ARARAT WIND FARM – BIRD AND BAT MONITORING PROGRAM

FIRST YEAR ANNUAL REPORT APRIL 2017 TO MARCH 2018

Ararat Wind Farm Pty Limited
Windlab

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July 2018

Report No. 15120 (11.0)

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1. INTRODUCTION

Ararat Wind Farm, located in western Victoria, has a total of 75 turbines across an approximately 6,000-hectare area of agricultural and wooded land, approved by the Minister for Planning with a Bird and Bat Management Plan (BBMP) prepared as part of the overall Environmental Management Plan. This BBMP was prepared by BL&A and approved by the (then) Department of Sustainability and Environment (now the Department of Environment, Land, Water and Planning).

The first year of post-construction monitoring was undertaken from April 2017 to March 2018 (inclusive). The post-construction monitoring during this period included the following investigations:

- Monthly carcass searches beneath 4 mandatory turbines and 21 randomly selected turbines, including:
  - Scavenger trials to determine carcass removal rates before detection;
  - Observer efficiency trials to determine the rate at which the observers detect carcasses; and
  - Pulse surveys during the bat season between October and April, inclusive.
- A spring 2017 bird utilisation survey (BUS) to assess bird activity at the wind farm; and
- Two bat activity surveys using ultrasonic bat detectors in spring 2017 and autumn 2018 to determine presence and distribution of bat species and activity levels (number of recorded calls).

This report presents the results of the first year of implementation of the BBMP (April 2017 to March 2018) and it is divided into the sections described below.

Section 2 presents the methods and results of the bird and bat monitoring program.

Section 3 presents the results of the bird utilisation survey.

Section 4 presents the methods and results of the bat surveys.

Section 5 discusses the implications and conclusions.

This investigation was undertaken by a team from Brett Lane & Associates Pty Ltd, comprising Curtis Doughty (Senior Zoologist), Khalid Al-Dabbagh (Senior Zoologist), Jackson Clerke (Zoologist), Mal Wright (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

2. OBJECTIVES AND MONITORING ACTIVITIES

The Ararat Wind Farm (AWF) comprises 75 wind turbines across agricultural and wooded land in western Victoria (Figure 1), owned and operated by Ararat Wind Farm Pty Limited. Construction occurred from November 2015 to April 2017 and the AWF has been fully operational since April 2017. The Rotor Swept Area (RSA) of the turbines is between 30–140 metres above the ground.

Under condition 6e of both wind farm permits (ARCC: 09/004799 and NGSC:5.2009.94.1) a Bird and Bat Management Plan (BBMP) was required to be prepared as part of the overall Environmental Management Plan. This was prepared by Brett Lane and Associates Pty Ltd (BL&A) and approved by the state government (now DELWP). This condition states that:

*"**The Bird and Bat Management Plan** must include:*

i. A statement of the objectives and overall strategy for managing and mitigating any significant bird and bat strike arising from the wind energy facility operations;

ii. A monitoring program of at least two years duration either commencing from the commissioning of the last turbine of the first stage of the approved development and use (if any) or alternatively such other time of commencement as is to the satisfaction of the Minister for Planning;

iii. The monitoring program must incorporate turbine numbers T32, T33, T64 and T65, and include surveys during the breeding and migratory seasons to ascertain:

- *The species, number, age, sex (if possible) and date of bird and bat strike*
- *The number and species of birds and bats struck at lit versus unlit turbines* [Note that this condition is not relevant as none of the turbines within the Ararat Wind Farm will be lit.]
- *Any seasonal and yearly variation in the number of bird and bat strikes*
- *Whether further detailed investigations are to be undertaken in consultation with the Department of Sustainability and Environment[1] and to the satisfaction of the Minister for Planning.*

iv. Procedures for the reporting of any bird or bat strikes to the Department of Sustainability and Environment[1] within 7 days of becoming aware of any strike identifying where possible whether the strike was by a lit or unlit turbine;

v. Information on the efficacy of searches for carcasses of birds and bats, and where practical, information on the rate of removal of carcasses by scavengers, so that correction factors can be determined to enable calculations of the total number of mortalities;

vi. Procedures for the regular removal of carcasses likely to attract raptors to areas near turbines;

vii. Procedures for periodic reporting, within agreed timeframes, of the findings of the monitoring to the Department of Sustainability and Environment[1] and the local community;

viii. Recommendations in relation to a mortality rate for specified species which would trigger the requirement for responsive mitigation measures to be undertaken by

[1] Now the Department of Environment, Land, Water and Planning

the operator of the wind energy facility to the satisfaction of the Minister for Planning;

ix. *Details of any responsive mitigation measures which may be implemented if the trigger mortality rate for a specified species is exceeded; and*

x. *Implementation measures developed in consultation with the Department of Sustainability and Environment[1] to offset any impacts detected during monitoring including turbine operation management and on-site or off-site habitat enhancement (including management or improvement of habitat or breeding sites).*

BL&A implemented the monitoring program of the BBMP for Ararat Wind Farm during its first year of operation.

The aim of the BBMP is to provide an overall strategy for managing and mitigating any significant bird and bat strikes arising from the wind energy facility operations. This is achieved by establishing monitoring and management procedures consistent with the methods outlined by the Australian Wind Energy Association (AusWEA 2005) and endorsed in the Clean Energy Council's Best Practice Guidelines (CEC 2013).

The objectives of this plan have been derived from the planning permit conditions and are specified in more detail below:

- Monitor the presence and behaviour of bird and bats, and their mortality on and near the wind farm for a period of two years, by:
  - Undertaking bird and bat surveys to ascertain bird and bat movements following commencement of operation and compare this with data obtained before construction and to provide background data for evaluation of bird and bat strikes. Surveys include:
    - One Bird Utilisation Survey undertaken in the first spring–summer season ; and
    - Two bat surveys undertaken during October–November and February–March;
  - Calibrating and undertaking monthly carcass searches beneath 25 turbines;
- Ascertain the occurrence of any seasonal and yearly variation in the number of bird and bat strikes and whether further detailed investigations are to be undertaken in consultation with the state Department of Environment, Land Water and Planning (DELWP) and to the satisfaction of the Minister for Planning;
- Ascertain wind farm impacts on species of concern, such as Powerful Owl and Wedge-tailed Eagle by specifically targeting Turbine numbers T32, T33, T64, and T65;
- Describe mitigation options that may be appropriate (subject to investigation) to reduce the risk of bird and bat collision with operating wind turbines in the event that an adaptive management trigger is activated;
- Detail procedures for the regular removal of carcasses likely to attract raptors and predators;
- Detail information on the efficacy of searches for carcasses of birds and bats, and where practical, information on the rate of removal of carcasses by scavengers, so that correction factors can be determined to enable calculations of the total number of mortalities;

- Detail procedures for periodic reporting, within agreed timeframes, of the findings of the monitoring to DELWP and the local community;
- Provide recommendations in relation to a mortality rate for specified species which would trigger the requirement for responsive mitigation measures to be undertaken by the operator of the wind energy facility to the satisfaction of the Minister for Planning;
- Provide details of any responsive mitigation measures which may be implemented if the trigger mortality rate for a specified species is exceeded; and
- Implement measures developed in consultation with DELWP to offset any impacts detected during monitoring including turbine operation management and on-site or off-site habitat enhancement (including management or improvement of habitat or breeding sites).

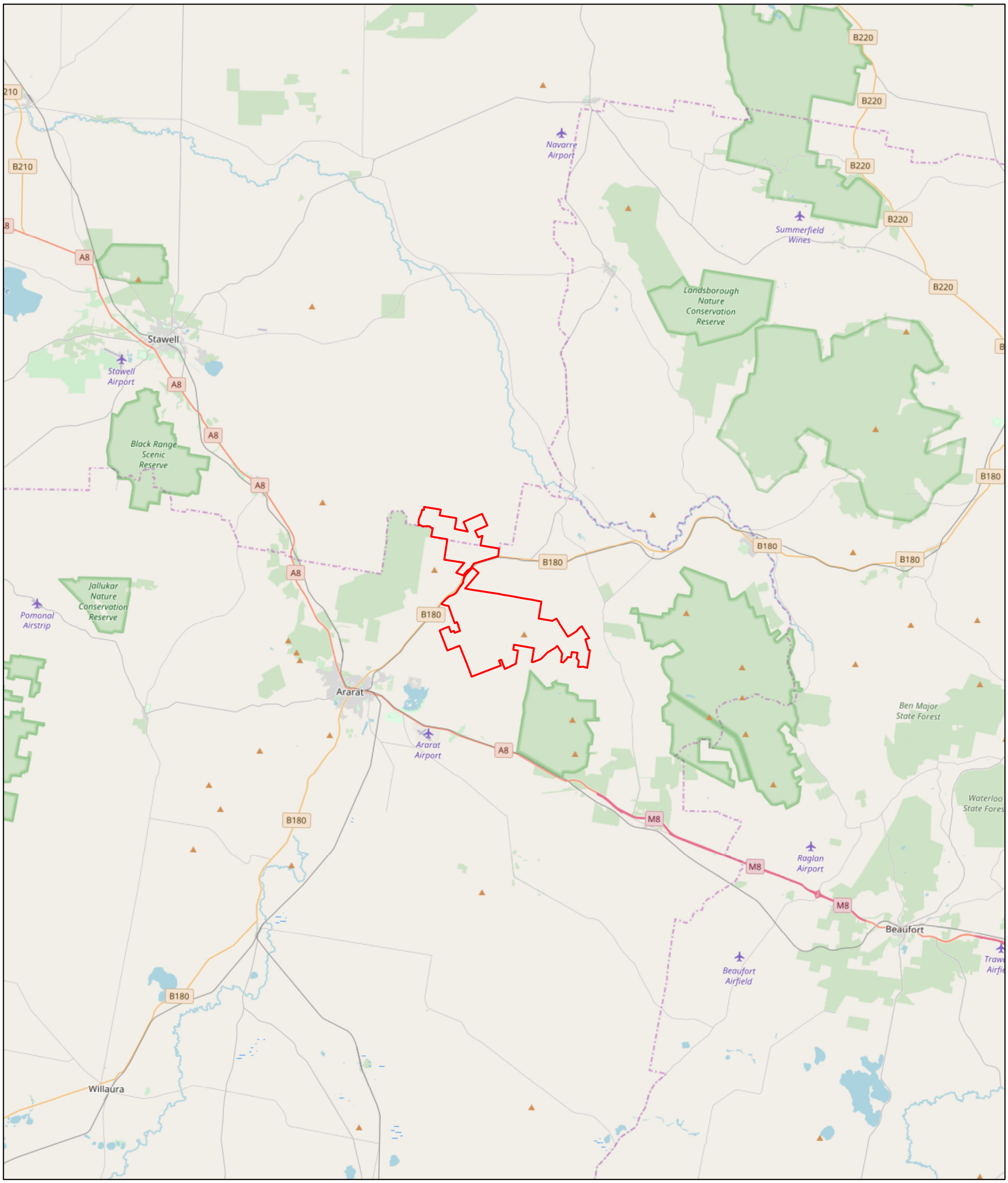
The strategy employed to ensure that these objectives are met includes:

- Pre-construction surveys;
- Post-construction monitoring surveys; and
- Reporting.

The strategy employed to ensure that any impact triggers and/or unacceptable impacts are detected includes the following.

- Post-construction monitoring surveys, including carcass searches under operating turbines;
- Analysis of the results from monitoring; and
- Reporting.

The BBMP is adaptive; therefore, management measures can be amended based on monitoring results to ensure a more efficient management plan is implemented.



Kilometers

0 1 2 4 6 8 10 12 14 16 18

Windfarm boundary

Figure 1: Regional location of Ararat Wind Farm

Project: Ararat Wind Farm

Client: Windlab

Project No.: 15120	Date: 7/06/2018	Created By: N. May

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3. BIRD AND BAT MONITORING PROGRAM

3.1. Methodology

3.1.1. Carcass searches

From April 2017 to March 2018, monthly carcass searches were carried out under 25 turbines at Ararat Wind Farm. Four turbines were compulsorily checked each month as per the planning permit conditions and the BBMP; the remaining 21 turbines were selected based on a stratified random sampling design at the beginning of the implementation of the BBMP (Table 1).

Table 1: List of turbines searched

Turbine number	Turbine number	Turbine number	Turbine number
3	**32**	52	**65**
5	**33**	56	66
15	36	58	69
20	38	61	73
25	44	62	
26	49	63	
27	50	**64**	

Note: Turbine numbers in bold were to be checked compulsorily

Carcass searches were undertaken under each of the 25 turbines (Figure 5) every month during a three to six-day search period. Between April 2017 and September 2017, turbines were searched once during the search period; during the bat season between October 2017 and March 2018, the inner zone of each turbine (see below) was searched twice during each search period ('pulse' searches).

A 120-metre-radius circular zone surrounding each designated turbine was searched each month, with two target search zones: the inner and outer zone (Figure 2) as follows:

- The inner zone: transects are spaced at four metres apart and carried out up to 75 metres from the turbine tower; nearly all microbats, and the majority of small to medium birds are expected to be found in this inner zone (based on the Hull and Muir model, 2010); and
- The outer zone: between 75 metres and 120 metres radius from the turbine tower base aims at detect the medium and larger bodied birds; transects are spaced at twelve metres apart.

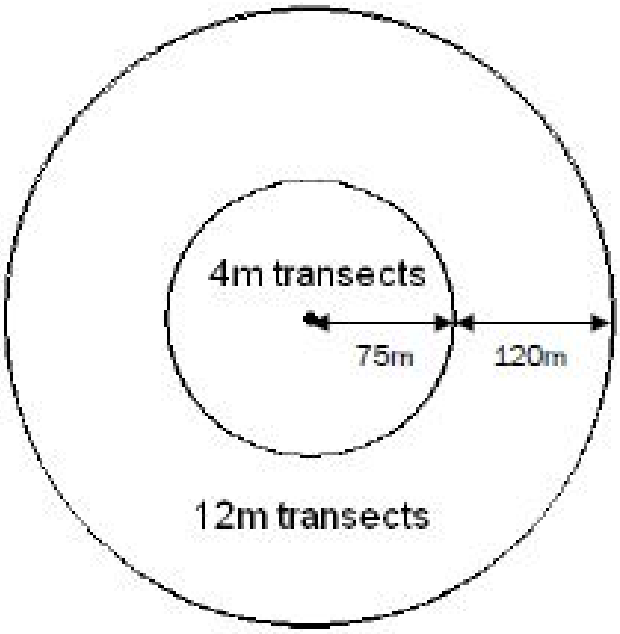

Figure 2: Inner and outer carcass search zones underneath the turbines

The BBMP (BL&A 2013) states that searcher efficiency and scavenger trials are to be undertaken twice during the monitoring period in two distinct seasons – Spring and Autumn. The objective of having two trials is to account for the different vegetation conditions, with one being undertaken following Winter and Spring growth when the grass is long (October–November) and the other post-summer when the grass is short (March–April).

3.1.2. Searcher efficiency trial

The Spring searcher efficiency trial was undertaken in the first year of monitoring on 16th October 2017. The searcher efficiency trials were undertaken to assess the efficiency of the observers Jackson Clerke and Curtis Doughty (zoologists with BL&A), who conducted the searches at Ararat Wind Farm during 2017 and 2018.

Two carcasses were placed under each of the ten pre-selected turbines at the wind farm. These were turbine numbers: 3, 5, 15, 20, 36, 38, 49, 50, 52 & 66. Weather conditions during the trial was good, being of moderate temperature and overcast with a gentle wind.

Observer 1 placed the carcasses at turbines 20, 38, 49, 50 and 52 for observer 2 to search and observer 2 placed the carcasses at turbines 3, 5, 15, 36 and 66 for observer 1 to search. The positions of the placed carcasses were randomly generated using the Microsoft Excel® random number function. All small carcasses (bat and small bird) and 25% of the medium–large bird carcasses were placed within the inner zone. The remaining carcasses were distributed though the outer zone.

The 20 carcasses used for this trial were those collected during previous carcass searches, as well as road killed bird carcasses collected in preceding months and stored in a freezer at the wind farm office. Some Common Mynah carcasses were also sourced from mynah control groups to be used in the trials. Due to a shortage of bat carcasses, four house mice were used to simulate bats.

A total of ten carcasses were used for each observer. This included five bats/small birds and five medium to large birds (see Table 2).

The observer searched all turbines within four hours of the carcasses being placed and recorded the number of carcasses found on the first search. The observer efficiency was calculated as the percentage of carcasses found of those placed.

Table 2: Species of carcasses used in searcher efficiency and scavenger trials

Observer 1 (Curtis Doughty)		Observer 2 (Jackson Clerke)	
October 2017 Trial			
Bats/small birds	Large to medium Birds	Bats/small birds	Large to medium Birds
White-striped Freetail Bat	Australian Magpie	White-striped Freetail Bat	Australian Magpie
House Mouse	Nankeen Kestrel	House Mouse	Nankeen Kestrel
House Mouse	Nankeen Kestrel	House Mouse	Nankeen Kestrel
Common Mynah	Peregrine Falcon	Common Mynah	Wedge-tailed Eagle
Common Mynah	Wedge-tailed Eagle	Common Mynah	Wedge-tailed Eagle

Autumn searcher efficiency trials were undertaken at the beginning of the second year of monitoring in April 2018 and will be documented in the second annual report. The outcomes of both trials will be used in the data analysis undertaken at the end of the second year.

3.1.3. Scavenger trial

The average duration of carcasses in the field prior to being removed by scavengers contributes to an essential correction factor required for the calculation of bird and bat mortality rates at wind farms.

The first scavenger trial was undertaken from the 16th October to 16th November 2017. and lasted 31 days. Twenty carcasses were placed at ten pre-selected turbines, as described for the searcher efficiency trial. These were monitored daily each morning for the first five days. They were then monitored on days 7, 9, 11, 14, 17, 21, 24, 28 and 31 for the October trial. The average duration in days that carcasses remained on the ground before being taken by a scavenger was then calculated for bats/small birds and medium to large birds.

Not all carcasses were removed by scavengers by day 31. In this scenario if a carcass was still present on site at day 31 it was assumed it was taken by day 31 and the experiment is terminated.

Autumn scavenger trials were undertaken at the beginning of the second year of monitoring in April 2018 and will be documented in the second annual report. The outcomes of both trials will be used in the data analysis undertaken at the end of the second year.

3.2. Carcass search results for first year of monitoring

The results between April 2017 and March 2018 at Ararat Wind Farm of the monthly bird and bat carcass searches, as well as incidental records from across the wind farm, are summarised in Table 3 and represented in Figure 3. The table shows the number of

carcasses and feather spots found during formal searches of selected turbines and incidental records by BL&A or wind farm personnel from across the wind farm site.

Table 3: Summary of carcass search results for bird and bats from March 2017 to March 2018

Search type	Season	Month	Bird	Bat	Feather spot	Total
Formal searches	Autumn	April	2	2	2	6
		May	2	1	–	3
	Winter	June	2	–	–	2
		July	–	–	–	0
		August	1	–	–	1
	Spring	September	3	–	–	3
		October	5	6	2	13
		November	2	19	4	25
	Summer	December	2	4	1	7
		January	2	7	4	13
		February	1	3	1	5
	Autumn	March	2	2	–	4
Formal search totals			24	44	14	82
Incidental records	Autumn	April*	–	–	–	0
		May	2	–	–	2
	Winter	June	–	–	–	0
		July	–	–	–	0
		August	–	–	–	0
	Spring	September	2	–	–	2
		October	5	2	–	7
		November	1	4	–	5
	Summer	December	1	1	–	2
		January	2	4	–	6
		February	–	1	–	1
	Autumn	March	–		–	0
Incidental record totals			13	12	0	25

* 2 incidental bird carcasses and 2 incidental bat carcasses were found in March 2017 before the wind farm was fully operational – not included in this total

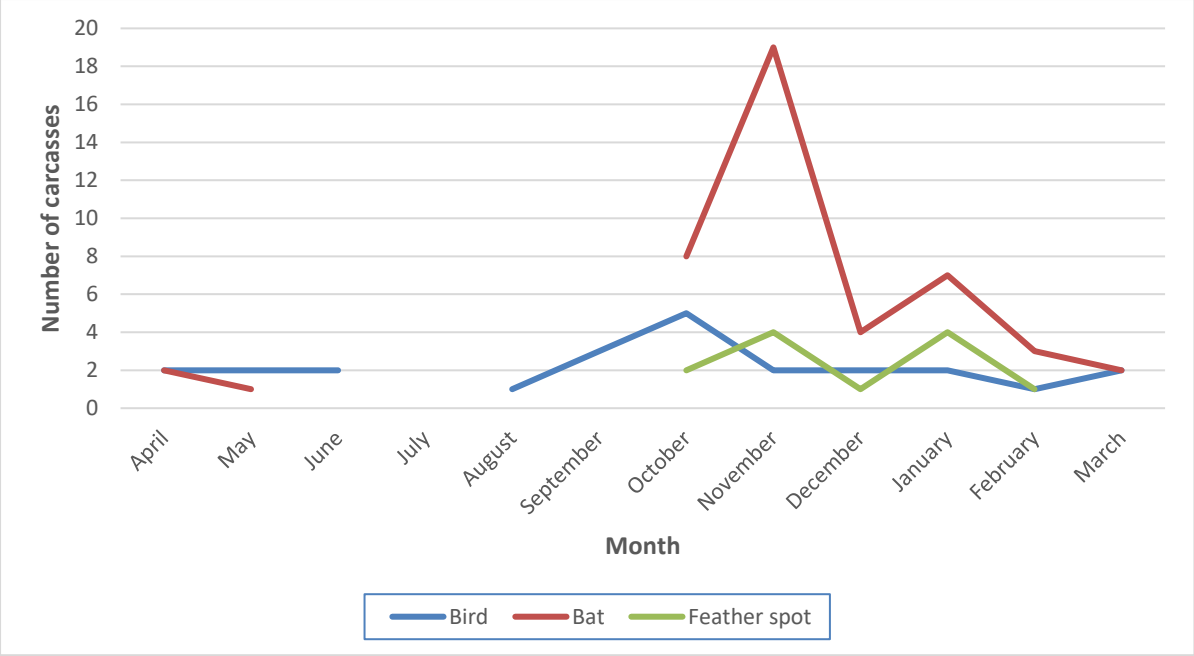

Figure 3: Number of carcasses found in each month during the first year of monitoring

3.2.1. Birds

A total of 39 bird carcasses were found, 24 during the formal mortality search program and 15 incidentally (Table 3). Fourteen (14) feather spots were recorded during the searches. One to five birds were found each month, except for July 2017 (none found) when birds were less active. None of the carcasses recorded during the monitoring period was a threatened species.

Incidental carcasses were also almost evenly distributed among the 12 months of the search, with zero to two birds found. However, there was a peak in October 2017 when five birds were collected incidentally.

Note: Two bird carcasses found in March 2017 (Appendix 1) before the wind farm was fully operational are not included in the above data.

Most feather spots were found during the warmer months and none were found between May through to September 2017 and in March 2018. The increased prevalence of feather spots during the warmer months reflect the increased activity of both the birds and their scavengers.

A summary of the diversity of bird species carcasses found under turbines between April 2017 and March 2018 is provided in Table 4, separated into: formal searches; incidental finds; and feather spots; detailed data for birds is presented in Appendix 1. A total of 24 bird carcasses were found under turbines during the formal carcass searches. Additionally, 12 incidental finds and 15 feather spots were also found within 120 metres from the base of turbine towers during this period.

The Wedge-tailed Eagle was the most commonly found bird under turbines between April 2017 and March 2018, with a total of eighteen (18) carcasses: twelve (12) found during formal monthly carcass searches under turbines and six (6) found outside of the formal searches from across the wind farm; and one feather spot – 19 fatalities in total. The implications of this finding are discussed further in Section 6.

A total of thirteen (13) of the common and widespread Australian Magpie were found under turbines during the first year of monitoring. Nine (9) of these records were found during formal searches and four (4) were incidental records. Four (4) Brown Falcons were found under turbines as carcasses or feather spots.

The remaining birds found under turbines are all commonly occurring species in farmland and woodland areas in south eastern Australia: Common Starling, Little Raven, Nankeen Kestrel, Whistling Kite, Australian Raven, European Goldfinch, Noisy Miner, Sacred Kingfisher, Sulphur-crested Cockatoo and Welcome Swallow.

Table 4: Summary of bird carcasses found from April 2017 to March 2018

Species	Number during formal searches	Incidental records	Feather spots	Totals
Wedge-tailed Eagle	12	6*	1	19
Australian Magpie	1	4	8	13
Brown Falcon	3		1	4
Common Starling	1	1	1	3
Little Raven	1		1	2
Nankeen Kestrel	1	1		2
Whistling Kite	1		1	2
Australian Raven	1			1
European Goldfinch	1			1
Noisy Miner			1	1
Sacred Kingfisher	1			1
Sulphur-crested Cockatoo			1	1
Welcome Swallow	1			1
Totals	24	12	15	51

* 2 incidental carcasses were found in March 2017 before the wind farm was fully operational – not included in this total

3.2.2. Bats

A total of forty-four (44) bat carcasses were collected during the first year of mortality searches at Ararat Wind Farm during formal searches. In addition, twelve (12) bat carcasses were found incidentally at non-targeted turbines (Table 3 & Table 5). None of the bat carcasses collected under turbines was a threatened species.

No bat carcasses were found between June and September; the colder months when bat activity is comparatively low or absent as most bats are in a torpor state which is similar to hibernating or have migrated from the area. November 2017 was the peak period for bat carcasses with nineteen (19) being detected during formal searches and four (4) being recorded incidentally.

Note: Two bat carcasses found in March 2017 (Appendix 2) before the wind farm was fully operational are not included in the above data.

The White-striped Freetail Bat was the most commonly found bat species during the April 2017–March 2018 monitoring period at Ararat Wind Farm with twenty-nine (29) found during formal searches and eleven (11) during incidental carcass searches. The Gould's Wattled Bat was also commonly found under turbines with nine (9) found in formal

searches. Southern Freetail Bat and Large Forest Bat occurred in lower numbers (6 and 1 carcasses respectively).

The diversity and number of bat species carcasses are shown in Table 5 and detailed in Appendix 2.

Table 5: Summary of bat carcasses from March 2017 to March 2018

Species	Number formal carcasses	Incidental records	Totals
White-striped Freetail Bat	29	11*	40
Gould's Wattled Bat	9	0*	9
Southern Freetail Bat	5	1	6
Large Forest Bat	1	–	1
Totals	44	12	56

* 1 incidental carcass of each species was recorded in March 2017 before the wind farm was fully operational – not included in this total

3.3. Results of scavenger and observer efficiency trials – October 2017

3.3.1. Searcher efficiency

Jackson Clerke and Curtis Doughty, zoologists from BL&A, executed the searches for this monitoring period and therefore undertook the searcher efficiency trial in October 2017, coinciding with the long grass season. The searcher efficiency results are shown in Table 6.

Table 6: Searcher efficiency trial results for October 2017

Turbine	Searcher	Carcass	Detected	Turbine
		Long grass		
3	Curtis	Australian Magpie	X	20
3	Curtis	Nankeen Kestrel	✓	20
5	Curtis	Common Mynah	✓	38
5	Curtis	House Mouse	X	38
15	Curtis	Common Mynah	✓	49
15	Curtis	Nankeen Kestrel	✓	49
36	Curtis	House Mouse	X	50
36	Curtis	Peregrine Falcon	✓	50
66	Curtis	White-striped Freetail Bat	X	52
66	Curtis	Wedge-tailed Eagle	✓	52
20	Jackson	Common Mynah	✓	3
20	Jackson	Nankeen Kestrel	✓	3
38	Jackson	Australian Magpie	✓	5
38	Jackson	White-striped Freetail Bat	✓	5
49	Jackson	Wedge-tailed Eagle	✓	15
49	Jackson	House Mouse	X	15
50	Jackson	House Mouse	X	36
50	Jackson	Wedge-tailed Eagle	✓	36
52	Jackson	Nankeen Kestrel	✓	66
52	Jackson	Common Mynah	✓	66

Notes: ✓ = Found (14); X = missed (6)

The average efficiency was a 70% detectability rate. An overall efficiency was significantly different for bats/small birds and medium to large birds. The detectability rate for bats/small birds was 50% and 90% for medium to large birds (Table 7).

Table 7: Average searcher efficiency at Ararat Wind Farm for the two different size classes

	Carcasses found	Carcasses placed	Average efficiency
Bats/small birds	5	10	50 %
Medium to large bids	9	10	90 %

3.3.2. Scavenger trial

The results of the scavenger trials are presented in Table 8. Day 0 indicates the beginning of the trial when the carcasses were placed and day 31 is the termination date of the trial.

During the first-year trials, most of the carcasses were removed by scavengers by day 21 with three carcasses remaining untouched until day 31, when the experiment was terminated. This pattern of carcass removal by scavengers resulted in an average duration in the field of 10.3 days.

Table 8: Scavenger disappearance rate at Ararat Wind Farm – October 2017

Turbine No.	Day	0	1	1	2	2	3	3	4	5	7	9	11	14	17	21	24	28	31	Days in field
	Species/Date	16 Oct 2017	17 Oct 2017 am	17 Oct 2017 pm	18 Oct 2017 am	18 Oct 2017 pm	19 Oct 2017 am	19 Oct 2017 pm	20 Oct 2017	21 Oct 2017	23 Oct 2017	25 Oct 2017	27 Oct 2017	30 Oct 2017	2 Nov 2017	6 Nov 2017	9 Nov 2017	13 Nov 2017	16 Nov 2017	
3	Nankeen Kestrel	P	P	X																1.5
3	Australian Magpie	P	P	P	P	X														2.5
5	Common Mynah	P	P	P	P	P	P	P	P	P	P	P	P	P	X					17
5	Mouse	P	P	P	P	P	P	P	P	P	X									7
15	Common Mynah	P	P	P	P	P	P	P	P	P	X									7
15	Nankeen Kestrel	P	P	P	P	P	P		X											4
20	Nankeen Kestrel	P	P	P	P	P	P		X											4
20	Common Mynah	P	P	P	P	P	P	P	P	X										5
36	Mouse	P	P	P	P	P	P	P	P	X										5
36	Peregrine Falcon	P	P	P	P	P	P		X											4
38	White-striped Freetail Bat	P	P	P	P	P	P	P	P	X										5
38	Australian Magpie	P	P	P	P	P	P	P	P	P	P	P	X							11
49	Wedge-tailed Eagle	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	31
49	Mouse	P	P	P	P	P	P	P	P	P	P	P	P	P	P	X				21
50	Whistling Kite	P	P	P	P	P	P	*	P	P	P	P	P	P	P	P	P	P	P	31
50	Mouse	P	P	P	P	P	P	P	P	P	P	X								9
52	Nankeen Kestrel	P	P	P	P	P	X													3
52	Common Mynah	P	P	P	P	P	P	P	X											4
66	White-striped Freetail Bat	P	P	P	P	P	X													3
66	Wedge-tailed Eagle	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	31
																			Average	10.3 days

Notes: P = Still present on ground when checked, X = Carcass has been taken by a scavenger, * = Fox scat on carcass.

3.3.3. Carcass distribution under turbines

The location of carcasses was explored using data pooled between March 2017 (two incidental March 2017 records) and March 2018 (Figure 4). Carcasses were found between one to over 100 metres from turbine bases. Birds and bats differed in their distribution under turbines. Birds were found from just next to the turbine base to over 100 metres with almost even numbers at all distances from 1 to 100 metres. The vast majority of bat carcasses (92%) were found within 59 metres from the base of the turbine.

The distribution of carcasses conforms with earlier findings at other wind farms (Hull & Muir 2010).

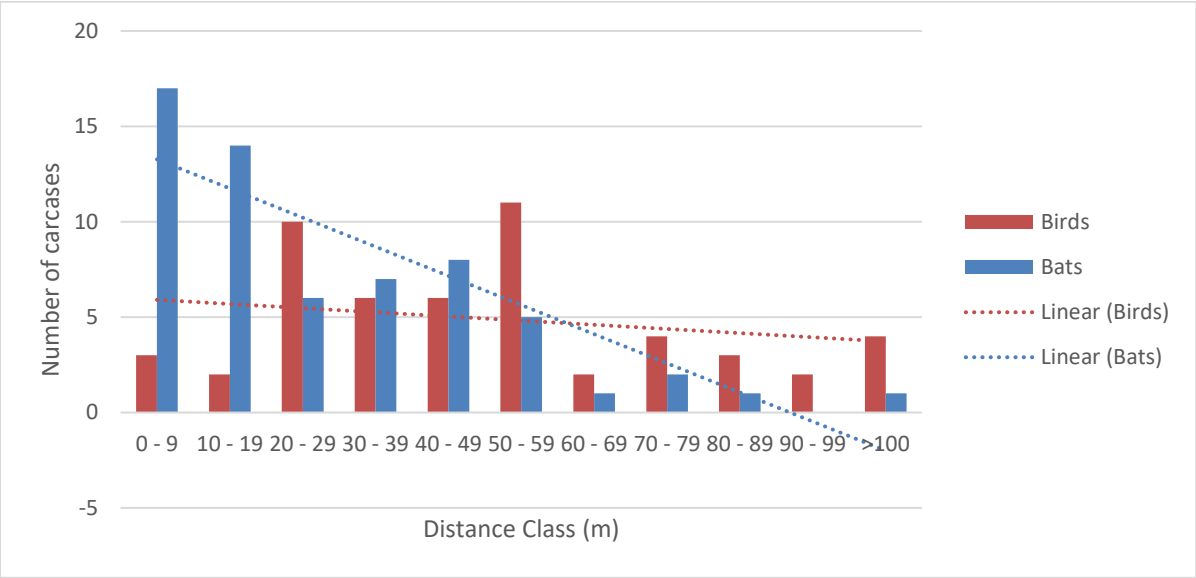

Figure 4: Distances of bird and bat carcasses from turbine bases

4. BIRD UTILISATION SURVEY

4.1. Methodology

4.1.1. Fixed-site bird count method

The fixed-point bird count method used to collect bird utilisation data over a five-day period in November 2017 involved an observer stationed at a survey site for 15 minutes. The adequacy of using 15 minutes as an interval to record the presence of birds during the bird utilisation survey (BUS) was investigated in an earlier study at another wind farm site (BL&A unpublished data). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 15 minutes of observation. Based on this result, the period of 15 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during replicate surveys.

During this period, all birds observed within 200 metres were recorded. The species, the number of birds and the height of the bird when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded.

For the purpose of the post construction bird utilisation surveys, flight height relative to the rotor swept area (RSA) height is presented below. These heights were based on the actual turbine heights that were constructed and were different from those used during the pre-construction phase as the turbine heights changed during the planning process.

- A = Below RSA (< 30 metres above ground)
- B = At RSA (30 – 140 metres above ground)
- C = Above RSA (> 140 metres above ground)

In the BUS, heights were measured at 10 metre intervals between 0 and 40 metres and at 20 metre intervals above 40 metres and up to 160 metres. This allowed for more precise description of bird flight heights.

4.1.2. Locations of survey sites

Ten fixed survey sites were established at eight impact sites and two reference sites. Impact sites were located near and among turbine locations and reference sites were located on edge of the wind farm boundaries in areas of similar habitat or at least 500 metres away from the proposed turbines.

The survey sites were distributed as evenly as possible (subject to access constraints) across the wind farm site to maximise coverage in areas where wind turbines would be located (Figure 5). Impact sites were positioned on elevated ground where possible, allowing a clear view in all directions.

The reference sites were established on public land for ease of access and were located in areas covered by some remnant native vegetation to provide a clear picture of birds occurring in close proximity to the wind farm site.

Figure 5: BUS and bat survey points

Project: Ararat Wind Farm

Client: Windlab

Project No.: 15120	Date: 24/05/2018	Created By: N. May

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4.1.3. Timing of the surveys

The bird utilisation survey was undertaken over five days from the 17th – 21st November 2017. The timing covers a suitable period for surveying birds as the bird populations are generally at their maximum abundance following the breeding season and most of the spring and summer visitors to the wind farm were present.

During the surveys, eight counts were made at each survey site. Counts were made at different times of the day to allow for time-of-day differences in bird movements and activity. Table 9 indicates when each site was counted on each survey day. This schedule ensured that all sites were visited at all times of day so that no time-of-day biases affected the pooled count data.

Table 9: BUS count times

Days	Daily times of survey							
	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30
1	1	2	3	4	5	6	7	8
2	3	4	5	6	7	8	R1	R2
3	5	6	7	8	R1	R2	1	2
4	7	8	R1	R2	1	2	3	4
5	R1	R2	1	2	3	4	5	6
Days	**Daily times of survey**							
	12:00	13:00	13:30	14:00	14:30	15:00	15:30	16:00
1	R1	R2	1	2	3	4	5	6
2	1	2	3	4	5	6	7	8
3	3	4	5	6	7	8	R1	R2
4	5	6	7	8	R1	R2	1	2
5	7	8	R1	R2	1	2	3	4

Note: See Figure 5 for survey site locations. The prefix 'R' refers to reference sites.

4.1.4. Incidental observations

In addition to the observations during formalised, fixed-site counts, incidental observations of birds of concern (threatened species, raptors, and waterbirds) were made whilst travelling throughout the proposed wind farm site. Notes were also made on woodland birds observed in remnant woodlands and any early morning and evening roosting movements. Emphasis was placed on observing birds that were moving through the site at RSA height.

4.2. Limitations

The November 2017 BUS was undertaken during late spring which is good timing for capturing resident and spring and summer migratory species. The purpose of the survey was to collect a range of data, including usage of the site by resident and migratory birds that may only occur at certain times of the year.

For these reasons, the utilisation rates and species relative abundances recorded during the current surveys are considered to be representative of the site year-round as they take into consideration both time-of-day and seasonal variation in bird activity and species occurrence. They are therefore considered to provide a comprehensive basis on which to assess the bird risks associated with the operation of the wind farm.

4.3. Results

4.3.1. Survey suitability

A cumulative species curve has been plotted for the November bird surveys to determine the suitability of the method. The cumulative species curve shows the number of different bird species observed over consecutive fixed-point bird counts conducted at the observation sites.

The species curve showing the results of the November 2017 bird surveys is shown in Figure 6. The cumulative species curve indicates that the number of new bird species recorded levelled out at between 50–60 counts, after which the line attained its asymptote and only a small number of additional bird species were recorded. This result suggests that the survey effort provides a representative picture of the diversity of bird species flying over the wind farm site during the survey period.

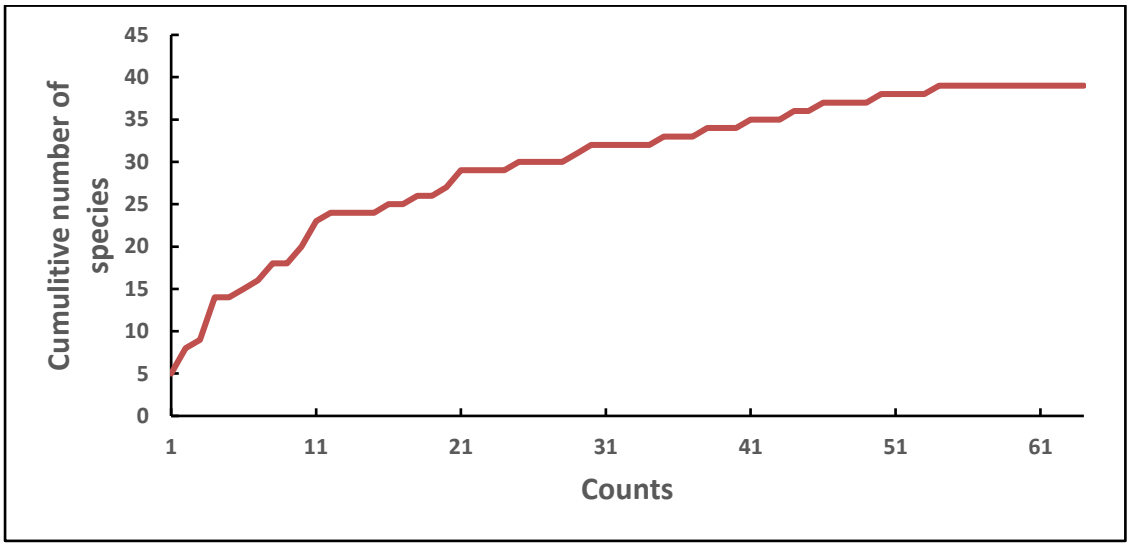

Figure 6: Cumulative number of bird species recorded during consecutive counts at the impact sites

4.3.2. Species composition

The Victorian Biodiversity Atlas (VBA) reported 156 species of bird for an area of 10-kilometre radius surrounding the Ararat Wind Farm site (DELWP 2017). The list is extensive as it includes records taken over many years.

The number of species actually counted during the November 2017 formal BUS counts reached 56 species, 39 of which were recorded at the impact sites and 36 at the reference sites. The number of species tallied during the formal BUS counts equated to 36% of birds recorded within the 10-kilometre radius of the wind farm site (DELWP 2017). Most of the other birds were not recorded in the formal BUS as they were taken over many seasons or either of rare occurrence or water birds restricted to the larger water bodies away from the wind farm site.

The species diversity compared well with other wind farms in the area and constituted mainly of a combination of birds of open grasslands and stock grazing paddocks as well as woodland birds.

4.3.3. Species abundance

The species observed during the November 2017 BUS are summarised in Table 10 for the eight impact sites and Notes: No **bird was recorded flying over 140 m during the surveys**

Table 11 for the two reference sites. Both tables include a list of the species observed during the BUS in each of the observation sites, as well as the number of individual birds per species recorded at each of the three height zones (<30 m), at (30–140 m) and above (>140 m) RSA height. (*Note:* no birds were observed flying at above 140 metres.)

Impact sites

The following five most dominant bird species constituted a total of 46 percent of all birds utilising the impact sites. These were (in order of their dominance):

- Australian Magpie (22.7%);
- Superb Fairywren (8.9%);
- Raven (6.3%);
- Galah (5.3%); and
- Crimson Rosella (4.9%).

These five species are common farmland birds, including those that are commonly known to utilise open farmlands, and mostly found in the interface between woodland and open grazing paddocks.

Reference sites

At the reference sites the five most common species recorded included (in order of abundance):

- Australian Magpie (13.2%);
- Crimson Rosella (7.8%);
- Sulphur-crested Cockatoo (7.8%);
- Striated Pardalote (7.2%); and
- Long-billed Corella (5.9%)

The five most commonly recorded species at the reference sites constituted a total of 42 percent of all birds utilising the reference sites. The dominant species of birds recorded at the reference sites were similar to those recorded at the impact sites with the exception of the presence of more cockatoos since the reference sites were part of public road reserve and encompassed large and mature eucalypt trees.

Of note is the fact that the total number of birds recorded at the two reference sites was significantly higher (except for site 4) than that recorded at all of the eight impact sites. Possible reasons for this may be attributed to:

- The reference sites were part of a road reserve with remnant vegetation that had large and mature eucalypt trees which naturally attracted more birds and particularly cockatoos;
- Site 4 has an abundance of mature eucalypts and had similar abundance of birds as the reference sites;

- The reference sites were mainly in low land compared to impact sites which usually were on top of ridges and mostly situated on hills cleared of trees, and
- Reference sites included few farm dams which attracted waterbirds and swallows.

Table 10: Number and height distribution of birds at the impact sites

Species	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		Totals		G. total	% of obs.
	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m	<30m	30–140 m		
Australian Magpie	8	1	8		8		11		8		8		8		9		68	1	69	22.7
Superb Fairywren			7		2		8				7				3		27		27	8.9
Raven	2	1	1	2	4		2		2	4					1		12	7	19	6.3
Galah	8				4			2			2						14	2	16	5.3
Crimson Rosella			3		2		2		4		1		1		2		15		15	4.9
Brown Thornbill			6		3						3						12		12	3.9
Long-billed Corella	1		1	1	1		2	1	2	2		1					7	5	12	3.9
Sulphur-crested Cockatoo					2		2	1					6	1			10	2	12	3.9
Blue-winged Parrot	5				5		1										11		11	3.6
Red Wattlebird							2		1		7		1				11		11	3.6
Australian Pipit	5		4		1												10		10	3.3
Striated Pardalote							6				3		1				10		10	3.3
Grey Fantail							7								1		8		8	2.6
Grey Shrike-thrush			1				3				1		1		2		8		8	2.6
Red-rumped Parrot							5		1		2						8		8	2.6
Black-faced Cuckoo-shrike							2				2		2		1		7		7	2.3
Yellow-faced Honeyeater					2		5										7		7	2.3
European Goldfinch			1						5								6		6	2.0
Buff-rumped Thornbill			1		1										1		3		3	1.0
Common Starling	3																3		3	1.0
Rufous Whistler			1				2										3		3	1.0
Brown-headed Honeyeater							1				1						2		2	0.7
Collared Sparrowhawk										2							0	2	2	0.7
Laughing Kookaburra					1										1		2		2	0.7
Nankeen Kestrel						1			1								1	1	2	0.7
New Holland Honeyeater							1				1						2		2	0.7
Southern Whiteface			2														2		2	0.7
Striated Thornbill							1								1		2		2	0.7
Wedge-tailed Eagle										1						1	0	2	2	0.7
Yellow-tailed Black Cockatoo							1	1									1	1	2	0.7
Brown Falcon						1											0	1	1	0.3
Brown Songlark													1				1		1	0.3
Magpie-lark											1						1		1	0.3
Pallied Cuckoo													1				1		1	0.3
Shining Bronze-Cuckoo			1														1		1	0.3
Welcome Swallow															1		1		1	0.3
White-faced Heron			1														1		1	0.3
White-throated Treecreeper															1		1		1	0.3
Yellow-rumped Thornbill			1														1		1	0.3
Totals	32	2	39	3	36	2	64	5	24	9	39	1	22	1	24	1	280	24	304	100

Notes: No bird was recorded flying over 140 m during the surveys

Table 11: Number and height distribution of birds at the reference sites during the November 2017 survey

Species	R1		R2		Totals	% of observations
	<30 m	30 – 140 m	<30 m	30 – 140 m		
Australian Magpie	8		8		16	10.5
Crimson Rosella	4		8		12	7.8
Sulphur-crested Cockatoo	6	1	5		12	7.8
Striated Pardalote	8		3		11	7.2
Long-billed Corella	5	1	2	1	9	5.9
Raven	2	2	5		9	5.9
Welcome Swallow	3	1	5		9	5.9
Superb Fairywren	3		3		6	3.9
Buff-rumped Thornbill	4		1		5	3.3
Laughing Kookaburra	4		1		5	3.3
Magpie-lark	1		4		5	3.3
Red Wattlebird	3		2		5	3.3
Fairy Martin	2		2		4	2.6
White-plumed Honeyeater			4		4	2.6
Yellow-rumped Thornbill	2		2		4	2.6
Grey Shrike-thrush	1		2		3	2.0
Musk Lorikeet	1		2		3	2.0
Red-rumped Parrot	1		2		3	2.0
Willie Wagtail	1		2		3	2.0
Black-faced Cuckoo-shrike	1		1		2	1.3
Brown Thornbill	1		1		2	1.3
Galah		1	1		2	1.3
Mistletoebird	2				2	1.3
New Holland Honeyeater			2		2	1.3
Rufous Songlark			2		2	1.3
Rufous Whistler			2		2	1.3
Yellow-faced Honeyeater			2		2	1.3
Australian Wood Duck			1		1	0.7
Brown Falcon			1		1	0.7
Brown Songlark			1		1	0.7
Brown-headed Honeyeater	1				1	0.7
Eastern Rosella	1				1	0.7
Grey Teal			1		1	0.7
Pacific Black Duck			1		1	0.7
Straw-necked Ibis			1		1	0.7
White-throated Treecreeper	1				1	0.7
Grand Total	66	6	80	1	153	100.0

Notes: No bird was recorded flying over 140 m during the surveys

The distribution of bird numbers recorded among the survey sites is shown in Table 12. The total number of birds counted at the impact sites varied between a minimum total of 23 birds at impact site 7 to a maximum total of 69 birds at impact site 4. The higher number at some of the survey sites was mainly due to the presence of large numbers of woodland birds in the woodland remnants surrounding the survey site.

The mix of bird species recorded at each survey site reflected the nature and type of habitat in the count area. At sites with patches of native vegetation, such as remnant woodlands, more bush birds were encountered compared with sites with open grazing paddocks and few or no trees.

The density of birds was almost similar between the sites of the survey (as shown by the overlap of standard errors – Figure 7), except for site 4 which was significantly higher than the rest of the sites. The highest bird density was at survey site 4 and the lowest at site 7 (Figure 7). Bird density (number of birds/ha/hour) was comparatively high at survey sites containing woodland areas included in the count area (such as site 4), and lower at sites of open grazing grassland.

The trend in bird abundance at the reference site was similar to that of the impact sites with comparatively higher densities than the impact sites (Figure 7), due to factors discussed above.

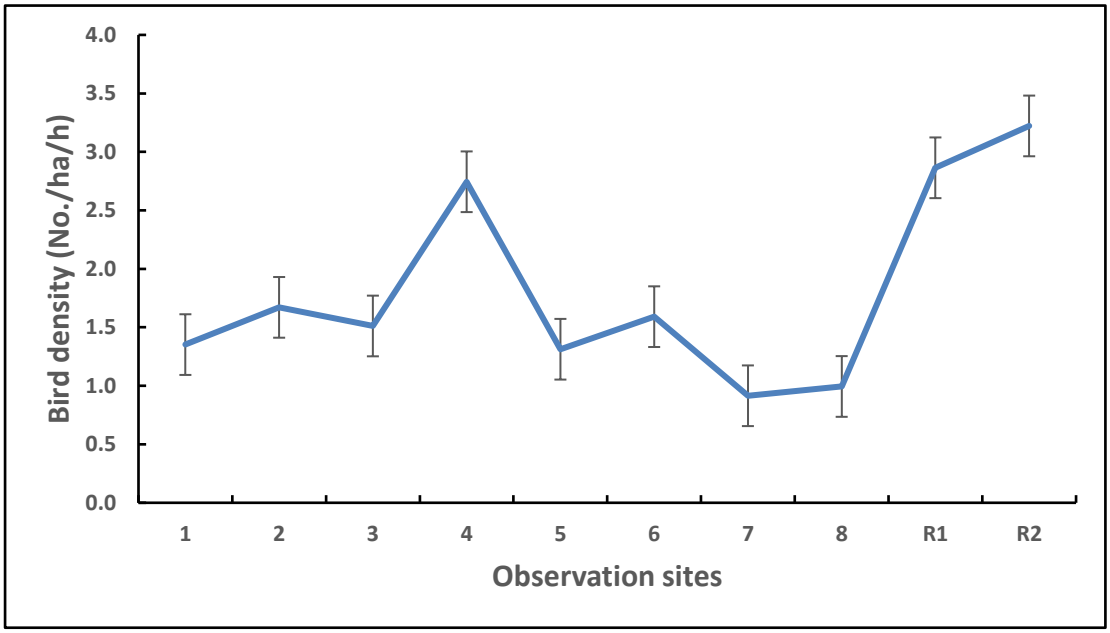

Figure 7: Bird density at the impact and reference sites (Average ± SE)

Table 12: Numbers and their height distribution of birds recorded at each survey site during November 2017 survey

Sites	Number of birds at			% Importance	% at RSA	% RSA of all birds	Density No./ha/h
	<30 m	30 – 140 m	Totals				
1	32	2	34	11.2	8.3	0.7	1.4
2	39	3	42	13.8	12.5	1.0	1.7
3	36	2	38	12.5	8.3	0.7	1.5
4	64	5	69	22.7	20.8	1.6	2.7
5	24	9	33	10.9	37.5	3.0	1.3
6	39	1	40	13.2	4.2	0.3	1.6
7	22	1	23	7.6	4.2	0.3	0.9
8	24	1	25	8.2	4.2	0.3	1.0
Totals	280	24	304	100.0	100.0	7.9	1.5
R1	66	6	72	47.1	85.7	3.9	2.9
R2	80	1	81	52.9	14.3	0.7	3.2
Totals	146	7	153	100.0	100.0	4.6	3.0

Notes: No bird was recorded flying over 140 m during the surveys

4.3.4. Flight heights

Bird heights were classified as below (< 30 metres), at (30–140 metres), and above (> 140 metres) RSA height. The number of birds found flying at RSA heights are summarised in Table 13 (*Note:* no birds were observed flying at above 140 metres).

Overall, of all bird flights observed during the BUS, 7.9% were at RSA height at the surveyed impact sites (Table 13).

Of the species recorded utilising the impact sites, 10 were seen flying at RSA height. The most common species at this height were the Ravens (29.2% of all RSA birds) and Long-billed Corella (20.8%). The above two species accounted for 50% of all birds at this height. The remaining species were less common at RSA heights but represented other large birds, such as, cockatoos and raptors; these birds are usually found to fly high and prone to collision with operating turbines.

At the reference sites 7 individuals birds belonging to five species observed flying at RSA height. These species were similar to those observed at these heights in the impact sites.

The number of birds recorded at the different flight heights were further analysed and presented in Figure 8.

The distribution of flight heights was similar between the surveying sites with the majority of birds recorded flying below RSA height during the BUS survey. Overall, 92.1% of birds were recorded below RSA height, with 7.9% at RSA height and none recorded above RSA height.

The height distribution confirms that most birds were recorded below RSA height therefore reducing impact and or collision risks between birds and operational wind turbines.

Table 13: Species flying at rotor swept height (RSA) at the impact sites during BUS survey

Species	Birds at RSA*	Total birds	% at RSA
Raven	7	19	36.8
Long-billed Corella	5	12	41.7
Galah	2	16	12.5
Sulphur-crested Cockatoo	2	12	16.7
Collared Sparrowhawk	2	2	100
Wedge-tailed Eagle	2	2	100
Australian Magpie	1	69	1.4
Nankeen Kestrel	1	2	50
Yellow-tailed Black Cockatoo	1	2	50
Brown Falcon	1	1	100
Grand Total	**24**	**304**	**7.9**

* RSA height (30 -140 m)

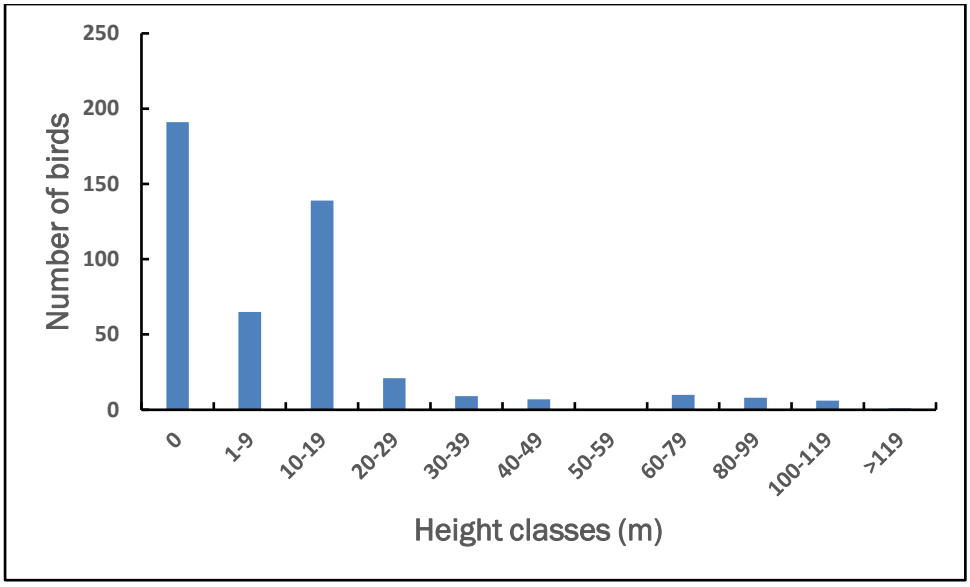

Figure 8: Height distribution of birds utilizing Ararat Wind Farm

4.3.5. Raptors

Seven individual raptors belonging to four raptor species were recorded during the BUS survey (Table 14). None of these raptors were exceptionally abundant, they were all recorded in small numbers in comparison to other bird species. Of the 304 birds recorded utilising the wind farm site, only two percent were raptors.

Raptors are known to fly at RSA heights. The Wedge-tailed Eagle utilise uplifting air currents and soar high while searching for their prey. Of the seven raptors recorded in this survey, 85.7 percent were flying at RSA heights.

Two Wedge-tailed Eagle were recorded during BUS flying at RSA heights.

Table 14: Raptor and waterbird species recorded at the impact survey sites during the November 2017 survey at Ararat Wind Farm

Raptors	Number at			% at RSA
	Below RSA	At RSA	Total	
Nankeen Kestrel	1	1	2	50.0
Brown Falcon	0	1	1	100.0
Collared Sparrowhawk	0	2	2	100.0
Wedge-tailed Eagle	0	2	2	100.0
Total raptors	**1**	**6**	**7**	**85.7**

4.3.6. Listed species & waterbirds

Most birds recorded utilising the wind farm site during the BUS were common birds. No threatened bird species were recorded during the formal BUS count.

Similarly, the waterbird fauna of the area was very poor; only one species, namely the common White-faced Heron was recorded once during BUS. A total of 11 other waterbirds that have been recorded incidentally at the Ararat Wind Farm site include:

- Australasian Grebe;

- Australian Shelduck;
- Australian Wood Duck;
- Black Swan;
- Grey Teal;
- Hoary-headed Grebe;
- Little Pied Cormorant;
- Masked Lapwing;
- Pacific Black Duck;
- Straw-necked Ibis; and
- White-necked Heron.

Waterbird abundance is generally low, with the exception of the Australian Wood Duck which congregates in groups around some of the farm dams. The low abundance of waterbirds is a reflection of the lack of suitable water bodies within the wind farm site. Waterbirds were generally observed in farm dams and the low-lying gullies and valleys across the wind farm usually away from the turbines that are mostly located along the high ridges.

5. BAT SURVEY

5.1. Methods

During the spring 2017 and summer/autumn 2018 surveys, automated SongMeter® and Anabat® bat detectors recorded the species-specific echolocation calls of free-flying bats at eight sites that were representative of the habitat types of Ararat Wind Farm and located near proposed wind turbine locations (Figure 5). The detectors were programmed to commence operation approximately 30 minutes before dusk, and to cease approximately 30 minutes after dawn.

The electronic bat detector unit used an SDHC card that recorded bat echolocation calls, along with the date and time of each call.

Calls from the units were downloaded and sent to Rob Gration (Australian Bat Specialist, Melbourne, Victoria) for identification. The files from the recording sites were viewed in Anabat software, which provides a sonogram display of frequency versus time. Call identification was based on a key developed by comparing the characteristics of bat calls with reference calls from known species recorded across Australia. Identification is largely based on changes to frequency patterns over time, especially as the characteristic frequency changes. Only those recordings that contained at least two definite and discrete calls were classified as bat calls. For most species, a call sequence of several seconds in duration is required before identification can be made confidently.

5.1.1. Timing of the Surveys

Spring 2017 survey: The bat survey was conducted over the period from 16th to 24th November 2017. The recording of bat calls was undertaken over nine consecutive nights utilising five SongMeter and three Anabat units recording concurrently at eight sites (Figure 5).

Summer 2018 survey: The bat survey was conducted over the period from 2nd to 9th March 2018. The recording of bat calls was undertaken over eight consecutive nights utilising three SongMeter and five Anabat units recording concurrently at eight sites (Figure 5).

These sites encompassed a variety of habitats present on the wind farm such as windbreaks (linear rows of planted trees), freshwater and/or brackish wetlands and open cropped or grazing paddocks comprising mixed native and introduced grasses.

Bat recording for the spring survey totalled 480 hours over 60 detector-nights from eight different recorders at eight sites. The summer survey amounted to 464 hours over 58 detector-nights.

5.1.2. Location and description of recording sites

The location and characteristics of the recording sites are described below (see Figure 5 for survey site locations).

- Site 1: On top of a cleared hill, between Turbine 2 and Turbine 3, set on a fence post overlooking open grazing paddocks. No trees close to the survey site.
- Site 2: On top of a high hill, close to turbine 10, set on a small tree surrounded by grazing paddocks and small eucalypt regrowth patch.

- Site 3: On a dead tree trunk, close to turbine 49 and surrounded by other mature eucalypt trees and a small patch of remnant woodland.
- Site 4: On a tree between turbines 28 and 29 within large grazing paddock and surrounded by scattered eucalypts, approximately 100 metres away.
- Site 5: On top of a high hill close to turbine 31 and surrounded by a eucalypt remnant woodland.
- Site 6: In a small woodland remnant, among old and mature eucalypt trees between turbines 69 and 70 and surrounded by open grazing paddocks.
- Site 7: On top of a high hill close to turbine 65 and overlooking a large remnant eucalypt woodland.
- Site 8: On top of a high hill, similar to site 7 and close to turbine 32. This site sits on the edge of steep ridge and overlooking large eucalypt woodland.

5.1.3. Limitations

The identification of echolocation calls from microbats in south-eastern Australia is facilitated by the fact that many calls are species-specific. Calls that could not be identified definitively were allocated to species complexes.

A further limitation in the use of this technique is that it is not possible to census bat numbers. For example, 10 calls of a particular species may be recorded but it is not known if this represents 10 individuals of that species or one individual of that species flying past the bat recorder 10 times or anywhere in between. Therefore, it is not possible to determine utilisation rates, only activity levels.

Occasionally recording devices such as those used in the survey experience technical difficulties, which are not uncommon. As a result, short periods of time may not be recorded and total hours of recordings vary between the different recorders. Weather conditions including severe storms during the recording period may at time interfere with the recording process.

The bat detectors used during this survey sample a limited airspace to a distance of approximately 20–30 metres.

Finally, bat activity levels may vary in response to weather variables such as air temperature, relative humidity, barometric pressure, wind speed, direction & gusts, rain and moonlight. Typically, bats are found to be less active during the following circumstances (G. Richards; pers. comm.):

- During periods of full moon, and when the moon is high in the sky;
- At higher wind speeds a decrease in activity may be observed at wind speeds over 10 metres per second (recognising recordings at higher wind speed may be attenuated); and
- During moderate to heavy rainfall.

5.2. Results of the survey

5.2.1. Bat species

Eight species of bats were recorded during bat surveys at Ararat Wind Farm (Table 15). Of these:

- Seven were common, widespread and secure bat species that occur in farmland and other habitats throughout south eastern Australia;
- One confirmed threatened species, the Yellow-bellied Sheathtail Bat, is a listed threatened species under the *Flora and Fauna Guarantee Act 1988* (FFG Act) and is more abundant in northern Australia; and
- In addition to the species positively identified, two multi-species complexes were also identified. None of the complexes included a threatened species as part of the complex.

The ultrasonic calls of Long-eared bats (*Nyctophilus* spp.) are difficult to distinguish to species level, and hence are grouped under their generic name. The species that are likely to occur at Ararat Wind Farm are *Nyctophilus geoffroyi* and *N. gouldi*. These species are not listed as threatened.

Similarly, calls of species of Forest Bats (*Vespadelus* spp.) can be difficult to differentiate and therefore some of their calls have been combined into the species complex for the purposes of analysis. None of these species are threatened.

The seasonal distribution of the species of bats was slightly different between the two seasonal surveys. While eight species were recorded during the spring 2017 survey, only six species were recorded during the summer 2018 survey. The two bat species not recorded during the summer included the threatened Yellow-bellied Sheathtail Bat and the Eastern Falsistrelle.

The Yellow-bellied Sheathtail Bat is a wide-ranging species through tropical and sub-tropical Australia. In Victoria, the species is considered to be a rare visitor in late summer and autumn. Many of the Victorian specimens have been found in exposed situations in an exhausted condition (e.g. hanging from the outside wall of buildings in broad daylight), which might suggest that they have been unintentionally driven south by adverse wind conditions. The species occurs in a wide range of habitats from wet and dry sclerophyll forests to open woodlands. It usually roosts in large tree hollows but sometimes uses buildings (Menkhorst 1995, Churchill 2008).

Table 15: Bat diversity at Ararat Wind Farm

Common name	Scientific name	Sites recorded: spring 2017	Sites recorded: summer 2018	Conservation status
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventis*	4	--	Threatened, rare, migratory
White-striped Freetail Bat	*Tadarida australis*	1, 3, 5, 6, 7, 8	1, 2, 3, 5, 6, 7	Common, Secure
Southern Freetail Bat	*Mormopterus planiceps*	1, 2, 3, 4, 6, 7, 8	1, 2, 3, 5, 7	Common, Secure
Gould's Wattled Bat	*Chalinolobus gouldi*	All sites	1, 2, 3, 4, 5, 6, 7	Common, Secure
Chocolate Wattled Bat	*Chalinolobus morio*	4, 5, 6, 7	2, 6, 7	Common, Secure
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	S 1, 3, 5	--	Common, Secure
Large Forest Bat	*Vespadelus darlingtoni*	1, 2, 4, 5, 6, 7, 8	All sites	Common, Secure
Little Forest Bat	*Vespadelus vulturnus*	2, 4, 5, 7	5, 2, 7	Common, Secure
Species complex				
Long-eared Bat	*Nyctophilus spp.*	1, 3	3, 6, 7	Spp. complex
Forest Bat spp.	*Vespadelus darlingtoni / V. Regulus / V. vulturnus*	All sites	All sites	Spp. complex

5.2.2. Bat activity

Bat activity during the recording period varied between the different species, time of recordings and the habitats at the recording sites. Over 1600 calls in spring 2017 and 900 in summer 2018 were recorded, of which over 65 percent were identified to species level.

The presence, absence and frequency of records of each species at each of the eight sites can be used as a simple measure of bat activity on the wind farm site. Such data was summarised in Table 16 for the spring 2017 survey and in Table 17 for the summer 2018 survey.

In terms of the nightly frequency of occurrence, the most recorded bats during the spring 2017 survey were (Table 16):

- Gould's Wattled Bat (55% of the 60 nights of recording);
- White-striped Freetail Bat (51.7%); and
- Southern Freetail Bat (35.0%).

And those during the summer 2018 survey were (Table 17):

- Gould's Wattled Bat (55% of the 58 nights of recording);
- White-striped Freetail Bat (39.7%); and
- Southern Freetail Bat (35.0%).

This data shows that the same species of bats were dominant during both seasonal surveys. Some species were recorded almost every night and at almost all survey sites.

The similarity of bat species and the frequency of their appearance in the nightly records or otherwise their relative activity was further compared between the two seasonal surveys. Figure 9 demonstrates that the activity of each of the species recorded at the wind farm site was very similar between the two seasons. Such results indicate that the bat fauna is rather stable with little seasonal variation between species utilising the of the Ararat Wind Farm site.

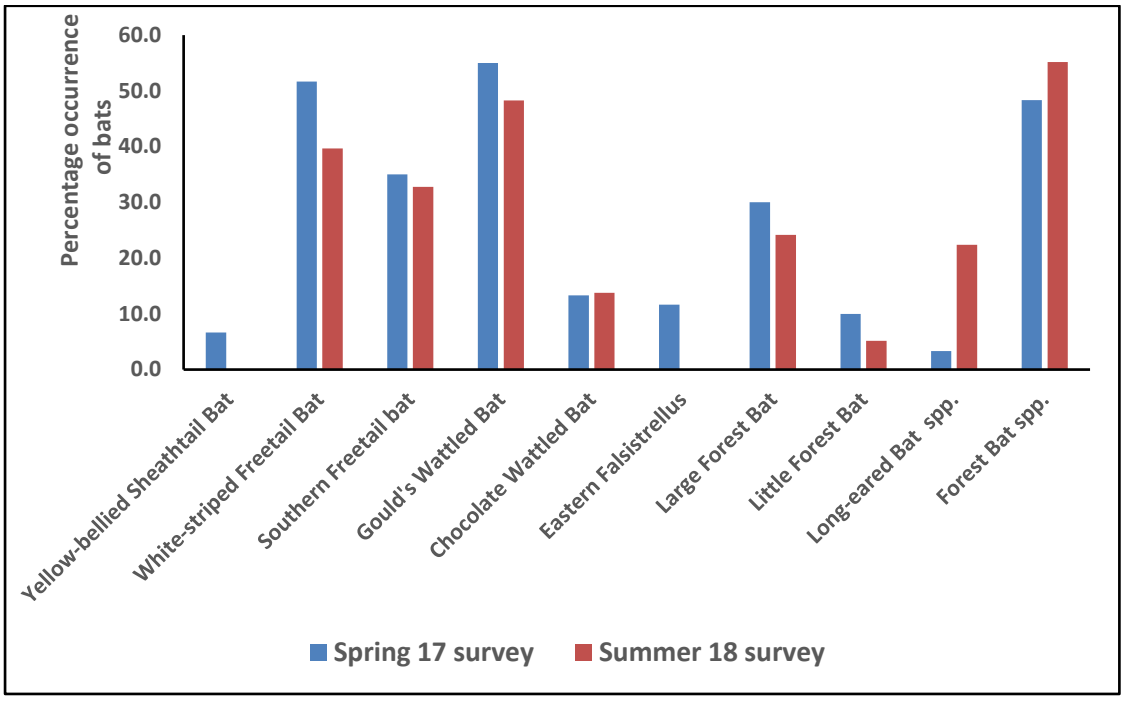

Figure 9: Comparison of the frequency of occurrence of bat species – spring and summer

Table 16: Summary of number of nights at which bat species were recorded at each of the eight sites of study during spring 2017 survey

Species of bats	Number of nights in which bats were recorded at each of the sites								Total nights	% Occurrence
	S1	S2	S3	S4	S5	S6	S7	S8		
Yellow-bellied Sheathtail Bat				4					4	6.7
White-striped Freetail Bat	4		2		6	4	7	8	31	51.7
Southern Freetail bat	3	5	1	3		6	6	5	21	35
Gould's Wattled Bat	6	8	2	4	7	6	6	6	33	55
Chocolate Wattled Bat			2	1	1	4	1		8	13.3
Eastern Falsistrellus	5		1			1			7	11.7
Large Forest Bat	4	1		3	3	6	3	2	18	30
Little Forest Bat		2		2	5		1		6	10
Identified to call complex										
Long-eared Bat	1		1						2	3.3
Forest Bat spp.	2	2	6	3	6	6	7	2	29	48.3
Total nights	**6**	**9**	**9**	**5**	**9**	**7**	**7**	**8**	**60**	**100**

Table 17: Summary of number of nights at which bat species were recorded at each of the eight sites of study during summer 2018 survey

Species of bats	Number of nights in which bats were recorded at each of the sites								Total nights	% Occurrence
	S1	S2	S3	S4	S5	S6	S7	S8		
Yellow-bellied Sheathtail Bat									0	0
White-striped Freetail Bat	6	1	4		6	2	4		23	39.7
Southern Freetail bat	4	3	5		4		3		19	32.8
Gould's Wattled Bat		8	7		4	2	7		28	48.3
Chocolate Wattled Bat		4	2	1		1			8	13.8
Eastern Falsistrellus									0	0
Large Forest Bat	4	3				1	3	3	14	24.1
Little Forest Bat							3		3	5.2
Identified to call complex										
Long-eared Bat			6			1	6		13	22.4
Forest Bat spp.	3	4	6		3	5	7	4	32	55.2
Total nights	**7**	**8**	**7**	**7**	**7**	**7**	**7**	**8**	**58**	**100**

5.2.3. Bat abundance

The absolute abundance (density) of bats cannot be measured from the number of bat calls recorded during the timed surveys (see limitations section above). Notwithstanding this limitation, calls can be used as an indication or simple measure of the relative abundance.

The details of the daily records of bat calls at both of the spring 2017 and summer 2018 surveys are kept on records by BL&A and could be provided on request. For the purpose of the current report, the data is summarised and presented as number of calls recorded at each of the eight sites during spring 2017 (Table 18) and summer 2018 (Table 19).

In general, the number of calls emitted by the various bat species was different between the sites; such calls mainly reflected the nature of the sites, its topography and vegetation cover. Sites close to large remnant woodland (such as sites 6,7 & 8) produced higher number of calls compared to sites from open grazing paddocks or cleared hills (sites 1, 4 & 5).

Similar to the bat activity patterns discussed above (Section 5.2.2); the various species of bats had different levels of relative abundance. The three most common species, in sequence of their abundance, were namely; Gould's Wattled Bat, Southern Freetail Bat, and White-striped Freetail Bat. These dominant species were the same in both of the spring 2017 and summer 2018 surveys. In addition, the Forest Bat complex was equally abundant in both seasons.

In spite of the similarity between the main dominant species at each of the spring 2017 and summer 2018 surveys; the total number of calls was almost twice as much in spring than in summer, indicating higher abundance of bats during the spring (Figure 10).

The abundance of threatened species was very low and recorded only during the spring 2017 survey. There were 20 calls from the Yellow-bellied Sheathtail Bat at one site amounting to an average of 0.3 calls per site (Table 18). This bat is a high-flying species that usually flies fast and straight above the canopy, but lower over open spaces and at the forest edge (Churchill 2008). It is thus potentially susceptible to collision with wind turbines near treed areas.

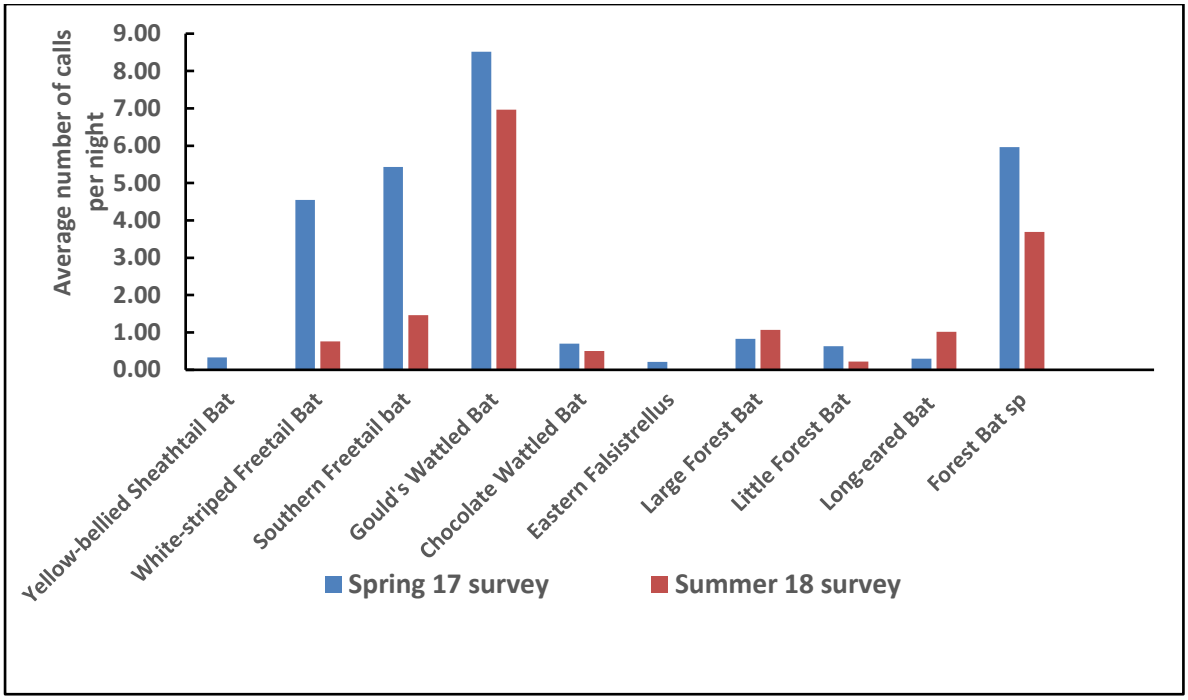

Figure 10: Comparison between bat calls during spring 17 and summer 18 surveys.

5.2.1. Bats of special concern

Bat species vary in their flight heights; while some forage by flying close to the ground or within and under tree canopies, others, such as the White-striped Freetail Bat (WSFB) are known to fly at heights up to 45 metres above ground or even higher and therefore can collide fatally with operating turbines when foraging within wind farm sites (BL&A; Unpubl. Data).

The WSFB is considered as a species of concern and warranted a more detailed study of their numbers and use of the various sections of the wind farm site due to the amount of casualties found under turbines (Section 3.2.2).

The number of calls recorded for White-striped Freetail Bat from the eight sampling points is listed in Table 18 for spring 2017 and Table 19 for summer 2018. The recording rate of this species averaged 4.6 calls per night in spring 2017 and much lower rate of 0.8 calls per night in summer 2018. In terms of the importance of this species, the calls formed 17.7 percent of all bat calls in spring 2017, and 4.8 percent in summer 2018.

The relatively high activity of the WSFB, particularly during the spring survey, was reflected in the number of carcasses of this species found under the operating turbines during the mortality monitoring which was conducted between April 2017 and March 2018. There was a total of 41 WSFB carcasses collected under turbines including 34 found during the formal search programme and seven found incidentally, with the peak number of kills occurring during November 2017 (Section 3.2.2).

Notwithstanding their comparatively high activity levels on the wind farm site, experience elsewhere (based on collision monitoring at ten wind farms in southern Australia over the last 15 years, BL&A, unpubl. data) indicates that this species collides in small numbers with wind turbines (between 0.5 and two bats per turbine per year).

Table 18: Summary of number of calls recorded during the spring 2017 survey

Specie of bats	Number of calls at								Total calls	Av. / night
	S1	S2	S3	S4	S5	S6	S7	S8		
Yellow-bellied Sheathtail Bat				20					20	0.3
White-striped Freetail Bat	4		4		18	16	59	172	273	4.6
Southern Freetail bat	5	30	1	6		112	98	74	326	5.4
Gould's Wattled Bat	42	72	5	15	46	91	195	45	511	8.5
Chocolate Wattled Bat			33	1	2	5	1		42	0.7
Eastern Falsistrellus	10		1			2			13	0.2
Large Forest Bat	6	1		3	11	21	5	3	50	0.8
Little Forest Bat		3		6	27	1	1		38	0.6
Identified to call complex										
Long-eared Bat	1		1						2	0.3
Forest Bat spp.	6	11	52	5	48	123	109	4	358	6
Total bat calls	**74**	**117**	**97**	**56**	**152**	**371**	**468**	**298**	**1633**	**27.2**
No of recording nights	**6**	**9**	**9**	**5**	**9**	**7**	**7**	**8**	**60**	**1**

Table 19: Summary of number of calls recorded during the summer 2018 survey

Species of bats	S1	S2	S3	S4	S5	S6	S7	S8	Total calls	Av. / night
Yellow-bellied Sheathtail Bat									0	0.0
White-striped Freetail Bat	9	1	14		9	2	9		44	0.8
Southern Freetail bat	10	8	39		9		19		85	1.5
Gould's Wattled Bat	35	115	123	1	37	2	91		404	7.0
Chocolate Wattled Bat		14	2			1	12		29	0.5
Eastern Falsistrellus										0.0
Large Forest Bat	9	5	17	1	10	1	15	4	62	1.1
Little Forest Bat					1	2	10		13	0.2
Identified to call complex										
Long-eared Bat			16			5	38		59	1.0
Forest Bat spp.	7	11	18		5	16	136	21	214	3.7
Total bat calls	**70**	**154**	**229**	**2**	**71**	**29**	**330**	**25**	**910**	**15.7**
No of recording nights	**7**	**8**	**7**	**7**	**7**	**7**	**7**	**8**	**58**	**1.0**

6. SUMMARY, IMPLICATIONS AND ADAPTIVE MANAGEMENT

Post-construction bird and bat carcass searches for the first year of the operation of Ararat Wind Farm were undertaken in accordance with the approved BBMP (BL&A 2013).

6.1. Threatened species

Given that no carcasses were found that belonged to threatened species the AWF is considered to pose a low risk to threatened bird and bat species.

6.2. Birds

6.2.1. Overall carcass search results

Between April 2017 and March 2018, 432 turbine searches were undertaken (impact sites) and 39 bird carcasses were found (including feather spots) representing one bird carcass every 11th turbine search.

The number of carcasses found of each species bears no correlation to the actual abundance of these species within the wind farm site as measured by BUS surveys (Section 4.3). Factors contributing to collision of birds with operating turbines are likely to be governed by bird behaviour, foraging habits and flight behaviour. For example, birds such as magpie, corella, raven and pipit are usually common birds flying and foraging among operating turbines, yet the rate of mortality is very low and does not reflect their abundance.

The bird species found during the carcass searches constitute a very small proportion of the bird species recorded on the wind farm (91 species). Many of the woodland birds do not regularly fly at RSA height and therefore do not feature in the carcass search results. There was a slight peak in the number of bird carcass found in October.

BL&A undertook an analysis pooling carcass monitoring data from 10 wind farm sites in southern Australia (6,617 turbine searches) with 243 bird carcasses being found for all wind farms, resulting in a rate of one bird carcass found every 27th turbine search (BL&A unpublished presentation at CEC forum 2016).

The carcass find rate at Ararat Wind Farm is higher from the rate at which carcasses are found at windfarms elsewhere in southern Australia.

The Wedge-tailed Eagle is over-represented in carcass searches compared with their relative abundance during bird utilisation surveys (discussed in Section 6.2.3).

6.2.2. Overall BUS results

The conclusions from the November 2017 BUS of the Ararat Wind Farm are presented below:

- The study area consists largely of cleared ridges and plateaus supporting an abundance of common, predominantly farmland birds;
- The study area supports a low proportion of raptors compared to the number of all other birds that were recorded using the site. Raptors represented 2% of all birds recorded at impacts sites during BUS;
- The study area supports a low proportion of waterbirds compared to the number of all other birds that were recorded using the site. Waterbirds represented less than 0.5% of all birds recorded at both impact and reference sites during the BUS;

- Bird abundance and diversity were higher at sites surrounded by remnant woodlands or scattered trees compared to sites lacking trees;
- The proportion of birds recorded at RSA height (at impact sites) was low and amounted to 7.9% of all birds utilising the wind farm site; and
- The proportion of raptors recorded at RSA height against all birds recorded (at impact sites) was very low and amounted to 2% of all birds utilising the wind farm site.

6.2.3. Species of concern

There were three bird species of concern highlighted in the BBMP, these include the following:

- Powerful Owl;
- Barking Owl; and
- Wedge-tailed Eagle.

There have been no Powerful Owl or Barking Owl carcasses detected under turbines and it is considered highly unlikely that these species have been impacted on by the wind farm. However there have been carcasses of Wedge-tailed Eagle (WTE) found under turbines, discussed below.

A total of nineteen (19) Wedge-tailed Eagle carcasses were found on the wind farm site during the first year of operation. There was a slight peak in the number of Wedge-tailed Eagle carcasses found in October. Most of these carcasses were young birds that would have recently fledged and left their nests.

To gain a better understanding of the utilisation of surrounding habitat by the species, all Wedge-tailed Eagle nests observed in the vicinity of the wind farm have been recorded and active eagle nests monitored. At least five resident pairs of Wedge-tailed Eagle have been recorded in the vicinity of the wind farm.

Notwithstanding the above losses, incidental observations during the March 2018 visit to the wind farm indicated the presence of a healthy population of Wedge-tailed Eagles observed flying on and near the wind farm site with seven eagles seen at once circling over one of the ridges.

It is therefore assumed that young Wedge-tailed Eagles from outside the wind farm vicinity that were new to the area in search of new territory were most likely involved in turbine collisions.

The low number of eagles observed to utilise the wind farm site during the formal post-completion BUS count does not appear to reflect the actual hazards these birds are exposed to from the operating wind turbines. It is considered likely that eagles collide with turbines mainly due to their soaring habits and preference to the type of habitat (windy with uplifting air currents) of the wind farm.

6.2.4. Implications and adaptive management

The carcass find rate at Ararat Wind Farm is higher from the rate at which carcasses are found at windfarms elsewhere in southern Australia.

Since the commencement of operation, wind farm personnel have implemented adaptive management measures, actively removing animal carcasses like sheep and kangaroos from the wind farm to reduce the potential for scavenging by eagles.

However, due to the high number of Wedge-tailed Eagles found under turbines further detailed investigations are warranted. Mitigation options that may be appropriate (subject to the investigation) to reduce the risk of Wedge-tailed Eagle collision with operating turbines may include but not limited to the following:

- Continue monitoring nesting sites during the breeding season. This will give an indication as to the impact the turbines may be having on the resident population. If a fall in breeding attempts is observed, it is a good indication that the local population is declining;
- Continue to undertake regular removal of carcasses across the wind farm. Wedge-tailed Eagles are predators and scavengers and will feed on sheep and kangaroo carcasses. Regular removal of these carcasses will make the area less attractive to feed; and
- Undertake regular rabbit control. The rabbit is a highly sought food source for the Wedge-tailed Eagle. By controlling the number of rabbits on the wind farm site it may deter eagles from coming to the area. (*Note*: poisoning is not recommended as a control method due to the possibility of secondary poisoning.)

Statistical analysis of the carcass search data will be undertaken at the end of the two-year monitoring period. This will involve determining total number of mortalities using the correction factors.

6.3. Bats

6.3.1. Overall survey data

The majority of bat species found to utilise the Ararat Wind Farm during detection surveys were found to belong to widespread species that are very common in South-eastern Australia and found to be equally common on other wind farms in the region.

Eight species of bats were recorded during bat surveys at Ararat Wind Farm. Of these:

- Seven were common, widespread and secure bat species that occur in farmland and other habitats throughout south eastern Australia; and
- One confirmed threatened species, the Yellow-bellied Sheathtail Bat, is a listed threatened species under the *Flora and Fauna Guarantee Act 1988* (FFG Act) and is more abundant in northern Australia.

The data collected in the spring 2017 and summer 2018 surveys were similar to those collected during an early seasonal survey undertaken during spring 2007 and summer 2008 (BL&A 2009). In the early surveys, 9 species of bats and one species complex were recorded compared to the eight species and two species complexes recorded during the current survey; however, there were some slight variation in the species list, particularly the presence of threatened species.

In the 2007/2008 surveys, two threatened or insufficiently known species, namely the Southern Bentwing Bat and Eastern Broad-nosed Bat, respectively, were recorded. These species were not recorded during the recent surveys. Similarly, the Yellow-bellied Sheathtail Bat recorded in the recent survey period was not recorded in the earlier surveys.

Bat activity at the proposed Ararat Wind Farm compares well with other wind farm sites in similar, largely agricultural settings (BL&A; unpubl. data). Findings from this survey are summarised below:

- Eight species of bats were recorded during the bat surveys:
  - Seven were common, widespread and secure bat species that occur in farmland and other habitats throughout south eastern Australia;
  - One confirmed threatened species, the Yellow-bellied Sheathtail Bat, listed threatened species under the FFG Act and is more abundant in northern Australia;
  - In addition to the species positively identified, two multi-species complexes were also identified. None of the complexes included a threatened species as part of the complex;
- The vast majority of bat activity was attributable to common and widespread species; and
- The threatened species was recorded on one night with very low numbers of calls compared with most other species – a total of 20 calls were attributable to threatened species out of over 1600 recordings.

6.3.2. Overall carcass search results

A total of forty-four (44) bat carcasses were collected during the first year of mortality searches at Ararat Wind Farm during formal searches. In addition, twelve (12) bat carcasses were found incidentally at non-targeted turbines. None of the bat carcasses collected under turbines was a threatened species.

No bat carcasses were found between June and September; the colder months when bat activity is comparatively low or absent as most bats are in a torpor state which is similar to hibernating or have migrated from the area. November 2017 was the peak period for bat carcasses with nineteen (19) being detected during formal searches and four (4) being recorded incidentally.

The non-threatened White-striped Freetail Bat was the most commonly found bat species during the April 2017–March 2018 monitoring period at Ararat Wind Farm with twenty-nine (29) found during formal searches and eleven (11) during incidental carcass searches. The White-striped Freetail Bat is widespread on the wind farm site based on the bat survey results and it usually flies at RSA heights, which puts it at risk of collision with turbines. Due to the high number of White-striped Freetail Bat found at the wind farm, further detailed investigations are warranted on the species (discussed in the following section).

6.3.3. Species of concern

One bat species of concern was highlighted in the BBMP:

- Southern Bent-wing Bat.

There have been no Southern Bent-wing Bat carcasses detected under turbines and it is therefore considered unlikely that this species has been impacted on by the wind farm.

Following the first year post-commencement surveys, a further two species were identified as of potential concern:

- Yellow-bellied Sheathtail Bat (threatened); and
- White-striped Freetail Bat (non-threatened).

Yellow-bellied Sheathtail Bat

During the spring 2017 and summer 2018 surveys, there was record of one threatened species (Yellow-bellied Sheathtail Bat) detected at one site during the spring 2017 bat survey.

There is no information on the numbers of Yellow-bellied Sheathtail Bats that visit Victoria as it has only been recorded rarely and irregularly. The numbers of individuals that occur in Victoria compared with other, more common bat species, indicates that the Victorian population would be small and unlikely to represent a highly significant part of the overall, larger, national population.

Given the low number of Yellow-bellied Sheathtail Bat calls recorded, the implications of the Ararat Wind Farm for the population of this species are considered to be negligible.

White-striped Freetail Bat

The White-striped Freetail Bat (WSFB) was the most commonly found bat species during the April 2017–March 2018 monitoring period at Ararat Wind Farm with twenty-nine (29) found during formal searches and eleven (11) during incidental carcass searches. This is considered a high number of White-striped Freetail Bat carcasses to be found under turbines at an operating wind farm.

Notwithstanding their comparatively high activity levels on the wind farm site, experience elsewhere based on collision monitoring at ten wind farms in southern Australia over the last 15 years (BL&A, unpubl. data) indicates that this species collides in small numbers with wind turbines (between 0.5 and two bats per turbine per year). At Ararat Wind Farm the collision rate for the first year was approximately 4 WSFB per turbine per year.

The loss of this number of bats on a wind farm the scale of the Ararat Wind Farm may have local population impacts; however, it is considered unlikely to result in any regional or larger scale impacts on WSFB populations. Further detailed investigations may be warranted on the species.

6.3.4. Implications and adaptive management

With the exception of the White-striped Freetail Bat, the impacts on common bat species is considered to be negligible, as the number of dead bats found during the mortality monitoring program was very low and is considered unlikely to have any impact on these common species' populations.

It is considered that the loss of a relatively high number of White-striped Freetail Bat on a wind farm the scale of the Ararat Wind Farm may have local population impacts. Further detailed investigations may be warranted on the species.

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Appendix 1: Summary of bird mortality associated with wind turbines at Ararat Wind Farm from March 2017 to March 2018

Season	Date	Common name^	Report (R)/ Feather spot (FS)/ Incidental (INC)	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Autumn	8/03/2017*	Wedge-tailed Eagle	INC 0.1 (001-17)	6	55	0	Deceased for some time, been scavenged by fox or similar after death
Autumn	13/03/2017*	Wedge-tailed Eagle	INC 0.2 (002-17)	3	22	315	Appears been deceased several days.
Autumn	20/04/2017	Australian Magpie	FS 1.1	32	75	215	50 plus feathers.
Autumn	21/04/2017	Sulphur-crested Cockatoo	FS 1.2	50	52	266	Scavenged, only a few feathers remaining.
Autumn	21/04/2017	Nankeen Kestrel	R 1.3	56	45	300	Intact bird.
Autumn	21/04/2017	Wedge-tailed Eagle	R 1.4	56	35	305	Well scavenged, found in three separate places, wings, feathers, neck and head collected.
Autumn	1/05/2017	Australian Magpie	INC 2.1	50	10	250	Collected by wind farm personnel.
Autumn	21/05/2017	Australian Magpie	INC 2.2	47	1	160	Collected by wind farm personnel.
Autumn	24/05/2017	Wedge-tailed Eagle	R 2.1	56	33	345	Intact eagle missing its head.
Autumn	25/05/2017	Welcome Swallow	R 2.3	49	20	80	Intact, found on hardstand.
Winter	20/06/2017	Brown Falcon	R 3.1	44	90	200	Scavenged some feathers and bones remain.
Winter	20/06/2017	Common Starling	R 3.2	36	30	78 & 135	A pair of wings found 25 metres apart.
Winter	15/08/2017	Wedge-tailed Eagle	R 5.1	36	59	180	Highly decomposed, head not present. Otherwise intact.
Spring	18/09/2017	Wedge-tailed Eagle	R 6.1	36	80	80	Fresh, impact wound on back. Stored in freezer.
Spring	18/09/2017	European Goldfinch	R 6.2	56	20	10	Impact under wing. Fresh. Stored in freezer
Spring	18/09/2017	Brown Falcon	R 6.3	44	20	0	Scavenged. Decapitated, wing found about 80m NE from turbine. No other parts located.
Spring	15/09/2017	Nankeen Kestrel	INC 6.1	41	3	200	Collected by wind farm personnel. Stored in freezer.
Spring	26/09/2017	Australian Magpie	INC 6.2	71	3	300	Collected by wind farm personnel. Stored in freezer.
Spring	6/10/2017	Whistling Kite	INC 7.1	48	40	130	Collected by wind farm personnel. Stored in freezer.
Spring	11/10/2017	Wedge-tailed Eagle	INC 7.2	62	46	0	Collected by wind farm personnel. Stored in freezer.
Spring	11/10/2017	Wedge-tailed Eagle	INC 7.3	29	82	180	Collected by wind farm personnel. Stored in freezer.
Spring	11/10/2017	Wedge-tailed Eagle	INC 7.4	14	28	270	Collected by wind farm personnel. Stored in freezer.
Spring	18/10/2017	Wedge-tailed Eagle	R 7.02	26	50	W	In two halves.
Spring	18/10/2017	Wedge-tailed Eagle	R 7.03	33	50	S	Scavenged, decayed.
Spring	18/10/2017	Wedge-tailed Eagle	R 7.04	33			Scavenged, decayed.
Spring	18/10/2017	Wedge-tailed Eagle	R 7.05	64	15	N	Decayed.
Spring	19/10/2017	Australian Raven	R 7.10	69	116	206	Scavenged.
Spring	17/10/2017	Australian Magpie	INC 7.6	57	20	40	Scavenged.
Spring	20/10/2017	Australian Magpie	FS 7.1	44	35	180	Very small feathers and some with very large quills, black and white in colour.
Spring	20/10/2017	Noisy Miner	FS 7.2	26	55	14	Many feathers and upper beak.
Spring	20/11/2017	Brown Falcon	R 8.07	58	50	E	Old, hollow and dry.
Spring	23/11/2017	Sacred Kingfisher	R 8.21	61	41	22	Wing only.
Spring	21/11/2017	Little Raven	FS 8.01	62	110	E	Feather spot.
Spring	22/11/2017	Australian Magpie	FS 8.02	25	118	73	Several feather spots in the general area from the same individual.
Spring	22/11/2017	Wedge-tailed Eagle	FS 8.03	33	70	N	Feather spot.
Spring	23/11/2017	Common Starling	FS 8.04	36	25	217	Feather spot, 20 feathers.
Spring	21/11/2017	Wedge-tailed Eagle	INC 8.05	24	54	328	Desiccated, immature bird.

Season	Date	Common name^	Report (R)/ Feather spot (FS)/ Incidental (INC)	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
Summer	11/12/2017	Australian Magpie	R 9.01	36	55	E	Old and decayed.
Summer	11/12/2017	Wedge-tailed Eagle	R 9.02	44	88	NE	Completely decomposed.
Summer	12/12/2017	Brown Falcon	FS 9.1	27	35	S	Feather spot, scavenged by WTE only feathers and some bones remain.
Summer	12/12/2017	Common Starling	INC 9.02				Found in substation switchyard.
Summer	8/01/2018	Wedge-tailed Eagle	INC 10.1	46	49	NE	Found on hard stand by wind farm personnel.
Summer	9/01/2018	Whistling Kite	R 10.04	15	31	W	Desiccated, only top half found.
Summer	10/01/2018	Wedge-tailed Eagle	R 10.07	44	55	E	Found in four pieces.
Summer	8/01/2018	Australian Magpie	FS 10.1	44	69	S	Feather spot.
Summer	9/01/2018	Australian Magpie	FS 10.2	61	98	WNW	Feather spot.
Summer	9/01/2018	Australian Magpie	FS 10.3	61	27	N	Feather spot.
Summer	10/01/2018	Australian Magpie	FS 10.4	33	78	N	Feather spot.
Summer	16/01/2018	Wedge-tailed Eagle	INC 10.2	44	25	NE	Found by WF personnel. Decapitated. Stored in freezer.
Summer	7/02/2018	Wedge-tailed Eagle	R 11.3	32	48	60	Desiccated. Wing found only.
Summer	5/02/2018	Australian Magpie	FS 11.1	56	113	210	Feather spot.
Autumn	7/03/2018	Wedge-tailed Eagle	R 12.1	73	62	SW	Intact, fairly recent.
Autumn	8/03/2018	Little Raven	R 12.4	63	70	SW	Wing only.

* Prior to the wind farm being fully operational; ^ no threatened species were recorded

Appendix 2: Summary of bat mortality associated with wind turbines from March 2016 to February 2017

Date	Common Name^	Species	Report Number	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
30/03/2017*	Gould's Wattled Bat	*Chalinolobus gouldii*	INC 0.3 (003-17)	45	3	270	Appears been deceased several days.
30/03/2017*	White-striped Freetail Bat	*Austronomis australis*	INC 0.4 (003-17)	45	3	270	Appears been deceased several days.
19/04/2017	White-striped Freetail Bat	*Austronomis australis*	R 1.1	15	5	200	Intact and fresh carcass.
20/04/2017	White-striped Freetail Bat	*Austronomis australis*	R 1.2	63	25	335	Partly eaten by ants.
25/05/2017	White-striped Freetail Bat	*Austronomis australis*	R 2.2	65	52	45	
11/10/2017	White-striped Freetail Bat	*Austronomis australis*	INC 7.5	32	12	330	Collected by wind farm personnel. Stored in freezer.
17/10/2017	Southern Freetail Bat	*Mormopterus planiceps*	R 7.01	58	47	NNE	Fresh
18/10/2017	White-striped Freetail Bat	*Austronomis australis*	R 7.06	64	14	100	Intact.
18/10/2017	White-striped Freetail Bat	*Austronomis australis*	R 7.07	64	48	278	Scavenged by maggots.
18/10/2017	White-striped Freetail Bat	*Austronomis australis*	R 7.08	64	58	192	Scavenged by maggots.
18/10/2017	Southern Freetail Bat	*Mormopterus planiceps*	R 7.09	65	1	S	Intact, fresh.
21/10/2017	White-striped Freetail Bat	*Austronomis australis*	R 7.11	33	1	E	Old carcass
17/10/2017	White-striped Freetail Bat	*Austronomis australis*	INC 7.5	59	35	288	Intact.
3/11/2017	White-striped Freetail Bat	*Austronomis australis*	INC 8.01 (014/17)	62	14	45	Collected by wind farm personnel. Stored in freezer.
9/11/2017	White-striped Freetail Bat	*Austronomis australis*	INC 8.02 (015/17)	77	14	NW	Collected by wind farm personnel. Stored in freezer.
15/11/2017	White-striped Freetail Bat	*Austronomis australis*	INC 8.03 (016/17)	73	5	N	Collected by wind farm personnel. Stored in freezer.
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.01	36	25	SW	Desiccated.
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.02	36	10	232	Intact.
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.03	36	20	350	
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.04	36	62	228	Wings and bones.
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.05	5	5	SW	Desiccated.
20/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.06	58	10	S	Desiccated.
21/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.08	63	59	W	Intact, fresh.
21/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.09	33	8	200	Intact, dry, inside eaten.
21/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.10	64	42	NNE	Desiccated, intact.
22/11/2017	Gould's Wattled Bat	*Chalinolobus gouldii*	R 8.11	69	1	140	Intact, dry.
22/11/2017	Gould's Wattled Bat	*Chalinolobus gouldii*	R 8.12	73	5	SE	Intact, desiccated.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.13	36	33	SE	Desiccated.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.14	36	10	S	Intact, fresh.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.15	58	1	NE	Intact, dry.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.16	58	25	NE	Desiccated.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.17	66	56	235	Intact.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.18	49	30	173	Desiccated, dry.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.19	61	31	224	Desiccated.
23/11/2017	White-striped Freetail Bat	*Austronomis australis*	R 8.20	61	40	179	Fresh.
21/11/2017	White-striped Freetail Bat	*Austronomis australis*	INC 8.04	67	10	SW	Intact.
1/12/2017	White-striped Freetail Bat	*Austronomis australis*	INC 9.01	10	8	W	Intact, collected by wind farm personnel and stored in freezer.
12/12/2017	White-striped Freetail Bat	*Austronomis australis*	R 9.03	64	100	NNE	Very desiccated.
12/12/2017	White-striped Freetail Bat	*Austronomis australis*	R 9.04	69	30	S	Desiccated.

Date	Common Name^	Species	Report Number	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Notes
14/12/2017	White-striped Freetail Bat	*Austronomis australis*	R 9.05	62	36	W	Intact, broken wing, collision the previous night.
14/12/2017	Large Forest Bat	*Vespadelus darlingtoni*	R 9.06	50	16	N	Intact, wound on back.
8/01/2018	White-striped Freetail Bat	*Austronomis australis*	R 10.01	3	70	NW	Desiccated.
8/01/2018	Southern Freetail Bat	*Mormopterus planiceps*	R 10.02	36	5	SW	Intact though dry.
8/01/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 10.03	56	45	N	Intact.
9/01/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 10.05	15	83	NNW	Scavenged, only half of body left.
9/01/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 10.06	61	45	N	Intact, laceration on back.
11/01/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 10.08	61	45	S	Intact.
11/01/2018	Southern Freetail Bat	*Mormopterus planiceps*	R 10.09	63	17	S	Fresh, mostly intact.
14/01/2017	White-striped Freetail Bat	*Austronomis australis*	INC 10.3	38	16	W	Intact, found by wind farm personnel.
17/01/2018	White-striped Freetail Bat	*Austronomis australis*	INC 10.4	65	5	NE	Intact, collected by wind farm personnel and stored in freezer.
17/01/2018	White-striped Freetail Bat	*Austronomis australis*	INC 10.5	64	6	W	Intact, collected by wind farm personnel and stored in freezer.
25/01/2018	White-striped Freetail Bat	*Austronomis australis*	INC 10.6	40	18	37	Collected by wind farm personnel. Stored in freezer.
6/02/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 11.1	50	50	90	Desiccated, old. Decapitated, maybe scavenged.
6/02/2018	White-striped Freetail Bat	*Austronomis australis*	R 11.2	52	5	180	Split abdomen. Not usable in trials
7/02/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R11.4	73	73	289	Intact, partially scavenged, ants eaten wing membrane.
28/02/2018	Southern Freetail Bat	*Mormopterus planiceps*	INC 11.1	53	1	W	Intact, found by wind farm personnel.
7/03/2018	Gould's Wattled Bat	*Chalinolobus gouldii*	R 12.2	73	18	SW	Hollow and dry.
7/03/2018	Southern Freetail Bat	*Mormopterus planiceps*	R 12.3	5	43	S	Desiccated.

* Prior to the wind farm being fully operational; ^ no threatened species were recorded