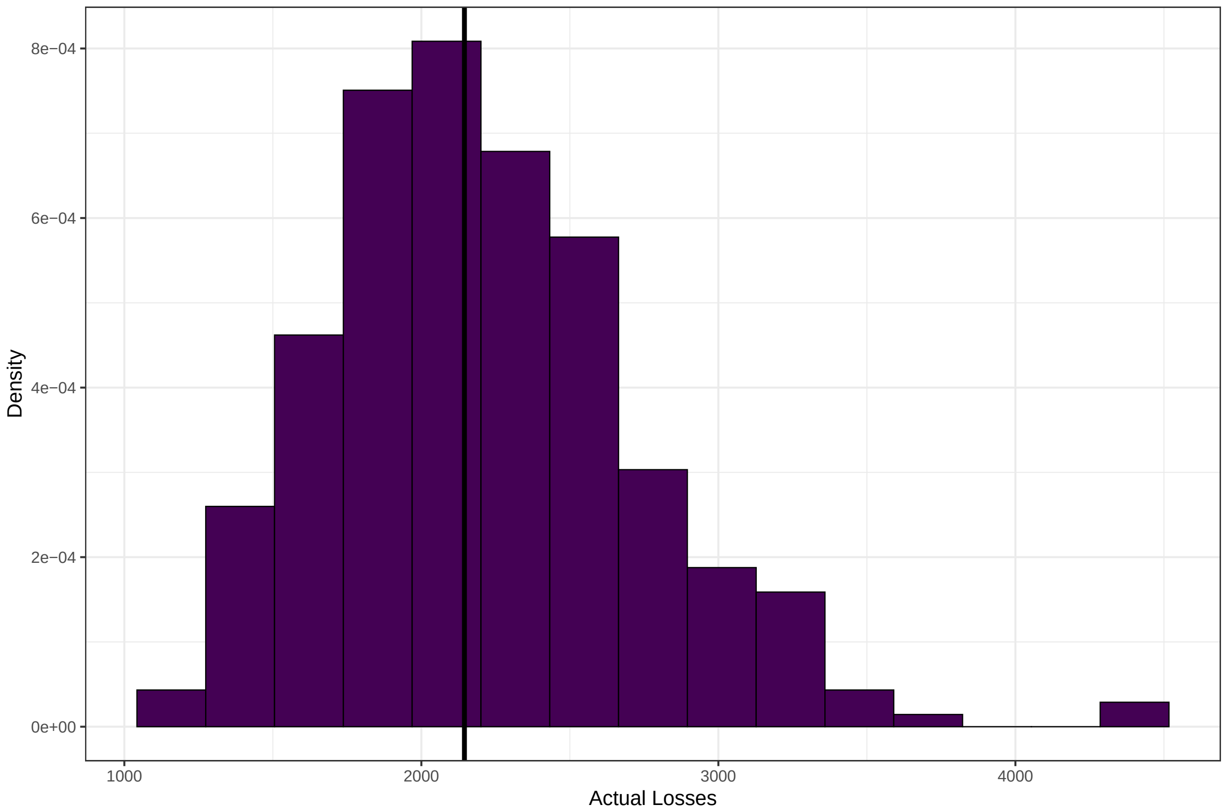

Figure 4: Histogram of the second year losses distribution (bats), given 37 were detected on-site. The black solid line shows the median.

Bird mortality estimate - results

Both years

During the two years of surveys a total of 43 birds were found during formal surveys (Table 4). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 3281 and a median of 3254 birds lost on site over the twenty-four months.

Table 10 displays the percentiles of the distributions from both estimators, to show the confidence interval in this average. Figure 5 shows the distribution.

In determining the estimate, 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.

Based on the detected carcasses and feather spots and measured detectability and scavenge rate, we expect that there was a total site loss of around 3281 birds over the survey period, and are 95% confident that fewer than 3672 individuals were lost.

Table 10: Percentiles of estimated total bird losses over the two years of survey period.

0%	50% (median)	90%	95%	99%	99.9%
1489	2525	3437	3672	3974	4041

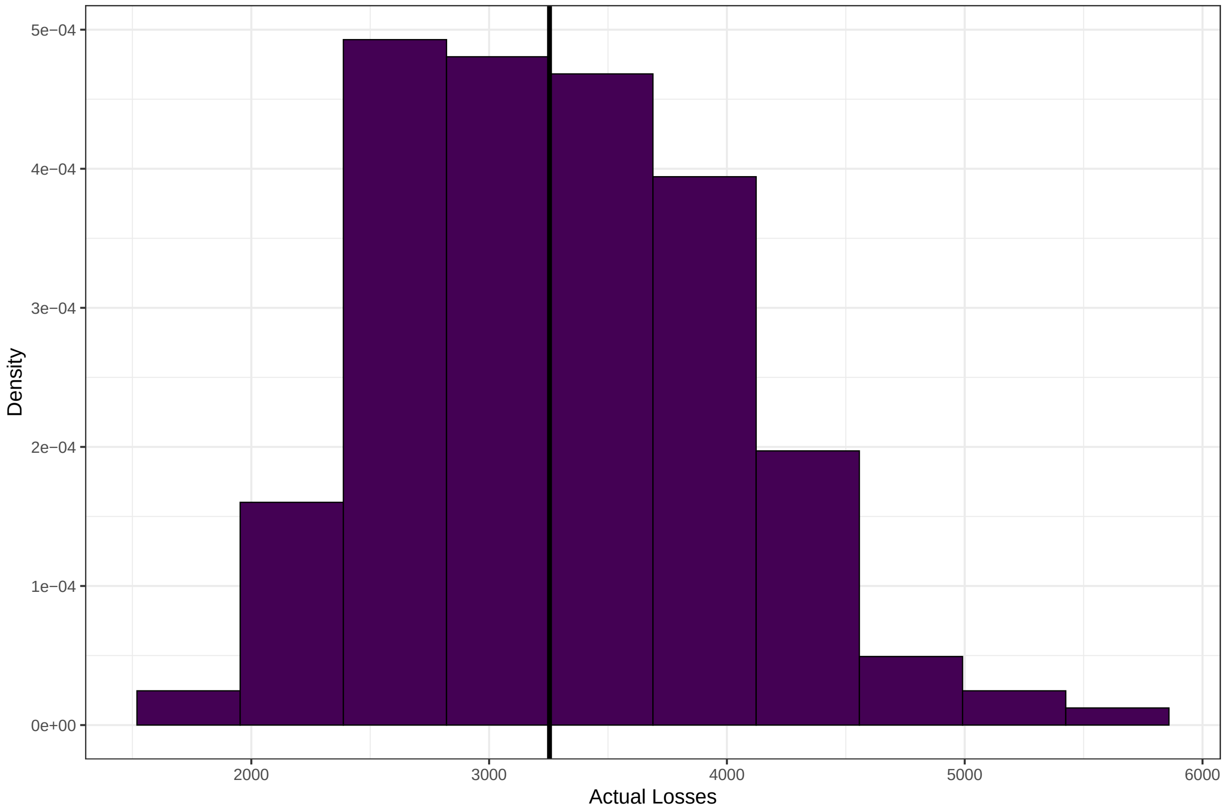

Figure 5: Histogram of the total losses distribution (birds), given 43 were detected on-site. The black solid line shows the median.

Year 1

During the first year of surveys a total of 19 birds were found during formal surveys (Table 5). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 1402 and a median of 1325 birds lost on site over the first year.

Table 11 displays the percentiles of the distributions from both estimators, to show the confidence interval in this average. Figure 6 shows the distribution.

In determining the estimate, 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.

Based on the detected carcasses and feather spots and measured detectability and scavenge rate, we expect that there was a total site loss of around 1402 birds over the survey period, and are 95% confident that fewer than 2165 individuals were lost.

Table 11: Percentiles of estimated total bird losses over the first year of survey.

0%	50% (median)	90%	95%	99%	99.9%
594	1325	1953	2165	2419	2886

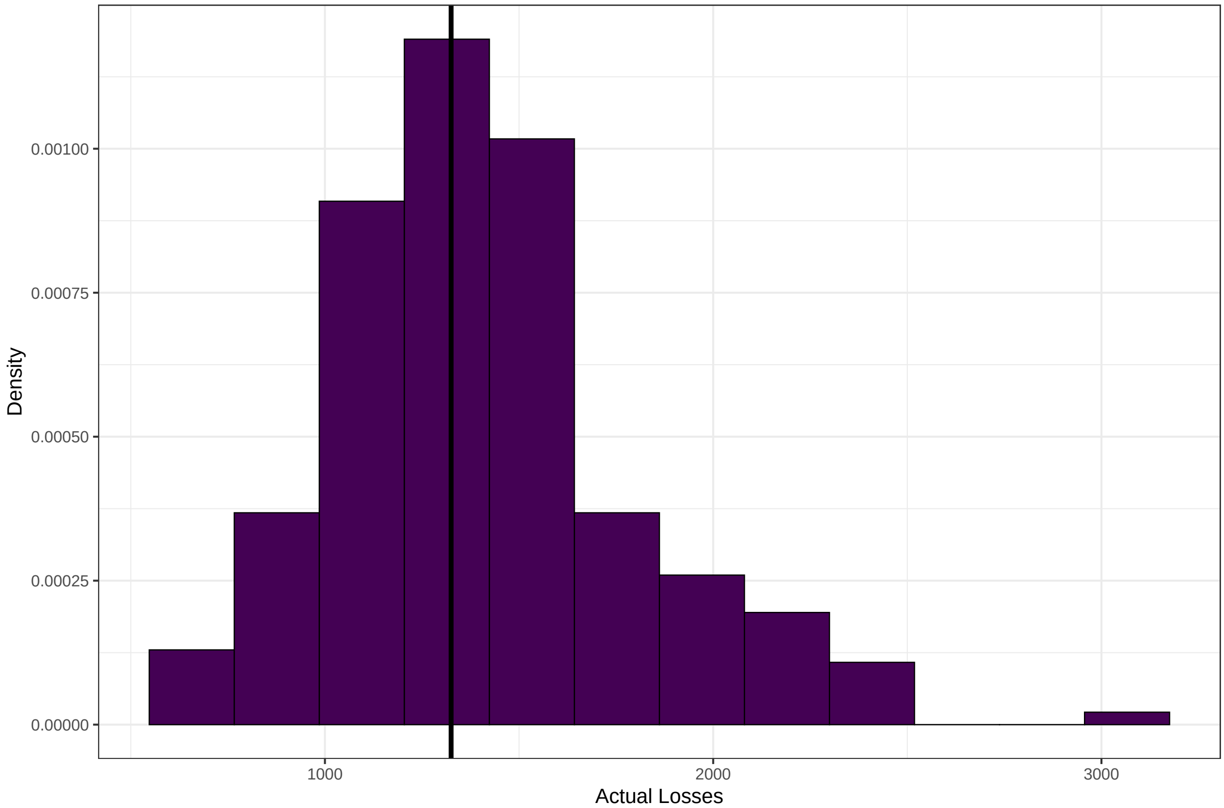

Figure 6: Histogram of the first year losses distribution (birds), given 19 were detected on-site. The black solid line shows the median.

Year 2

During the second year of surveys a total of 24 birds were found during formal surveys (Table 6). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 1821 and a median of 1799 birds lost on site over the second year.

Table 12 displays the percentiles of the distributions from both estimators, to show the confidence interval in this average. Figure 7 shows the distribution.

In determining the estimate, 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.

Based on the detected carcasses and feather spots and measured detectability and scav-

enge rate, we expect that there was a total site loss of around 1821 birds over the survey period, and are 95% confident that fewer than 2606 individuals were lost.

Table 12: Percentiles of estimated total bird losses over the second year of survey.

0%	50% (median)	90%	95%	99%	99.9%
903	1799	2361	2606	2953	3248

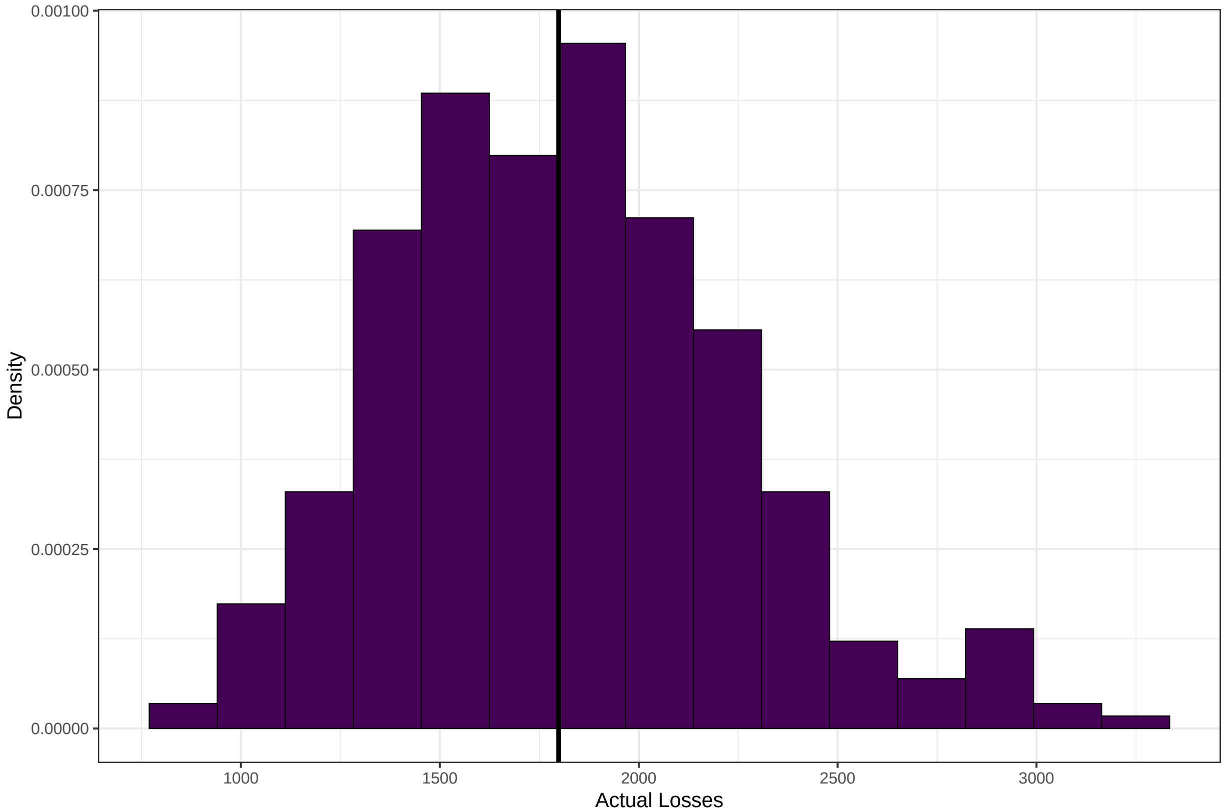

Figure 7: Histogram of the second year losses distribution (birds), given 24 were detected on-site. The black solid line shows the median.

Comparison of year one and year two results

Bat results

During the first year of surveys (2020-02-10 to 2021-03-10) a total of 51 bats were found during formal surveys. The resulting estimate of total mortality is an expectation (mean) of around 2849 bats over the survey period, and we are 95% confident that fewer than 3839 individuals were lost.

In comparison, in the second year of surveys a total of 37 bats were found during formal surveys. The resulting estimate of total mortality an expectation of 2211 bats over the survey period, and we are 95% confident that fewer than 3159 individuals were lost.

Statistical testing (using the Kolmogorov-Smirnov test) was used to determine if there was a significant difference between the modelled distribution of mortalities in year one and year two.

When considering all bat mortalities, we find the distribution of the first year to be shifted right, compared to the distribution of year two mortalities (the test statistic $D = 0.49$ is greater than the critical value D* = 0.35 at the 0.05 significance level).

Assuming all model assumptions hold, this would imply that the true total number of bat losses in year one was significantly higher than the number of losses in year two.

Bird results

During the first year of surveys a total of 19 birds were found during formal surveys. The resulting estimate of total mortality is an expectation of around 1402 birds over the survey period, and we are 95% confident that fewer than 2165 individuals were lost.

In comparison, in the second year of surveys a total of 24 birds were found during formal surveys. The resulting estimate of total mortality an expectation of 1821 birds over the survey period, and we are 95% confident that fewer than 2606 individuals were lost.

Using the Kolmogorov-Smirnov test, we find the distribution of the first year to be shifted left, compared to the distribution of year two mortalities (the test statistic $D = 0.42$ is greater than the critical value D* = 0.35 at the 0.05 significance level).

Assuming all model assumptions hold, this would imply that the true total number of bird losses in year one was significantly lower than the number of losses in year two.

Concluding remarks

In evaluating the potential impact, it is important to remember that all mortality estimators have an inherent assumption that there is an unlimited supply of carcasses to be found. In particular, we did not apply an upper limit on the number of bats that could be onsite, and we assumed that bats were present all year round. The ecological feasibility of this assumption should be accounted for if using these results to comment on overall ecological impact.

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Appendix 2: Detailed carcass search results of the first 24-month monitoring period

Monitoring period	Season	Month	Date	Common Name	*Scientific Name*	Bat/Bird Feather spot/ Incidental	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Year 1	Autumn	March	11/03/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	154	72	88	Decomposed and partially scavenged
Year 1	Autumn	March	11/03/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	151	52	270	> 3 days old
Year 1	Autumn	March	11/03/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	158	78	300	> 3 days old
Year 1	Autumn	March	11/03/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	30	92	37	> 3 days old
Year 1	Autumn	March	12/03/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	15	92	280	> 3 days old
Year 1	Autumn	March	12/03/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	40	12	270	> 3 days old
Year 1	Autumn	March	12/03/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	40	63	345	> 3 days old
Year 1	Autumn	March	13/03/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	21	84	340	1-3 days old. Head removed partially scavenged
Year 1	Autumn	March	19/03/2020	Wedge-tailed Eagle	*Aquila audux*	Bird	None	85		0	1-3 days old. Found by wind farm staff. Juvenile post-fledging dispersal
Year 1	Autumn	April	14/04/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	151	94	29.5	> 3 days old, FA 45mm
Year 1	Autumn	April	14/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	151	135	57	> 3 days old, FA 32 mm
Year 1	Autumn	April	14/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	151	24	213	> 3 days old, FA 34 mm
Year 1	Autumn	April	14/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	151	67	225	> 3 days old, FA 33 mm
Year 1	Autumn	April	14/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	151	53	165	> 3 days old, FA 33 mm
Year 1	Autumn	April	14/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	158	122	156	> 3 days old, FA 33 mm
Year 1	Autumn	April	15/04/2020	Brown Falcon	*Falco berigora*	Bird	None	30	57	214	> 3 days old, head and abdomen injury
Year 1	Autumn	April	15/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	21	147	354	< 24 hours old, female adult, FA 33 mm, broken L elbow/wing
Year 1	Autumn	April	15/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	224	59	320	1-3 days old, adult female, FA 61mm, lower abdomen & wing injury
Year 1	Autumn	April	15/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	51	0	1-3 days old, juv. male, FA 61 mm
Year 1	Autumn	April	15/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	216	63	350	> 3 days old, FA 61 mm
Year 1	Autumn	April	15/04/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	190	80	237	1-3 days old, FA 46 mm, broken L wing
Year 1	Autumn	April	15/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	220	120	70	> 3 days, FA 33 mm, very desiccated
Year 1	Autumn	April	15/04/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	220	61	67	> 3 days, FA 34 mm, very desiccated
Year 1	Autumn	April	15/04/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	220	113	180	> 3 days old
Year 1	Autumn	April	16/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	103	78	350	1-3 days old, FA 61 mm, abdomen injury
Year 1	Autumn	April	16/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	103	34	28	>3 days old, desiccated, FA 61 mm
Year 1	Autumn	April	16/04/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	103	106	56	> 3 days old, L wing detached (as feather spot)
Year 1	Autumn	April	16/04/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	214	24	150	> 3 days old
Year 1	Autumn	April	16/04/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	40	56	188	> 3 days old, FA 62 mm
Year 1	Autumn	May	12/05/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	154	76	102	1-3 days old, neck injury, FA 44mm
Year 1	Autumn	May	12/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	151	22	77	> 3 days old, FA 63 mm
Year 1	Autumn	May	12/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	151	93	162	> 3 days old, FA 58 mm
Year 1	Autumn	May	12/05/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	161	72	9	> 3 days old, right wing and neck broken
Year 1	Autumn	May	13/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	53	36	74	> days old, lower abdominal injury, FA 57 mm
Year 1	Autumn	May	13/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	224	79	0	1-3 days old, FA 61 mm
Year 1	Autumn	May	13/05/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	198	97	76	> 3 days old, FA 45 mm
Year 1	Autumn	May	13/05/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	198	85	216	> 3 days old, neck broken
Year 1	Autumn	May	14/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	15	68	126	> 3 days old, FA 63 mm
Year 1	Autumn	May	14/05/2020	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	214	141	217	> 3 days old, FA 44 mm

Monitoring period	Season	Month	Date	Common Name	*Scientific Name*	Bat/Bird Feather spot/ Incidental	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Year 1	Autumn	May	14/05/2020	Brown Falcon	*Falco berigora*	Bird	None	214	84	357	> 3 days old, broken L wing
Year 1	Autumn	May	14/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	195	72	70	> 3 days old, broken L wing, FA 60 mm
Year 1	Autumn	May	14/05/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	190	96	277	> 3 days old, FA 59 mm
Year 1	Winter	June	10/06/2020	Brown Falcon	*Falco berigora*	Bird	None	30	97	310	1-3 days old, neck trauma
Year 1	Winter	June	11/06/2020	Brown Falcon	*Falco berigora*	Bird	None	195	53	321	> 3 days old, carcass had been ploughed
Year 1	Winter	June	11/06/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	15	66	353	> 3 days old, carcass had been ploughed
Year 1	Winter	August	10/08/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	158	90	0	1-3 days old. Damage to abdomen.
Year 1	Winter	August	11/08/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	85	240	> week old. Very decomposed and ploughed into ground. Likely been there for over a month.
Year 1	Spring	September	7/09/2020	Nankeen Kestrel	*Falco cenchroides*	Bird	None	158	55	280	Shoulders and wings only >3 days
Year 1	Spring	September	8/09/2020	Brown Falcon	*Falco berigora*	Bird	None	195	87	225	Mostly scavenged, head wings and feather spots, no torso, >3 days
Year 1	Spring	October	7/10/2020	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	89	188	Abdominal contusion, FA 61mm, 1-3 days
Year 1	Spring	November	2/11/2020	Corvid sp.	*Corvid sp.*	Bird	None	53	15	90	Feather spot
Year 1	Spring	November	3/11/2020	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	217	50	37	> 3 days old, FA 33 mm
Year 1	Summer	January	5/01/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	151	103	320	> 3 days old, FA 32 mm, very desiccated
Year 1	Summer	January	5/01/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	158	42	14	>3 days old, FA 33 mm.
Year 1	Summer	January	6/01/2021	Grey Shrike-thrush	*Colluricincla harmonica*	Bird	None	66	90	240	Decapitated, grey bird.
Year 1	Summer	January	6/01/2021	Nankeen Kestrel	*Falco cenchroides*	Bird	None	15	36	352	1-3 days old, Young adult. Neck broken.
Year 1	Summer	January	6/01/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	15	100	329	> 3 days old, desiccated, FA 33 mm
Year 1	Summer	January	7/01/2021	Nankeen Kestrel	*Falco cenchroides*	Bird	None	21	52	48	> 3 days, sub-adult, broken left upper and lower wing
Year 1	Summer	January	7/01/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	21	95	327	> 3 days, desiccated, FA 34 mm
Year 1	Summer	January	7/01/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	195	94	333	> 3 days, desiccated, FA 33 mm
Year 1	Summer	January	7/01/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	29	52	87	> 3 days, intact, FA 44 mm
Year 1	Summer	January	7/01/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	29	73	286	Wings only, FA 62 mm
Year 1	Summer	February	8/02/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	154	90	200	> 3 days, intact, FA 43 mm
Year 1	Summer	February	8/02/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	154	44	297	Wing only, FA 62 mm
Year 1	Summer	February	8/02/2021	Unknown	*Unknown*	Bird	None	151	57	250	Unknown species, chick not hatched from egg, egg dissolved
Year 1	Summer	February	8/02/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	158	82	256	> 3 days, desiccated, FA 33 mm
Year 1	Summer	February	8/02/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	158	109	338	> 3 days, FA 33 mm
Year 1	Summer	February	9/02/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	30	91	315	Head injury, 1-3 days, female, FA 61mm
Year 1	Summer	February	9/02/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	217	101	314	> 3 days, desiccated, FA 33 mm
Year 1	Summer	February	10/02/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	195	77	356	Abdominal injury, 1-3 days, desiccated, FA 34 mm
Year 1	Summer	February	10/02/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	198	62	260	Left shoulder/back injury, <24 hours, FA 32mm
Year 2	Autumn	April	6/04/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	154	87	345	>3 days
Year 2	Autumn	April	6/04/2021	Unknown bat	*NA*	Bat		154	85	340	only left half of bat left highly decomposed, not enough for accurate ID
Year 2	Autumn	April	6/04/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	161	15	220	>3 days
Year 2	Autumn	April	7/04/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	40	35	340	>3 days back and head scavenged
Year 2	Autumn	April	7/04/2021	Chocolate wattled Bat	*Chalinolobus morio*	bat	None	30	80	110	completely desiccated, >3days
Year 2	Autumn	April	7/04/2021	Common Starling	*Sturnus vulgaris*	Feather Spot	None	21	90	40	>3days
Year 2	Autumn	April	7/04/2021	Unknown bat	*NA*	Bat	None	21	80	265	only right wing left, >3days
Year 2	Autumn	April	8/04/2021	Wattled bat Sp.	*Chalinolobus Sp.*	Bat	None	214	60	255	body scavenged
Year 2	Autumn	April	8/04/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	75	15	1-3 days

Monitoring period	Season	Month	Date	Common Name	*Scientific Name*	Bat/Bird Feather spot/ Incidental	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Year 2	Autumn	April	8/04/2021	European blackbird	*Turdus philomelos*	Bird	None	224	80	75	No injuries 1-3days
Year 2	Autumn	April	8/04/2021	White-striped Freetail Bat	*Austronomus australis*	Incidental	None	31	10	285	No injuries <24 hours
Year 2	Autumn	May	4/05/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	66	59	97	>3 days old FA 43 mm
Year 2	Autumn	May	4/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	66	51	77	>3 days old, FA 63 mm
Year 2	Autumn	May	5/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	15	103	330	>3 days old, FA 62 mm
Year 2	Autumn	May	5/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	224	72	15	1-3 days old, adult male, abdominal injuries, FA length 63 mm
Year 2	Autumn	May	6/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	70	341	> 3 days old, FA 62 mm
Year 2	Autumn	May	6/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	217	82	27	>3 days old, FA 61 mm
Year 2	Autumn	May	6/05/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	220	86	26	1-3 days old, abdominal injuries
Year 2	Autumn	May	6/05/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	103	58	318	>3 days old, FA 61 mm
Year 2	Autumn	May	6/05/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	214	67	234	>3 days old+M102
Year 2	Autumn	May	6/05/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	29	69	221	1-3 days old, lower abdomen missing, FA 43 mm
Year 2	Winter	June	22/06/2021	Barn Owl	*Tyto alba*	Bird	None	66	20	285	Fresh, no clear signs of injuries
Year 2	Winter	June	22/06/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	bat	None	40	20	270	>3 days
Year 2	Winter	June	23/06/2021	Raven Spp.	*Corvus Sp.*	Bird	None	198	85	300	very old, >3 days a few feathers and bones
Year 2	Winter	August	3/08/2021	Currawong sp.	*Strepera sp.*	Feather Spot	None	198	80	290	Feathers and bones. Cranium, no beak (W=44mm, L50mm). Feathers: Non-descript brown feathers, with small tufts of feathers with a white base, longest feather 30cm. Feather size and shape rule out raptors. Possible Raven spp., but most likely Pied Currawong (presence of white feathers)
Year 2	Winter	August		Wedge-tailed Eagle	*Aquila audux*	Bird	None				
Year 2	Spring	September	13/09/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	158	78	180	FA 34mm, belly fur paler than back fur.1-3 days old (maggots), cut on side of body near wing.
Year 2	Spring	September	14/09/2021	Common Starling	*Sturnus vulgaris*	Bird	None	66	49	120	1-3 days old (maggots). Skull crushed and damage to abdomen.
Year 2	Spring	September	15/09/2021	Australasian Pipit	*Anthus novaeseelandiae*	Bird	None	29	39	110	Just wing and some flesh
Year 2	Spring	September	15/09/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	198	30	160	1-3 days old (full of maggots), 1 wing separate from body. Abdomen and head mangled and decomposed but dark brown in colour. FA 45mm
Year 2	Spring	September	15/09/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	21	81	145	1-3 days old (full of maggots), 1 wing missing. FA 57mm
Year 2	Spring	October	4/10/2021	Unknown	*Unknown*	Feather Spot	None	30	90	270	Feather spot - few body feathers only
Year 2	Spring	October	5/10/2021	Barn Owl	*Tyto alba*	Feather Spot	None	29	85	160	Feather Spot - Flight feathers and some body feathers remained only. Old
Year 2	Spring	October	5/10/2021	Nankeen Kestrel	*Falco cenchroides*	Feather Spot	None	29	92	5	Feather Spot - Flight and tail feathers and some body feathers remained only. Old
Year 2	Spring	October	5/10/2021	Eurasian Skylark	*Alauda arvensis*	Bird	None	198	70	160	Whole carcass partially decomposed
Year 2	Spring	October	5/10/2021	Common Starling	*Sturnus vulgaris*	Bird	None	158	45	175	Fresh maggots present - Whole carcass - abdominal injury
Year 2	Spring	November	16/11/2021	Australian Magpie	*Cracticus tibicen*	Feather Spot	None	21	25	99	Single feather. Likely moult not mortality
Year 2	Spring	November	16/11/2021	Unknown	*Unknown*	Feather Spot	None	29	60	7	Single, small dark body feather. Likely Magpie as lacked structural colour of Starling or Raven
Year 2	Spring	November	16/11/2021	Unknown	*Unknown*	Feather Spot	None	224	30	348	See photo. Dark brown/grey with Buff tips along
Year 2	Spring	November	16/11/2021	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	190	60	173	Note: FA approx. 48mm
Year 2	Spring	November	17/11/2021	Common Starling	*Sturnus vulgaris*	Bird	None	158	80	235	
Year 2	Spring	November	17/11/2021	Common Starling	*Sturnus vulgaris*	Feather Spot	None	158	50	260	Same species as subsequent finds
Year 2	Spring	November	18/11/2021	Common Starling	*Sturnus vulgaris*	Bird	None	103	100	316	Juvenile bird. Just the bill and section of head with a few feathers. See below comments

Monitoring period	Season	Month	Date	Common Name	*Scientific Name*	Bat/Bird Feather spot/ Incidental	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Year 2	Spring	November	18/11/2021	Common Starling	*Sturnus vulgaris*	Bird	None	103	100	90	Note: Same species as above and missing head. Potentially same bird
Year 2	Summer	December	14/12/2021	White-striped Freetail Bat	*Austronomus australis*	Bat	None	214	73	340	No maggots, very dry >3 days old. FA: 57mm
Year 2	Summer	December	14-Dec	Brown Falcon	*Falco berigora*	Bird	None	217	57	0	Heavily scavenged, missing head, wings and feet. A bunch of distinct tail feathers allowed id. >3 days old
Year 2	Summer	December	14/12/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	224	51	221	No maggots, wings damaged. <24 hrs. FA 33mm
Year 2	Summer	December	15/12/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	154	50	88	Wound on back. Some blood visible. <24hrs. FA 36mm
Year 2	Summer	December	15/12/2021	Southern Freetail Bat	*Mormopterus planiceps*	Bat	None	154	109	280	Wound on back/side. <24hrs old. FA 35mm
Year 2	Summer	January	11/01/2022	Unknown sp.	*Unknown*	Bat	None	220	40	0	Fresh, no clear signs of injuries
Year 2	Summer	January	11/01/2022	Brown Falcon	*Falco berigora*	Bird	None	217	62	0	Desiccated whole skull and bill only
Year 2	Summer	January	12/01/2022	White-striped Freetail Bat	*Austronomus australis*	Bat	None	30	70	280	Fresh, no clear signs of injuries
Year 2	Summer	January	12/01/2022	White-striped Freetail Bat	*Austronomus australis*	Bat	None	158	85	293	Fresh, no clear signs of injuries
Year 2	Summer	January	12/01/2022	Unknown sp.	*Unknown*	Bat	None	151	80	210	Desiccated intact
Year 2	Summer	February	1/02/2022	Australian Pipit	*Anthus australis*	Bird	None	214	20	156	Whole carcass desiccated and intact
Year 2	Summer	February	2/02/2022	Bat spp.	*Unknown*	Bat	None	154	40	48	
Year 2	Summer	February	2/02/2022	Barn Owl	*Tyto alba*	Bird	None	66	30	0	
Year 2	Autumn	March	7/03/2022	Bat spp.	*Unknown*	Bat	None	216	15	0	Completely desiccated skeleton only with a bit of skin holding it together
Year 2	Autumn	March	8/03/2022	White-striped Freetail Bat	*Austronomus australis*	Bat	None	198	90	315	Whole carcass desiccated and intact
Year 2	Autumn	April	12/04/2022	White-striped Freetail Bat	*Austronomus australis*	Bat	None	15	40	240	Fresh, wound to left rear dorsal side. <24 hrs
Year 2	Autumn	April	12/04/2022	Gould's Wattled Bat	*Chalinolobus gouldii*	Bat	None	53	80	60	Fresh, no clear signs of injuries. FA 43mm
Year 2	Autumn	April	12/04/2022	Grey Fantail	*Rhipidura phasiana*	Bird	None	154	85	0	
Year 2	Autumn	April	12/04/2022	Unknown sp.	*Unknown*	Bat	None	154	80	180	