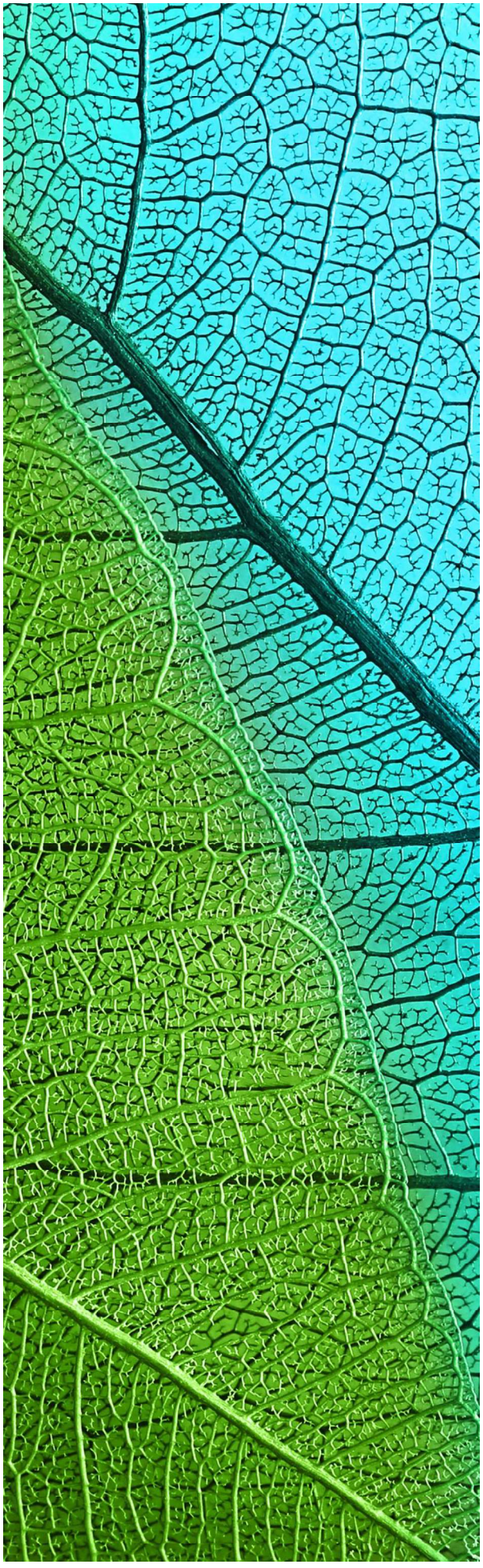

Sapphire Wind Farm

First Year Annual Report of the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for SWF1 Operations Pty Ltd

April 2020
Report No. 16045 (18.0)

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1. Executive Summary

Sapphire Wind Farm (SWF) is located in the New England region of northern New South Wales. The site is 24 kilometres west of Glen Innes and three kilometres north of the Gwydir Highway (Figure 1). The site has been mostly cleared of its original native vegetation and used for grazing.

The wind farm currently comprises 75 turbines and associated infrastructure. The development consent was modified in 2016 to reduce the number of turbines from 159 to 75, proposed in the original approval in 2007.

As per Condition C6 of the NSW approval for Sapphire Wind Farm a Bird and Bat Adaptive Management Plan (BBAMP) was developed and approved in 2017. Brett Lane & Associates Pty Ltd (BL&A), the predecessor to Nature Advisory Pty Ltd (Nature Advisory), was engaged to implement the BBAMP.

The first phase of the monitoring program comprised seven months during the pre-operational period and the first year of fully operational surveys including:

- Monthly monitoring of bird and bat collisions with turbines through carcass searches, including scavenger surveys (to determine carcass removal rates before detection), and observer efficiency trials (to determine how well observers detect carcasses);
- Monitoring 'at risk' groups of birds, including raptors and White-throated Needletail; and
- Assessing the effects of the wind farm on bird activity at the site, based on bird utilisation rates.

During the carcass search period, a total of 19 bird and bat remains were found. Of this, during the pre-operational phase, only a portion of turbines were constructed. From July 2018 to January 2019, one bat carcass and one feather spot were found during formal searches and four bird and two bat carcasses were found incidentally. Each bird or bat remain was found under a turbine that was only partially constructed and non-operational.

During the official first year of the operational phase, four bird carcases, one bat carcass and one feather spot were found while conducting formal searches. In addition, five bird carcasses were recorded as incidental finds.

The carcass of one threatened species – Grey-headed Flying Fox – was recorded at Sapphire Wind Farm during the monitoring period. The species is listed as vulnerable under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The carcass was found tangled in a fence line and therefore unlikely to have been caused by collision with a wind turbine.

Among all species, the Australian Magpie was the most commonly found species during carcasses searches, followed by the Crested Pigeon and Wedge-tailed Eagle. These three species are common and wide-spread birds favouring open farmland habitats.

Results from Bird Unitisation Surveys (BUS) suggested that Sapphire Wind Farm supported a low diversity and abundance of common, predominantly farmland birds. The study area supported a total of 50 species of birds; 42 at the impact and 41 at the reference points. The species with

the highest frequency of observation was Noisy Miner, followed by Australian Magpie and Eastern Rosella.

The majority of birds were recorded flying below rotor swept area (RSA) heights. The birds recorded flying at RSA heights were both raptors and common woodland birds. Waterbirds were found to be largely confined to farm dams and were common waterbird species, including Australian Wood Duck and Straw-necked Ibis. The Speckled Warbler was the only threatened bird species (vulnerable in NSW under the BC Act) recorded utilising the wind farm site.

Overall, results from first year of carcass monitoring shows a low rate of bird and bat mortality due to the operation of Sapphire Wind Farm, compared with other wind farms in eastern Australia. The bird and bat collision monitoring program will continue throughout 2020 for a complete second year. Monitoring of at-risk species and incidental monitoring will also continue in year two at Sapphire Wind Farm.

2. Introduction

Sapphire Wind Farm (SWF) is located in the Kings Plain District, 24 kilometres west of Glen Innes and 28 kilometres east of Inverell in the northern tablelands of New South Wales (NSW) (Figure 1). A total of 75 turbines and associated infrastructure are sited within approximately 8,921ha of land. The land has been predominately cleared for grazing. SWF is owned by CWP Renewables.

SWF proposed a 159-turbine wind farm in the northern Tablelands of NSW in 2007. The NSW Department of Planning and Infrastructure (DPI) and the Commonwealth Department of the Environment (DotE) approved the wind farm in June 2013 and December 2014 respectively. In January 2016, Sapphire Wind Farm Pty Ltd requested a modification to the approval to reduce the number of turbines from 159 to up to 109 turbines and increase the maximum tip height to 200 metres above the ground and rotor diameter to 126 metres. The DPE and the DotE approved the Modification request in June 2016. The project completed construction in late 2018 with a refined design which involved the construction of 75 turbines at locations approved in the Modification.

Condition C6 of the NSW approval required the preparation of a Bird and Bat Adaptive Management Program (BBAMP), these requirements have been outlined in the following section. Element (d) required the proponent to identify 'at risk' bird and bat groups, seasons and/or areas within the project site which may attract high levels of mortality. The BBAMP was prepared by Brett Lane & Associates Pty Ltd, predecessor of Nature Advisory Pty Ltd (BL&A 2017) and approved by the Director-General of DPI.

Sapphire Wind Farm Pty Ltd engaged Nature Advisory to implement the approved Bird and Bat Adaptive Management Program (BBAMP) for the SWF. Specifically, the scope of the work included:

- Operational bird and bat carcass (mortality) monitoring program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

This report is divided into the following sections:

Section 3 provides the methods and results of the carcass search program.

Section 4 provides the methods and results of the monitoring 'at risk' bird species.

Section 5 provides the methods and results of the bird utilisation survey.

Section 6 discusses the conclusions of the first year of monitoring at SWF.

This investigation was undertaken by a team from Nature Advisory, comprising Ahmad Barati (Zoologist), Jackson Clerke (Zoologist) and Bernard O'Callaghan (Senior Ecologist and Project Manager).

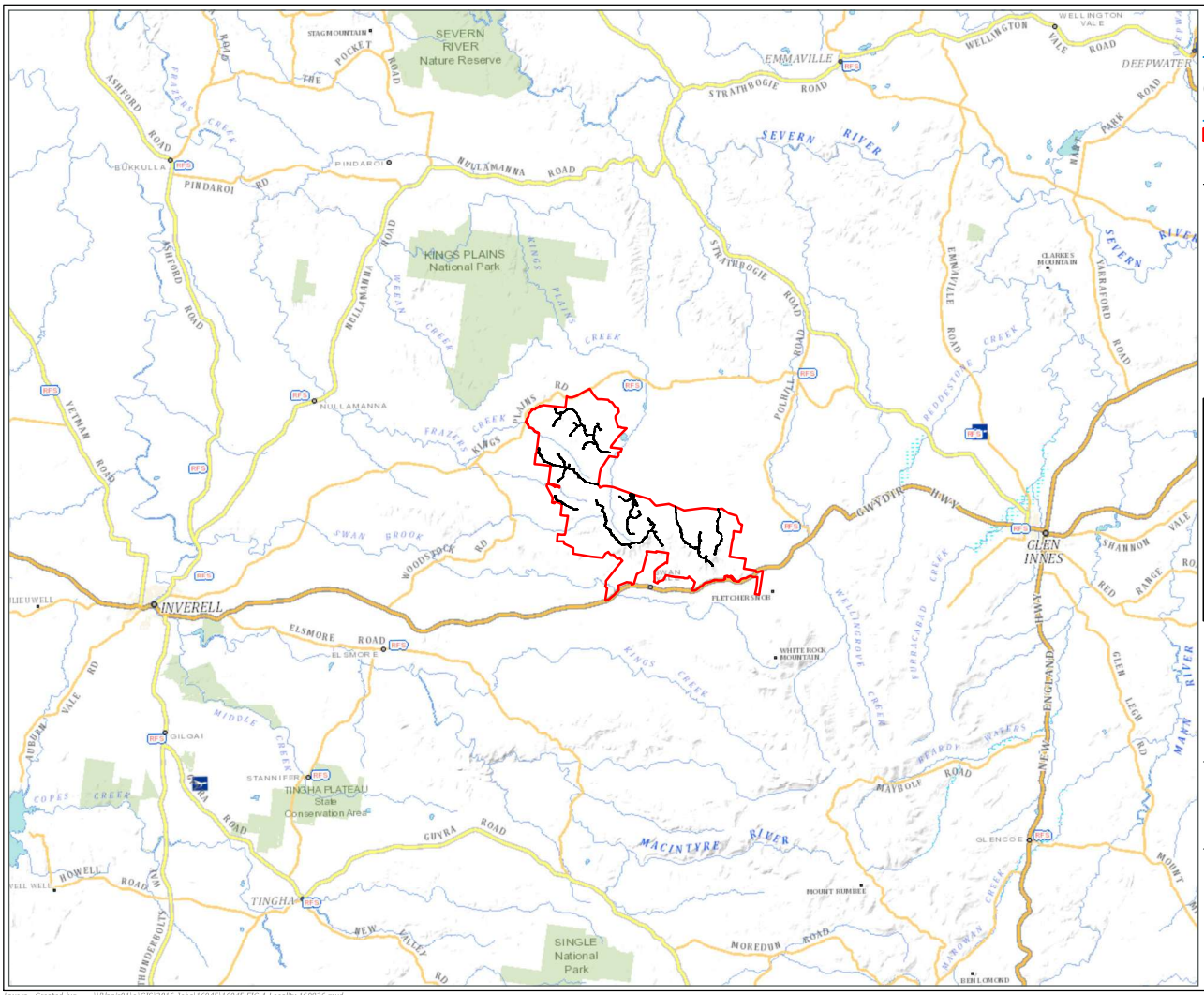

Figure 1: Locality map

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

Study area
Turbines
Access tracks

N

Kilometers
0 5.5

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3. Carcass searches

3.1. Methods

3.1.1. Carcass searches

The mortality monitoring regime at SWF began in the pre-operational phase in July 2018. Monthly carcass searches were conducted for seven months while the wind farm wasint partial operation. SWF became fully operational in February 2019. The first official year of full operation was from February 2019 to January 2020. This is the first year of the two-year mortality monitoring program at SWF under the BBAMP (BL&A 2017). The term 'monitoring period' used here refers to the pre-operational phase and official first year of monitoring, a total of 19 months.

Monthly carcass searches were undertaken under 18 turbines at SWF. Turbines were selected based on a randomised sampling design at the beginning of the implementation of the BBAMP (Table 1). This involved the selection of a random sub-set of turbines for monthly carcass searching. Random selection enables an assumption that the selected turbines together are representative of all turbines in the wind farm.

Table 1. List of turbines searched

Turbine number	Turbine number	Turbine number
4	23	48
5	32	53
7	34	58
14	41	63
16	43	68
18	48	69

Carcass searches involved surveying all the sampled turbines once a month during a five to six-day search period. Searches were conducted under each of the 18 turbines (Figure 2). Within a few days after each initial turbine search, the turbine was searched again in what is referred to as a 'pulse search'. This entails the inner zone of each turbine (Figure 2 below) being searched a second time.

A 100-metre-radius circular zone surrounding each designated turbine was searched each month, with two target search zones: the inner and outer zone as follows:

- The inner zone: transects are spaced at four metres apart and carried out up to 60 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 61 metres and 100 metres radius from the turbine tower base aims at detecting the medium and larger bodied birds; transects are spaced at twelve metres apart.

Ahmad Barati (zoologist with Nature Advisory) has undertaken all carcass monitoring to date.

Mortalities were classed as either a bird carcass, a feather spot, a bat carcass or an incidental find. The last is any of the aforementioned classes found outside of the formal, monthly search

(i.e. including at both target non-target turbines, finds by wind farm personnel). It is likely that feather spots represent a bird that has collided with a turbine and has later been scavenged. When a dead bird or bat was recorded under a turbine, a pro-forma was filled out and numbered, and a photograph of the carcass in situ taken.

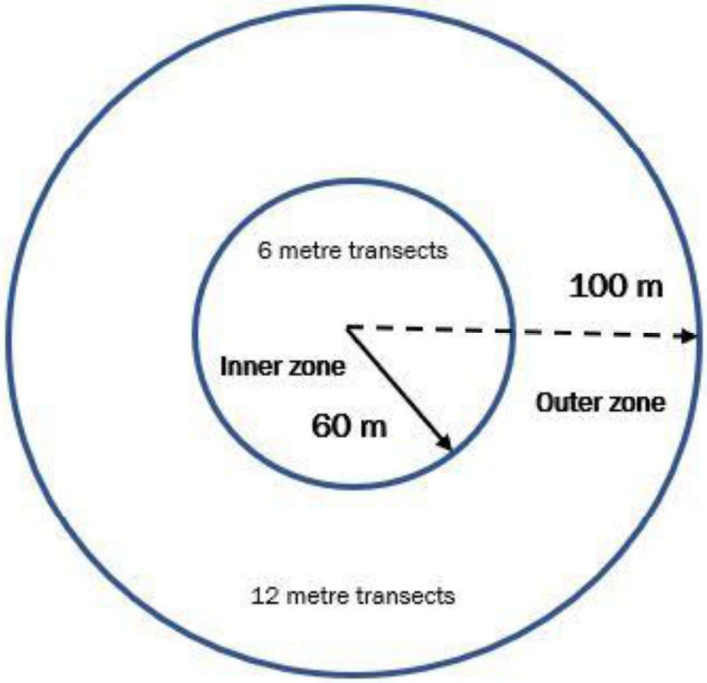

Figure 2. Diagram of inner and outer search zones at turbines

On finding a bird carcass, feather-spot or bat carcass, the finder:

- Completed a casualty report;
- Removed it from the site to avoid re-counting; and
- Transferred fresh carcasses to a freezer at the site office for storage so it could be identified and used later in observer efficiency and scavenger trials (see below).

The locations of all the turbines and the turbines searched are shown in Figure 3.

According to the BBAMP, an investigation may be warranted if any threatened or listed species is found as a casualty under a wind turbine; this is referred to as an 'impact trigger'. An immediate report must made if the following scenario occurs:

> *"A threatened bird/bat species (or recognisable parts thereof) listed under the Commonwealth EPBC Act or NSW Threatened Species Conservation Act 1995, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel."*

In the case of a non-threatened species carcass found, an impact trigger is defined as:

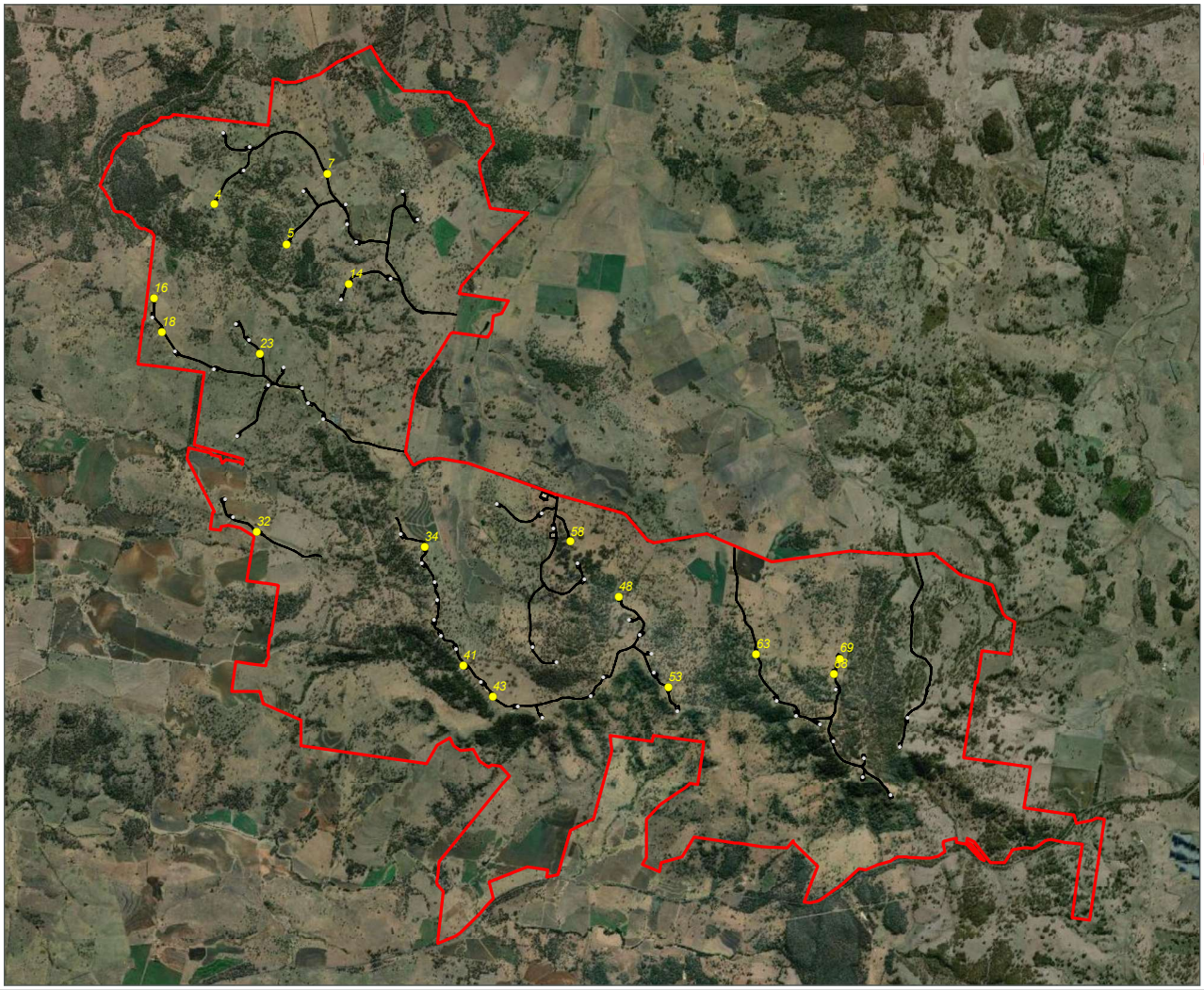

Figure 2: Sapphire Wind Farm turbine layout

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

Study area
Target turbines
Turbines
Access tracks

N

Kilometers
0 1

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"A total of four or more bird or bat carcasses, or parts thereof, of the same species in two successive searches at the same turbine of a non-threatened species (excluding ravens, magpies, White Cockatoos, corellas, pipits and introduced species.

3.1.2. Searcher efficiency trials

The BBAMP (BL&A 2017) states that searcher efficiency trials are to be undertaken twice a year during the two-year monitoring period in each of the two distinct seasons. The objective of having two trials is to account for the different vegetation conditions, with one being undertaken following summer rains when the grass is long (October-January) and the other in the drier winter months when the grass is short (July-August).

It is noted that NSW was severely affected by the drought and 2019 bushfires. The winter trial was undertaken in August, however, there was no significant change in vegetation condition over the summer period. Therefore, the second efficiency trial was postponed and will be undertaken in year two when the vegetation can be classified as "long grass".

The purpose of these trials is to assess the efficiency of the zoologist implementing the carcass monitoring regime; Ahmad Barati, from February 2019 to January 2020. During the first year of the operational phase at SWF, the winter trial was undertaken on the 8th of August 2019.

A total of twenty carcasses were used in the trial. This included five bats and fifteen birds (Table 2). A total of 16 of the 20 carcasses had been collected during previous searches at SWF or other nearby winds farm, as well as road killed bird carcasses collected in preceding months and stored in a freezer at the wind farm office. The additional four bird carcasses comprised of Common Myna species that were sourced from the control programs of Common Myna Action Groups. All bats used in the trial were sourced from other wind farms in the region.

An observer (Jackson Clerke, zoologist with Nature Advisory) oversaw the efficiency trials and was responsible for placing the carcasses for the searcher and assessing the efficiency. Three to four carcasses were placed under six pre-selected turbines at the wind farm. The positions of the placed carcasses (distance and bearing from turbine) were randomly generated using the Microsoft Excel® random number function. All small carcasses (bats and mynas) and 25% of the medium–large bird carcasses were placed within the 100-metre outer zone. The remaining carcasses were distributed though the 60-metre inner zone.

The observer searched all turbines within two 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.

The information collected in both trials will be used in the thorough statistical data analysis to be completed for the second annual report at the end of the second year of BBAMP implementation.

Table 2. Species of carcass used in searcher efficiency trials at SWF

Turbine	Species	Size class
	Winter (low vegetation)	
23	Common Myna	Small Bird
	Wedge-tailed Eagle	Large Bird
	Common Myna	Small Bird
	White-striped Freetail Bat	Bat
18	Wedge-tailed Eagle	Large Bird
	Common Myna	Small Bird
	White-striped Freetail Bat	Bat
	Sulphur-crested Cockatoo	Medium-Sized Bird
16	Wedge-tailed Eagle	Large Bird
	White-striped Freetail Bat	Bat
	Eastern Rosella	Medium-Sized Bird
	Pacific Baza	Medium-Sized Bird
14	Australian Wood Duck	Medium-Sized Bird
	White-striped Freetail Bat	Bat
	Tawny Frogmouth	Medium-Sized Bird
	Wedge-tailed Eagle	Large Bird
7	Common Myna	Small Bird
	Eastern Rosella	Small Bird
	Chocolate Wattled Bat	Bat
	Wedge-tailed Eagle	Large Bird

3.1.3. Scavenger trials

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.

Scavenger trials conducted during winter when the grass was short as required at SWF under the BBAMP. The first trial was undertaken in winter, when vegetation was low, concurrently with formal monthly searches beginning from 8th August to 17th September 2019. Carcasses were placed at the same six pre-selected turbines as described for the searcher efficiency trials (Table 3).

Monitoring was carried out using remote-sensor camera traps. The first ten camera traps were deployed at a close distance to one carcass each. Once a carcass was scavenged, the camera was collected and deployed at another carcass until all 20 carcasses were monitored for at least 31 days. The cameras were retrieved after 31 days of monitoring and the photographs recorded on the SD card reviewed to determine on what day, if at all, the carcass was scavenged.

The use of the camera was time effective as it allowed for continuous monitoring of the carcass and an indication of the type of scavenger. 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. If the carcass was still present on site at day 30, as a precautionary approach it was recorded as being scavenged at day 30. The carcass was then removed and the experiment terminated.

Table 3. Species of carcasses used in the 2019 winter scavenger trial at SWF

Bats	Small Birds	Medium Birds	Large Birds
White-striped Freetail Bat	Common Myna	Australian Wood Duck	Wedge-tailed Eagle
	Rainbow Lorikeet	Nankeen Kestrel	
	Magpie-lark	Eastern Rosella	
		Crimson Rosella	
		Sulphur-crested Cockatoo	

The second trial will be undertaken during summer-autumn when ground cover is higher in the second year of monitoring.

3.2. Results

3.2.1. Carcass search results

A total of 19 bird and bat remains were found under turbines during the monitoring period at SWF. During formal searches, four bird carcasses, two bat and two feather spots were found. Nine bird carcasses and two feather spots were recorded from incidental finds. As is standard practice, it has been assumed that feather-spots discovered beneath turbines are the result of an initial turbine collision, with scavenging predators such as Red Fox or ravens later consuming the carcass and leaving feather remains.

The results of the formal bird and bat carcass searches at SWF are summarised in Table 4. The table shows the number of carcasses and feather spots found during formal searches, and incidentally. The total number of monthly carcass findings are shown in Figure 3.

Table 4:Summary of carcass search results for bird and bats from July 2018 to January 2020 at SWF

Search type	Season	Month	Bird	Bat	Feather spot	Total mortalities
Formal searches	Pre-operations period search results					
	Winter	Jul-18				0
		Aug-18			1	1
	Spring	Sep-18				0
		Oct-18				0
		Nov-18				0
	Summer	Dec-18		1		1
		Jan-19				0
	Official full wind farm operations period					
	Summer	Feb-19				0
	Autumn	Mar-19				0
		Apr-19				0
		May-19				0
	Winter	Jun-19	1			1
		Jul-19	1			1
		Aug-19				0

Search type	Season	Month	Bird	Bat	Feather spot	Total mortalities
	Spring	Sep-19	2			2
		Oct-19		1		1
		Nov-19			1	1
	Summer	Dec-19				0
		Jan-20				0
Formal searches total						**8**
Incidental search results						
Incidental Records	**Pre-operations period search results**					
	Winter	Aug-18	2			2
	Spring	Sep-18			2	2
	Summer	Dec-18	1			1
		Jan-19	1			1
	Official full wind farm operations period					
	Summer	Oct-19	1			1
		Feb-19	2			2
		Nov-19	1			1
		Jan-20	1			1
Incidental finds total						**11**
Combined totals						**19**

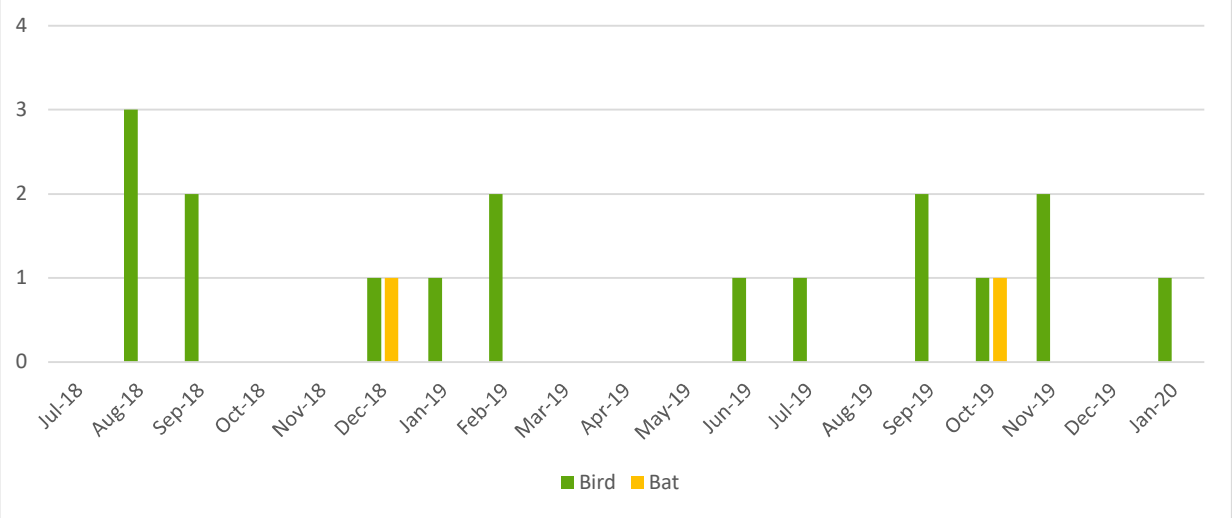

Figure 4. Number of carcasses found in each month during the monitoring period at SWF

Birds

A total of 17 bird carcasses were found at SWF during the pre-operational and first year operational monitoring periods (July 2018-January 2020). Of all carcasses found, four carcasses and two feather spots were found during formal monthly searches. The remaining 11 carcasses were found incidentally by wind farm personnel. Between zero and three bird carcasses were recorded each month (Figure 4).

Below is a summary of each bird carcass that was recorded during the monitoring period at SWF (Table 5).

Table 5. Summary of detected bird mortality across the SWF

Species	Percentage of total bird collisions	Percentage of all bird and bat collisions	Totals
Australian Magpie	23.53	21.05	4
Crested Pigeon	17.65	15.79	3
Wedge-tailed Eagle	17.65	15.79	3
Australian Wood Duck	11.76	10.53	2
Tawny Frogmouth	11.76	10.53	2
Musk Lorikeet	5.88	5.26	1
Eastern Rosella	5.88	5.26	1
Collared Goshawk	5.88	5.26	1
Subtotal	100	89.47	17

The species of carcasses most commonly found was Australian Magpie. A total of four carcasses or feather spots were recorded, representing 21.05% of all bird and bat collisions. This is similar to results at other wind farms in eastern Australia. They commonly fly at RSA height and are an abundant species commonly found in farmland settings.

During the 19 months of monitoring, Crested Pigeon was found on three occasions, representing 15.79% of all bird and bat collisions. All carcasses were found during the pre-operational period under one turbine that was only partially constructed and non-operational.

Wedge-tailed Eagle carcasses were found three times at SWF, which accounts for 17.65% of bird collisions and 15.79% of all bird and bat collisions during the monitoring period. The Wedge-tailed Eagle is another species that commonly collides with turbines due to its soaring habits and preferred open habitats near wooded areas.

Species of birds that less commonly collided with turbines at SWF included Tawny Frogmouth, Musk Lorikeet. Species found only once included Musk Lorikeet, Eastern Rosella and Pacific Baza.

On average, the mortality rate due to collision with turbines at SWF during the monitoring period was low when compared to the other wind farms in eastern Australia. The factors that potentially contribute to the low mortality rate are discussed later in this report. No circumstances occurred during the monitoring period at SWF that would be identified as an impact trigger.

Detected bird mortality at SWF is summarised in Appendix 1.

Table 6 below, with species listed in ranked order of the number of carcasses found. Detailed information on each bird carcass, feather spot and incidental record during 2019 can be found in Appendix 1.

Table 6. Summary of bird carcass records at SWF from July 2018-January 2020

Species common name	Scientific name	Formal searches	Incidental records	Feather spots	Totals
Australian Magpie	*Cracticus tibicen*	1	2	1	4
Crested Pigeon	*Ocyphaps lophotes*		3		3
Wedge-tailed Eagle	*Aquila audax*		3		3
Australian Wood Duck	*Chenonetta jubata*	1	1		2
Tawny Frogmouth	*Podargus strigoides*	1		1	2
Musk Lorikeet	*Glossopsitta concinna*		1		1
Eastern Rosella	*Platycercus eximius*		1		1
Pacific Baza	*Aviceda subcristata*	1			1
Total					17

Bats

Two bat carcasses were recorded at SWF during the pre-operational and first year operational periods. These were both found during formal searches and accounted for 10.5% of all bird and bat collisions. Tables 7 and 8 outline the percentage of total collisions and species of carcasses found at SWF during the monitoring period.

Table 7. Summary of detected bat mortality across the SWF

Species	Percentage of total bat collisions	Percentage of all bird and bat collisions	Totals
Grey- headed Flying Fox	50	5.26	1
Chocolate Wattled Bat	50	5.26	1
Subtotal	100	10.53	2

Grey-headed Flying–Fox is listed as "Vulnerable' under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act). The carcass was found on 1st December 2018 tangled on a fence line (Figure 5) at a distance of over 100 meters from the turbine. Given the distance of this carcass and its condition when detected, it was extremely unlikely that mortality was caused by collision with the wind turbine; rather, it flew into the barb–wire fence. Thus, it did not trigger a response under the BBAMP for an impact on a threatened species caused by collision with a turbine. Mortality of Grey-headed Flying Fox as a result of getting caught in fence lines is common, as this has also been observed at other wind farms (Figure 5).

The Chocolate Wattled Bat was also found at SWF. This species is a common bat in the region. Overall, the mortality rate among bats at SWF was very low compared to other monitored wind farms in eastern Australia. The possible reasons for this are discussed below.

Table 8. Summary of bat carcass records at SWF from July 2018-January 2020

Species common name	Scientific name	Formal searches	Incidental records	Totals
Grey-headed Flying Fox	*Pteropus poliocephalus*	1		1
Chocolate Wattled Bat	*Chalinolobus morio*	1		1
Total				2

Figure 5. Grey- headed Flying–Fox mortality due to collision with fence line at SWF (left) and similar finding at another wind farm (right). Photos: A. Barati

Distance of carcasses from turbines

Carcasses were distributed from the base of turbines up to 100 meters with an average distance of 34 ± 10.7 (mean ± SE) from the turbines (Figure 6). A high proportion of caresses (ca. 70%) were found at a distance of 0-39 metres from the turbines (Figure 6). Overall, there was a weakly significant negative correlation between number of carcasses and the distance from the turbines (df = 6, 0.10 < p >0.05, R^2= -0.65).

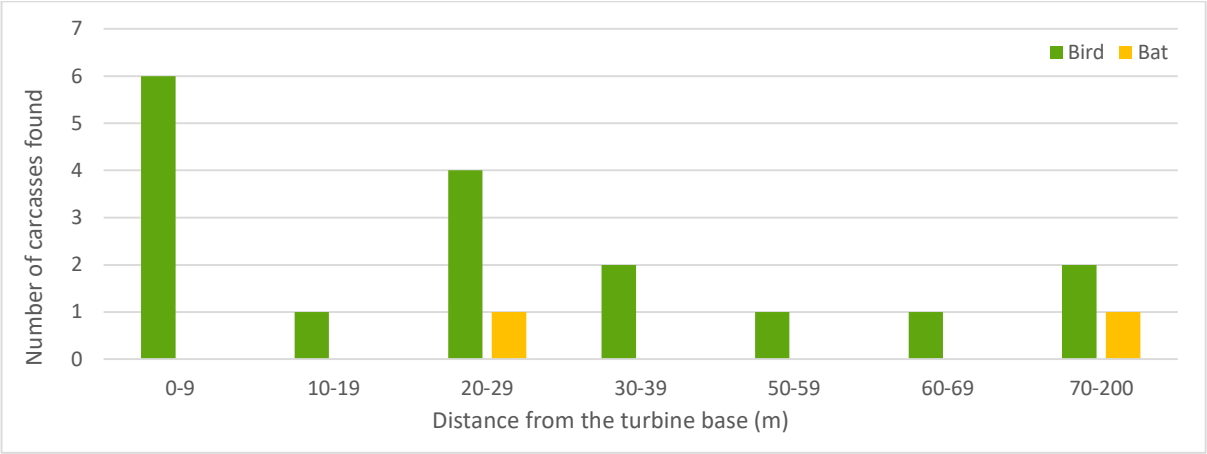

Figure 6. Distribution of carcasses found at distance categories from the turbine

3.2.2. Searcher efficiency results

The zoologist from Nature Advisory who conducted all monthly searches, Ahmad Barati, underwent the searcher efficiency trails. As required by the BBAMP, one of the trials was done during winter when vegetation was low. The results of the winter searcher efficiency trials are outlined in Tables 9 and 10.

The average efficiency was 100 percent detectability rate. No carcasses were missed by the observer.

Table 9. Searcher efficiency trial results

Turbine	Species	Size class	Detected
	Winter (high vegetation)		
23	Common Myna	Small Bird	✓
	Wedge-tailed Eagle	Large Bird	✓
	Common Myna	Small Bird	✓
	White-striped Freetail Bat	Bat	✓
18	Wedge-tailed Eagle	Large Bird	✓
	Common Myna	Small Bird	✓
	White-striped Freetail Bat	Bat	✓
	Sulphur-crested Cockatoo	Medium-Sized Bird	✓
16	Wedge-tailed Eagle	Large Bird	✓
	White-striped Freetail Bat	Bat	✓
	Eastern Rosella	Medium-Sized Bird	✓
	Pacific Baza	Medium-Sized Bird	✓
14	Australian Wood Duck	Medium-Sized Bird	✓
	White-striped Freetail Bat	Bat	✓
	Tawny Frogmouth	Medium-Sized Bird	✓
	Wedge-tailed Eagle	Large Bird	✓
7	Common Myna	Small Bird	✓
	Eastern Rosella	Small Bird	✓
	Chocolate Wattled Bat	Bat	✓
	Wedge-tailed Eagle	Large Bird	✓

Notes: ✓ = Found; X = missed.

Table 10. Average searcher efficiency at SWF for the different size classes

Carcass size class	Carcasses found	Carcasses placed	Average efficiency
Bats	5	5	100%
Small birds	5	5	100%
Medium-sized birds	5	5	100%
Large birds	5	5	100%

3.2.3. Scavenger trial results

The results of the scavenger trial are presented in Table 11 and the raw data is in Appendix 2. Scavenger trail data obtained during the first year of monitoring at SWF.

The average number of days the bird and bat carcasses remain on the ground before they are scavenged is ten days. Due to their small size, bats and smaller birds are usually taken earlier: in this trial carcasses remained an average of 4 days for bats and 2.6 days for small birds.

Medium birds remained on average 4.4 days before they are scavenged. Wedge-tailed Eagle carcasses were rarely scavenged, with all five not taken by scavengers by the end of day 31, a finding similar for this species at other wind farm sites in eastern Australia. Red Fox have been identified as the dominant scavenger at SWF (Appendix 2 and Figure 7).

Table 11. Results of the 2019 winter scavenger trial at SWF

Time period	Carcass type	Number of carcasses	Number of days in the field	Average days in the field
Short grass/winter	Bat	5	30	**4**
	Small Bird	5	30	**2.6**
	Medium birds	5	30	**4.4**
	Large birds	5	30	**30**
	Total	20		**10.2**

Figure 7. Examples of scavengers at SWF detected by camera traps, Common Brushtail Possum left and Red Fox right.

4. Monitoring 'at-risk' species

Experience from other wind farms indicates that ongoing bird utilisation surveys (BUS) provide varying levels of information. A baseline was generated in the initial surveys in 2011 on bird utilisation of the site. A review of this information combined with information from other sources has been collated in the risk assessment and is considered to provide an adequate pre-construction baseline to compare future changes.

Monitoring of "at risk" groups provides useful information within an adaptive management framework for addressing the bird and bat impacts of the wind farm.

As part of the BBAMP, monitoring of 'at-risk' species groups coinciding with monthly carcass searches is required at SWF. These surveys determine if the operating turbines will have an effect on the behaviour of any of these species.

4.1. Species of concern

The key "at risk" groups have been identified through the risk assessment (BBAMP 2017). These include:

- Wedge-tailed Eagle
- Other raptors
- White-throated Needletail
- Regent Honeyeater
- Swift Parrot

4.2. Wedge-tailed Eagle and other raptors

The details of any raptor observation during monthly carcass searches have been outlined in Table 12. Three species were recorded during the first year of monitoring, Wedge-tailed Eagle, Whistling Kite and Nankeen Kestrel.

The overall level of habitat use by raptors at SWF is low-moderate.

Overall, due to the topography at SWF, the area can be predominately identified as low quality habitat for Wedge-tailed Eagle. The observation rate within the wind farm was low.

The Nankeen Kestrel was observed on three occasions at SWF. This species prefers open habitats within woodland or grasslands and occurs commonly in farmland landscapes.

Whistling Kite was observed on several occasions at SWF, but more frequently outside the wind farm scavenging on remains of livestock or wildlife. Despite this, no mortality of Whistling Kite was recorded at SWF.

Table 12. Raptor observations at SWF

Date	Species	Number of Individuals	Behaviour	Nearest Turbine
30/07/2018	Wedge-tailed Eagle	1	Flying, soaring, 500m south of turbine 32,	32
17/09/2018	Wedge-tailed Eagle	2	Flying southwards near 18	18
30/11/2018	Wedge-tailed Eagle	2	Perched, flying 500m north of turbine 18	18

Date	Species	Number of Individuals	Behaviour	Nearest Turbine
5/02/2019	Whistling Kite	1	Perched, flying 700m from turbine 41 between turbine 41 and turbine 43	41
22/05/2019	Nankeen Kestrel	1	Flying 500m east of turbine 14	14
22/05/2019	Nankeen Kestrel	1	Perched on trees near turbine 14	14
31/05/2019	Nankeen Kestrel	1	Perched then flying near turbine 16	16
8/08/2019	Wedge-tailed Eagle	1	Flying turbine 4 to turbine 16	4
9/09/2019	Wedge-tailed Eagle	2	Flying around turbine 58 to the west	58
11/12/2019	Whistling Kite	1	Flying around turbine 7 towards 5	7
5/11/2019	Wedge-tailed Eagle	1	Flying between turbine 41 and turbine 43	41
15/01/2020	Wedge-tailed Eagle	1	Flying 500m from turbine 5	5

4.3. White-throated Needletail, Regent Honeyeater and Swift Parrot

There were no records of White-throated Needletail, Regent Honeyeater or Swift Parrot during either the pre-commissioning or first year operational phase at SWF.

There are a very limited number of ironbark trees, which can provide habitats for the Regent Honeyeater and Swift Parrot when flowering. Year 2019 was extremely dry throughout the northern tablelands and no flowering ironbark trees were reported this season. Therefore, suitable habitats for the Regent Honeyeater and Swift Parrot at SWF are extremely limited. In addition, no individuals of the species were recorded during BUS at SWF.

The nearest known existing habitat for the Regent Honeyeater was at Travelling Stock Reserves (TSR) near Bundarra, about 50 kilometres southwest of SWF. During an informal survey, a pair of Regent Honeyeater were sighted in this area on 10th of October 2019 (A. Barati, personal observations). Birds remained in the area for about two weeks, but based on other reports, failed to breed in this habitat.

Monitoring of these species' groups will continue throughout the second year of monitoring at SWF.

5. Bird Utilisation Surveys

5.1. Introduction

The bird utilisation survey (BUS) was undertaken consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the industries latest Best Practice Guidelines (Clean Energy Council 2018).

5.2. Methods

The fixed-point bird count method involved an observer stationed at a survey point for 15 minutes. The adequacy of using 15 minutes as a period to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (BL&A unpublished data). The study 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 the survey.

During this period, all bird species and numbers of individual 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.

Flight height is presented as below, at or above rotor swept area (RSA) height:

- **A =** Below RSA (< 74 metres above ground)
- **B =** At RSA (74 – 200 metres above ground)
- **C =** Above RSA (> 200 metres above ground)

During the surveys, eight counts (replicates) were made at each of the four-impact and two reference points. Table 13 indicates when each point was counted on each survey day. This schedule ensured that all points were visited equally at different times of day to allow for time-of-day differences in bird movements and activity.

5.2.1. Locations of survey sites

Six fixed survey points were established; four impact points and two reference points. Impact points were located near operational turbines and reference points were located at least 500 metres away from turbines in areas of similar habitat (Figure 8).

The survey points were distributed as evenly as possible (subject to access constraints) across the wind farm to sample the various habitat types and maximise coverage in areas where wind turbines are located (Figure 8). Impact points were positioned as far as possible on elevated ground, allowing a clear view in all directions. Table 13 below provides a description of the habitats associated with each impact and reference point.

Table 13. Habitat associated with each survey point

Survey point	Habitat description
BUS01	Located inside the wind farm, close to turbine number 59. A remnant of native vegetation but also close to a large fragmented area with scattered trees. No understorey.
BUS02	Inside the wind farm close to turbine number 58. Large open area but some scattered eucalypt trees. No understorey due to cattle and sheep grazing the area.
BUS03	Located on the top of ridge, close to turbine 10. Fragmented on one side but some scattered eucalypts present at other slope. Area dominated by native pest species such as Noisy Miner. No understorey.
BUS04	Near turbine 5. Close to a remnant patch of eucalypt trees, but open area and highly modified on one side. No understoreey and close to small dam.
Ref1	Inside the wind farm, about 700 metres away from turbine 58. Small patch of native woodland dominated by eucalypt trees.
Ref2	Located outside wind farm boundary, at about 500 south west of the main office, close to the road. This area contains a remnant of native eucalypt trees with some grassy understorey. Relatively suitable habitat for woodland birds.

5.2.2. Timing of the surveys

The BBAMP states that the surveys were to be conducted in summer. The bird utilisation survey was undertaken during four days in November 2019 and one day in February 2020. The November 2019/February 2020 BUS lasted five days and was undertaken during the period 26th – 30th November 2019 and 22nd February 2020. The timing covered a suitable period for surveying birds as their populations were at their maximum abundance following spring breeding and most of the summer migrant visitors to the wind farm area were likely still present. The timing of the final day in February was due to the challenging environmental conditions with haze from fires on other days.

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 14 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 14.Times when points were counted for each fixed-point bird count survey day

Date/ time	26-Nov-19	27-Nov-19	29-Nov-19	30-Nov-19	22-Feb-20
	Day 1	Day 2	Day 3	Day 4	Day 5
9:00	BUS01	BUS01	Ref2		BUS03
9:30	BUS02	BUS02		BUS03	
10:00	Ref1	Ref1	BUS04	BUS04	Ref2
10:30	Ref2		BUS03		
11:00		BUS03		BUS01	BUS01
11:30	BUS04	BUS04	Ref2	BUS02	BUS02

Date/ time	26-Nov-19	27-Nov-19	29-Nov-19	30-Nov-19	22-Feb-20
	Day 1	Day 2	Day 3	Day 4	Day 5
12:00				Ref1	Ref1
12:30				BUS04	
13:00	BUS03	BUS01	BUS01	BUS03	BUS04
13:30	Ref2	BUS02	BUS02	Ref2	
14:00			Ref1		Ref1
14:30	Ref1				
15:00	BUS02	Ref2	BUS03	BUS01	
15:30	BUS01	BUS03	BUS04	BUS02	
16:00		BUS04	Ref2	Ref1	

Note: See Figure 8 for survey point locations. The prefix 'BUS' refers to impact points and 'Ref' refers to reference points.

5.2.3. Incidental observations

In addition to the observations during formalised surveys, fixed-point counts, incidental observations of birds of concern (threatened species, raptors, waterbirds) were made whilst travelling throughout the wind farm sites. Notes are 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.

5.2.4. Limitations

The current bird utilisation survey was undertaken during spring/summer of 2019/2020. During this spring/summer, extensive bushfires around the sites were a major source of concern and caused limitations for access to the site. Given this, one day of BUS survey was postponed and moved to February when conditions became more suitable.

The purpose of the surveys 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 for the time period covered as they take into consideration time-of-day in bird activity and species occurrence. They are therefore considered to provide an interim basis on which to assess the bird risks associated with SWF. Further post-construction BUS will elucidate seasonal variation and provide a more comprehensive comparison with post-construction bird utilisation.

5.2.5. Data preparation and analysis

Raw data was entered into spreadsheet files and tables and graphs were extracted. Graphs where generated in Microsoft Excel and R environment. To test for the proportions of species in height categories, Chi-square distribution test was used. To investigate the differences of species diversity and abundance between impact and reference sites, an analysis of variance (ANOVA) was performed with species diversity and abundance as dependent factor and sites type (impact/reference) as predictors. All statistical analyses were undertaken in R environment (R Core Team 2018).

Figure 8: Location of BUS points at Sapphire Wind Farm

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 03/04/2020

Study area
Turbines
Access tracks
BUS and reference points

N

Kilometers
0 1

Nature Advisory
PO Box 337, Camberwell, VIC 3124, Australia
www.natureadvisory.com.au
03 9815 2111 - info@natureadvisory.com.au

Layers - Created by: - E:\GIS\2016 Jobs\160405\160405 FIG 2 Layout 160826.mxd

5.3. Results

The raw data of the spring/summer BUS undertaken at Sapphire Wind Farm is presented in Appendices 3 & 4.

Survey suitability

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the observation points during the spring/summer survey period has been plotted in Figure 9.

The cumulative species–count sequence curve below shows a clear asymptote, suggesting that the number of new species added to the diversity was levelling off after 45 counts, and only a few species were added afterwards. The result strongly suggested that the surveys provided a representative picture of the diversity of bird species flying over the wind farm site during the survey period.

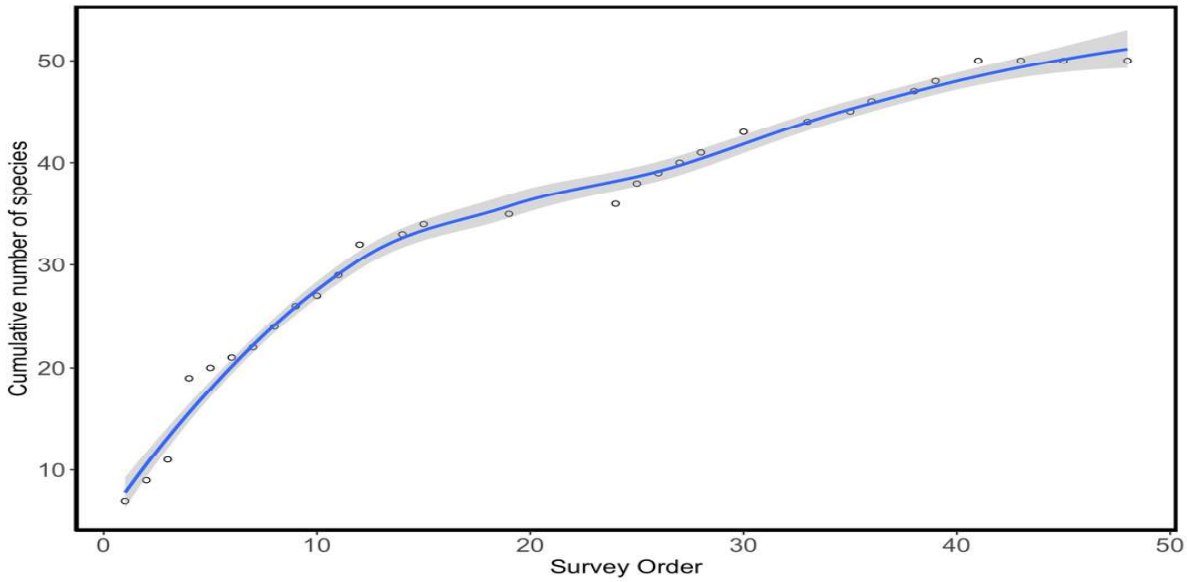

Figure 9. The cumulative number of species of birds recorded during consecutive counts at the BUS points at SWF

5.3.1. Species composition

Overall, 50 bird species were recorded during the spring/summer survey (Figure 9). Of all species recorded, 42 species were recorded at the impact survey points and 41 at the reference survey points (Appendices 3 and 4). Species recorded were predominantly farmland and woodland bird species with limited records of raptors and waterbirds.

The species with the highest frequency of observation at the impact points were Noisy Miner followed by Australian Magpie, Eastern Rosella and Galah (Figure 10). At the reference sites, the same common species dominated the count although with a slight change in the rank of the common species being Noisy Miner followed by Galah, Eastern Rosella and Australian Magpie (Figure 11).

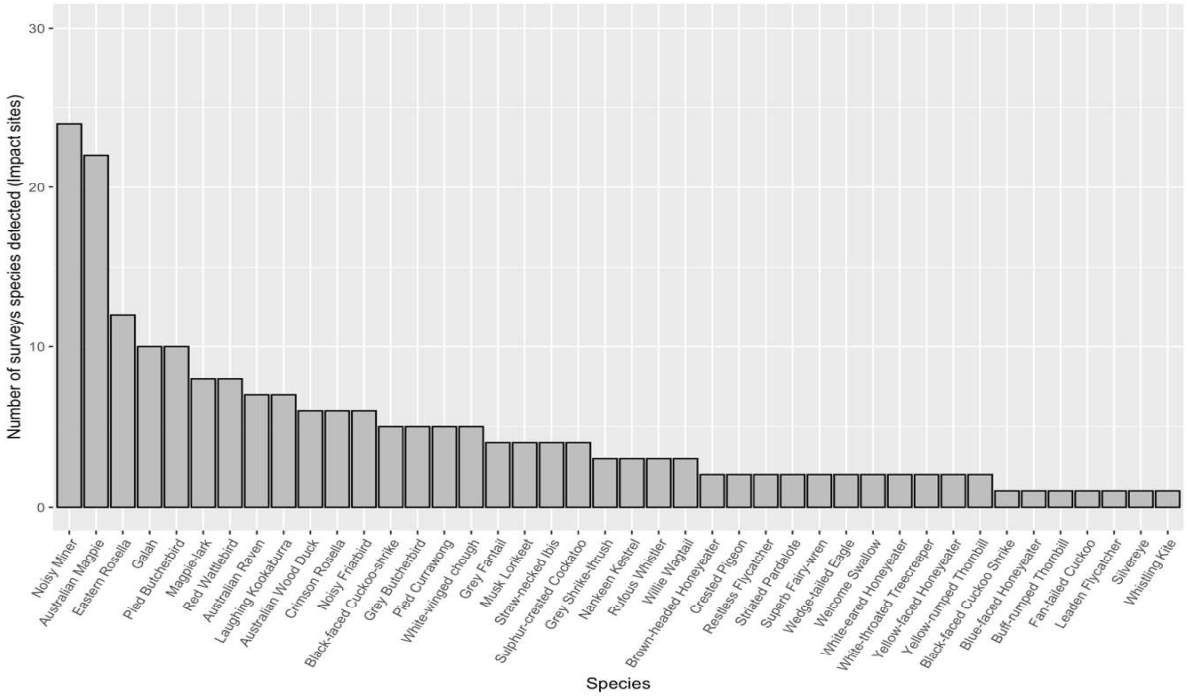

Figure 10: Frequency of species detection in impact sites at SWF. Values represent the number of surveys that a given species was observed

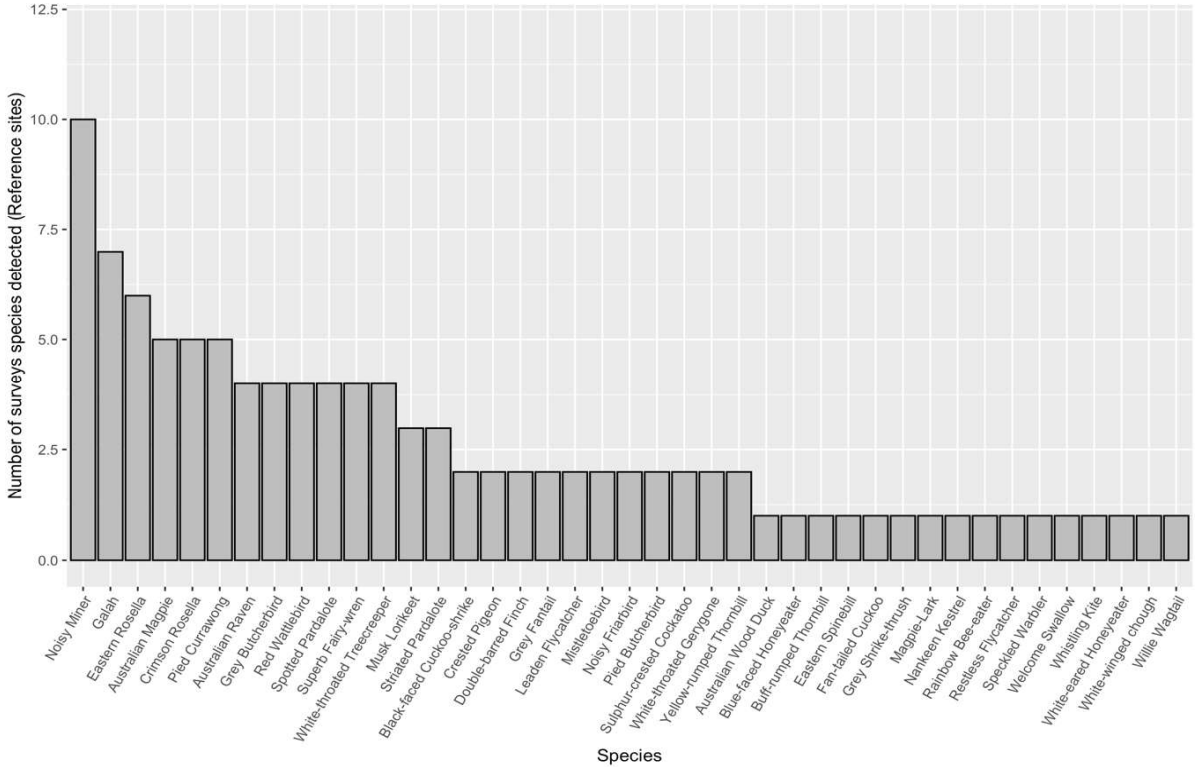

Figure 11: Frequency of species observed at reference sites. Values represent number of surveys that a given species was detected.

Species differed in term of their abundance (number of individuals) at both impact (Figure 12) and reference sites (Figure 13).

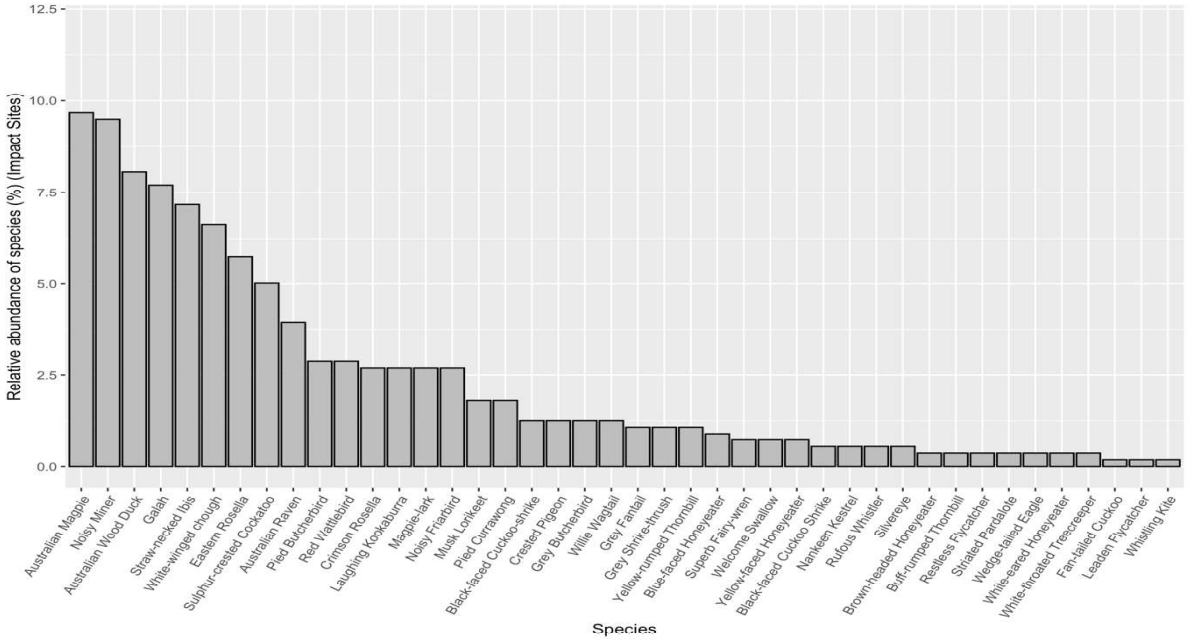

Figure 12: Relative abundance of species observed in impact sites at SWF. Values represent percentages of individual of a given species

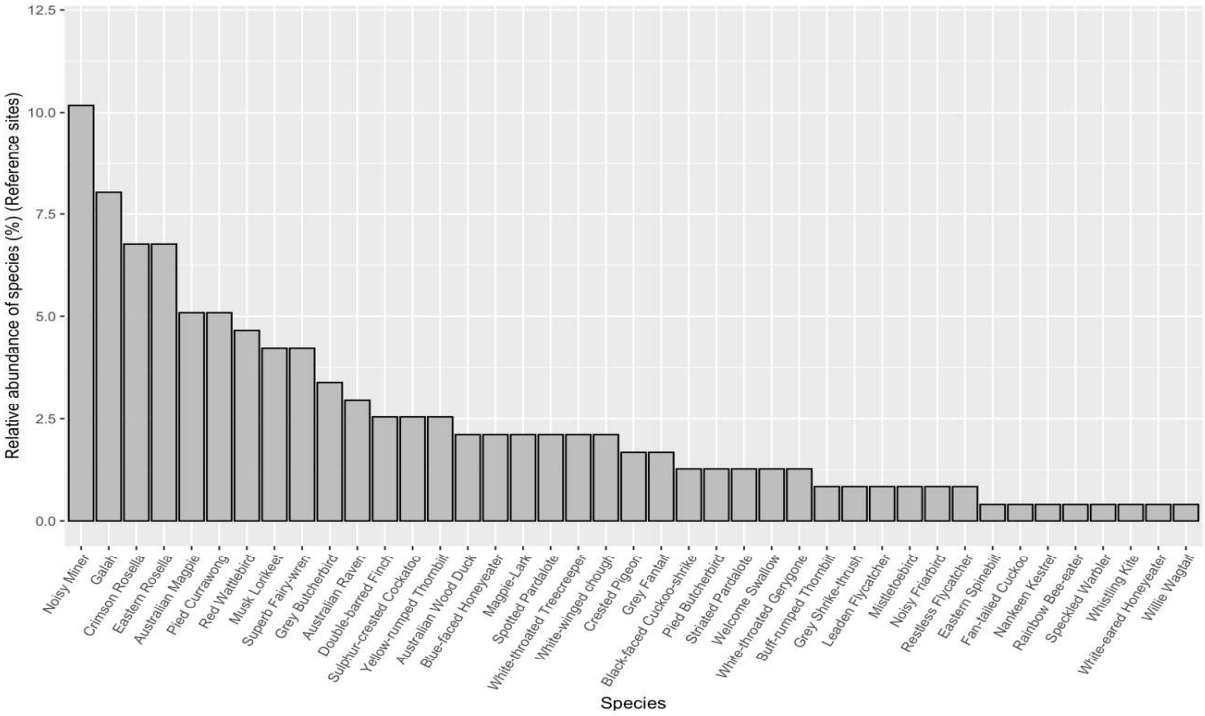

Figure 13: Relative abundance of species observed in reference sites at SWF. Values represent percentages of individual of a given species

The five most common species in term of their abundance (e.g. number of individuals recorded) at the impact and reference survey points are presented below (Table 15). These five species comprised 41% of all individual birds recorded at the impact survey points and about 35% at the reference survey points. The common resident species were the leading species and dominated over the spring/summer season. Tables 16 and 17 presents the distribution of bird numbers (relative abundance) and their height distribution among the impact and reference points.

Table 15. Abundance of species of birds recorded at impact and reference survey points

Impact survey points (% of total individuals birds recorded)	Reference survey points (%of total individuals birds recorded)
Australian Magpie (9.6%)	Noisy Miner (10.2%)
Noisy Miner (9.79%)	Galah (8.1%)
Australian Wood Duck (8.1%)	Eastern Rosella (6.7%)
Galah (7.7%)	Crimson Rosella (6.7%)
Straw-necked Ibis (7.1%)	Pied Currawong (5.1%)

Table 16: Summary of the diversity, numbers and height distribution of birds at the impact survey points recorded during spring/summer survey at SWF

Species	BUS01			BUS02			BUS03			BUS04			Total			Grand Total	Rel. Importance (%)
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Australian Magpie	9			19			14			12			54			54	9.68
Australian Raven				15			4			3			22			22	3.94
Australian Wood Duck				15						30			45			45	8.06
Black-faced Cuckoo Shrike	3												3			3	0.54
Black-faced Cuckoo-shrike	1			3			3						7			7	1.25
Blue-faced Honeyeater										5			5			5	0.9
Brown-headed Honeyeater										2			2			2	0.36
Buff-rumped Thornbill				2									2			2	0.36
Crested Pigeon							3			4			7			7	1.25
Crimson Rosella	3			6			2			4			15			15	2.69
Eastern Rosella	8			9			6			9			32			32	5.73
Fan-tailed Cuckoo	1												1			1	0.18
Galah				31			5			7			43			43	7.71
Grey Butcherbird	1			3			1			2			7			7	1.25
Grey Fantail	4									2			6			6	1.08
Grey Shrike-thrush	4									2			6			6	1.08
Laughing Kookaburra	6			2			7						15			15	2.69
Leaden Flycatcher	1												1			1	0.18
Magpie-Lark	5			2			4			4			15			15	2.69
Musk Lorikeet	2			7			1						10			10	1.79
Nankeen Kestrel	1						2						0			3	0.54
Noisy Friarbird	5			2			3			5			15			15	2.69
Noisy Miner	14			9			18			12			53			53	9.5
Pied Butcherbird	5			7			2			2			16			16	2.87
Pied Currawong	4			4			2						10			10	1.79
Red Wattlebird	1			5			8			2			16			16	2.87
Restless Flycatcher							2						2			2	0.36
Rufous Whistler	1			1						1			3			3	0.54
Silvereye	3												3			3	0.54
Straw-necked Ibis										40			40			40	7.17
Striated Pardalote	1									1			2			2	0.36
Sulphur-crested Cockatoo	8			15						5			28			28	5.02
Superb Fairy-wren										4			4			4	0.72
Wedge-tailed Eagle					1			1					0	2		2	0.36
Welcome Swallow	2						2						4			4	0.72
Whistling Kite							1						1			1	0.18
White-eared Honeyeater	1									1			2			2	0.36
White-throated Treecreeper	2												2			2	0.36
White-winged chough	20			5			7			5			37			37	6.63
Willie Wagtail	4									3			7			7	1.25
Yellow-faced Honeyeater	4												4			4	0.72
Yellow-rumped Thornbill	3									3			6			6	1.08
Grand Total	**127**	**0**	**0**	**162**	**1**	**0**	**97**	**1**	**0**	**170**	**0**	**0**	**556**	**2**	**0**	**558**	**100**

Notes: A = Below RSA height, B = At RSA height, C= Above RSA height.

Table 17: Summary of the diversity, numbers and height distribution of bird at the reference survey points recorded during spring/summer survey at SWF

Species	Reference 1			Reference 2			Total			Grand Total	Relative Importance (%)
	A	B	C	A	B	C	A	B	C		
Australian Magpie	9			3			12			12	5.08
Australian Raven	5			2			7			7	2.97
Australian Wood Duck	5						5			5	2.12
Black-faced Cuckoo-shrike							3			3	1.27
Blue-faced Honeyeater							5			5	2.12
Buff-rumped Thornbill							2			2	0.85
Crested Pigeon	4						4			4	1.69
Crimson Rosella	11						16			16	6.78
Double-barred Finch	6						6			6	2.54
Eastern Rosella	3						16			16	6.78
Eastern Spinebill	1						1			1	0.42
Fan-tailed Cuckoo	1						1			1	0.42
Galah	8						19			19	8.05
Grey Butcherbird	5						8			8	3.39
Grey Fantail	1						4			4	1.69
Grey Shrike-thrush							2			2	0.85
Leaden Flycatcher							2			2	0.85
Magpie-Lark	5						5			5	2.12
Mistletoebird	2						2			2	0.85
Musk Lorikeet	8						10			10	4.24
Nankeen Kestrel	1						1			1	0.42
Noisy Friarbird							2			2	0.85
Noisy Miner	14						24			24	10.17
Pied Butcherbird	2						3			3	1.27
Pied Currawong	12						12			12	5.08
Rainbow Bee-eater							1			1	0.42
Red Wattlebird	7						11			11	4.66
Restless Flycatcher	2						2			2	0.85
Speckled Warbler							1			1	0.42
Spotted Pardalote				5			5			5	2.12
Striated Pardalote	1			2			3			3	1.27
Sulphur-crested Cockatoo				6			6			6	2.54
Superb Fairy-wren	2			8			10			10	4.24
Welcome Swallow	3						3			3	1.27
Whistling Kite	1						1			1	0.42
White-eared Honeyeater				1			1			1	0.42
White-throated Gerygone				3			3			3	1.27
White-throated Treecreeper				5			5			5	2.12
White-winged chough	5						5			5	2.12
Willie Wagtail	1						1			1	0.42
Yellow-rumped Thornbill				6			6			6	2.54
Grand Total	**125**	**0**	**0**	**111**	**0**	**0**	**236**	**0**	**0**	**236**	**100**

Notes: A = Below RSA height, B = At RSA height, C= Above RSA height.

5.3.2. Variabilities of species diversity and abundance among survey points

Species richness (e.g. mean number of species per site) varied between the six observation points, but the difference was not significant (Figures 14 and 15). The number of species recorded at each of the observation points was influenced mainly by surrounding habitats, and was usually higher on points surrounded by remnant vegetation and large trees, than on those points in open, treeless habitats.

The diversity of bird species (species/survey) varied between the six observation points and depended primarily on the habitat surrounding each of the points. Points within or close to patches of remnant woodlands returned higher richness than those within open treeless habitats. Those points with more mature native trees, that are located close to or within a remnant woodland attracted more species than those in open grazing paddocks. These locations included points BUS04 and Reference 2 which showed higher diversity of birds compared with highly cleared areas such as BUS03 and BUS04 (Figure 14). The species richness varied from 5.62± 1.3 (mean ± se) at BUS03 to the 7 ± 1.30 at reference point 2. Mean number of species detected per site was 6.34 ± 1.42 at impact points and 6.62 ± 1.14 at reference points. ANOVA test suggested that this slight difference is not significant (ANOVA, F=0.46, df=1, p=0.49).

As was the case with species diversity, mean abundance of birds (number of birds/survey) varied between sites. The variations of abundance among site was higher than variations of species diversity (Figure 15). Mean number of birds recorded per survey varied from 13.85 ± 4.79 at Reference 2 to 21.25 ±9.01 at BUS04 and with an average value of 16.56 ± 3.2 across all sites (Figure 15). In addition, the mean abundance of birds recorded per survey at impact points was 17.43 ± 7.90 whereas the mean abundance at reference points was slightly lower (14.75 ± 3.58). The difference between mean abundance of bird was found to be statistically insignificant between impact and reference points (ANOVA, F=1.66, df=1, p=0.21). Generally, similar to species richness, points in or close to patches of remnant woodlands showed higher abundance than those in open treeless habitats.

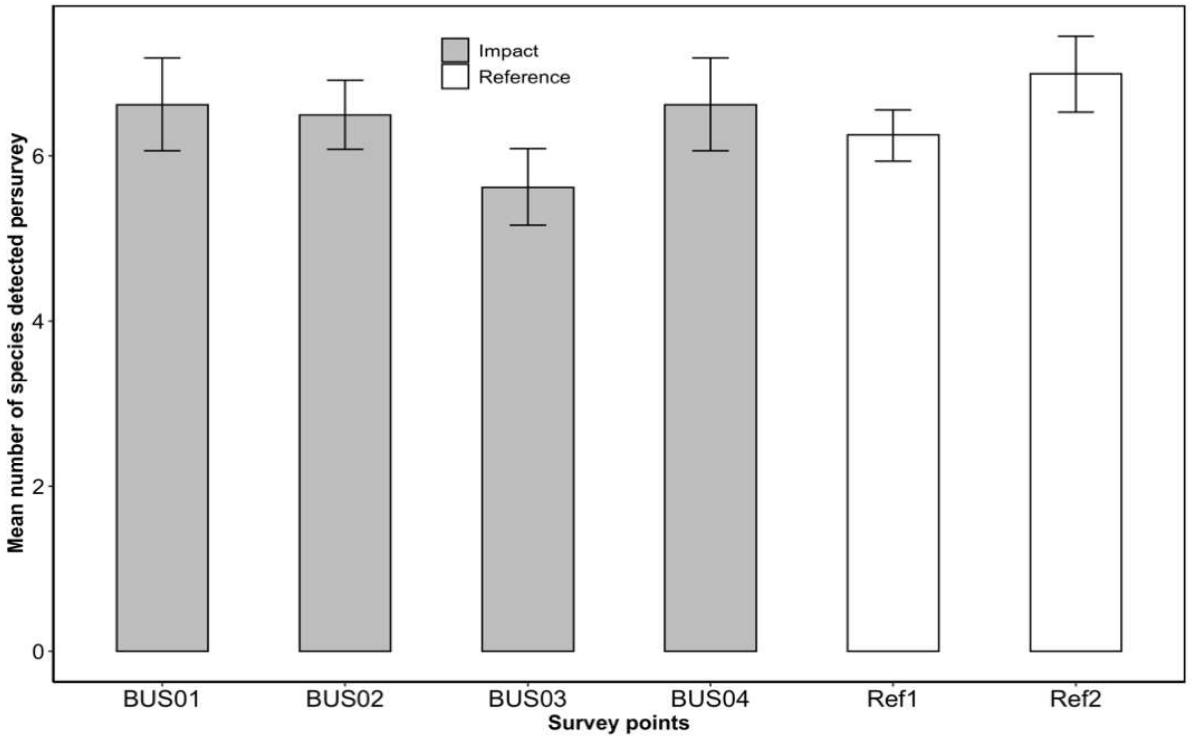

Figure 14. Mean diversity (number of species per survey) of birds among impact and references survey points

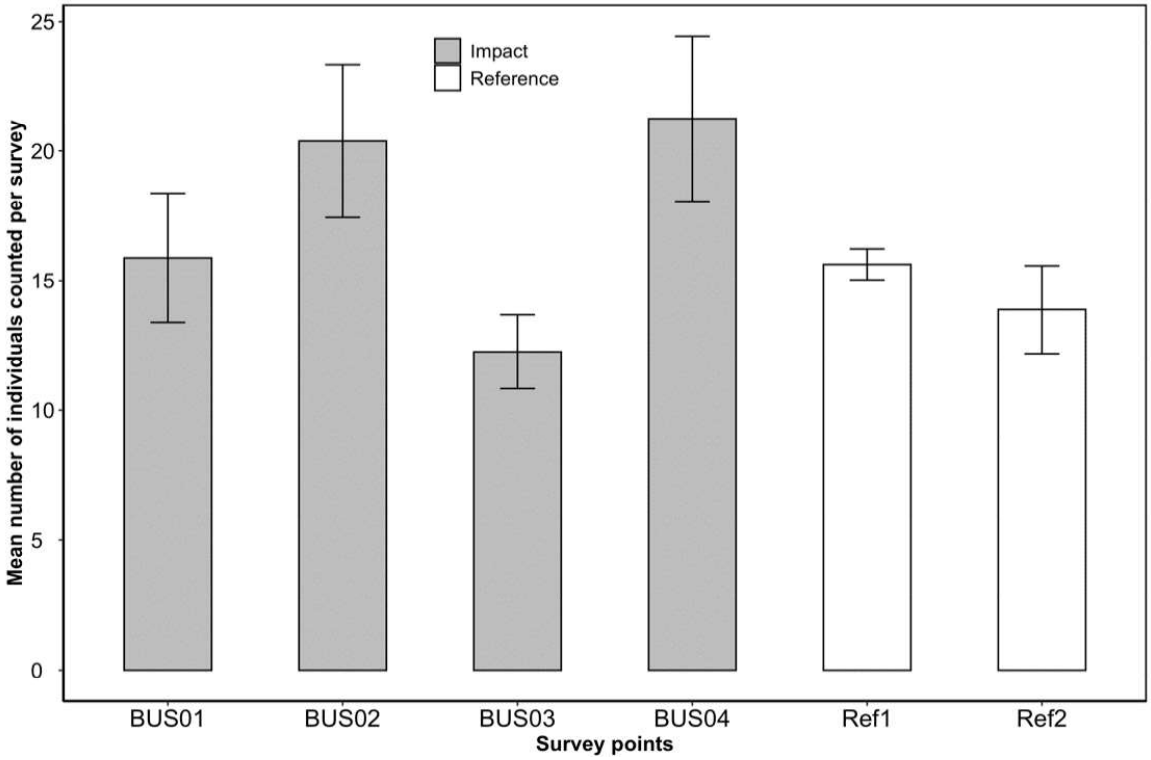

Figure 15. Mean abundance (number of birds recorded per survey) at impact and survey points

Table 18. Summary of the relative abundance (numbers) and height distribution of bird at the impact and reference points during spring/summer survey at SWF

Observation points/ Impact	A	B	C	Total	% Importance	% at RSA
BUS04	170			170	30	0
BUS01	127			127	22.7	0
BUS02	162	1	0	162	29.03	0.6
BUS03	97	1	0	98	17.5	1.02
Impact Total	**556**	**2**	**0**	**558**	**100**	**0.35**
Reference point 2	125			125	53	0
Reference point 1	111			111	47	0
Reference total	**236**	**0**	**0**	**236**	**100**	**0**
Grand Total	**794**	**0**	**0**	**794**		**0.25**

Notes: A = Below RSA height, B = At RSA height, C= Above RSA height.

5.3.3. Flight heights

Bird heights were classified as below RSA (< 74 metres), at RSA (74–200 metres), and above RSA (> 200 metres) heights. Detailed results of the number of birds recorded at the different flight heights are presented in Table 18. As expected, birds were not distributed equally in different height groups (A, B and C). A significant proportion of birds were observed below RSA (χ^2 = 786.02, df=1, p < 0.01, Table 19, Figure 16). Similar patterns were observed for impact and reference points separately (Impact sites: χ^2 = 600.2, df=1, p < 0.01; Reference sites: χ^2 = 725.3, df=1, p < 0.01) with the majority of birds occurring at the height of below RSA. The majority of birds were recorded flying below RSA heights at impact (99.65%) and reference points (100%).

Table 19. Summary of number of birds recorded at the three flight heights at SWF

Flight Height	Impact survey points		Reference survey points	
	Number of birds	Percentage of all birds	Number of birds	Percentage of all birds
A (below RSA)	556	99.6	236	100
B (at RSA)	2	0.4	0	0
C (above RSA)	0	0	0	0
Total birds recorded	**558**	**100**	**236**	**100**

The diversity of species of birds seen flying at RSA heights was relatively low compared to the total birds recorded at impact points; 1 out of 42 species (2.38%) were at RSA at the impact sites, and no observation was made at RSA height at the reference points.

The Wedge-tailed Eagle was the only bird species recorded flying at RSA height. The detailed height distribution of all birds utilising the wind farm site is shown in Figure 16. The height distribution confirms that most birds flew below RSA height at SWF, or were either on the ground or in trees (from 1 to 20 metres height), therefore significantly reducing collision risks between birds and operating wind turbines.

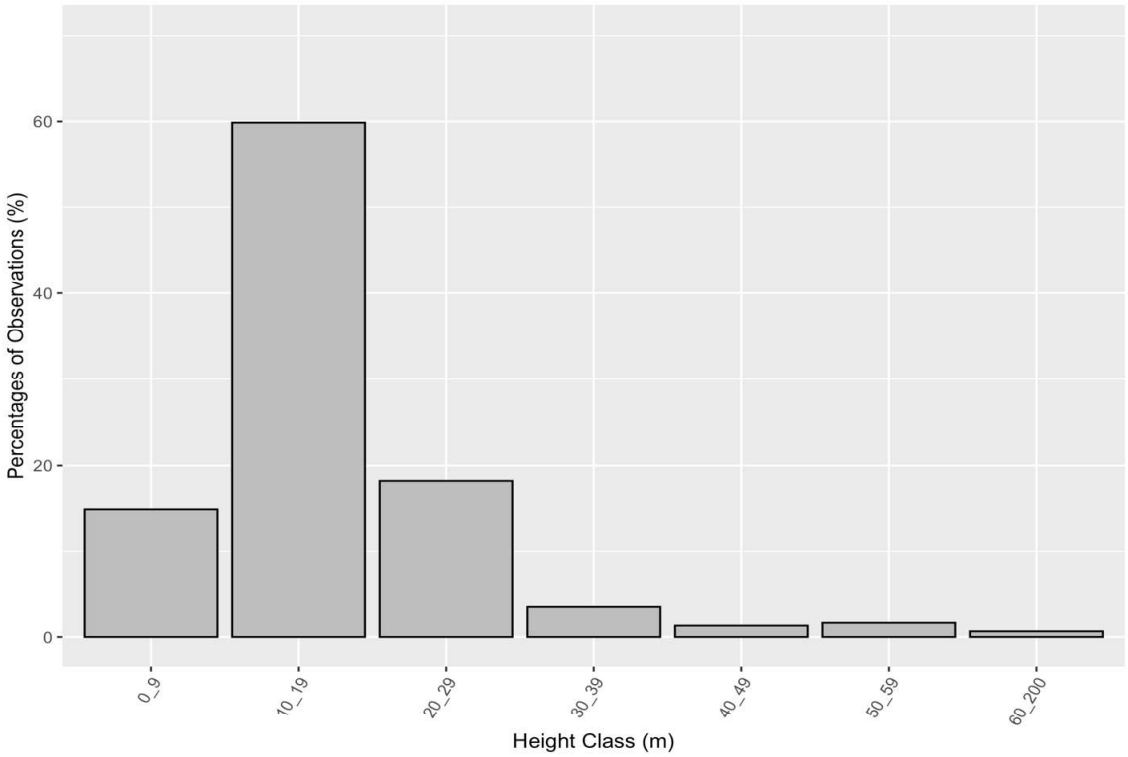

Figure 16. The distribution of bird heights as recorded during BUS at SWF

5.3.4. Threatened Species

The majority of birds found to utilise the wind farm site were common birds. Of the species recorded during the bird utilisation surveys, one species; the Speckled Warbler, was a listed species.

The Speckled Warbler is listed as vulnerable under the BC Act and occurs throughout most of NSW but is sparsely scattered, with most breeding in the western slopes of the Great Dividing Range. It is primarily a bird of eucalypt woodlands with an open or sparse understorey and ground cover of grasses. One individual of this species was recorded during the spring BUS in suitable habitat. Impacts on this vulnerable species are considered low as the flight height of this species is well below RSA height and also given that this species was recorded only once at a reference point, which was over one kilometre away from the nearest turbine at SWF.

5.3.5. Raptors

Three raptor species were recorded during the spring/summer survey, comprising a total of eight observations (Table 20). The majority of raptors were seen flying below RSA heights (75%), however, the overall importance calculated as a percentage of all birds recorded during BUS was rather low and constituted 0.25%.

The Wedge-tailed Eagle was the only raptor species recorded flying at RSA heights during the BUS.

The Wedge-tailed Eagle was recorded occasionally within the study area. Importantly, no active Wedge-tailed Eagle nests were found at SWF during either the BUS surveys or carcass searches.

Raptors are usually the most vulnerable species to collide with operating turbines because of their soaring habits while foraging, however, the carcass monitoring at SWF suggests that the collision rate of raptors at SWF is considerably lower than many other wind farms. Most of the areas at SWF are open woodland with a usually flat landscape thus not an ideal habitat for Wedge-tailed Eagle. The low occurrence of the Wedge-tailed Eagle is reflected both in BUS as well as carcass search results (see carcass monitoring results above).

5.3.6. Waterbirds

Two waterbird species were recorded during the surveys, comprising 90 observations in total (11% of all birds). Of these, 50 observations were of Australian Wood Duck and 40 were Straw-necked Ibis (Table 20).

The Australian Wood Duck is a very common farmland waterbird that usually roosts along the edges of farm dams and forages in open paddocks next to the dams during both day and night. Flocks of this species were observed mainly at point BUS04 on a nearby dam positioned within the counting area. This species was also recorded during the carcass monitoring program at SWF on several occasions.

The Straw-necked Ibis is another common farmland bird which can be seen regularly flying and foraging in flocks. Similar to the Australian Wood Duck, they were also regularly seen close to the dam within BUS04 point. Similar species of waterbirds were seen on the reference points, as in the impact points, the Australian Wood Duck was the most common species. No waterbirds were recorded flying at RSA height during the spring/summer survey (Table 20).

Table 20: Raptor and Waterbird species recorded at the impact survey points during spring/summer survey at Sapphire Wind Farm

Species	Total number of birds	Total flying at RSA heights	% flying at RSA heights	% RSA of total RSA birds	% RSA bird of all BUS birds
Raptors					
Nankeen Kestrel	4	0	0	0	0
Wedge-tailed Eagle	2	2	100	100	0.25
Whistling Kite	2	0	0	0	0
Total raptors	**8**	**2**	**25**	**–**	**0.25**
Waterbirds					
Australian Wood Duck	50	0	0	0	0
Straw-necked Ibis	40	0	0	0	0
Total waterbirds	**90**	**0**	**0**	**0**	**0**
Grand Total	**98**	**0**	**0**	**–**	**0**

6. Summary, Implications and Adaptive Management

Post-construction bird and bat carcass searches for the first year of the operation of SWF were undertaken in accordance with the approved BBAMP (BL&A 2017).

6.1. Birds

6.1.1. Overall carcass search results

Between July 2019 and January 2020 (19 months), 684 turbine searches were undertaken (including 342, 100-metres radius searches and 342 60-meter radius). During these searches 19 bird carcasses were found (including feather spots) representing one bird carcass per 18 turbine searches.

During the pre-operational phase at SWF, the most commonly found species was the Crested Pigeon, followed by the Australian Magpie. The carcasses were found under turbines that had only been partially constructed and were non-operational at the time.

The Australian Magpie was the most abundant of all bird and bat species found during formal searches, followed by the Crested Pigeon and the Wedge-tailed Eagle.

The overall mortality rate of birds and bats at SWF is considered to be low compared to other wind farms in eastern Australia. This can be attributed primarily to the habitat types, with cleared and fragmented areas throughout the wind farm. Another factor that might contribute to the low mortality rate, especially for bats, is the height of turbines at SWF which is far above the canopy leve,l thus reducing the risk of bat and bird collision with turbines. Interestingly, no carcasses were found in October-November 2018 or March-May 2019. The 2019 bushfire and drought could have had an impact on these results resulting in comparatively low movement and activities of species around the wind farm. Observations by Nature Advisory at other wind farms for which pre-drought data exist show an up to 80% decline in some bird activity as a consequence of the recent drought.

It should be noted, one Little Eagle was found at SWF injured beneath a powerline. This species is listed as 'Vulnerable' in New South Wales under the BC Act. It was found 900 metres from the nearest turbine on 26th July 2018 by wind farm staff and was transferred to the local vet. A short investigation concluded that it was highly unlikely that the casualty was caused by a wind turbine. Therefore, the mortality was not attributed to collision with turbines and not recorded as an incidental or casualty record, or to have triggered an impact trigger.

6.1.2. At risk species

Five species or groups of birds were identified in the BBAMP as being at risk from the wind farm. These include the following.

- Wedge-tailed Eagle
- Other raptors
- White-throated Needletail
- Regent Honeyeater

- Swift Parrot.

The density and frequency of observations of Wedge-tailed Eagle during BUS and also carcass monitoring was generally low at SWF. During carcass monitoring, ten individuals of the Wedge-tailed Eagle were recorded at SWF. To gain a better understanding of how this species and other raptors are using the site, ongoing monitoring will continue during year two of operations at SWF. In addition, further attempts will be made to identify potential nest sites of Wedge-tailed Eagle and monitoring in the breeding season for occupancy. Flight paths will be more detailed and mapped to gain a better understanding of turbines at most risk of strike. It is considered likely that raptor collisions are due mainly to their soaring habits and preference for the topography (windy with uplifting air currents) at the wind farm.

Two other raptor species observed at SWF were Nankeen Kestrel and Whistling Kite. Nankeen Kestrel and Whistling Kite are usually observed inside the wind farm but the total number and frequency of observations for both species was comparatively low. No Nankeen Kestrel or Whistling Kite carcasses were found under turbines.

No White-throated Needletail, Regent Honeyeater or Swift Parrot were observed at SWF during BUS or carcass monitoring programs. However, monitoring for potential occurrence of these species will continue in year two.

6.1.3. Conclusions from 2019/2020 bird utilisation surveys

The conclusions from the spring/summer 2019/2020 BUS at Sapphire Wind Farm are presented below.

- The areas inside and surrounding Sapphire Wind Farm are largely made of cleared plateaus supporting a low diversity and abundance of common, predominantly farmland birds. Notably, the area supports a low diversity of raptors due to the lack of suitable habitats.
- The bird utilisation surveys found a total of 50 species of birds; 42 at the impact and 41 at the reference points.
- The species with the highest frequency of observation was Noisy Miner followed by Australian Magpie and Eastern Rosella. The five main species observed during BUS, comprised 41% of all individual birds recorded at the impact survey points and about 35% at the reference survey points.
- The relative abundance of birds varied between the six observation points, depending on the habitat surrounding each of the points. Points within or close to patches of remnant woodlands returned higher relative abundance than those within open treeless habitats. Survey sites with more mature native trees, that are located close to or within a remnant woodland attracted more birds than highly cleared grazing paddocks. Despite these variations, the diversity of species at impact and reference points did not significantly differ based on statistical tests, suggesting a more uniform habitat across most parts of the wind farm and surrounding areas.
- The majority of birds were recorded flying below RSA heights (99.65% at impact & 100% at reference points).

- Overall, a low proportion of birds (0.25%) were observed at RSA height. The Wedge-tailed Eagle was the only species recorded at RSA height.
- Waterbirds were found to be largely confined to farm dams and were mainly very common waterbird species including Australian Wood Duck and Straw-necked Ibis.
- The Speckled Warbler was the only threatened species (BC Act) recorded utilising the wind farm site. This species was recorded at reference point 2, away from the turbines.

6.1.4. Implications and adaptive management

The number of carcasses found at Sapphire Wind Farm is comparable to other wind farms in the region. The mortality rate at SWF is considered to be low based on observations at other wind farms. However, due to the relatively short period of monitoring, this low impact rate might not provide a realistic picture of bird and bat mortality rate at SWF. The mortality monitoring regime will continue into year two to provide a more accurate understanding of the impacts of SWF on birds and bats. Also, monitoring of at-risk species, and incidental finds will continue to be recorded during the 2020-2021 monitoring period.

Species listed in section 6.1.2, classified as 'at risk' species were not observed at SWF during this monitoring period. It is important to note that 2019 was extremely dry in most parts of the Northern Tablelands, including SWF. Given this, flowering ironbark trees were scarce providing limited habitat for species such as Regent Honeyeater and Swift Parrot. However, this condition altered in late 2019 and early 2020 with increased rainfall. Thus, further investigation for potential occurrence of these species, particularly Regent Honeyeater, is recommended if eucalypts flower later in the year.

6.2. Bats

6.2.1. Overall carcass search results

Overall, impacts on bat species are considered to be negligible as the number of bats found during the mortality monitoring program was very low. It is considered unlikely that the project is having a significant impact on any bat species' population. The monitoring program will continue throughout year two of operation to provide a longer-term picture, including a year with better rainfall.

6.2.2. Implications and adaptive management

During carcass monitoring at SWF, only two mortalities of bats were recorded during the pre-operational and official first year operational monitoring periods. No incidental finds were recorded. This number of bats is extremely low compared to the mean bat collision rates at other wind farms. One reason for this is the height of turbines, which are well above the canopy height and higher than most wind farms monitored in this way to date. This may be reducing the risk of collision with turbines given bat activity at height is much lower than closer to the ground based on recordings at wind monitoring masts on a range of wind farms elsewhere in NSW. The other factor might be the low population density of bats in this area due to site characteristics or the drought.

One carcass of a threatened species of bat, the Grey-headed Flying–Fox, was found caught in barbed-wire fencing. This find did not trigger an investigation under the BBAMP due to the determination of the incident as not having been caused by a wind turbine. Grey-headed Flying-Fox have also been found flying into barbed–wire fencing at nearby wind farms. It is suggested that ongoing observations of this phenomenon be recorded to determine the scale of impacts barbed-wire fencing is having on the Grey-headed Flying–Fox.

7. References

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Appendix 1. Bird and bat mortality data obtained during the pre-operational period and first year of monitoring at SWF (July 2018-January 2020)

Season	Date	Common name	Threatened Status	Report (R)/ Feather spot (FS)/ Incidental (INC)	Turbine number	Distance from turbine (m)
Winter	6/08/2018	Crested Pigeon		INC18.8.1	Powerline	NA
Winter	9/08/2018	Crested Pigeon	-	INC18.8.2	57	1
Winter	27/08/2018	Australian Magpie	-	FS18.8.3	57	1
Winter	13/09/2018	Crested Pigeon	-	INC18.9.1	16	50
Spring	13/09/2018	Australian Magpie	-	INC18.9.2	57	5
Spring	12/12/2018	Wedge- tailed Eagle	-	INC18.12.1	57	5
Summer	27/12/2018	Grey- headed Flying-Fox	Vulnerable (NSW & Federal)	R18.12.2	66 (entangled in a fence)	100
Summer	24/01/2018	Wedge- tailed Eagle	-	INC19.1.1	18	100
Summer	4/02/2019	Wedge-tailed Eagle	-	INC19.2.1	56	25
Summer	21/02/2019	Eastern Rosella	-	INC19.2.2	70	65
Summer	7/06/2019	Australian Wood Duck	-	R19.6.1	57	10
Winter	11/07/2019	Tawny Frogmouth	-	R19.7.1	48	20
Winter	4/09/2019	Pacific Baza	-	R19.9.1	18	30
Spring	9/09/2019	Australian Magpie	-	R19.9.2	68	25
Spring	4/10/2019	Chocolate Wattled Bat	-	R19.10.1	48	30
Spring	25/10/2019	Musk Lorikeet	-	INC19.10.2	32	20
Spring	4/11/2019	Tawny Frogmouth	-	FS19.11.1	63	25
Spring	1/11/2019	Australian magpie	-	INC19.11.1	WTG 29	15
Summer	13/01/2020	Australian Wood Duck	-	INC19.1.1	33	1

Appendix 2. Scavenger trail data obtained during the first year of monitoring at SWF

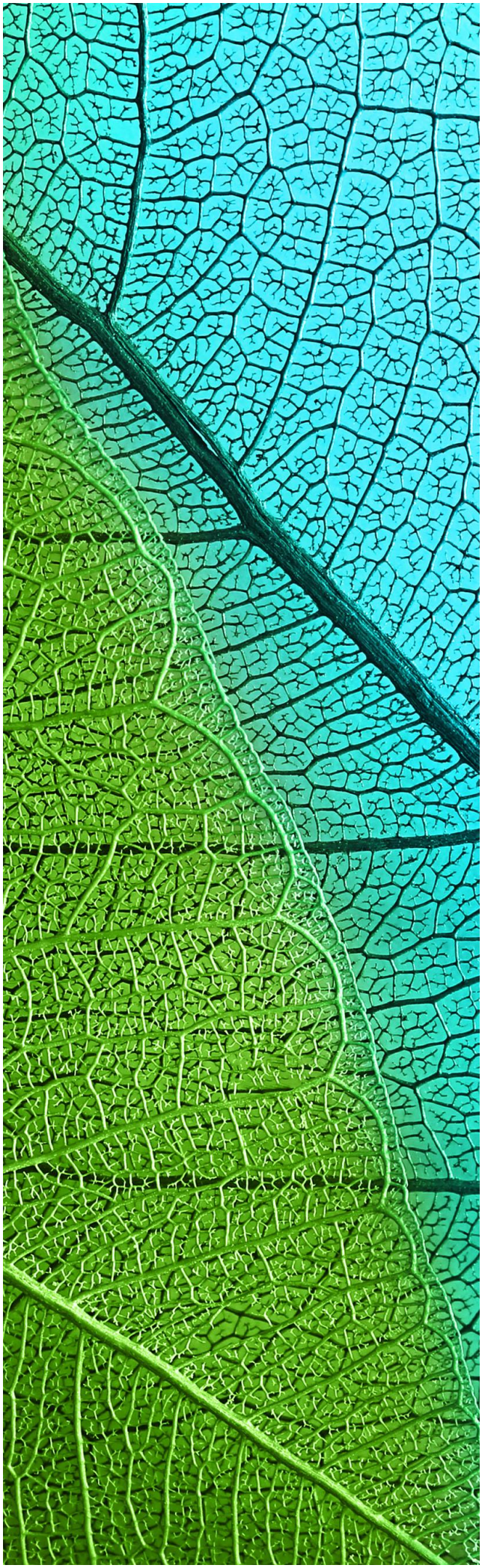
Season	Species	Carcass size	Placement Date	Scavenged date	Days in the field	Turbine
Winter	Common Myna	Small Bird	8/08/2019	9/08/2019	1	23
	Wedge-tailed Eagle	Large Bird	8/08/2019	NA	30	23
	Australian Wood Duck	Medium-Sized Bird	8/08/2019	19/08/2019	11	14
	Rainbow Lorikeet	Small Bird	9/08/2019	16/08/2019	7	41
	Nankeen Kestrel	Medium-Sized Bird	9/08/2019	16/08/2019	7	18
	Wedge-tailed Eagle	Large Bird	9/08/2019	NA	30	23
	Common Myna	Small Bird	9/08/2019	9/08/2019	1	41
	Eastern Rosella	Medium-Sized Bird	9/08/2019	11/08/2019	2	14
	White-striped Freetail Bat	Bat	11/08/2019	13/08/2019	2	23
	Wedge-tailed Eagle	Large Bird	13/08/2019	NA	30	58
	White-striped Freetail Bat	Bat	13/08/2019	17/08/2019	4	58
	Wedge-tailed Eagle	Large Bird	15/08/2019	NA	30	23
	Magpie-lark	Small Bird	15/08/2019	17/08/2019	2	23
	White-striped Freetail Bat	Bat	16/08/2019	25/08/2019	9	41
	Crimson Rosella	Medium-Sized Bird	16/08/2019	16/08/2019	1	58
	Sulphur-crested Cockatoo	Medium-Sized Bird	16/08/2019	17/08/2019	1	41
	White-striped Freetail Bat	Large Bird	16/08/2019	NA	30	41
	White-striped Freetail Bat	Bat	16/08/2019	16/08/2019	1	41
	Common Myna	Small Bird	16/08/2019	18/08/2019	2	16
	White-striped Freetail Bat	Bat	17/08/2019	20/08/2019	3	58

Appendix 3: Raw data for the spring/summer impact BUS points at Sapphire Wind Farm

Site	BUS01								BUS02									BUS03									BUS04								Total
Height class	Below RSA								Below RSA								At RSA	Below RSA								At RSA	Below RSA								
Species/replicate	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	8	1	2	3	4	5	6	7	8	1	1	2	3	4	5	6	7	8	
Australian Magpie	3		1		2		3		5		2	2	3	2	2	3		1	3	3	3		2	2			1	3		3				5	54
Australian Raven												3		5	5	2		3				1					3								22
Australian Wood Duck											10	5																5		10	10		5		45
Black-faced Cuckoo-shrike	1		3										2			1			2		1														10
Blue-faced Honeyeater																																5			5
Brown-headed Honeyeater																																	1	1	2
Buff-rumped Thornbill													2																						2
Crested Pigeon																								3									4		7
Crimson Rosella								3	3		3														2							4			15
Eastern Rosella	5		3						3				2	2	2						3	3						1				2	3	3	32
Fan-tailed Cuckoo							1																												1
Galah										10	2	10		5	1	3				3		2						2				5			43
Grey Butcherbird					1					3															1				1					1	7
Grey Fantail	1	1				2																										2			6
Grey Shrike-thrush						2		2																						2					6
Laughing Kookaburra					2	2	2							1	1									5	2										15
Leaden Flycatcher				1																															1
Magpie-lark			2			2		1							2								2	2				2						2	15
Musk Lorikeet							2				5		2												1										10
Nankeen Kestrel								1											1			1													3
Noisy Friarbird	5									2									2		1						2			3					15
Noisy Miner	1	5	3		1		2	2	3			1	2	2	1				3	2	3	3	3	3	1		2	1	2	2	2			3	53
Pied Butcherbird	1	2			2					1				2	2	2							2				1					1			16
Pied Currawong					2			2		2					2								2												10
Red Wattlebird				1					3	2								2			5	1								1	1				16
Restless Flycatcher																						1		1											2
Rufous Whistler								1			1																	1							3
Silvereye					3																														3
Straw-necked Ibis																												15		10	10		5		40
Striated Pardalote							1																					1							2
Sulphur-crested Cockatoo						4	4				15																							5	28
Superb Fairy-wren																												2						2	4
Wedge-tailed Eagle																	1									1									2
Welcome Swallow					2															2															4
Whistling Kite																						1													1
White-eared Honeyeater						1																											1		2
White-throated Treecreeper		1		1																															2
White-winged Chough		20										5								5				2						5					37
Willie Wagtail		2			2																											3			7
Yellow-faced Honeyeater						2		2																											4
Yellow-rumped Thornbill				3																														3	6
Grand Total	17	31	12	6	17	15	15	14	17	20	38	26	13	19	18	11	1	6	11	15	16	13	11	18	7	1	9	29	7	31	28	21	20	25	558

Appendix 4: Raw Data for the spring/summer reference BUS points at Sapphire Wind Farm

Reference site	Ref 1								Ref2								Total
Height class	Below RSA								Below RSA								
Species/replicate	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	
Australian Magpie	2	1		3		3								3			12
Australian Raven		3	2									1				1	7
Australian Wood Duck		5															5
Black-faced Cuckoo-shrike											2		1				3
Blue-faced Honeyeater														5			5
Buff-rumped Thornbill																2	2
Crested Pigeon	1				3												4
Crimson Rosella	1		3	5			2							5			16
Double-barred Finch						3		3									6
Eastern Rosella								3			3	3		3	2	2	16
Eastern Spinebill					1												1
Fan-tailed Cuckoo						1											1
Galah			5		3				1		5	2			2	1	19
Grey Butcherbird			3				2						2			1	8
Grey Fantail					1								3				4
Grey Shrike-thrush													2				2
Leaden Flycatcher									1	1							2
Magpie-lark	5																5
Mistletoebird						1		1									2
Musk Lorikeet						3	5				2						10
Nankeen Kestrel				1													1
Noisy Friarbird										1				1			2
Noisy Miner	2	5		2	2		1	2			1	3		3	3		24
Pied Butcherbird							2						1				3
Pied Currawong			2	3	3	2		2									12
Rainbow Bee-eater															1		1
Red Wattlebird	5			2						2		2					11
Restless Flycatcher							2										2
Speckled Warbler									1								1
Spotted Pardalote									1	1					2	1	5
Striated Pardalote					1				1	1							3
Sulphur-crested Cockatoo															5	1	6
Superb Fairy-wren						2			3					3	2		10
Welcome Swallow								3									3
Whistling Kite				1													1
White-eared Honeyeater														1			1
White-throated Gerygone										2		1					3
White-throated Treecreeper									1			1	2			1	5
White-winged Chough		5															5
Willie Wagtail								1									1
Yellow-rumped Thornbill									3							3	6
Grand Total	16	19	15	17	14	15	14	15	12	8	13	13	11	24	17	13	236



Sapphire Wind Farm

Second Year Annual Report of the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for SWF1 Operations Pty Ltd

June 2021
Report No. 16045 (26.1)

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1. Executive Summary

Sapphire Wind Farm (SWF) is located in the New England region of northern New South Wales. The site is 24 kilometres west of Glen Innes and three kilometres north of the Gwydir Highway (Figure 1). The site has been mostly cleared of its original native vegetation and used for grazing.

The wind farm currently comprises 75 turbines and associated infrastructure. The development consent was modified in 2016 to reduce the number of turbines from 159 to 75.

As per Condition C6 of the NSW approval for Sapphire Wind Farm a Bird and Bat Adaptive Management Plan (BBAMP) was developed and approved in 2017. Brett Lane & Associates Pty Ltd (BL&A), the predecessor to Nature Advisory Pty Ltd (Nature Advisory), was engaged to implement the BBAMP.

The first phase of the monitoring program comprised began in the partial-operational phase in July 2018 and in total comprised 24 months of fully operational surveys, including:

- Monthly monitoring of bird and bat collisions with turbines through carcass searches, including scavenger surveys (to determine carcass removal rates before detection), and observer efficiency trials (to determine how well observers detect carcasses);
- Monitoring 'at risk' groups of birds, including raptors and White-throated Needletail; and
- Assessing the effects of the wind farm on bird activity at the site, based on bird utilisation rates.

Between July 2018 and January 2021 (31 months), 930 turbine searches were undertaken (including 463, 100-metres radius searches and 464 60-meter radius). During these searches; 14 bird carcasses, 10 bat and 13 feather spots were found. A total of 9 birds, two feather spots and one bat were found incidentally. This consisted of 15 bird and five bat species identified.

Based on statistical analysis relation to bat mortality, based on the number of detected carcasses and the detectability and scavenging rate, there was a total site loss (all turbines combined) of around 166 bats over the 31 month search period, with the upper 95% confidence limit of fewer than 252 individuals. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 64 bats with 95% confidence that fewer than 98 individuals were lost. Importantly, this is the lowest annual level of bat mortality at a wind farm monitored by Nature Advisory (unpub data).

Based on statistical analysis relation to bird mortality, based on the number of detected carcasses and the detectability and scavenging rate, there was a total site loss over 31 months of survey corresponded to an estimated loss of 457 birds with 95% confidence that fewer than 658 individuals were lost. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 177 birds with 95% confidence that fewer than 255 individuals were lost.

Individual estimates were undertaken for Wedge-tailed Eagle and the estimate of total mortality over the 31 months was 13 individuals with 95% confidence that fewer than 27 individuals were lost. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 5 WTEs with 95% confidence that fewer than 10 WTEs were lost.

The Australian Magpie was the most abundant of all bird and bat species mortalities found during formal searches, making up 18% of all mortality, followed by Wedge-tailed Eagle, which made up 13% of all mortality. Of the five bat species found 60% of these consisted of White-striped Freetail Bat.

Wedge-tailed Eagle was identified in the BBAMP as an 'at-risk' species. Its comparatively high mortality rate, is reflected in the raptor monitoring results, where Wedge-tailed Eagle was observed the most often from the three raptor species, and the BUS, where it was the only species observed flying at RSA height of all bird species observed. It is estimated that 13 individuals were lost during the monitoring period.

Other 'at-risk' species; White-throated Needletail, Regent Honeyeater or Swift Parrot were not observed during the monitoring program. The main habitat, Ironbark trees, are in very low numbers on the site and even when flowering would provide very limited habitat and foraging opportunities for the species. Therefore, risk from SWF operation is considered to be very low for these species.

No threatened or non-threatened management triggers occurred as a result of the monitoring program. It is unlikely that the results from the monitoring program or the mortality estimates suggest a significant impact on any of the species identified as mortalities. Each is a relatively common and widespread species to farmland landscapes in NSW and other parts of Australia, and each is considered secure and not in decline. It is unlikely that BWF would have a significant impact on any populations regionally, on a state level or overall.

It is recommended that the carrion removal plan be implemented as per the BBAMP Section 5.1., lambing be restricted, in consultation with land holders, within 200 metres of turbines, SWF staff continue to record any incidental carcasses found.

In line with Sapphire Wind Farm Condition C6, ongoing information collation should be included in reports submitted to the Director-General and OEH on an annual basis for the first five years of operation as outlined in Condition C6 of the Project Approval. This report represents the reporting on the first two years of operation.

2. Introduction

Sapphire Wind Farm (SWF) is located in the Kings Plain District, 24 kilometres west of Glen Innes and 28 kilometres east of Inverell in the northern tablelands of New South Wales (NSW) (Figure 1). A total of 75 turbines and associated infrastructure are sited within approximately 8,921ha of land. The land has been predominately cleared for grazing.

SWF proposed a 159-turbine wind farm in the northern Tablelands of NSW in 2007. The NSW Department of Planning and Infrastructure (DPI) and the Commonwealth Department of the Environment (DotE) approved the wind farm in June 2013 and December 2014 respectively. In January 2016, Sapphire Wind Farm Pty Ltd requested a modification to the approval to reduce the number of turbines from 159 to up to 109 turbines and increase the maximum tip height to 200 metres above the ground and rotor diameter to 126 metres. The DPE and the DotE approved the Modification request in June 2016. The project completed construction in late 2018 with a refined design which involved the construction of 75 turbines at locations approved in the Modification.

Condition C6 of the NSW approval required the preparation of a Bird and Bat Adaptive Management Program (BBAMP), these requirements have been outlined in the following section. Element (d) required the proponent to identify 'at risk' bird and bat groups, seasons and/or areas within the project site which may attract high levels of mortality. The BBAMP was prepared by Brett Lane & Associates Pty Ltd, predecessor of Nature Advisory Pty Ltd (BL&A 2017) and approved by the Director-General of DPI.

Sapphire Wind Farm Pty Ltd engaged Nature Advisory to implement the approved Bird and Bat Adaptive Management Program (BBAMP) for the SWF. Specifically, the scope of the work included:

- Operational bird and bat carcass (mortality) monitoring program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

This report comprises the second annual report, covering all monitoring activities up to and including the second year of official operation of SWF. As per Section 4.7 of the BBAMP, the second annual report includes, but is not limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- The survey methods (including list of observers, dates and times of observations);
- Results of carcass searches and incidental carcass observations;
- Estimates of bird and bat mortality rates (avifauna impacted per turbine per year) based on statistical analysis;
- Seasonal and annual variation in the number and composition of bird and bat strikes, where detectable;
- Any other mortality recorded on site but not during designated carcass searches (i.e., incidental records by site personnel);

- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework and relevant adaptive management measures.
- A summary of livestock carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs and their timing;
- A discussion of the results, including:
    - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.
    - Bird risk reduction measures.
    - Any further recommendations for reducing mortality, if necessary.
    - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
    - Usage of the wind farm area by 'at risk' species and factors influencing this (ie. climatic, geographical and infrastructure).
    - Analysis of the effectiveness of the decision-making framework.
    - Recommendations for further monitoring.

This report is divided into the following sections:

Section 3 provides the methods and results of the carcass search program.

Section 4 provides the methods and results of the monitoring 'at risk' bird species.

Section 5 provides the methods and results of the bird utilisation survey.

Section 6 discusses the conclusions of the first year of monitoring at SWF.

This investigation was undertaken by a team from Nature Advisory, comprising Ahmad Barati (Zoologist), Candice Larkin (Zoologist), Jackson Clerke (Zoologist), Bernard O'Callaghan (Senior Ecologist and Project Manager) and Brett Lane.

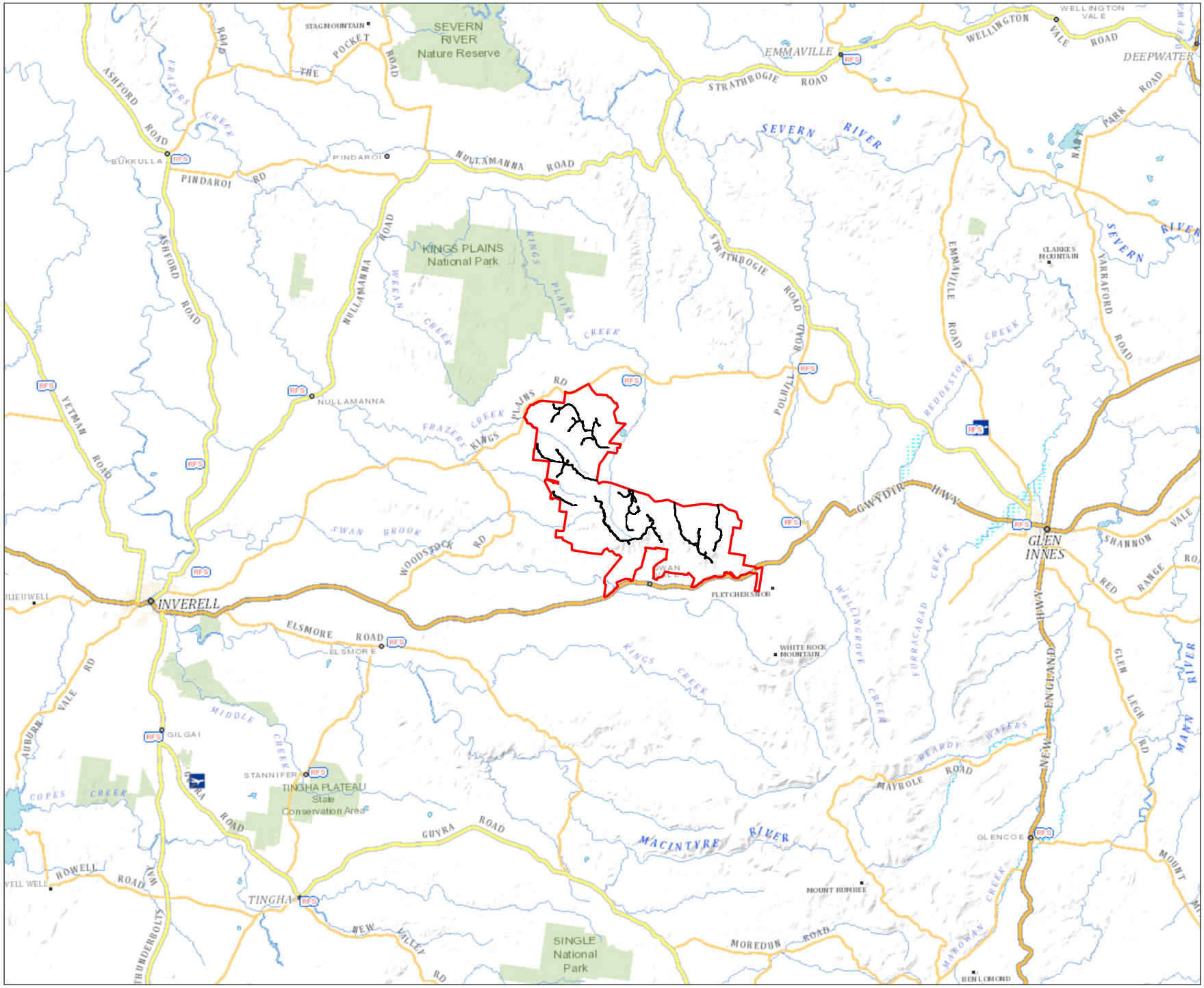

Figure 1: Locality map

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

Study area
Turbines
Access tracks

N

Kilometers
0 5.5

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3. Carcass searches

3.1. Methods

3.1.1. Carcass searches

The mortality monitoring regime at SWF began in the partial-operational phase in July 2018. Monthly carcass searches were conducted for seven months while the wind farm was in partial operation where 33% of the operating turbines were searched. SWF became fully operational in February 2019 and the searches of the 33% of the operating turbines continued. The first full operation was from February 2019 to January 2020 and the second year included February 2020 to January 2021. This report covers all monitoring activities to date as part of the initial two-year mortality monitoring program at SWF under the BBAMP. The term 'monitoring period' used here refers to the period from July 2018 to January 2021 a total of 31 months.

Monthly carcass searches were undertaken under 18 turbines at SWF. Turbines were selected based on a randomised sampling design at the beginning of the implementation of the BBAMP (Table 1). This involved the selection of a random sub-set of turbines for monthly carcass searching. Random selection enables an assumption that the selected turbines together are representative of all turbines in the wind farm.

Table 1. List of turbines searched

Turbine numbers		
4	23	48
5	32	53
7	34	58
14	41	63
16	43	68
18	48	69

Carcass searches involved surveying all the sampled turbines once a month during a five to six-day search period out to a radius of 100 metres (Figure 2). Within a few days of the initial turbine searches, the turbines were then searched again in what is referred to as a 'pulse search'. This entails the inner zone of each turbine being searched a second time. The purpose of this is to provide additional data on frequency of mortalities occurring. It also provides additional opportunity to located any microbats which, given their small size, can be extremely difficult to locate.

A 100-metre-radius circular zone surrounding each designated turbine was searched each month, with two target search zones: the inner and outer zone, as follows:

- The inner zone: transects are spaced at four metres apart and carried out up to 60 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 61 metres and 100 metres radius from the turbine tower base aims at detecting the medium and larger bodied birds; transects are spaced at twelve metres apart.

Ahmad Barati (zoologist) undertook carcass searches in 2018 and 2020 and Candice Larkin (zoologist) undertook the surveys in 2020 and 2021.

Mortalities were classed as either a bird carcass, a feather spot, a bat carcass or an incidental find. The last is any of the aforementioned classes found outside of the formal, monthly search (i.e., including at both target non-target turbines, finds by wind farm personnel). It is likely that feather spots represent a bird that has collided with a turbine and has later been scavenged. When a dead bird or bat was recorded under a turbine, pro-forma was filled out and numbered, and a photograph of the carcass in situ taken.

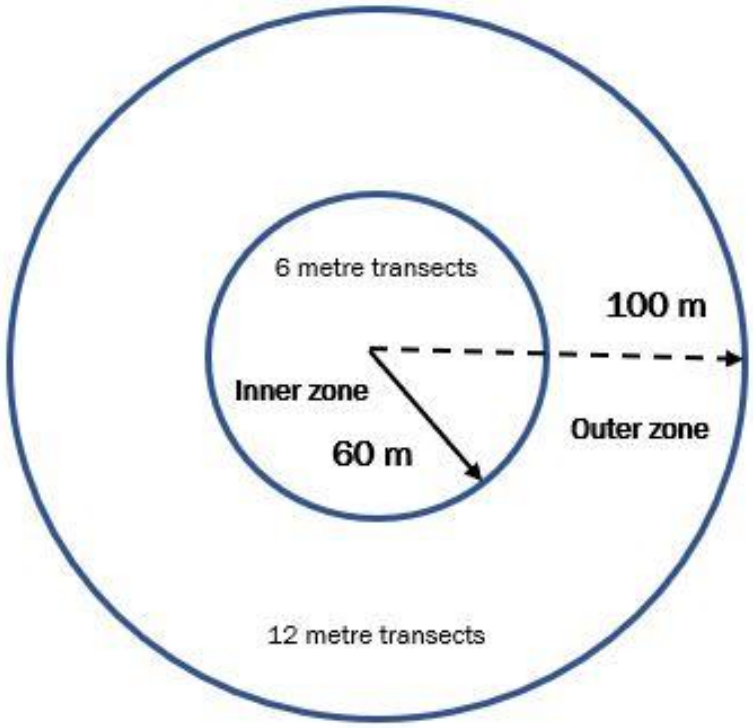

Figure 2. Diagram of inner and outer search zones at turbines

On finding a bird carcass, feather-spot or bat carcass, the finder:

- Completed a casualty report;
- Removed it from the site to avoid re-counting; and
- Transferred fresh carcasses to a freezer at the site office for storage so it could be identified and used later in observer efficiency and scavenger trials (see below).

The locations of all the turbines and the turbines searched are shown in Figure 3.

According to Section 6 of the BBAMP, an investigation may be warranted if any threatened or listed species is found as a casualty under a wind turbine; this is referred to as an 'impact trigger'. An immediate report must made if the following scenario occurs:

> *"A threatened bird/bat species (or recognisable parts thereof) listed under the Commonwealth EPBC Act or NSW Threatened Species Conservation Act 1995, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel."*

In the case of a non-threatened species carcass found, an impact trigger is defined as:

> *"A total of four or more bird or bat carcasses, or parts thereof, of the same species in two successive searches at the same turbine of a non-threatened species (excluding ravens, magpies, White Cockatoos, corellas, pipits and introduced species.*

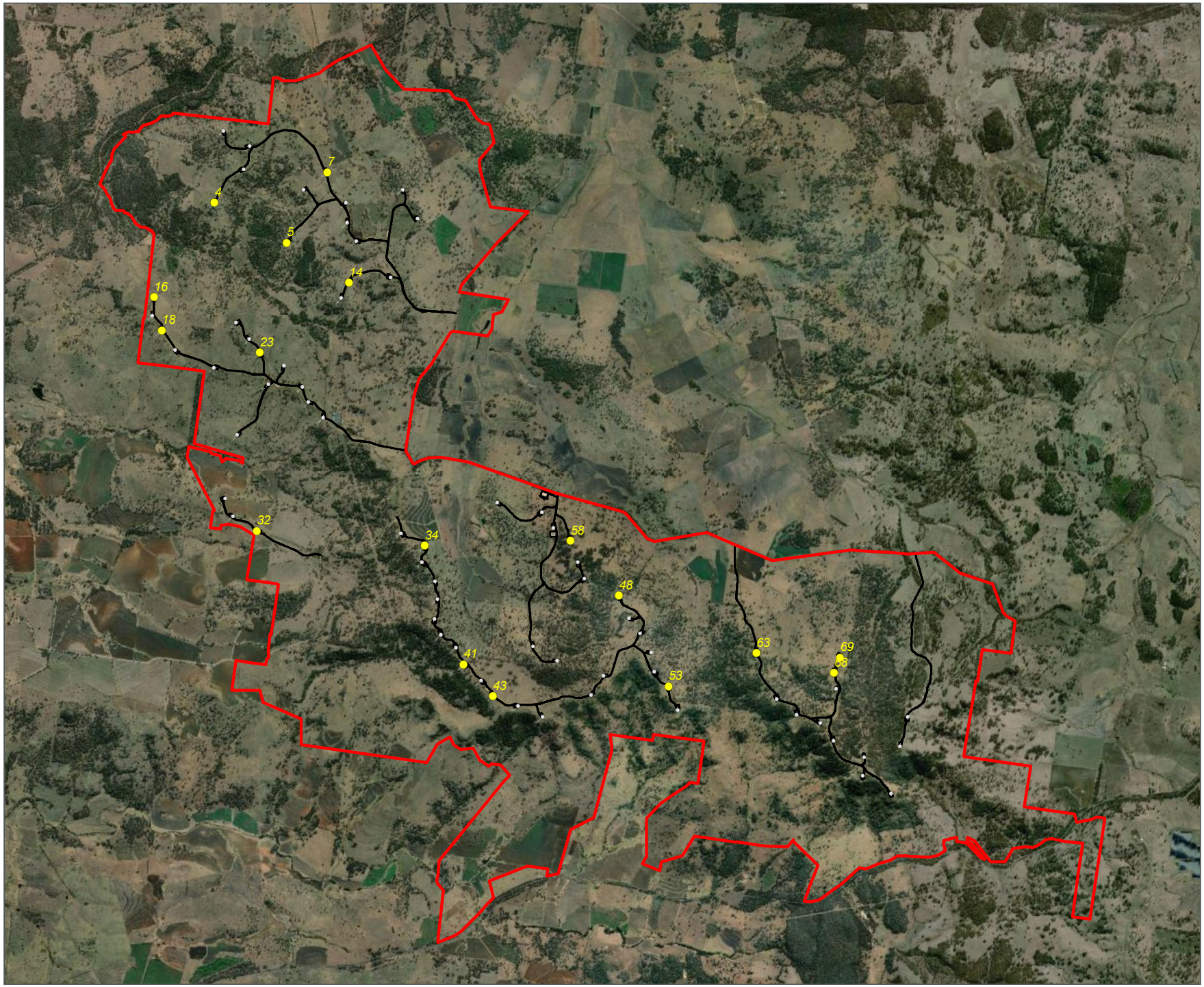

Figure 2: Sapphire Wind Farm turbine layout

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

- Study area
- Target turbines
- Turbines
- Access tracks

N

Kilometers
0 1

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3.1.2. Searcher efficiency trials

The BBAMP states that searcher efficiency trials are to be undertaken twice over the two-year monitoring period in each of the two distinct seasons. The objective of having two trials is to account for the different vegetation conditions, with one being undertaken following summer rains when the grass is long (October-January) and the other in the drier winter months when the grass is short (July-August).

It is noted that NSW was severely affected by the drought and 2019 bushfires. The winter trial was undertaken on the 8th of August 2019, however, there was no significant change in vegetation condition over the summer period. The second trial was undertaken on the 21st of November 2020, prior to which the region had received a sharp increase in rain compared to the previous year. This resulted in increased vegetation growth, abundance and height and provided an opportunity for the grass to be considered as "long" for the purposes of the trial.

The purpose of these trials is to assess the efficiency of the zoologists implementing the carcass monitoring regime; Ahmad Barati, from February 2019 to July 2020 and Candice Larkin, from July 2020 to January 2021.

A total of twenty carcasses were used in each trial. This included five bats and fifteen birds in each (Table 2). Most carcasses had been collected during previous searches at SWF or other nearby winds farm, as well as road killed bird carcasses collected in preceding months and stored in a freezer at the wind farm office. Common Myna species were sourced from the control programs of Common Myna Action Group. All bats used in the trial were sourced from other wind farms in the region.

Observers from Nature Advisory, who were not involved with carcass searches, oversaw the efficiency trials and were responsible for placing the carcasses for the searcher and assessing the efficiency. Three to four carcasses were placed under six pre-selected turbines at the wind farm in each trial. The positions of the placed carcasses (distance and bearing from turbine) were randomly generated using the Microsoft Excel® random number function. All small carcasses (bats and mynas) and 25% of the medium–large bird carcasses were placed within the 100-metre outer zone. The remaining carcasses were distributed though the 60-metre inner zone.

The searchers searched all turbines within two 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.

The information collected in both trials has been used in the statistical data analysis outlined in Section 4.

Table 2. Species of carcass used in searcher efficiency trials at SWF

Turbine	Species	Size class
Winter (low vegetation)		
23	Common Myna	Small Bird
	Wedge-tailed Eagle	Large Bird
	Common Myna	Small Bird
	White-striped Freetail Bat	Bat
18	Wedge-tailed Eagle	Large Bird
	Common Myna	Small Bird
	White-striped Freetail Bat	Bat
	Sulphur-crested Cockatoo	Medium-Sized Bird
16	Wedge-tailed Eagle	Large Bird
	White-striped Freetail Bat	Bat
	Eastern Rosella	Medium-Sized Bird
	Pacific Baza	Medium-Sized Bird
14	Australian Wood Duck	Medium-Sized Bird
	White-striped Freetail Bat	Bat
	Tawny Frogmouth	Medium-Sized Bird
	Wedge-tailed Eagle	Large Bird
7	Common Myna	Small Bird
	Eastern Rosella	Small Bird
	Chocolate Wattled Bat	Bat
	Wedge-tailed Eagle	Large Bird
Summer (tall vegetation)		
58	Wedge-tailed Eagle	Large Bird
	Collared Sparrowhawk	Small Bird
	Common Myna	Small Bird
	White-striped Freetail Bat	Large Bird
59	Wedge-tailed Eagle	Large Bird
	Australian Magpie	Medium-Sized Bird
	Noisy Miner	Small Bird
	White-striped Freetail Bat	Bat
48	Wedge-tailed Eagle	Large Bird
	Crested Pigeon	Medium-Sized Bird
	Eastern Rosella	Small Bird
	Gould's Wattled Bat	Bat
43	Wedge-tailed Eagle	Large Bird
	Noisy Miner	Small Bird
	Noisy Miner	Small Bird
	White-striped Freetail Bat	Bat
69	Wedge-tailed Eagle	Large Bird
	Australian Magpie	Medium-Sized Bird
	Eastern Rosella	Small Bird
	White-striped Freetail Bat	Bat

3.1.3. Scavenger trials

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. This correction factor contributes to statistical analysis and mortality estimates summarised in Section 4.

Scavenger trials were conducted during winter when the grass was short and again in summer, when the grass is longer, as required at SWF under the BBAMP. The first trial was undertaken in winter, when vegetation was low, concurrently with formal monthly searches beginning from 8th August to 17th September 2019. The second trial, undertaken in spring and summer, ran from 21st and 28th of November 2020, and from 3rd of February 2021. Additional data was also collected opportunistically in autumn 2020 from 21st and 23rd of April. Carcasses were placed at the same turbines selected for formal surveys and placed as zoologists undertook monthly surveys (Table 3).

Monitoring was carried out using remote-sensor camera traps. The first ten camera traps were deployed at a close distance (around 1 meter) to one carcass each. Once a carcass was scavenged, the camera was collected and deployed at another carcass until all 20 carcasses were monitored for at least 31 days. The cameras were retrieved after 31 days of monitoring and the photographs recorded on the SD card reviewed to determine on what day, if at all, the carcass was scavenged.

The use of the camera was time effective as it allowed for continuous monitoring of the carcass and an indication of the type of scavenger. 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. If the carcass was still present on site at day 30, as a precautionary approach it was recorded as being scavenged at day 30. The carcass was then removed and the experiment terminated.

Table 3. Species of carcasses used in scavenger trials at SWF

Placement Date	Turbine	Species placed	Carcass type
Winter 2019			
8/08/2019	23	Common Myna	Small Bird
8/08/2019	23	Wedge-tailed Eagle	Large Bird
8/08/2019	14	Australian Wood Duck	Medium-Sized Bird
9/08/2019	41	Rainbow Lorikeet	Small Bird
9/08/2019	18	Nankeen Kestrel	Medium-Sized Bird
9/08/2019	23	Wedge-tailed Eagle	Large Bird
9/08/2019	41	Common Myna	Small Bird
9/08/2019	14	Eastern Rosella	Medium-Sized Bird
11/08/2019	23	White-striped Freetail Bat	Bat
13/08/2019	59	Wedge-tailed Eagle	Large Bird
13/08/2019	58	White-striped Freetail Bat	Bat
15/08/2019	23	Wedge-tailed Eagle	Large Bird
15/08/2019	23	Magpie-Lark	Small Bird
16/08/2019	41	White-striped Freetail Bat	Bat
16/08/2019	58	Crimson Rosella	Medium-Sized Bird
16/08/2019	41	Sulphur-crested Cockatoo	Medium-Sized Bird
16/08/2019	41	White-striped Freetail Bat	Large Bird
16/08/2019	41	White-striped Freetail Bat	Bat
16/08/2019	16	Common Myna	Small Bird
17/08/2019	58	White-striped Freetail Bat	Bat
Autumn 2020			
21/04/2020	7	White-striped Freetail Bat	Bat
21/04/2020	7	Easter Rosella	Medium-Sized Bird

Placement Date	Turbine	Species placed	Carcass type
21/04/2020	16	White-striped Freetail Bat	Bat
23/04/2020	23	Australian Magpie	Medium-Sized Bird
23/04/2020	23	Australian Magpie	Medium-Sized Bird
23/04/2020	14	Australian Wood Duck	Medium-Sized Bird
23/04/2020	14	Wedge-tailed Eagle	Large Bird
23/04/2020	14	Nankeen Kestrel	Medium-Sized Bird
23/04/2020	5	Wedge-tailed Eagle	Large Bird
23/04/2020	5	White-striped Freetail Bat	Bat
Spring/summer 2020/21			
21/11/2020	58	White-striped Free-tailed Bat	bat
21/11/2020	58	Noisy Miner	small bird
21/11/2020	58	Collared Sparrowhawk	medium bird
21/11/2020	58	Wedge-tailed Eagle	large bird
21/11/2020	58	Eastern Rosella	small bird
21/11/2020	59	Noisy Miner	small bird
21/11/2020	59	White-striped Free-tailed Bat	bat
21/11/2020	59	Australian Magpie	medium bird
21/11/2020	48	Crested Pigeon	medium bird
21/11/2020	48	White-striped Free-tailed Bat	bat
21/11/2020	48	Little Red Flying Fox	bat
28/11/2020	34	Australian King-parrot	medium bird
28/11/2020	34	Australian Galah	medium bird
28/11/2020	63	White-striped Free-tailed Bat	bat
28/11/2020	63	Eastern Rosella	small bird
3/02/2021	9	Chocolate Wattled Bat	bat
3/02/2021	55	Galah	medium bird
3/02/2021	55	White-striped Free-tailed Bat	bat
3/02/2021	9	Eastern Rosella	small bird
3/02/2021	10	Australian Magpie	medium bird
3/02/2021	60	Dusky Woodswallow	small bird
3/02/2021	60	Red-rumped Parrot	small bird

3.2. Results

3.2.1. Carcass search results

A total of 49 bird and bat carcasses/remains were found under turbines during 31 months of the monitoring period at SWF. Of all birds and bats, during formal searches, 14 bird carcasses, 10 bat and 13 feather spots were found. A total of 9 birds, two feather spots and one bat were found incidentally. As is standard practice, it has been assumed that feather-spots discovered beneath turbines are the result of an initial turbine collision, with scavenging predators such as Red Fox or Ravens later consuming the carcass and leaving feather remains. Total number of carcasses per species is shown in Figure 4 and percentages of each species among all bird and bat finds is summarised in Figure 5.

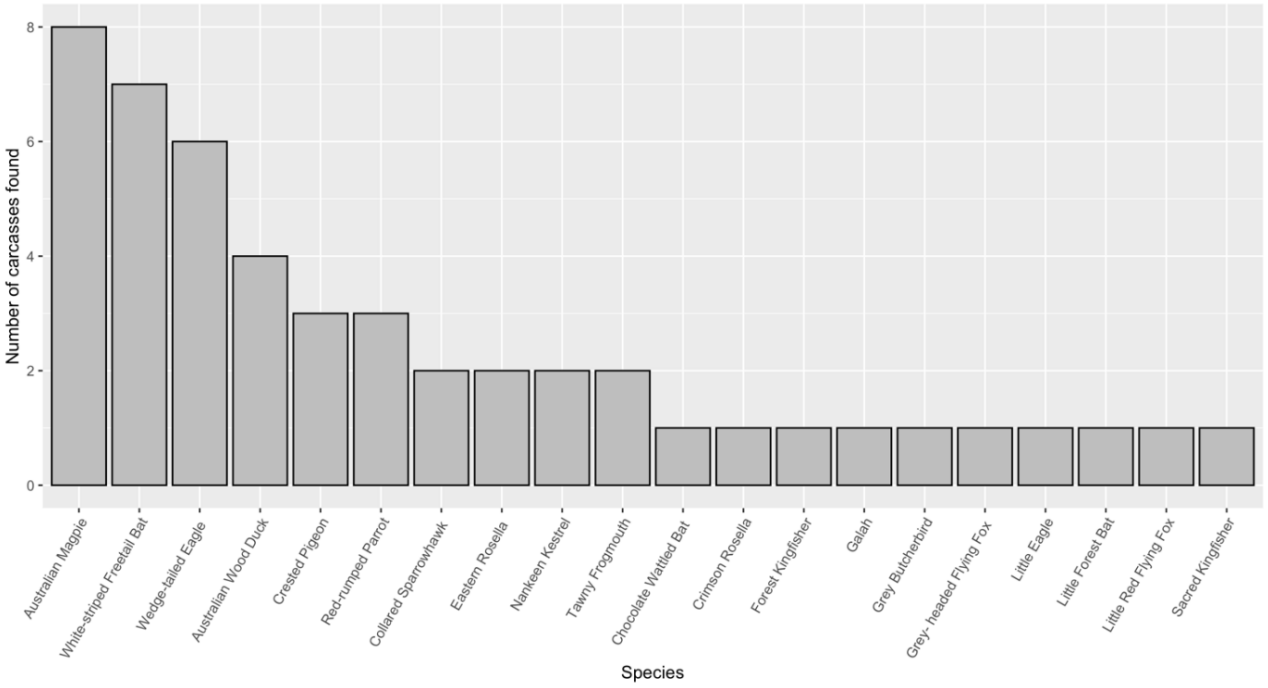

Figure 4: Number of bird and bat carcasses found during the monitoring period at SWF

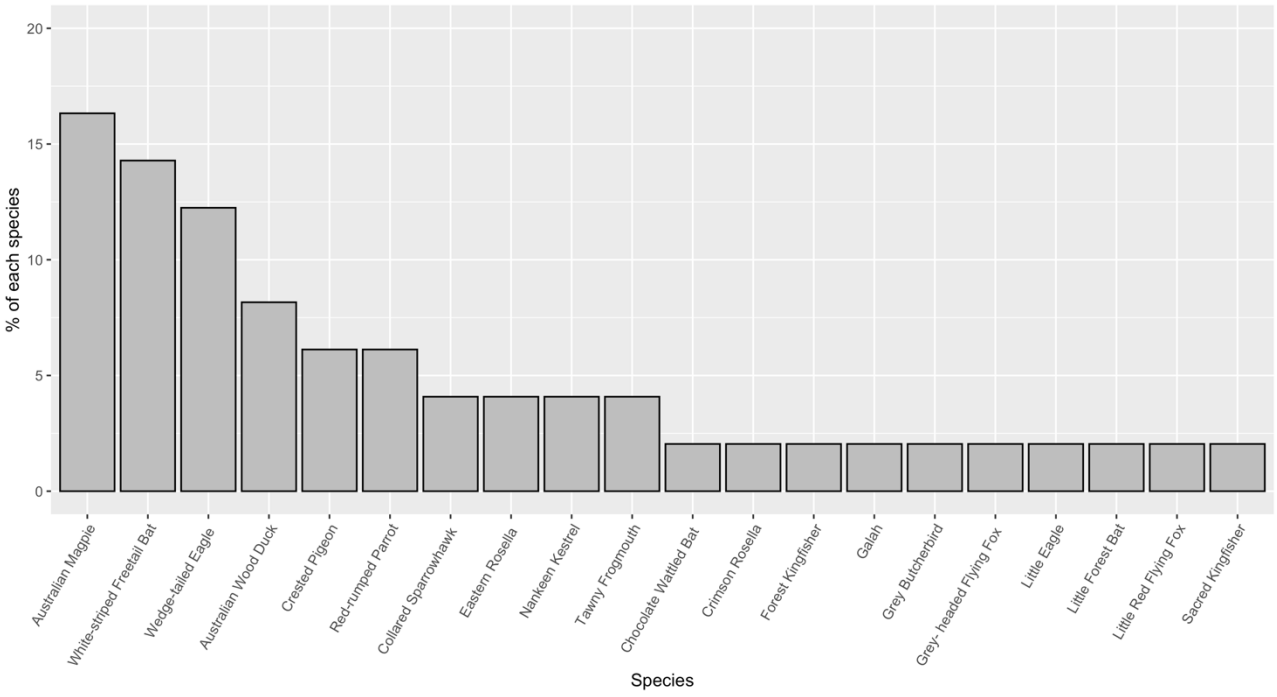

Figure 5: Percentages of each bird and bat species recorded at SWF during the monitoring period.

The results of the formal bird and bat carcass searches at SWF are summarised in Table 4. The table shows the number of carcasses and feather spots found during formal searches, and incidentally.

Table 4: Summary of carcass search results for bird and bats from July 2018 to January 2021 at SWF

Search type	Season	Month	Bird	Bat	Feather spot	Total mortalities
Formal searches	Partial-operational phase search results					
	Winter	Jul-18				0
		Aug-18			1	1
	Spring	Sep-18				0
		Oct-18				0
		Nov-18				0
	Summer	Dec-18		1		1
		Jan-19				0
	Official full wind farm operations period					
	Summer	Feb-19				0
	Autumn	Mar-19				0
		Apr-19				0
		May-19				0
	Winter	Jun-19	1			1
		Jul-19	1			1
		Aug-19				0
	Spring	Sep-19	2			2
		Oct-19		1		1
		Nov-19			1	1
	Summer	Dec-19				0
		Jan-20				0
		Feb-20	1			1
	Autumn	Mar-20		1		1
		Apr-20				0
		May-20		1		1
	Winter	Jun-20	1		2	3
		Jul-20	3		2	5
		Aug-20	2		1	3
	Spring	Sep-20		1	3	4
		Oct-20	2	1	1	4
		Nov-20		2	2	4
	Summer	Dec-20	1			1
		Jan-21		2		2
Formal searches total						37
Incidental search results						
Incidental Records	Partial-operational phase search results					
		Jul-18	1			
	Winter	Aug-18	2			2
	Spring	Sep-18			2	2
	Summer	Dec-18	1			1
		Jan-19	1			1
	Official full wind farm operations period					
	Summer	Feb-19	2			2
		Jan-20	1			1
	Autumn	Apr-20	1	1		2
Incidental finds total						12
Total finds for SWF BBAMP Project						49

Bird mortality during monitoring period

A total of 23 bird carcasses and 15 feather spots were recorded at SWF from July 2018 to January 2021. These finds belonged to fifteen different bird species (Figure 5). Of all carcasses found, 27 carcasses/feather remains were found during formal monthly searches. The remaining 11 finds carcasses were recorded after being found incidentally by carcass monitoring team or wind farm personnel. On average, 1.3 ± 0.34 bird remains were recorded per month during monitoring period.

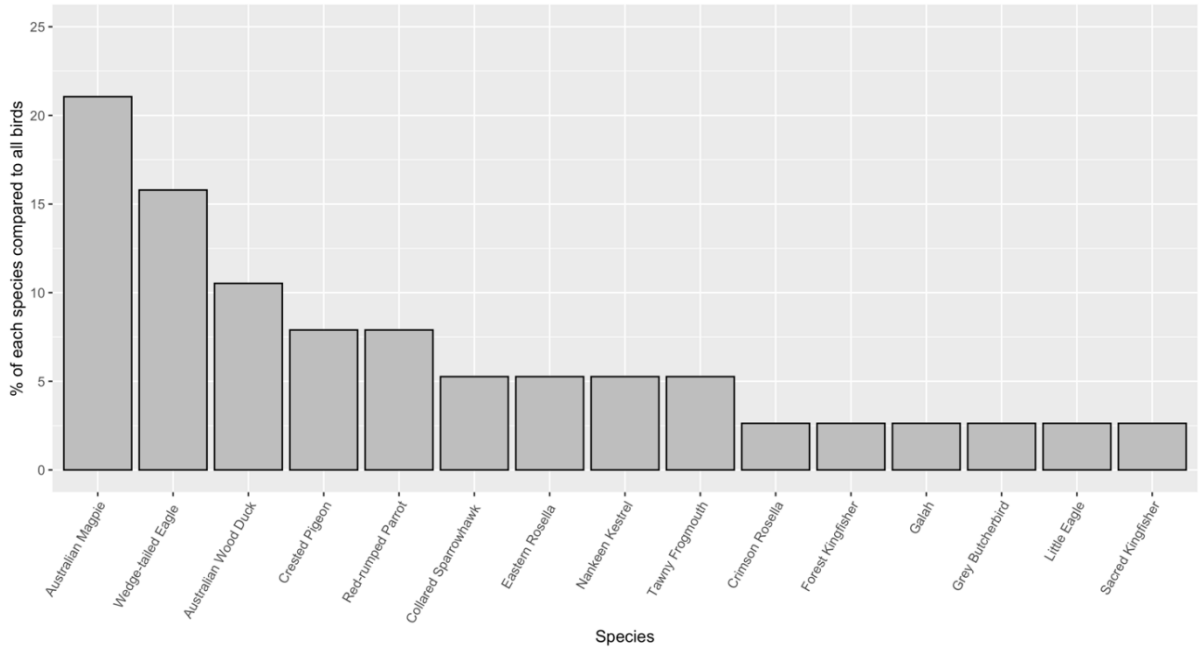

Figure 6: Percentage of carcasses recorded per each species of birds in relation to all bird species at SWF

Among all bird species recorded, the Australian Magpie (*Gymnorhina tibicen*) was the most common species. A total of eight Australian Magpie carcasses/feather remains were found at SWF during the monitoring period which accounts for 22% of all bird mortality and 18% of all bird and bat mortality during the monitoring period. The Australian Magpie is a very common species at the wind farm sites according to BUS surveys conducted inside the wind farm during operation phase of the wind farm. Thus, it is not surprising that this species in the most common bird species that is impacted by wind turbines. This species in usually among species with high mortality rate in most of other wind farms as well.

The second most common species among birds was Wedge-tailed Eagle (*Aquila audax*), which represented around 15% of bird species and 13% of total carcasses found at SWF during the monitoring period. During 31 months of monitoring period, a total of six Wedge-tailed Eagle mortalities were recorded at SWF, of which two were found during formal carcass search and four as incidental records. This species is an "at risk species" according to the BBAMP (Section 4).

Six species were recorded only once during carcass monitoring period; Crimson Rosella (*Platycercus elegans*), Forest Kingfisher (*Todiramphus macleayii*), Galah (*Eolophus roseicapilla*), Grey Butcherbird (*Cracticus torquatus*), Little Eagle (*Hieraeetus morphnoides*) and Sacred Kingfisher (*Todiramphus sanctus*).

During the monitoring period, no circumstances were witnessed during the survey period at SWF that would be identified as an impact trigger, according to the BAMP. Although there was a record of Little Eagle at the early stages of monitoring period, it was not directly related to turbine strike as described in the first annual report.

Detected bird mortality and the frequency of species occurrences is summarised in Table 5. Detailed information on each bird carcass, feather-spot and incidental record during the monitoring program to date can be found in Appendix 1: Bird and bat mortality data obtained during the pre-operational period and two years of monitoring at SWF (July 2018-January 2021).

Table 5: Summary of bird carcass records at SWF from July 2018 to January 2021

Common Name	Scientific Name	Formal	Incidental	Total	Feather Spots
Australian Magpie	*Gymnohina tibicen*	7	1	**8**	4
Australian Wood Duck	*Chenonetta jubata*	3	1	**4**	2
Crested Pigeon	*Ocyphaps lophotes*		3	**3**	1
Collared Sparrowhawk	*Accipiter cirrocephalus*	2		**2**	
Crimson Rosella	*Platycercus elegans*	1		**1**	1
Eastern Rosella	*Platycercus eximius*	1	1	**2**	1
Forest Kingfisher	*Todiramphus macleayii*	1		**1**	
Galah	*Eolophus roseicapilla*	1		**1**	1
Grey Butcherbird	*Cracticus torquatus*	1		**1**	
Nankeen Kestrel	*Falco cenchroides*	2		**2**	1
Red-rumped Parrot	*Psephotus haematonotus*	3		**3**	2
Sacred Kingfisher	*Todiramphus sanctus*	1		**1**	1
Tawny Frogmouth	*Podargus strigoides*	2		**2**	1
Wedge-tailed Eagle	*Aquila audax*	2	4	**6**	
Little Eagle	*Hieraaetus morphnoides*		1	**1**	
Total		**27**	**11**	**38**	**15**

Bat mortality during monitoring period

A total of 11 bat carcasses of five species were recorded at SWF during the monitoring period. Of all bat carcass recorded, the White-striped Freetail Bat (*Tadarida australis*) disproportionally represented over 60% of all carcass finds. The remaining four species had only one carcass per species in the total finds. Bat carcasses made up around 20% of all carcasses found during the pre-operation and first two years of full operation. Figure 6 outlines the percentage of total collisions and species of carcasses found at SWF during the monitoring period. Appendix 1 presents detailed bat mortality data.

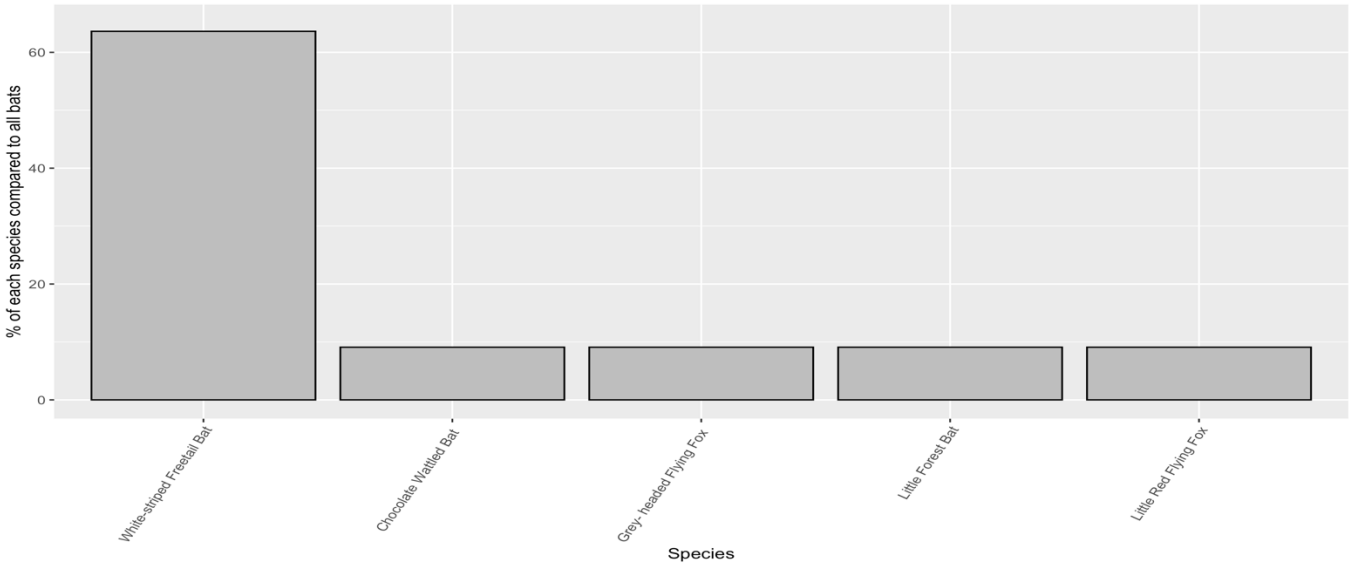

Figure 7: Percentages of each bat species compared to total bat carcasses found at SWF

Among all bat species recorded, the Grey-headed Flying Fox is listed as "Vulnerable' under both the NSW's *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act). The carcass was found on the 1st December 2018 tangled on a fence line at a distance of over 100 meters from the turbine (Figure 8). Given the distance of this carcass and its condition when detected, it was determined it was extremely unlikely that mortality was caused by wind turbine, thus, it did not trigger a response under the BBAMP for a threatened species. Collision and entanglement with barbed wire, along with power lines and netting, are known to cause flying-fox mortalities and this is unfortunately not uncommon (OEH 2020). Similarly, a Little Red Flying fox was found alive on barbed wire at SWF on the 27th of December 2020, and was removed by Candice Larkin and taken to a wildlife carer. The risk the wind farm poses to this species remains low and is considered to have a negligible impact on the overall population.

The other species found at SWF were the Chocolate Wattled Bat, Little Red Flying Fox and Little Forest Bat. These species are common bat species in the region and have been documented at other wind farms near SWF.

Figure 8:Grey- headed Flying Fox mortality due to fence lines at SWF (left) and similar condition at other wind farms (right). Photos: A. Barati

Distance of carcasses from turbines

Carcasses were distributed from the base of turbines up to 100 meters with an average distance of 49.3 ± 7.1 (mean ± SE) from the turbines (Figure 9). A high proportion of carcasses (ca. 66%) were found at a distance of 0-60 meters from the turbines. Overall, there was a significant negative correlation between number of carcasses and the distance from the turbines ($t = -2.5$, $df = 18$, $p=0.01$, $R^2= -0.51$). The distribution pattern of carcasses varied between bird and bat carcases in term of their average distance from the turbines. On average, birds were found to be slightly closer to the turbine compared with bats (Figure 10). However, the difference was not statistically significant based on Analysis of Variance (ANOVA test, $F=0.004$, $df=1$, $p>0.05$).

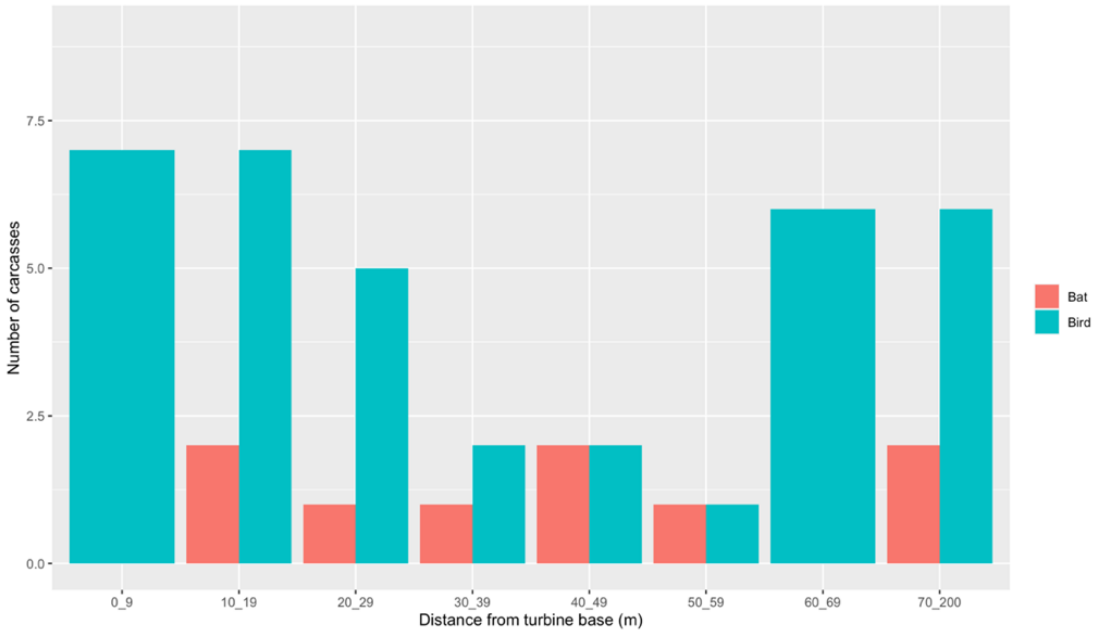

Figure 9: Distribution of carcasses found at distance categories from the turbine

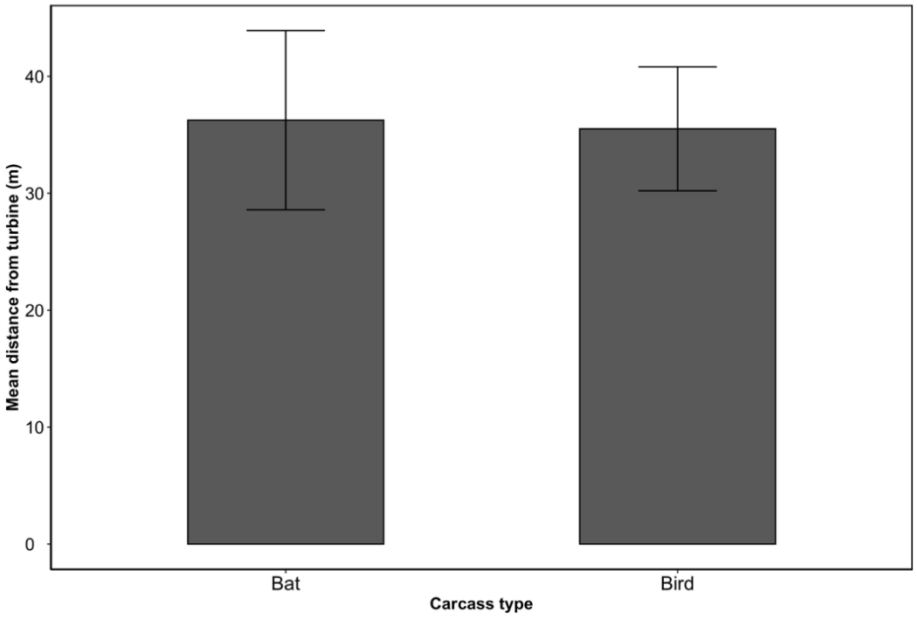

Figure 10: Mean distance of bird and bat carcasses from turbines at SWF during the period of carcass monitoring.

Monthly and seasonal variation of carcasses finds

The number of carcasses found across different months and seasons varied between from no detections per month, to five. The highest number of carcasses was recorded in July 2020 with a total of five birds and one bat recorded (Figure 11). Carcasses were distributed randomly in different seasons. No seasonal variation was apparent in the

mortality rate at the wind farm for birds (F=1.98, df=3,16, p>0.05) and bats (F=0.77, df=2,6, p>0.05). However, lack of significant seasonal variations in the bat mortality might be due to low numbers of bats recorded at this wind farm sites which is insufficient to demonstrate the seasonal changes (Figure 12).

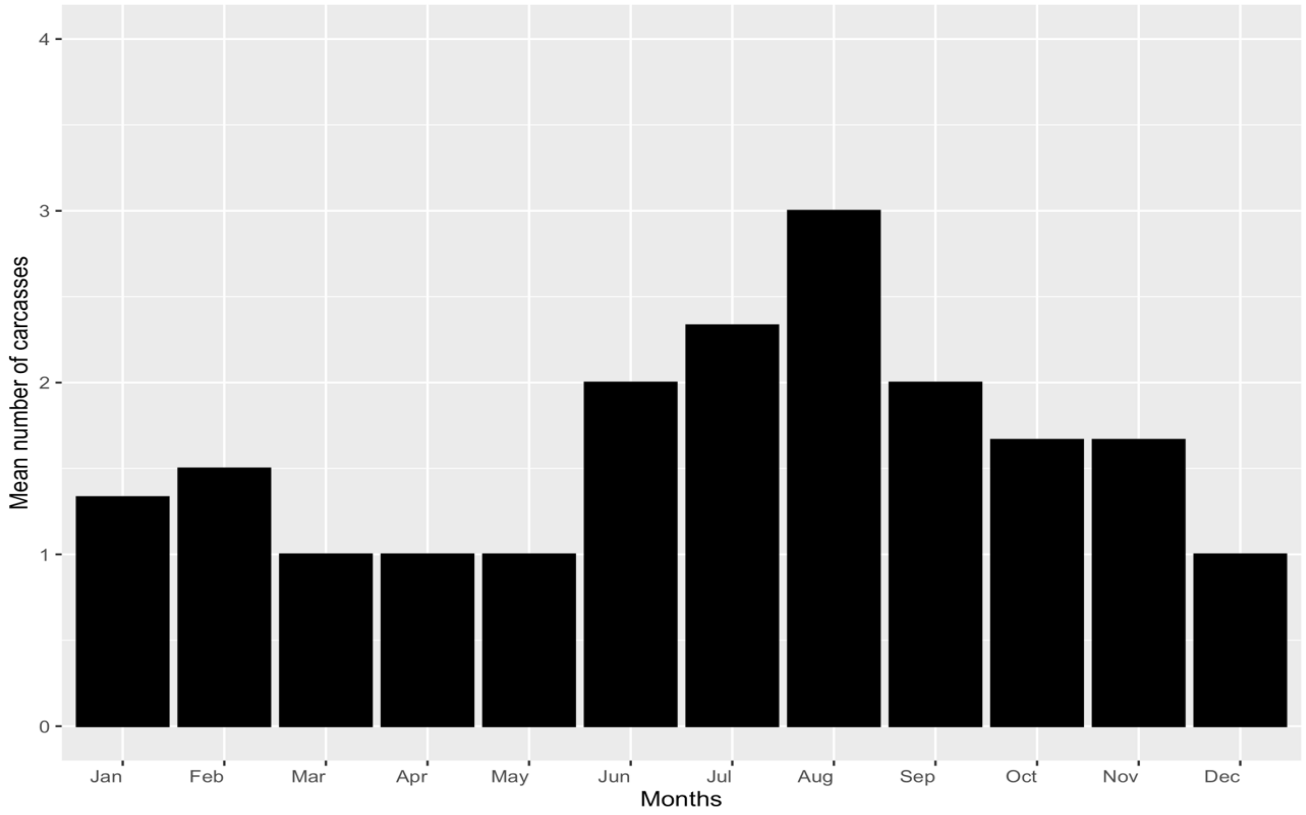

Figure 11: Mean number of carcasses recorded per each month at SWF during the period of carcass monitoring

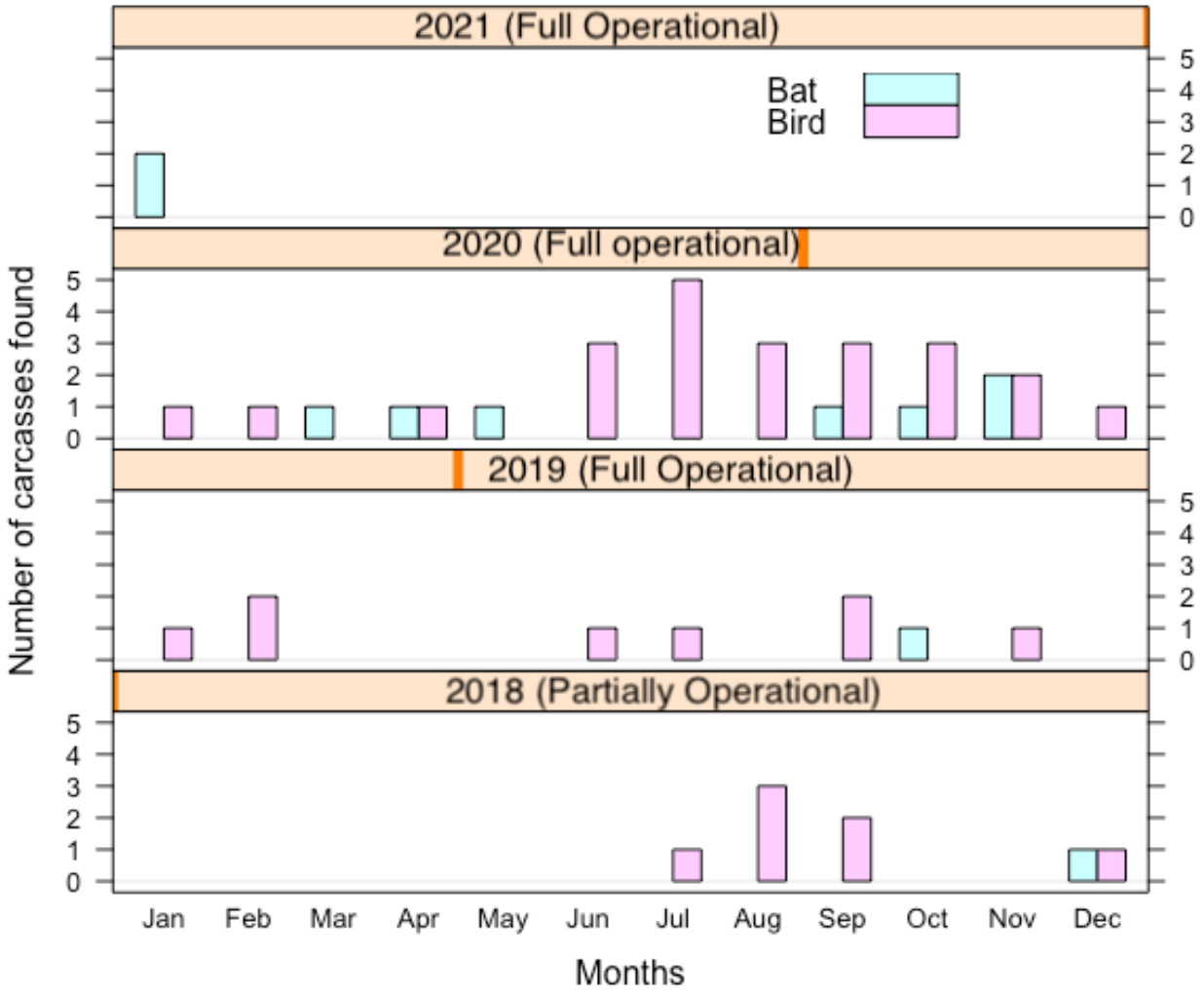

Figure 12: Number of birds and bat carcasses found during monitoring period from July 2018 to January 2021

3.2.2. Searcher efficiency results

Table 6 below outlines the results of both trials, by both zoologists undertaking the searches at SWF.

Efficiency during the winter trial was 100% with no carcasses missed by the searcher. During the summer trial one carcass from 18 was missed, resulting in efficacy of approximately 94.5% overall. Although 20 carcasses were laid out, two were apparently scavenged before the zoologist was able to find them during the trial search (i.e., they did not locate them during the trial and the observer could not locate it immediately after the trial was completed, meaning it had been scavenged prior to the zoologist commencing the search). These have been excluded from statistical analysis (Section 4). Only one small bird was missed during the efficiency trial in summer.

Table 6. Searcher efficiency trial results

Turbine	Species	Size class	Detected
Winter (low vegetation) - Searcher: Ahmad Barati			
23	Common Mynah	Small Bird	✓
	Wedge-tailed Eagle	Large Bird	✓
	Common Mynah	Small Bird	✓
	White-striped Freetail Bat	Bat	✓
18	Wedge-tailed Eagle	Large Bird	✓
	Common Mynah	Small Bird	✓
	White-striped Freetail Bat	Bat	✓
	Sulphur-crested Cockatoo	Medium-Sized Bird	✓
16	Wedge-tailed Eagle	Large Bird	✓
	White-striped Freetail Bat	Bat	✓
	Eastern Rosella	Medium-Sized Bird	✓
	Pacific Baza	Medium-Sized Bird	✓
14	Australian Wood Duck	Medium-Sized Bird	✓
	White-striped Freetail Bat	Bat	✓
	Tawny Frogmouth	Medium-Sized Bird	✓
	Wedge-tailed Eagle	Large Bird	✓
7	Common Myna	Small Bird	✓
	Eastern Rosella	Small Bird	✓
	Chocolate Wattled Bat	Bat	✓
	Wedge-tailed Eagle	Large Bird	✓
Summer (tall vegetation) - Searcher: Candice Larkin			
58	Wedge-tailed Eagle	Large Bird	✓
	Collared Sparrowhawk	Medium Bird	✓
	Common Myna*	Small Bird	× *
	White-striped Freetail Bat*	Bat	×*
59	Wedge-tailed Eagle	Large Bird	✓
	Australian Magpie	Medium Bird	✓
	Noisy Miner	Small Bird	×
	White-striped Freetail Bat	Bat	✓
48	Wedge-tailed Eagle	Large Bird	✓
	Crested Pigeon	Medium Bird	✓
	Eastern Rosella	Medium Bird	✓
	Gould's Wattled Bat	Bat	✓
43	Wedge-tailed Eagle	Large Bird	✓
	Noisy Miner	Small Bird	✓
	Noisy Miner	Small Bird	✓
	White-striped Freetail Bat	Bat	✓
69	Wedge-tailed Eagle	Large Bird	✓
	Australian Magpie	Medium Bird	✓
	Eastern Rosella	Small Bird	✓
	White-striped Freetail Bat	Bat	✓

Notes: ✓ = Found; X = missed.

***** Two carcasses scavenged prior to the trial turbine search commencing

3.2.3. Scavenger trial results

The results of the scavenger trial are presented in Table 7 and the detailed data are presented in Appendix 2.

During the periods where the grass was short (generally winter); bats were taken on average after 3.3 days, small birds 2.3, medium birds, 5.9 and large birds 30. During the

long grass periods (generally spring/summer) bats were taken on average after 13.2 days, small birds 8.5, medium birds, 6.7 and large birds were again 30, though there were only two large carcasses available during this period.

Bat and small birds lower average days in the field during short grass periods is likely related to their small size making them available to a wider range of scavengers such as; Ravens and Magpies. In contrast; the higher days on average during long grass for these classes may be related to the fact such scavengers as the aforementioned rely entirely on visual foraging habits. Longer grass would make scavenging more challenging during these times.

Medium carcasses remained more or less the same on average in the field between the periods and this may be related to this class being targeted by larger scavengers such as the Red Fox which relies primarily on scent to find food rather than visuals. Short or long grass would make little difference to such foraging habits.

The large carcasses consisted mainly of Wedge-tailed Eagle and were not scavenged, with none being taking before the trial was terminated after 30 days. This appears to be a common occurrence, as trials conducted by Nature Advisory at other wind farms in NSW using only Wedge-tailed Eagle carcasses showing that are typically not scavenged and remain in the field until they completely decompose (Nature Advisory unpublished data).

Figure 13 shows an example of motion camera results obtained during the scavenger trials.

Table 7. Results of the scavenger trials at SWF

Time period	Carcass type	Number of carcasses	Average days in the field
Short grass	Bat	8	3.3
	Small Bird	5	2.3
	Medium birds	10	5.9
	Large birds	7	30.0
	Total	30	10.0
Long grass	Bat	6	13.2
	Small Bird	5	8.5
	Medium birds	9	6.7
	Large birds	2	30.0
	Total	22	11.1
Overall totals	Bat	14	7.1
	Small Bird	10	5.6
	Medium birds	19	6.2
	Large birds	9	30.0
	Overall total	52	10.5

Figure 13. Examples of scavengers at SWF detected by camera traps, Common Brushtail Possum right and Red Fox left.

4. Statistical analysis

All data collected during the carcass search program has been provided to Symbolix Pty Ltd, a specialist data analyst organisation, in order to determine bird and bat mortality rates. All monthly searches, including during the commissioning phase, have been utilised to estimate mortality. Only formal finds have been included, that is finds by the searcher during formal monthly random carcass searches.

Detailed methods of analysis and mortality estimates are provided by Symbolix Pty Ltd in Appendix 3.

4.1. Results

Detailed results are summarised below. The estimations are given as overall (the entire monitoring period) and as 12-month periods beginning from the first monitoring month after the preconstruction survey.

4.1.1. Searcher Efficiency

No significant difference was detected between the two searcher efficiency trials undertaken (Section 3.2.2). Similarly, not difference is searcher efficiency was detected between birds and bats. As such efficiency was aggregated for mortality estimates.

Overall; efficiency was 92% mean detectability proportion with a 95% confidence interval of 80% to 98%.

4.1.2. Scavenger trials

There was no significant difference detected between scavenging rates for the different periods. Additionally, there was no significant difference detected between birds and bat scavenging rates. Thus, the results were aggregated.

The trials included seven Wedge-tailed Eagle carcasses, none of which were scavenged within the 30 days of the trails. As such, Wedge-tailed Eagle data has been excluded from the general bird and bat aggregate data and analysed separately due to their unique scavenging profile.

Under the assumptions outlined in Appendix 3, the mean time to total loss for bats, small birds, and medium birds is 12.3 days (95% confidence interval of 5.4, 27.9 days).

For large birds (Wedge-tailed Eagle), the mean time to total loss is 513 days (95% confidence window of 269, 977 days).

4.1.3. Bats

Based on the number of detected carcasses and the detectability and scavenging rate, it is estimated there was a total site loss (all turbines combined) of around 166 bats over the entire search period, the upper 95% confidence limit on this estimate is fewer than 252 individuals. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 64 bats with 95% confidence that fewer than 98 individuals were lost.

During the first year of searches a total of one bat was found during formal surveys. The resulting estimate of total mortality is estimated at (mean) 33 bats over the survey period with 95% confidence that fewer than 81 individuals were lost.

By comparison, in the second year of searches, a total of three bats were found during formal surveys. The resulting estimate of total mortality is 53 bats with 95% confidence that fewer than 103 individuals were lost.

There was not a significant difference in the mortality numbers for bats between the two years.

4.1.4. Birds

Based on the detected carcasses and feather spots and detectability and scavenging rate, a total site loss over 31 months of survey corresponded to an estimated loss of 457 birds with 95% confidence that fewer than 658 individuals were lost. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 177 birds with 95% confidence that fewer than 255 individuals were lost.

Individual estimates were undertaken for Wedge-tailed Eagle and the estimate of total mortality over the 31 months was 13 individuals with 95% confidence that fewer than 27 individuals were lost. On an annual basis of 12 months this corresponds to a total site loss estimated loss of 5 WTEs with 95% confidence that fewer than 10 WTEs were lost.

During the first year of searches, a total of three birds were found during formal surveys. The resulting estimate of total mortality was 80 birds over the survey period, with 95% confidence that fewer than 161 individuals were lost.

By comparison, in the second year of searches, a total of ten birds were found during formal searches. The resulting estimate of total mortality was 162 birds over the search period, with 95% confidence that fewer than 264 individuals were lost.

It was detected that mortality numbers were significantly higher for the second year than in the first, excluding Wedge-tailed Eagles.

For Wedge-tailed Eagle exclusively; the first-year mortality rate was zero individuals found and the resulting estimates are five over the survey period (95% confidence of less than 14). During the second year; two Wedge-tailed Eagles were detected resulting in an estimate of 12 mortalities over the second year of monitoring (95% confidence less than 14). Year one was significantly lower than the second.

4.2. Limitations

In evaluating the potential impact of the wind farm, 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, an upper limit was not applied on the number of bats and birds that could be onsite, and it has been assumed that bats and birds were present all year round. The ecological feasibility of this assumption must be accounted for when using these results to evaluate overall ecological impact.

Individual species' ecology, including movement patterns, flight habits, habitat usage, social habits and territories must be considered when using these estimations to evaluate impacts. This is explored further in Section 5. .

5. Monitoring 'at-risk' species

As part of the BBAMP, monitoring of 'at-risk' species groups coinciding with monthly carcass searches is required at SWF. These surveys determine if the operating turbines will have an effect on the behaviour of any of these species.

Monitoring of "at risk" groups provide useful information within an adaptive management framework for addressing the bird and bat impacts of the wind farm.

5.1. Species of concern

The key "at risk" groups were identified through the risk assessment (BBAMP 2017). These included:

- Wedge-tailed Eagle,
- Other raptors,
- White-throated Needletail,
- Regent Honeyeater, and
- Swift Parrot.

5.1.1. Wedge-tailed Eagle and other raptors

A total of three species over a total of 15 observations were recorded during the monitoring period. These consisted of; Wedge-tailed Eagle (9), Whistling Kite (2) and Nankeen Kestrel (4). This would indicate the overall level of habitat use by raptors at SWF is low.

Overall, due to the low topography at SWF, the area can be predominately identified as low-quality habitat for Wedge-tailed Eagle. The observation rate within the wind farm was low.

The Nankeen Kestrel was observed on three occasions at SWF. This species prefers open habitats within woodland or grasslands and occurs commonly in farmland landscapes.

Whistling Kite was observed on several occasions at SWF, but more frequently outside the wind farm scavenging on remains of livestock or wildlife. Despite this, no mortality of Whistling Kite was recorded at SWF.

The low numbers of raptors observed corresponds with the mortality results with only one of the species observed, Wedge-tailed Eagle, being identified as a mortality. Flight behaviours observed of this species frequently being recorded at 150-200 metres above the ground indicates risk behaviour that would bring them into the rotor swept area of turbines, causing collisions.

Table 8. Raptor observations at SWF

Date	Time	Species	Number of Individuals	Behaviour	Nearest Turbine
30/07/2018	13:00	Wedge-tailed Eagle	1	flying, soaring, south of turbine 32, 500 m	32
17/09/2018	11:30	Wedge-tailed Eagle	2	flying southwards near 18	18
30/11/2018	12:10	Wedge-tailed Eagle	2	perched, flying 500m north turbine 18	18
5/02/2019	9:30	Whistling Kite	1	perched, flying 700m from 41 between 41 and 43	41
22/05/2019	9:00	Nankeen Kestrel	1	flying east side of 14 about 500 m	14
22/05/2019	13:00	Nankeen Kestrel	1	perched on trees near 14	14
31/05/2019	14:10	Nankeen Kestrel	1	perched then flying near 16	16
8/08/2019	15:40	Wedge-tailed Eagle	1	flying turbine 4 to 16.	4
9/09/2019	9:30	Wedge-tailed Eagle	2	flying around turbine 58 to west	58
11/12/2019	10:00	Whistling Kite	1	flying around turbine 7 towards 5	7
5/11/2019	9:30	Wedge-tailed Eagle	1	flying between 41 and 43	41
15/01/2020	10:20	Wedge-tailed Eagle	1	flying at 500m from turbine 5	5
20/03/2020	13:00	Wedge-tailed Eagle	1	flying at ~200 m of height visible form turbine 14	14
23/03/2020	9:30	Wedge-tailed Eagle	1	flying between turbine 5 and 16 at ~150 m height	16
17/04/2020	10:20	Nankeen Kestrel	1	flying at around ~ 200 m height probably outside wind farm boundaries	68

5.1.2. White-throated Needletail, Regent Honeyeater and Swift Parrot

There were no observations of White-throated Needletail, Regent Honeyeater or Swift Parrot during either the pre-commissioning or operational phase at SWF.

There are a very limited number of ironbark trees, which can provide habitats for the Regent Honeyeater and Swift Parrot when flowering. Year 2019 was extremely dry throughout the northern tablelands and no flowering ironbark trees were observed. Therefore, suitable habitats for the Regent Honeyeater and Swift Parrot at SWF are extremely limited. In addition, no individuals of either species were recorded during BUS at SWF (Section 6).

The nearest known existing habitat for the Regent Honeyeater was at Travelling Stock Reserves (TSR) near Bundarra, about 50 kilometres southwest of SWF. During an informal survey, a pair of Regent Honeyeater were sighted in this area on 10th of October 2019 (A. Barati, personal observations). Birds remained in the area for about two weeks, but based on other reports, failed to breed in this habitat.

5.2. Mitigation measures to reduce risk

Section 5.1 of the BBAMP outlines mitigation measures to be implemented to reduce risk to 'at-risk' species identified in Section 3.5 of the BBAMP. This included a carrion removal program aimed at reducing predator occurrence on site, namely Wedge-tailed Eagles. This is outlined below:

- A designated suitable person will be appointed (such as a wind farm employee or landowner) to perform the function of Carrion Removal Coordinator who will undertake the activities described below.
    - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g., kangaroos, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars to look for large carcasses within 200 metres of each turbine.
    - Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be addressed by operator and landowner protocols.
    - Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines.
    - Consult with landowner or site or asset manager in relation to the appropriate disposal of collected carrion, to be located at least 200 metres away from the closest turbine.
    - Wind energy facility maintenance staff and landowners will be required to notify the Carrion Removal Coordinator immediately following identification of carrion on site in between monthly searches.
    - Carcass occurrence and removal will be recorded in a "management log book" maintained by SWF asset manager.

The Nature Advisory zoologist on site (Ahmad Barati pers. comms.) indicated that no carrion was observed under the turbines during the first year and that this was likely related to severe drought experienced in the region prior to 2020. Stock was observed primarily around water sources and animals were fed artificially through grain etc., away from turbines. During late 2019 and early 2020 the region received higher rainfall which resulted in higher grass.

Pest animal baiting is done in August by land holders annually.

6. Bird Utilisation Surveys

This section outlines bird utilisation surveys (BUS) undertaken at SWF to date. Two BUS surveys were undertaken during the monitoring program; one in Summer 2019/20 and another in Spring 2021.

The Summer 2019/20 BUS is detailed in the First Annual Report for Sapphire Wind Farm (Nature Advisory 2020) and summarised below. Refer to that report for detailed methodology and results.

The following section details methodology and results of the Spring 2021 BUS and compares results between the two surveys. The preconstruction surveys (ELA 2011) were undertaken by a different consultancy under a different methodology and unfortunately could not be used for before and after construction comparison.

6.1. Pre construction BUS survey (2009)

The data were collected from five survey periods between 27th October 2008 and the 15th May 2009. The results are outlined in the ecological assessment report by ELA (2011).

Bird surveys were undertaken by ELA (2011) and included the following.

- A total of 48 diurnal bird surveys were undertaken throughout the wind farm site, using the two hectare – 20 minute approach adopted from the Birdlife Australia methodology
- Incidental observations were also made while traversing around the site
- Call playback for nocturnal birds over 11 nights; and
- Spotlighting for 16 person hours.

6.1.1. Results

A total of 83 bird species were recorded during surveys, two of which were introduced. These species are listed in Appendix E of ELA (2011). The study area supports potential foraging habitats throughout all seasons and breeding as well as roosting habitat for a wide variety of bird species. Hollow bearing trees, suitable for breeding and roosting by birds and bats also occurred in a variety of areas. Habitat for wetland bird species was limited primarily to farm dams. Key findings include:

- No owl species were recorded;
- Raptor species recorded included:
    - *Falco cenchroides* (Nankeen Kestrel);
    - *Aquila audax* (Wedge-tailed Eagle);
    - *Elanus axillaris* (Black-shouldered Kite);
    - *Accipiter fasciatus* (Brown Goshawk); and
    - *Haliastur sphenurus* (Whistling Kite);
- Seven threatened species were recorded in the study area:
    - *Climacteris picumnus victoriae* (Brown Treecreeper);

- *Stagonopleura guttata* (Diamond Firetail);
- *Melanodryas cucullata cucullata* (Hooded Robin);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Petroica boodang* (Scarlet Robin);
- Pyrrholaemus saggitatus (Speckled Warbler); and
- Neophema pulchella (Turquoise Parrot).

- Twelve listed migratory species were identified as potentially occurring from an EPBC Act protected matters search within the study area. Of these, potential habitat occurred for seven species. None were recorded during surveys.

The bird utilisation surveys were considered a suitable level of effort to provide the basis of a program to monitor the impacts of the wind farm on birds.

6.2. Summer 2019/2020 BUS summary

The findings of the Summer 2019/2020 BUS are below:

- The areas inside and surrounding Sapphire Wind Farm are largely made of cleared plateaus supporting a low diversity and abundance of common, predominantly farmland birds. Notably, the area supports a low diversity of raptors due to the lack of suitable habitats.
- The bird utilisation surveys recorded a total of 50 species of birds; 42 at the impact and 41 at the reference points.
- The species with the highest frequency of observation was Noisy Miner followed by Australian Magpie and Eastern Rosella. The five main species observed during BUS, comprised 41% of all individual birds recorded at the impact survey points and about 35% at the reference survey points.
- The relative abundance of birds varied between the six observation points, depending on the habitat surrounding each of the points. Points within or close to patches of remnant woodlands returned higher relative abundance than those within open treeless habitats. Survey sites with more mature native trees, that are located close to or within a remnant woodland attracted more birds than highly cleared grazing paddocks. Despite these variations, the diversity of species at impact and reference points did not significantly differ based on statistical tests, suggesting a more uniform habitat across most parts of the wind farm and surrounding areas.
- The majority of birds were recorded flying below RSA heights (99.65% at impact & 100% at reference points).
- Overall, a low proportion of birds (0.25%) were observed at RSA height. The Wedge-tailed Eagle was the only species recorded at RSA height.
- Waterbirds were found to be largely confined to farm dams and were mainly very common waterbird species including Australian Wood Duck and Straw-necked Ibis.
- The Speckled Warbler was the only threatened species (BC Act) recorded utilising the wind farm site. This species was recorded at reference point 2, away from the turbines.

6.3. BUS Survey summer 2021

The bird utilisation survey (BUS) was undertaken consistent with a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005).

6.3.1. Methods

A fixed-point count method was used in the survey. The fixed-point bird count method involved an observer stationed at a survey point for 15 minutes. The adequacy of using 15 minutes as a period to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (Brett Lane & Associates Pty Ltd, unpublished data). The study 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 the survey.

During this period, all bird species and numbers of individual 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.

Flight height is presented as below, at or above rotor swept area (hereafter RSA) height:

- **A =** Below RSA (< 73 metres above ground)
- **B =** At RSA (74 – 200 metres above ground)
- **C =** Above RSA (> 200 metres above ground)

During the surveys, eight counts (replicates) were made at each of the four-impact and two reference points. Table 9 indicates when each point was counted on each survey day. This schedule ensured that all points were visited equally at different times of day to allow for time-of-day differences in bird movements and activity.

Table 9: Times when points were counted for each fixed-point bird count survey day

Time	Day 1	Day 2	Day 3
7:30		RF2	BUS1
8:00		BUS3	RF1
8:00		BUS4	RF2
8:30		BUS2	
9:00		RF1	BUS3
9:30	BUS2	BUS1	BUS4
10:00	BUS1	RF1	BUS1
10:30		BUS2	RF1
10:30		RF2	BUS2
11:00		BUS4	RF2
11:00		BUS3	BUS3

Time	Day 1	Day 2	Day 3
11:30		BUS4	
12:00		BUS2	
12:30	RF2	RF1	BUS1
13:00	BUS4	BUS1	
13:30	BUS3	BUS2	BUS3
13:30		RF2	
14:00		BUS4	
14:30	BUS2	BUS3	BUS4
15:00		BUS4	BUS3
15:30		RF2	RF2
15:30		BUS1	RF1
16:00		RF1	BUS1
16:30			BUS2

Note: See Figure 1 for survey point locations. The prefix 'Ref' refers to reference points.

6.3.2. Locations of survey points

Six fixed survey points were established; four impact points and two reference points. Impact points were located near operational turbines and reference points were located at least 500 metres away from impact points in areas of similar habitat (Figure 14).

The survey points were distributed as evenly as possible (subject to access constraints) across the wind farm to sample the various habitat types and maximise coverage in areas where wind turbines are located. Impact points were positioned as far as possible on elevated ground, allowing a clear view in all directions. Table 10 below provides a description of the habitats associated with each impact and reference point.

Table 10: Habitat associated with each survey point

Survey point	Habitat
BUS01	Located in inside the wind farm, close to turbine number 59. A remnant of native vegetation but also close to a large fragmented area with scattered trees. Clean understory cover.
BUS02	Inside the farm close to turbine number 58. Large open area but some scattered eucalypt trees some. Clean understory cover. Cattle and sheep grazing area.
BUS03	Located on the top of ridge, close to turbine 10. Fragmented on one side but some scattered eucalypts present at other slope. Area dominated by reverse keystone species such as Noisy Miners. Clear understory cover.
BUS04	Near turbine 5. Close to a remnant patch of eucalypt trees, but open area and highly modified on one side. Clean understory vegetation. Close to small dam.
Ref1	Inside the windfarm, about 700 metres from turbine 58. Small patch of native woodland mainly eucalypt trees.
Ref2	Located outside windfarm boundaries, at about 500 south west of the main office, close to the road. This area contains a remnant of native eucalypt trees with some grassy understory. Relatively suitable habitat for woodland birds.

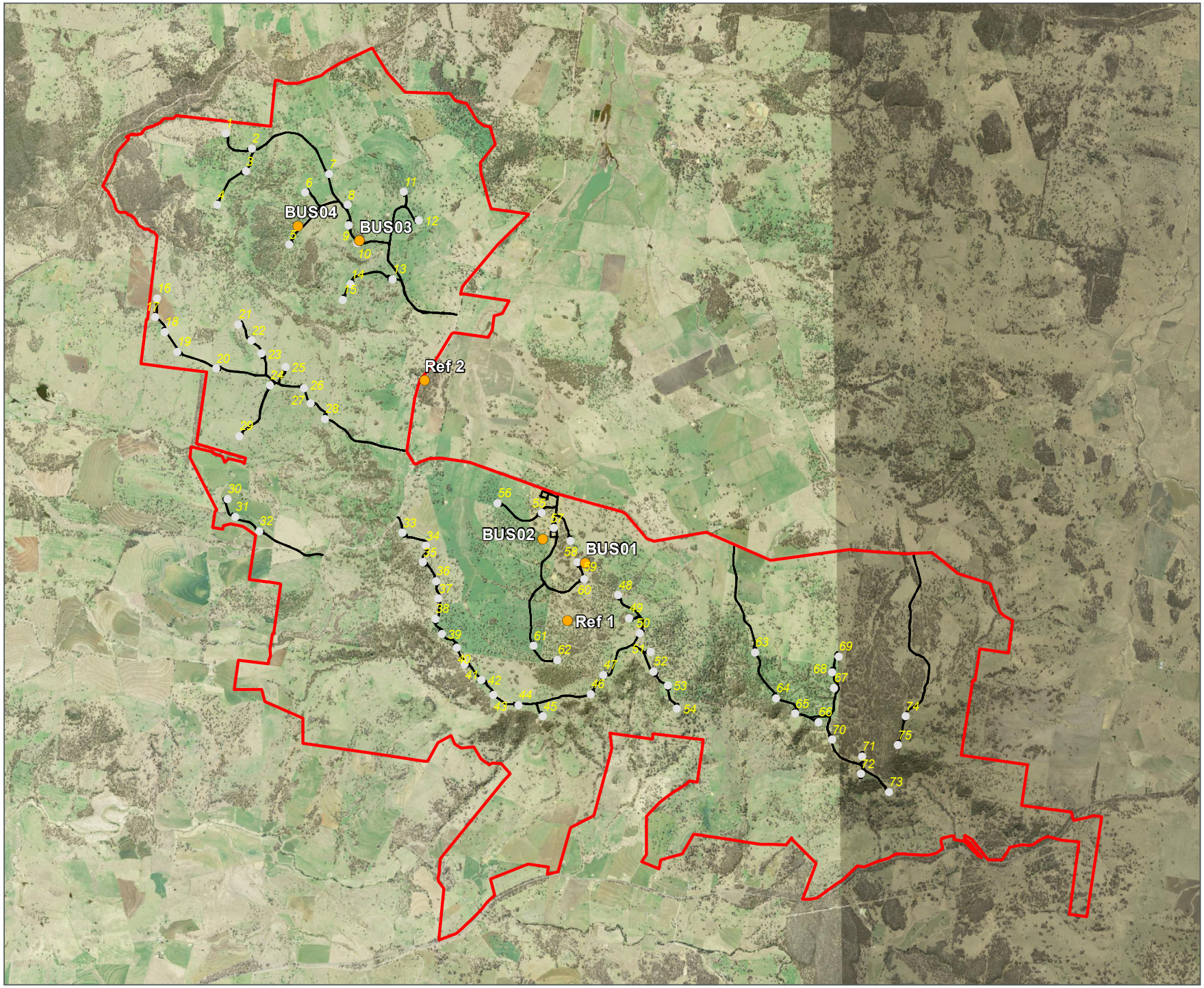

Figure 14Location of BUS points at Sapphire Wind Farm

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 03/04/2020

- Study area
- Turbines
- Access tracks
- BUS and reference points

N

Kilometers
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Nature Advisory
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03 9815 2111 - info@natureadvisory.com.au

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6.3.3. Incidental observations

In addition to the observations during formalised surveys, fixed-point counts, incidental observations of birds of concern (threatened species, raptors, waterbirds) were made whilst travelling throughout the wind farm sites. Notes are 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.

6.3.4. Limitations

The current bird utilisation survey was undertaken during summer of 2021. The utilisation rates and species abundances recorded during the current survey are considered to be representative of the site. They are also considered to provide a reasonable basis on which to assess the bird risks associated with the Sapphire Wind Farm.

6.3.5. Data preparation and statistical analysis

Observations were recorded in the pre-defined filed observation forms. Raw data were then entered into spreadsheet file and tables and graphs were extracted. Graphs were generated in Microsoft Excel and R (R Core Team 2018). First, the suitability of the survey method was checked using a cumulative species number graph (see results below). Chi-square distribution tests were used to investigate the distribution of individuals in height categories. To investigate the variations of species diversity and abundance between impact and reference sites and between different BUS, analysis of variance (ANOVA) was performed, with species diversity and abundance as dependent factor and sites type (impact/reference) as predicting parameter. All statistical analyses were undertaken in R environment (R Core Team 2018).

6.3.6. Results

6.3.7. Survey Suitability

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the observation points during the spring survey period has been plotted in Figure 15.

The cumulative species–count sequence curve below shows a clear asymptote, suggesting that the number of new species added to the diversity levelled off after around 40 counts, and only few species were added afterwards. The result strongly suggested that the surveys provided a representative picture of the diversity of bird species flying over the wind farm site during the survey period.

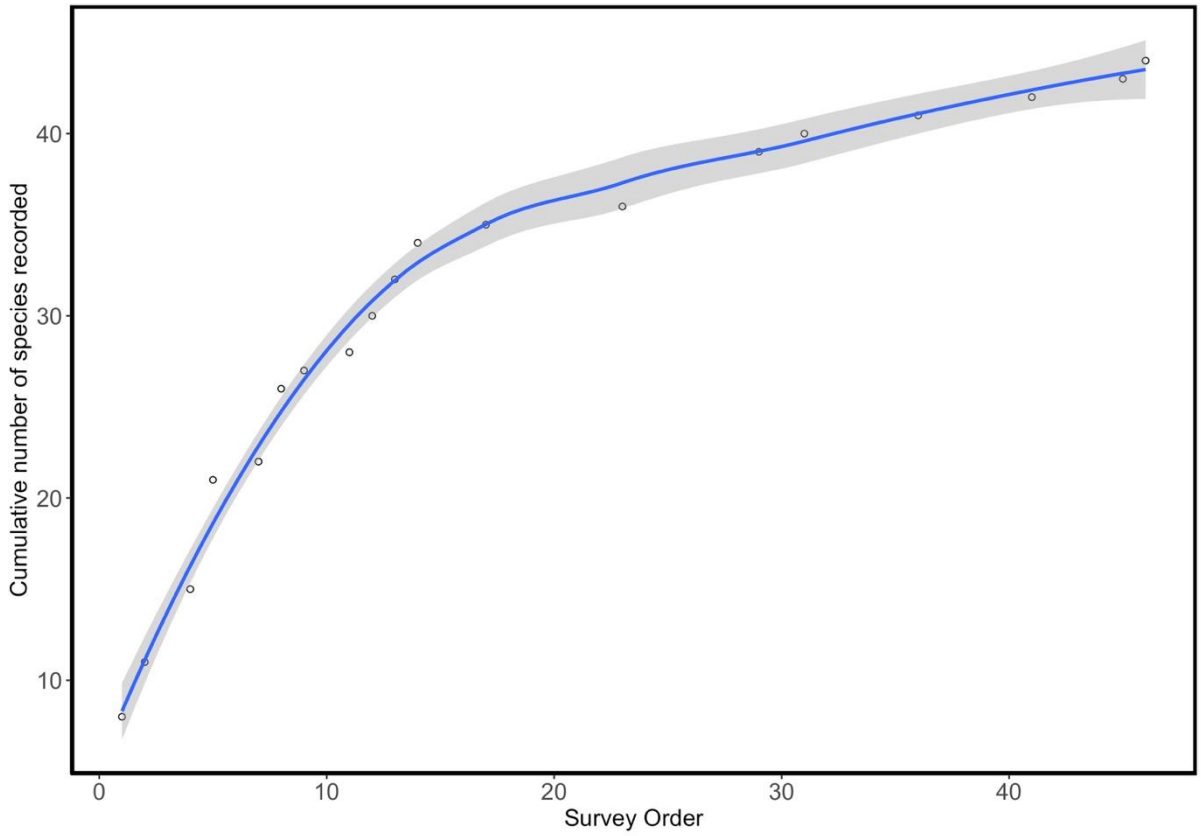

Figure 15: The cumulative number of species of birds recorded during consecutive counts at the BUS points at SWF

6.3.8. Species frequency and abundance

Overall, 44 bird species were recorded during the survey as summarised in Figure 16. Of all species recorded, 40 were recorded at the impact survey points and 32 at the reference sites (Table 11, Figure 16 & Figure 17). Species recorded during these surveys were predominantly farmland and bushland species with limited records of raptors and waterbirds. The raw data is presented in Appendix 4.

At the impact points, the Species with the highest frequency of observation were Noisy Miner (occurring in 31 out of 32 surveys) followed by Eastern Rosella (28 out of 32) and Australian Magpie (26 out of 32). At the reference sites, the species with highest observation were Noisy Miner (occurring in 16 out of 16 surveys), Easter Rosella (16 out of 16) and Sulphur-Crested Cockatoo (12 out of 16). Common species dominated the count although with slight change in the sequence of the common species. Thus, nearly similar pattern was observed between impact points and reference sites with the Noisy Miner being the most frequent species recorded during surveys.

Species richness (e.g., mean number of species per site) varied between the six observation points, but rather insignificantly (see below for details). The number of species recorded at each of the observation points was influenced mainly by availability of habitat diversity, and was usually higher on points surrounded by remnant vegetations, that include large trees, than those

points in open, treeless habitats. Table 11 presents the distribution of bird numbers (relative abundance) and their height distribution among the impact and reference observation points. Figure 18 and Figure 19 present this graphically.

The five most common species with respect to their abundance (e.g., number of individuals recorded) at the impact and reference survey points are presented in the table below. These five species comprised 64% of all individual birds recorded at the impact survey points and about 69% at the reference survey points. The common resident species were the leading species and dominated over the summer season.

Table 11: Highest species abundance of impact and reference points

Impact survey points (% of total individuals birds recorded)	Reference survey points (%of total individuals birds recorded)
Noisy Miner (21.07%)	Noisy Miner (26.37%)
Sulphur-crested Cockatoo (13.34%)	Eastern Rosella (18.14%)
Eastern rosella (13.09%)	Sulphur-crested Cockatoo (14.76%)
Red-rumped Parrot (9.7%)	Australian Magpie (6.11%)
Australian Magpie (7.3%)	Galah (5.27%)

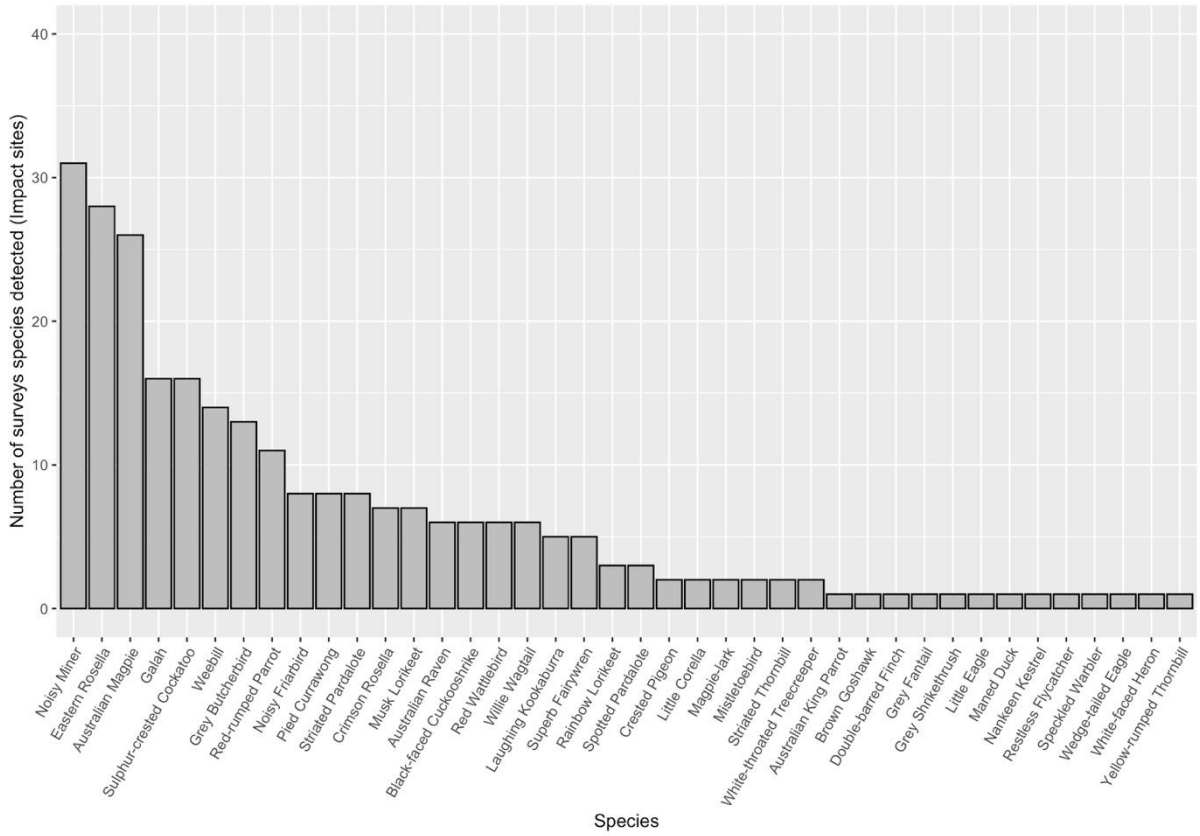

Figure 16: Frequency of species detection in impact sites at SWF. Values represent the number of surveys that a given species was observed

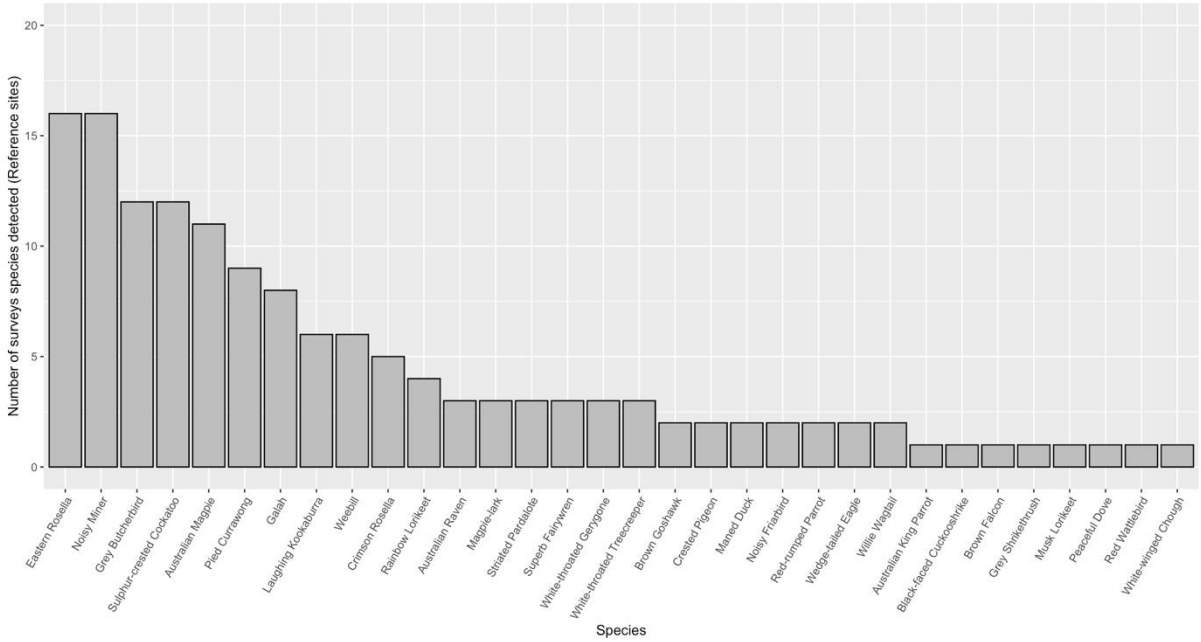

Figure 17: Frequency of species observed at reference sites. Values represent number of surveys that a given species was detected.

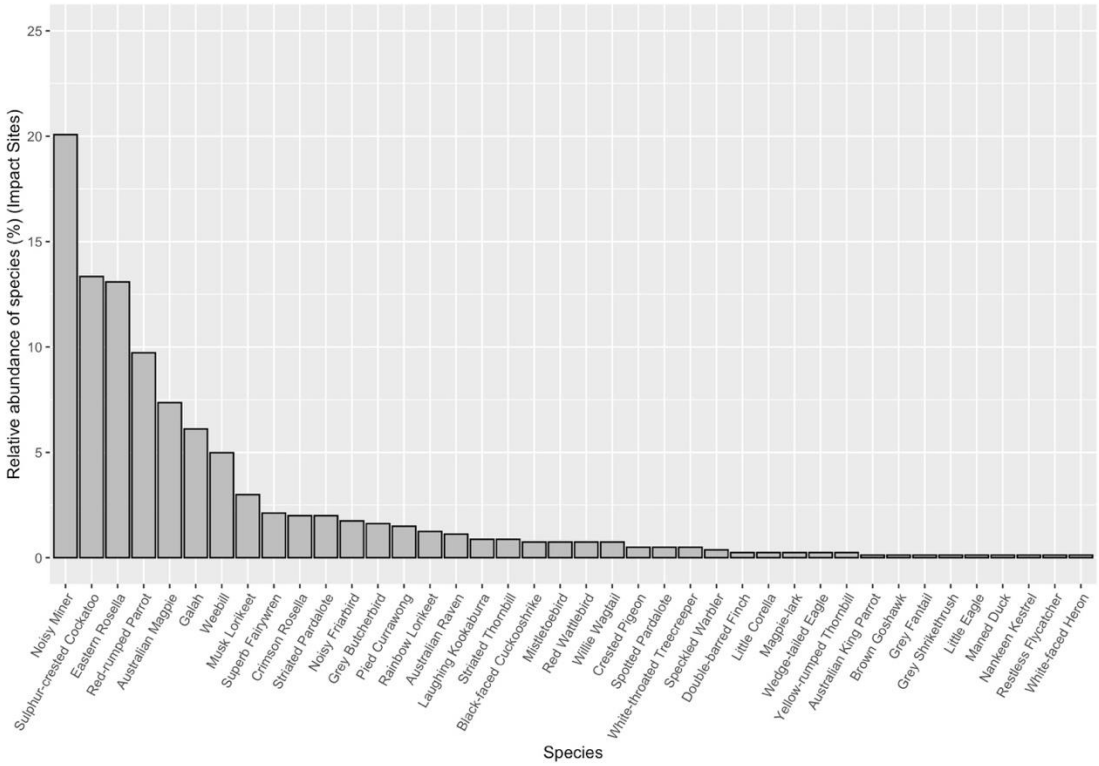

Figure 18: Relative abundance of species observed in impact sites at SWF. Values represent percentages of individual from a given species.

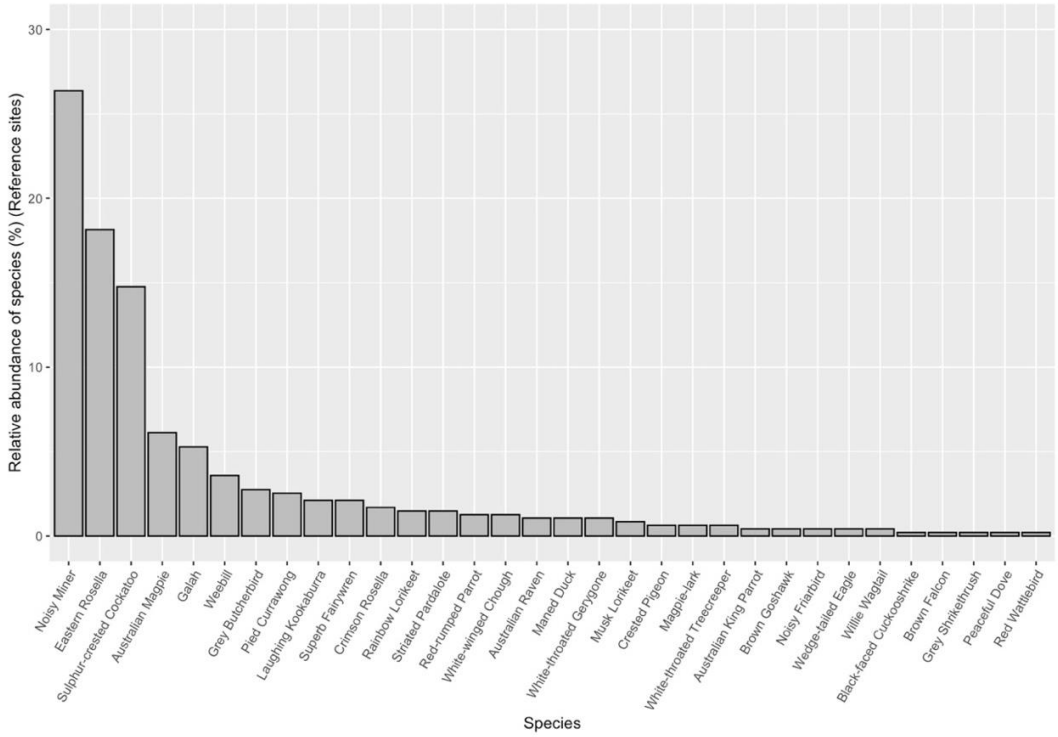

Figure 19: Relative abundance of species observed in reference sites at SWF. Values represent percentages of individual from a given species

6.3.9. Variabilities of species richness and abundance among survey points

The diversity of bird species (species/survey) varied between the six observation points and depended on the habitat surrounding each of the points. Table 12 summarises results for abundance and height distributions for each point. Points within or close to patches of remnant woodlands returned higher richness than those within open treeless habitats. Those points with more mature native trees, that are located close to or within a remnant woodland attracted more species than those in open grazing paddocks. These types of location included points BUS01 which showed the highest diversity of birds compared to highly cleared areas such as BUS03 and BUS04 (Figure 20). The species richness per survey varied from 11.75± 1.6 (mean ± se) at BUS02 to 5.8 ± 0.83 at BUS04. Mean number of species detected per site was 7.06 ± 0.63 at impact points and 9.06 ± 0.86 at reference points. ANOVA test suggested that this difference is not significant (ANOVA, F=0.84, df=1&46, p=0.36).

Similar to the species diversity patterns, mean abundance of birds (number of birds/survey) varied between sites. The variations of abundance among site were higher compared to variations of species richness (Figure 21). Mean number of birds recorded per survey varied from 35.5 ± 5.2 individuals/survey at BUS02 to as low as 14.5 ±1.9 individuals/survey at BUS03, with an average value of 27.5 ± 3.5 individuals/survey across all sites (Figure 8). In addition, the mean abundance of birds recorded per survey at impact points was 25.06 ± 2.6 individuals/survey whereas the mean abundance at reference points was slightly higher (29.62 ± 3.8). The difference between mean abundance of bird was found to be statistically insignificant between impact and reference points (ANOVA, F=0.95, df=1&46, p=0.33). Generally, similar to species richness, points within or close to patches of remnant woodlands returned higher abundance than those within open treeless habitats.

Table 12: Summary of the relative abundance (numbers) and height distribution of bird at the impact and reference points during spring survey at SWF

Observation points/ Impact	A	B	C	Total	% Importance	% at RSA
BUS1	279	0	0	279	22	0
BUS2	284	0	0	284	22	0
BUS3	114	2	0	116	9	1.7
				123	10	
Impact Total	**800**	**2**	**0**	**802**	**63**	**0.27**
Ref 2	244	1	0		19	0.44
Ref 1	228	1	0		18	
Reference total	**472**	**2**	**0**	**474**	**37**	**0.44**
Grand Total	**1272**	**4**	**0**	**1276**	**100**	**0.31**

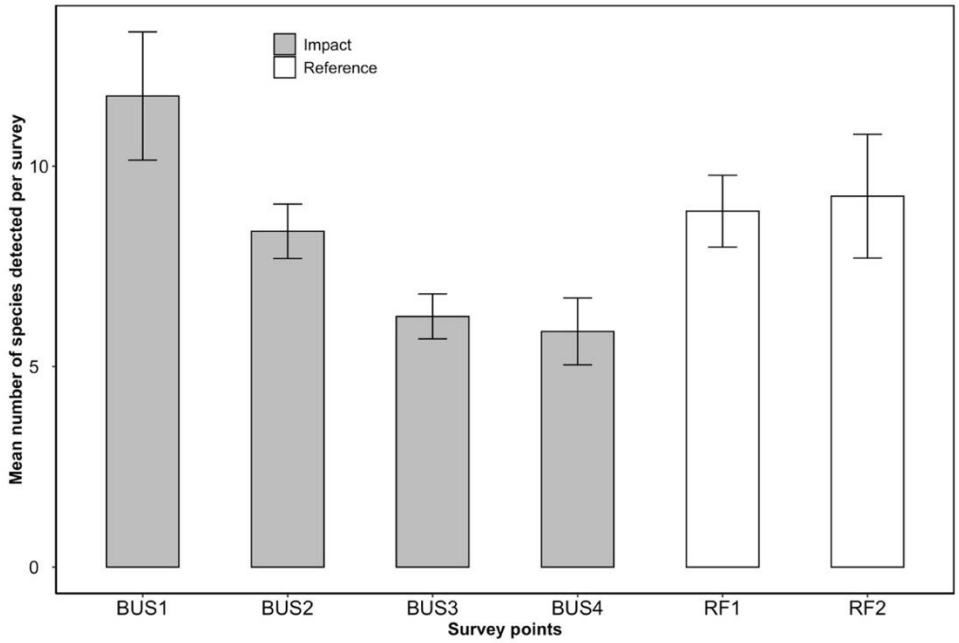

Figure 20: Mean richness (number of species per survey) of birds among impact and references survey points

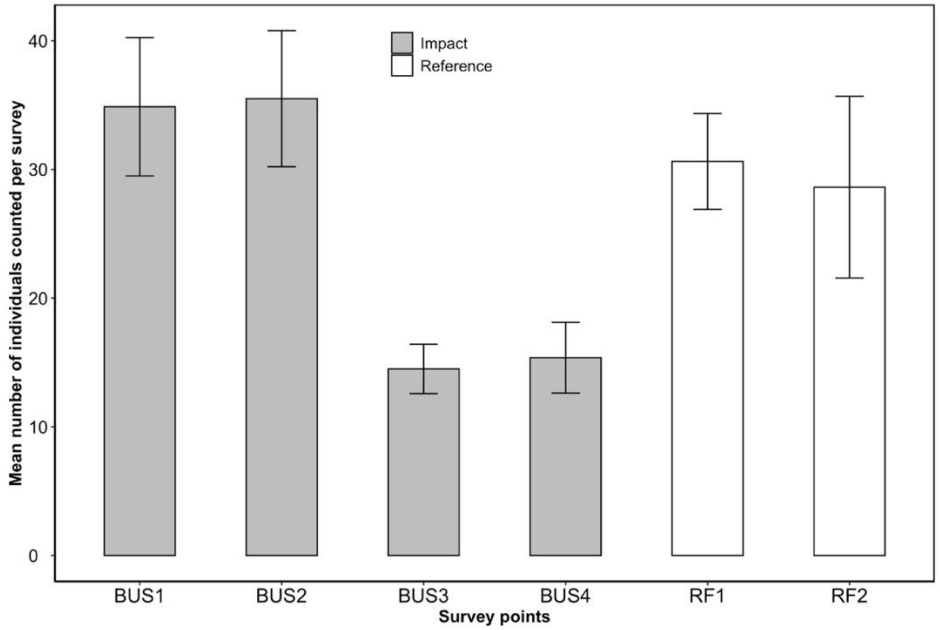

Figure 21: Mean abundance (number of birds recorded per survey) at impact and survey points

6.3.10. Flight Heights

Bird observation heights were classified as below RSA (< 73 metres), at RSA (74–200 metres), and above RSA (> 200 metres) heights. Table 13 presents a summary of observations in each height class and detailed results of the species numbers recorded in each the are presented in Appendix 4.

Birds were not distributed equally in different height groups (A, B and C) Figure 22. A significant proportion of birds were observed at the height of below RSA ($\chi^2 = 1260$, df=2, $p < 0.0001$). The same patterns were observed for impact and reference points separately (Impact sites: $\chi^2 = 794$, df=1, $p < 0.0001$; Reference sites: $\chi^2 = 466.2$, df=1, $p < 0.0001$) with the majority of birds occurring at the height of below RSA. The majority of birds were recorded flying below RSA heights at impact (99.7%, Figure 9) and reference points (99.5%).

Table 13: Summary of number of birds recorded at the three flight heights at SWF

Flight Height	Impact survey points		Reference survey points	
	Number of birds	Percentage of all birds	Number of birds	Percentage of all birds
A (below RSA)	800	99.7%	472	99.5%
B (at RSA)	2	0.3%	2	0.5%
C (above RSA)	0	0	0	0
Total birds recorded	**802**	**63%**	**474**	**37%**

The diversity of species of birds seen flying at RSA heights was very low compared to the total birds recorded at impact points and only one species out of 44 species (2%) was observed at RSA height.

Birds flying at the RSA heights consisted only of Wedge-tailed Eagle, which was recorded at both impact and reference sites. The relative abundance of birds flying at RSA heights at each of the survey points was randomly distributed. Wedge-tailed Eagle that were flying at RSA height were observed at Reference Sites 1 and 2 and BUS03 (2 individuals, Figure 23).

Height distribution shows that almost majority of birds flew below RSA height, which were either on the ground or in trees (from 1 to 20 metres height), therefore reducing collision risks between these bird species operational wind turbines. Over 85% of individual birds were observed at the height below 20 meters which, along with the height of turbine towers suggest a low risk of collision for most of the bird species.

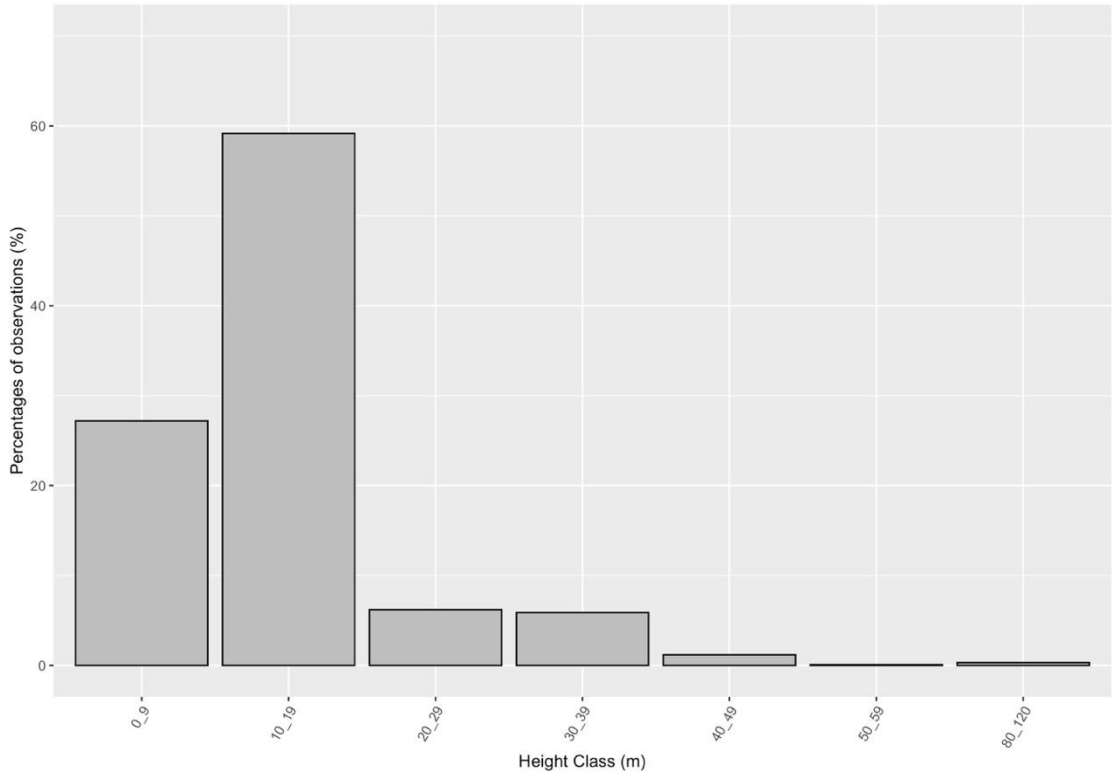

Figure 22: The distribution of bird heights as recorded during BUS at SWF

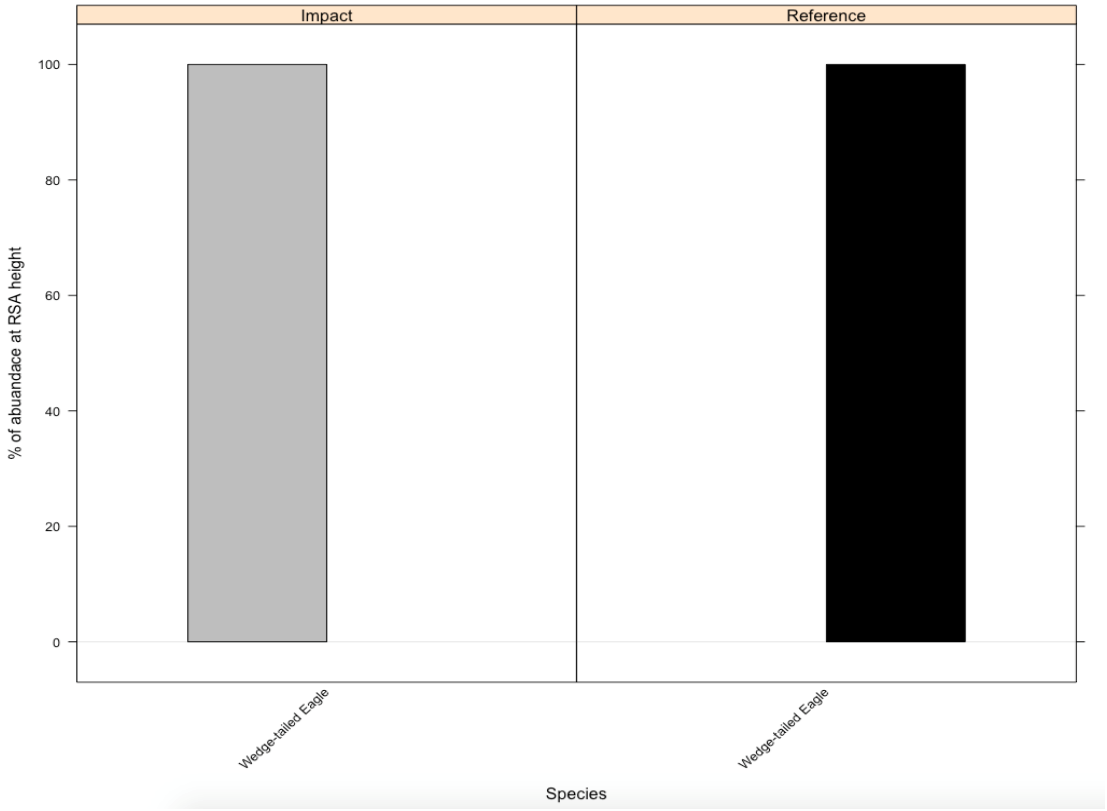

Figure 23: Relative abundance of species observed at RAS height at impact and reference point

6.3.11. Threatened Species

The majority of birds found to utilise the wind farm site were common birds. Two listed species recorded during the bird utilisation surveys; Little Eagle and Speckled Warbler.

The Speckled Warbler *Pyrrholaemus sagittatus* is considered as vulnerable (NSW *Biodiversity Conservation Act 2016*) and occurs throughout most of NSW but is sparsely scattered, with most breeding in the western slopes of the Great Dividing. It is primarily a bird of eucalypt woodlands with an open or sparse understorey and ground cover of grasses. This species was recorded at both 2019 and 2021 BUS. In 2019 BUS, there was one individual of this species recorded during spring surveys in similar areas described above as its preferred habitat. In 2021 BUS, three individuals were recorded. Impacts on this vulnerable species is considered low as the flight height of this species is below RSA risk zone and also given that this species was recorded only once at reference points which was over one kilometre away from the nearest turbine at SWF.

The Little Eagle *Hieraaetus morphnoides* is widespread in mainland Australia. The Little Eagle forages in or over a range of habitats from grassland to forest, mainly woodland or open woodland, and in southern Australia preys on a range of vertebrates though mostly mammals; successful broods are usually of one fledgling (e.g., Marchant & Higgins 1993; Debus 2017). This species is listed as Vulnerable in NSW. During BUS at Sapphire Wind Farm, Little Eagle was recorded once but was flying under RSA height.

6.3.12. Raptors

Five raptor species were recorded during the spring survey, comprising a total of 10 observations (Table 14). The majority of raptors were seen flying below RSA heights (60%), and 40% were recorded flying ta RSA heights. However, the overall importance calculated as a percentage of all birds recorded during BUS was rather low and constituted as low as 0.31%.

The most important raptors seen flying at RSA heights was Wedge-tailed Eagle which made up 100% of observations at RSA height. This species is a known common raptor in most open habitats and recorded as common in many similarly placed wind farms.

Overall, the frequency of observation of Wedge-tailed Eagle was low in this wind farm compared to nearby wind farms. Particularly due to the habitat types of the areas around Sapphire Wind Farm, it is usually rare to observe Wedge-tailed Eagles. Importantly, no active Wedge-tailed Eagle was found at SWF both during BUS. Raptors are usually the most vulnerable species to collision with operating turbines because of their soaring habits while foraging, however, the collision rate of raptors at SWF is considerably low compared to many other wind farms. Most of the areas at SWF are open woodlands with usually a flat landscape thus not an ideal habitat for raptors such as Wedge-tailed Eagles. The low occurrence of Wedge-tailed Eagle is reflected both in BUS and raptor observations at SWF.

6.3.13. Waterbirds

Only one waterbird species was recorded in this survey which was a White-faced Heron. This species was recorded only once and was observed below RSA height (Table 14). White-faced Heron is a very common farmland waterbird that usually found along the edges of farm dams and forage in open paddocks next to the dams during day and night.

Table 14: Raptor and Waterbird species recorded at the impact survey points during spring survey at Sapphire Wind Farm

Species	Total number of birds	Total flying at RSA heights	% flying at RSA heights	% RSA of total RSA birds	% RSA bird of all BUS birds
Raptors					
Brown Falcon	1	0	0	0	0
Brown Goshawk	3	0	0	0	0
Little Eagle	1	0	0	0	0
Nankeen Kestrel	1	0	0	0	0
Wedge-tailed Eagle	4	4	100	100	0.31
Total raptors	10	4	40	100	0.31
Waterbirds					
White-faced Heron	1	0	0	0	0
Total Waterbirds	1	0	0	0	0
Grand Total	**11**	**4**	**40**	**100**	**0.31**

6.4. Comparison between 2019 and 2021 post-construction BUS results

As per Sapphire Wind Farm BBAMP, two BUS surveys were conducted at project site. A total of 44 bird species of birds were recorded during 2021 survey, of which 40 species were recorded at the impact survey points and 32 at the reference sites. In 2019 surveys, higher quantities of bird species were recorded with a total of 50 species of birds; 42 at the impact and 41 species occurring only at the reference points. The different between the species richness between two survey was not statistically significant. However, there was a significant difference between the two surveys in term of mean number of birds recorded per survey. Overall, mean number of birds recorded per survey was 16.54 ± 0.98 in 2019 BUS and 26.58 ± 2.19 in 2021 BUS. Statistical analysis suggested that the mean number of birds (species abundance) was significantly higher in 2021 BUS (Figure 24).

However, it is noted that there was a considerable ecological shift in the period around the summer of 2020. The drought and the bushfires of 2019-20 are likely to have changed the pattern of movement in bird species. These changes were not able to be quantified through these surveys.

With respect to threatened species, during both BUS in 2019 and 2021, Speckled Warbler was recorded as a listed species. In 2021 BUS, in addition to Speckled Warbler, Little Eagle was also recorded during surveys.

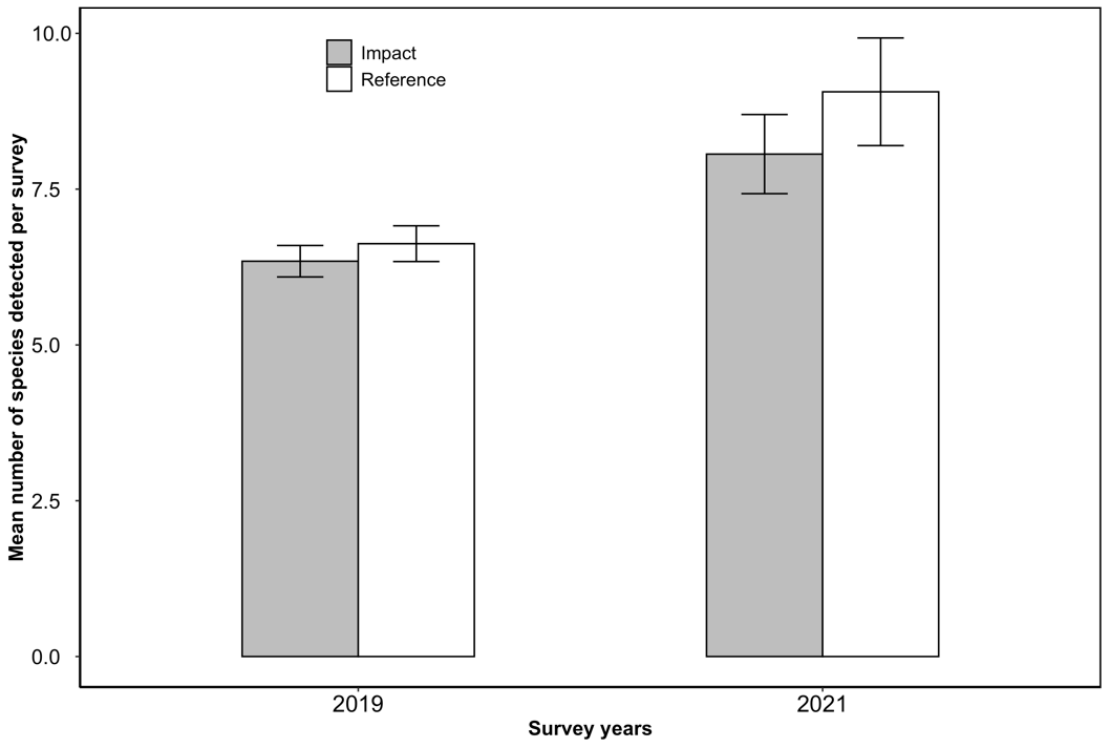

Figure 24: Mean abundance (number of birds recorded per survey) at impact and survey points during 2019 and 2021 BUS at Sapphire Wind Farm

6.5. Conclusions

The conclusions from the current spring BUS of the Sapphire Wind Farm are presented below:

- The areas inside and surrounding Sapphire Wind Farm are largely made of cleared plateaus supporting a low diversity and abundance of common, predominantly farmland birds. Notably, the area supports a low diversity of raptors and waterbirds due to the lack of suitable habitat.
- A total of 44 bird species were recorded during this survey of which, 40 species were recorded at the impact survey points and 32 at the reference sites.
- The species with the highest frequency of observation was Noisy Miner in both 2019 and 2021 surveys occurring in about 70% of surveys followed by other common species such as Australian Magpie and Easter Rosella. These five species comprised 64% of all individual birds recorded at the impact survey points and about 69% at the reference survey points. The common resident species were the leading species and dominated over the summer season.
- The relative abundance (birds/ha/hour) varied between the six observation points, depending on the habitat surrounding each of the points. Points within or close to patches of remnant woodlands returned higher relative abundance than those within open treeless habitats. Survey sites with more mature native trees, that are located close to or within a

remnant woodland attracted more birds than highly cleared grazing paddocks. Despite these variations, the richness of species at impact and reference points did not significantly differ based on statistical tests, suggesting a uniform habitat across most parts of the wind farm and surrounding areas.

- In this survey, the majority of birds were recorded flying below RSA heights (99.7% at impact and 99.5% at reference points). Similar results were observed in 2019 surveys with over 89% of birds recorded flying below RSA height at impact sites and 96% at reference points.
- Overall, a low proportion of birds (0.31%) were observed at RSA height. All birds recorded flying at RSA heights were Wedge-tailed Eagles. During 2019 surveys, other species such as Australian Raven and Nankeen Kestrel were also recorded flying at RSA height.
- The diversity of waterbirds was low with only one species recorded during the surveys and with only one individual.
- Two listed species were recorded at Sapphire Wind Farm including Little Eagle and the Speckled Warbler. The Speckled Warbler was also recorded in 2019 BUS suggesting that they might have a viable population within the site. Little Eagle was the other listed species recorded during this BUS. Little Eagle was not recorded in 2019 surveys but in one case an indicial collision of Little Eagle with the power lines was recorded at the early stages of the wind farm operation.

7. Discussion

The post-construction bird and bat carcass searches for the 31 months of the operation of SWF were undertaken in accordance with the approved BBAMP (BL&A 2017).

Between July 2018 and January 2021 all selected turbines were searched at least 24 times. In total 930 turbine searches were undertaken (including 463, 100-metres radius searches and 464 60-meter radius). During these searches; 14 bird carcasses, 10 bats and 13 feather spots were found. A total of 9 birds, two feather spots and one bat were found incidentally. This consisted of 15 bird and five bat species identified. It is estimated there was a total site loss (all turbines combined) of around 166 bats and 457 birds (including confidence intervals) over the survey period. For birds this equals roughly 0.2 birds per turbine per month and 0.01 bats per turbine per month over 31 months.

The Australian Magpie was the most abundant of all bird and bat species mortalities found during formal searches, making up 18% of all mortality combined, followed by Wedge-tailed Eagle, which made up 13% of all mortality. These results are not unusual for wind farms in NSW (Nature Advisory unpublished data) as both are common and widespread farmland species. Australian Magpie was the third most abundant bird observed in the BUS, after Noisy Miner and Eastern Rosella however, Noisy Miner recorded no mortalities and Eastern Rosella only two. This is likely related to Australian Magpie's preference for open habitats common in farmlands and typical positions for turbines in landscapes, whereas the others prefer woodlands. While not observed in the BUS, it is not uncommon for Magpies to fly quite high when traversing the landscape, as is evident in mortality results.

Of the five bat species found 60% of these consisted of White-striped Freetail Bat. A number of studies (Symbolix 2020, Moloney et. al 2019, Smales 2012) have identified this species is commonly over-represented as mortalities across Victorian wind farms. Observations by Nature Advisory (unpublished data) at various wind farms in other parts of the species' range are consistent with these findings. This is related to the species foraging habits with which it prefers to fly many times the height of the tree canopy for high flying insects. This unfortunately brings them into RSA of turbines.

It is unlikely that the results from the monitoring program or the mortality estimates suggest a significant impact on any of the species identified as mortalities. Each is a relatively common and widespread species to farmland landscapes in NSW and other parts of Australia, and each is considered secure and not in decline. It is unlikely that BWF would have a significant impact on any populations regionally, on a state level or overall. That said, Wedge-tailed Eagle was identified as an 'at-risk' species in the BBAMP and is considered further below.

The relatively high Wedge-tailed Eagle mortalities, compared with other species, is reflected in the raptor monitoring results, where Wedge-tailed Eagle was observed the most often from the three raptor species, and the BUS, where it was the only species observed flying at RSA height of all bird species observed. Wedge-tailed Eagle foraging habits are likely to main reason why this species was a frequent mortality. The species tend to soar from close to the ground, to many

hundreds of metres above it while searching for foraging opportunities, which unfortunately will bring them into RSA height and increase risk of collision compared with other species. It is estimated that 13 individuals were lost during the monitoring period. Statistical analysis showed the number of Wedge-tailed Eagles lost in the second year was significantly higher than the first. This may be related to the easing of drought conditions during the second year of monitoring providing more foraging opportunities in the area. While this level of mortality is not considered significant for the species, there are mitigation opportunities which can further reduce mortality risk for the 'at-risk' species. These are outlined in Section 8.

The estimated mortality and mortality monitoring results are relatively low compared with other wind farms that Nature Advisory monitors (Nature Advisory unpublish data) in northern NSW. This is likely related to the lower RSA height of turbine blades at SWF. A lower blade tip of >70 metres RSA appears to reduce the numbers of species which are likely to enter RSA, particularly that of micro-bat species (Section 3.2.1). This is generally supported by BUS surveys, where only Wedge-tailed Eagle was observed using RSA airspace, and mortality results which held low species diversity of mortalities and numbers of which were made up primarily of Australian Magpie and Wedge-tailed Eagle.

Additional reasons for low mortality may include; habitat types, with cleared and fragmented areas throughout the wind farm providing poor habitat for many species and foraging opportunities. The 2019 bushfire and drought resulting in comparatively low movement and activities of species around the wind farm, the consequences of which may have extended into the second year of monitoring.

Poor and limited habitat is likely the main reason for a lack of other 'at-risk' species observations during BUS or incidentally. White-throated Needletail, Regent Honeyeater or Swift Parrot were not observed during the monitoring program. The main habitat; Ironbark trees, are in very low numbers on the site and even when flowering would provide very limited habitat and foraging opportunities for the species. Therefore, risk from SWF operation is considered to be very low for these species and additional monitoring is not recommended.

Statistical analysis suggested that the mean number of birds (species abundance) was significantly higher in 2021 BUS. This variations in the abundance of birds could be associated with ecological conditions of the survey periods. BUS 2019 was primally conducted during the severe drought period with minimum rainfall. No flowing tree was observed in 2019 surveys. In contrast; BUS 2021 was undertaken during conditions after considerable rainfall and thus more favourable habitat conditions. The rainfall has ecological consequences such as higher food resources and flowering status of trees. For example, a higher diversity of parrots has been recorded in BUS 2021 compared to 2019.

This trend is also evident in the mortality results which showed that bird loses in the second year of monitoring were significantly higher than the first.

No threatened or non-threatened management triggers occurred as a result of the monitoring program. It should be noted, one Little Eagle was found at SWF injured beneath a powerline. This

species is listed as 'Vulnerable' in New South Wales under the BC Act. It was found 900 metres from the nearest turbine on 26th July 2018 by wind farm staff and was transferred to the local vet. A short investigation concluded that it was highly unlikely that the casualty was caused by a wind turbine. Therefore, the mortality was not attributed to collision with turbines and not recorded as an incidental or casualty record, or to have triggered an impact trigger.

Additionally, one Grey-headed Flying–Fox, listed as Vulnerable under the EPBC Act, was found caught in barbed-wire fencing. This find did not trigger an investigation under the BBAMP due to the determination of the incident as not having been caused by a wind turbine. Grey-headed Flying-Fox have also been found flying into barbed–wire fencing at nearby wind farms. It is suggested that ongoing observations of this phenomenon be recorded to determine the scale of impacts barbed-wire fencing is having on the Grey-headed Flying–Fox.

These two mortality cases demonstrate the effectiveness of the decision-making framework of the BBAMP when undertaking investigations into the impacts of the wind farm on threatened species.

8. Recommendations

This section provides recommendations on future monitoring and mitigation measures.

Carcass search program

It is considered that two years of mortality search data as described in the Sapphire Wind Farm BBAMP and outlined in the report above have provided a useful baseline set of data to gain an understanding of the impact the wind farm is having on bird and bat species. This carcass search program has provided useful estimates of bird and bat mortality and the species impacted by the wind farm.

The information gained in the first two years is considered as satisfactory. Extending the regular carcass searches beyond this two-year period is not recommended.

Incidental monitoring

It is recommended that incidental reporting of carcasses by SWF staff be continued. Carcasses and featherspots should continue to recorded on a datasheet, photograph and stored in the freezer on the wind farm site in line with the BBAMP. This data can be provided to Nature Advisory remotely to identify. This will continue to provide some indication of on-going impacts to birds and bats at the wind farm. Particularly for Wedge-tailed Eagle which is easily identifiable and visible from a distance. Data on incidental monitoring should be tabulated annually.

In line with Condition C6 this information should be included in reports submitted to the Director-General and OEH on an annual basis for the first five years of operation as outlined in Condition C6 of the Project Approval.

Species of concern.

This report identified:

- No impact triggers on listed species;
- Some mortality of Wedge tailed Eagles.

The BBAMP identified specific measures to reduce mortality of the WTEs which should continue as part of the implementation of the BBAMP. Specifically, these measures include:

- Carrion removal -
  The BBAMP requires ongoing carrion management as part on the operational implementation of the BBAMP. Thus, it is important that the carrion removal program be undertaken continued in line with Section 5.1 of the BBAMP. The reporting on carrion removal can be incorporated into the annual reports for the first five years of operation as outlined in Condition C6 of the Project Approval.
- Limit lambing near turbines - Where possible, lambing should not be encouraged in paddocks close to turbines in consultation with land holders. Where possible, lambing

should occur at least 200 metres from turbines to reduce the risk that raptors are attracted close to the turbines.

- Feeding stock close to turbines should be discontinued as it may contribute to unnecessary bird impacts. Stock should not be fed grain within a 200-metre radius of wind turbines as this may attract parrots and cockatoos that can then collide with turbines.

Ongoing reporting

In line with Condition C6 the information detailed above should be included in reports submitted to the Director-General and OEH on an annual basis for the first five years of operation as outlined in Condition C6 of the Project Approval. This report meets the requirement for the first two years of operation.

The annual report will provide an opportunity to monitor impacts on 'at-risk' species, particularly Wedge-tailed Eagle, and adaptive management in reviewing carrion removal or potential additional survey requirements.

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Appendix 1: Bird and bat mortality data obtained during the pre-operational period and two years of monitoring at SWF (July 2018-January 2021)

Report ID	Turbine number	Species ID	Type of Carcass	Distance from Turbine	Formal* or Incidental	Date of find
2018.7.01	NA	Little Eagle	Bird	NA	Incidental	26/07/2018
2018.8.01	57	Crested Pigeon	Bird	1	Incidental	6/08/2018
2018.8.01	57	Crested Pigeon	Bird	1	Incidental	9/08/2018
2018.8.01	16	Australian Magpie	Feather Spot	50	Feather Spot	27/08/2018
2018.9.01	57	Crested Pigeon	Feather Spot	5	Incidental	13/09/2018
2018.9.01	57	Australian Magpie	Feather Spot	5	Incidental	13/09/2018
2018.12.01	66	Wedge-tailed Eagle	Bird	100	Incidental	12/12/2018
2018.12.01	18	Grey- headed Flying Fox	Bat	100	Carcass	27/12/2018
2019.01.01	56	Wedge-tailed Eagle	Bird	25	Incidental	24/01/2018
2019.02.01	70	Wedge-tailed Eagle	Bird	65	Incidental	4/02/2019
2019.02.01	57	Eastern Rosella	Bird	10	Incidental	21/02/2019
2019.06.01	48	Australian Wood Duck	Bird	20	Carcass	7/06/2019
2019.07.01	18	Tawny Frogmouth	Bird	30	Carcass	11/07/2019
2019.09.01	68	Collared Sparrowhawk	Bird	25	Carcass	4/09/2019
2019.09.01	48	Australian Magpie	Bird	30	Carcass	9/09/2019
2019.10.01	32	Chocolate Wattled Bat	Bat	20	Carcass	4/10/2019
2019.11.01	63	Tawny Frogmouth	Feather Spot	25	Feather Spot	4/11/2019
2020.01.01	33	Australian Wood Duck	Bird	1	Incidental	13/01/2020
2020.02.01	69	Australian Magpie	Bird	5	Carcass	7/02/2020
2020.03.01	23	White-striped Freetail Bat	Bat	10	Carcass	31/03/2020
2020.04.01	58	White-striped Freetail Bat	Bat	5	Incidental	6/04/2020
2020.04.01	22	Wedge-tailed Eagle	Bird	50	Incidental	21/04/2020
2020.05.01	23	White-striped Freetail Bat	Bat	35	Carcass	15/05/2020
2020.06.01	16	Australian Magpie	Feather Spot	10	Feather Spot	11/06/2020
2020.06.01	14	Collared Sparrowhawk	Bird	60	Carcass	11/06/2020

Report ID	Turbine number	Species ID	Type of Carcass	Distance from Turbine	Formal* or Incidental	Date of find
2020.06.01	58	Australian Magpie	Feather Spot	10	Feather Spot	16/06/2020
2020.07.01	63	Crimson Rosella	Feather Spot	10	Feather Spot	25/07/2020
2020.07.01	53	Wedge-tailed Eagle	Bird	105	Carcass	25/07/2020
2020.07.01	16	Australian Wood Duck	Feather Spot	10	Feather Spot	26/07/2020
2020.07.01	59	Wedge-tailed Eagle	Bird	65	Carcass	28/07/2020
2020.07.01	58	Forest Kingfisher	Bird	5	Carcass	28/07/2020
2020.08.01	34	Australian Magpie	Bird	90	Carcass	26/08/2020
2020.08.01	58	Nankeen Kestrel	Bird	65	Carcass	19/08/2020
2020.08.01	59	Sacred Kingfisher	Feather Spot	40	Feather Spot	31/08/2020
2020.09.01	7	Australian Wood Duck	Feather Spot	25	Feather Spot	16/09/2020
2020.09.01	16	Red-rumped Parrot	Feather Spot	80	Feather Spot	16/09/2020
2020.09.01	32	White-striped Freetail Bat	Bat	45	Carcass	23/09/2020
2020.09.01	4	Nankeen Kestrel	Feather Spot	40	Feather Spot	27/09/2020
2020.10.01	69	White-striped Freetail Bat	Bat	35	Carcass	25/10/2020
2020.10.01	69	Grey Butcherbird	Bird	40	Carcass	25/10/2020
2020.10.01	68	Australian Magpie	Bird	15	Carcass	25/10/2020
2020.10.01	41	Galah	Feather Spot	10	Feather Spot	26/10/2020
2020.11.01	58	Red-rumped Parrot	Feather Spot	60	Feather Spot	21/11/2020
2020.11.01	59	Eastern Rosella	Feather Spot	85	Feather Spot	21/11/2020
2020.11.01	48	Little Red Flying Fox	Bat	70	Carcass	21/11/2020
2020.11.01	48	Little Forest Bat	Bat	45	Carcass	28/11/2020
2020.12.01	69	Red-rumped Parrot	Bird	60	Carcass	24/12/2020
2021.01.01	63	White-striped Freetail Bat	Bat	55	Carcass	26/01/2021
2021.01.01	58	White-striped Freetail Bat	Bat	10	Carcass	26/01/2021

***Formal: includes feather spot and carcass (bird and bat)**

Appendix 2: Scavenger trail data obtained during monitoring at SWF

Season	Species	Carcass size	Placement Date	Scavenged date	Days in the field	Turbine
Short grass	Common Myna	Small Bird	8/08/2019	9/08/2019	1	23
	Wedge-tailed Eagle	Large Bird	8/08/2019	NA	30	23
	Australian Wood Duck	Medium-Sized Bird	8/08/2019	19/08/2019	11	14
	Rainbow Lorikeet	Small Bird	9/08/2019	16/08/2019	7	41
	Nankeen Kestrel	Medium-Sized Bird	9/08/2019	16/08/2019	7	18
	Wedge-tailed Eagle	Large Bird	9/08/2019	NA	30	23
	Common Myna	Small Bird	9/08/2019	9/08/2019	1	41
	Eastern Rosella	Small Bird	9/08/2019	11/08/2019	2	14
	White-striped Freetail Bat	Bat	11/08/2019	13/08/2019	2	23
	Wedge-tailed Eagle	Large Bird	13/08/2019	NA	30	58
	White-striped Freetail Bat	Bat	13/08/2019	17/08/2019	4	58
	Wedge-tailed Eagle	Large Bird	15/08/2019	NA	30	23
	Magpie-lark	Small Bird	15/08/2019	17/08/2019	2	23
	White-striped Freetail Bat	Bat	16/08/2019	25/08/2019	9	41
	Crimson Rosella	Small Bird	16/08/2019	16/08/2019	1	58
	Sulphur-crested Cockatoo	Medium-Sized Bird	16/08/2019	17/08/2019	1	41
	White-striped Freetail Bat	Large Bird	16/08/2019	NA	30	41
	White-striped Freetail Bat	Bat	16/08/2019	16/08/2019	1	41
	Common Myna	Small Bird	16/08/2019	18/08/2019	2	16
	White-striped Freetail Bat	Bat	17/08/2019	20/08/2019	3	58
	White-striped Freetail Bat	Bat	21/04/2020	23/04/2020	2	7
	Eastern Rosella	Medium-Sized Bird	21/04/2020	25/04/2020	4	7
	White-striped Freetail Bat	Bat	21/04/2020	22/04/2020	1	16
	Australian Magpie	Medium-Sized Bird	23/04/2020	27/04/2020	4	23

Season	Species	Carcass size	Placement Date	Scavenged date	Days in the field	Turbine
	Australian Magpie	Medium-Sized Bird	23/04/2020	28/04/2020	5	23
	Australian Wood Duck	Medium-Sized Bird	23/04/2020	2/05/2020	9	14
	Wedge-tailed Eagle	Large Bird	23/04/2020	23/05/2020	30	14
	Nankeen Kestrel	Medium-Sized Bird	23/04/2020	29/04/2020	6	14
	Wedge-tailed Eagle	Large Bird	23/04/2020	23/05/2020	30	5
	White-striped Freetail Bat	Bat	23/04/2020	27/04/2020	4	5
Long grass	White-striped Free-tailed Bat	Bat	21/11/2020	21/11/2020	0	58
	Noisy Miner	Small Bird	21/11/2020	21/11/2020	0	58
	Collared Sparrowhawk	Small Bird	21/11/2020	21/11/2020	0	58
	Wedge-tailed Eagle	Large Bird	21/11/2020	not scavenged	30	58
	Eastern Rosella	Small Bird	21/11/2020	21/11/2020	0	58
	Noisy Miner	Small Bird	21/11/2020	not scavenged	30	59
	White-striped Free-tailed Bat	Bat	21/11/2020	Failed	Failed	59
	Australian Magpie	Medium-Sized Bird	21/11/2020	25/11/2020	4	59
	Crested Pigeon	Medium-Sized Bird	21/11/2020	23/11/2020	2	48
	White-striped Free-tailed Bat	Bat	21/11/2020	not scavenged	30	48
	Little Red Flying Fox*	Large Bat	21/11/2020	not scavenged	30	48
	Australian King-parrot	Medium-Sized Bird	28/11/2020	30/11/2020	2	34
	Australian Galah	Medium-Sized Bird	28/11/2020	29/11/2020	2	34
	White-striped Free-tailed Bat	Bat	28/11/2020	2/12/2020	4	63
	Eastern Rosella	Small Bird	28/11/2020	5/12/2020	7	63
	Chocolate Wattled Bat	Bat	3/02/2021	not scavenged	30	9
	Australian Galah	Medium-Sized Bird	3/02/2021	not scavenged	30	55
	White-striped Free-tailed Bat	Bat	3/02/2021	5/12/2020	2	55
	Eastern Rosella	Small Bird	3/02/2021	3/12/2020	0	9

Season	Species	Carcass size	Placement Date	Scavenged date	Days in the field	Turbine
	Australian Magpie	Medium-Sized Bird	3/02/2021	3/12/2020	0	10
	Dusky Woodswallow	Small Bird	3/02/2021	4/12/2020	1	60
	Red-rumped Parrot	Small Bird	3/02/2021	not scavenged	30	60

Appendix 3: Sapphire Wind Farm mortality estimate

symbolix

Sapphire Wind Farm Mortality Estimate

Prepared for Nature Advisory, 25 March 2021, Ver. 1.0

This report outlines an analysis of the mortality data collected at Sapphire Wind Farm from 2018-07-26 to 2021-01-26. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in August 2019 and November 2020
- Scavenger loss rates – consisting of trials in August 2019, April 2020, November 2020, and February 2021
- Mortality estimates - based on monthly surveys at 19 turbines, from 2018-07-26 to 2021-01-26

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]. Additional Wedge-tailed Eagle scavenger data was taken from Victorian wind farms - see Stark and Muir (2020).

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

[1] Sapphire WF mortality data for Symbolix updated 200324.xlsx

the range of searcher and scavenger efficiencies, and the survey frequency and coverage, and the true "found" details. After many simulations, we can estimate the likely range of mortalities that could have resulted in the recorded survey outcome.

This method has been benchmarked against analytical approaches (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

Three searcher efficiency trials were held (2019-08-08, 2020-11-21, and 2020-11-28). The detectability trials used both bird (30 replicates) and bat carcasses (10 replicates). A range of bird sizes were used, ranging from small (Myna), to medium (Australian magpie), to large (Wedge-tailed Eagle).

We found no evidence (using binomial regression) that the searcher efficiency differed between the surveys held in August 2019 and November 2020 ($z = -0.005$, $p = 0.996$).

We also found no evidence (via AIC) that searcher efficiency differed between bats and birds. Therefore, bird and bat detection efficiencies are aggregated in the following mortality estimate.

Table 1 summarises the result.

Bat and bird detectability is 92%, with a 95% confidence interval of [80%, 98%].

Table 1: Detection efficiencies for birds and bats.

Variable	Variable
Number found	37
Number placed	40
Mean detectability proportion	0.92
Detectability lower bound (95% confidence interval)	0.8
Detectability upper bound (95% confidence interval)	0.98

Scavenger efficiency

Scavenger efficiency trials were conducted during August 2019, April 2020, November 2020, and February 2021. Trials ran over 30 days, and used a similar set of species as the searcher efficiency trials.

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.

There is no evidence that scavenge rates were different between the different trials, based on AIC selection. Similarly, we found no evidence that birds (excluding Wedge-tailed Eagles) and bats have significantly different scavenger rates. Therefore, in the following mortality estimate, scavenger rates for bats and all bird species except WTEs are aggregated. WTEs were treated separately, as they generally have a very different scavenger rate profile from other birds.

The trials included 7 WTE carcasses, but none were scavenged during the 30-day trials. This is consistent with a recent analysis of data collected at Victorian wind farms which showed that the mean scavenge time for WTEs is much longer than for other bird species tested (Stark and Muir (2020)). Because none of the WTE carcasses in the trials at Sapphire Wind Farm were scavenged, it was not possible to model time until scavenge for WTEs using this data alone. However, we combined this data with data from scavenger trials at Victorian wind farms (Stark and Muir (2020)) to fit a survival curve for WTEs.

Due to results in Stark and Muir (2020), we have used a log-normal shape, which has been found to accurately describe the scavenger profile of carcasses in Victoria.

Figure 1 shows a survival curve fitted to the combined cohort of bats and birds (excluding WTEs) and a survival curve for WTEs. The survival curves (solid lines) show 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 8% to 43% of bat and bird (excluding WTEs) carcasses to remain after ten days with the expectation being around 18%.

Under these assumptions, the mean time to total loss via scavenge for bats and birds (excluding WTEs) is 12.3 days, with a 95% confidence window of [5.4, 27.9] days.

For WTEs, the mean time to total loss via scavenge is 513 days, with a 95% confidence window of [269, 977] days.

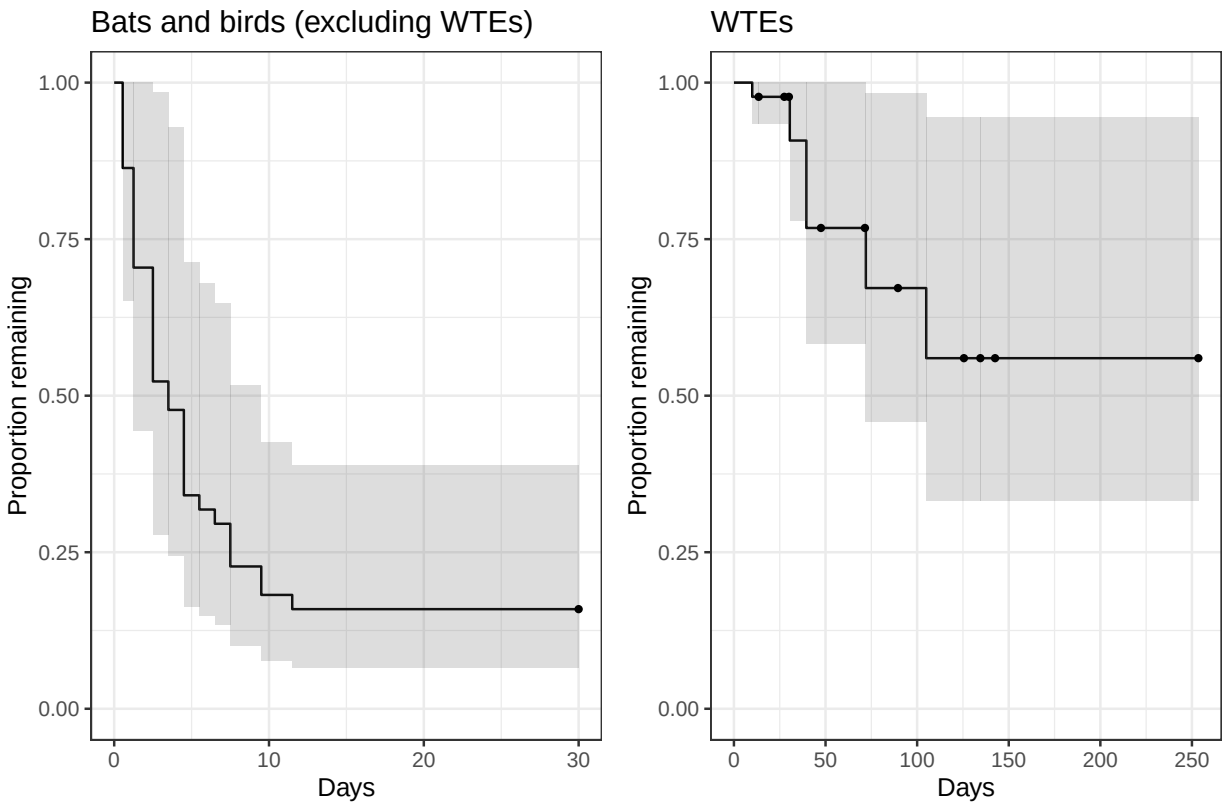

Figure 1: Survival curves with 95% confidence interval shaded.

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. 19 turbines were surveyed throughout the 31-month period, with between eight and 19 turbines generally surveyed twice each month. Turbines were surveyed out to a radius of 120 metres in standard surveys and to a radius of 60 metres in pulse surveys.

Table 2: Number of surveys per month.

Date	Number of surveys
2018 Jul	16
2018 Aug	16
2018 Sep	16
2018 Oct	16
2018 Nov	16
2018 Dec	16
2019 Jan	16
2019 Feb	36
2019 Mar	36
2019 Apr	36
2019 May	36
2019 Jun	36
2019 Jul	36
2019 Aug	36
2019 Sep	36
2019 Oct	36
2019 Nov	36
2019 Dec	36
2020 Jan	36
2020 Feb	36
2020 Mar	36
2020 Apr	36
2020 May	36
2020 Jun	36
2020 Jul	36
2020 Aug	36
2020 Sep	36
2020 Oct	36
2020 Nov	19
2020 Dec	20
2021 Jan	20

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 Sapphire Wind Farm from 2018-06-26 to 2021-01-26 (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 75 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 (2018-07-26) and until the final surveyed date (2021-01-26).
- 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 an log-normal scavenge shape ("olfactory" scavengers).
- We took scavenge loss and search efficiency rates as outlined above.
- 19 turbines were selected at random to be surveyed, and were searched out to a 120 metre radius for standard surveys and 60 metres for pulse survey. 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 assumed that the coverage factor was 75% for birds (excluding WTEs), 61% for WTEs, and 94% 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 3.

Table 3: Carcasses found during formal surveys over 31 months.

Species	Bat	Bird	Feather Spot
White-striped Freetail Bat	6	0	0
Chocolate Wattled Bat	1	0	0
Grey-headed Flying Fox	1	0	0
Little Forest Bat	1	0	0
Little Red Flying Fox	1	0	0
Australian Magpie	0	4	3
Collared Sparrowhawk	0	2	0
Wedge-tailed Eagle	0	2	0
Australian Wood Duck	0	1	2
Red-rumped Parrot	0	1	2
Nankeen Kestrel	0	1	1
Tawny Frogmouth	0	1	1
Forest Kingfisher	0	1	0
Grey Butcherbird	0	1	0
Crimson Rosella	0	0	1
Eastern Rosella	0	0	1
Galah	0	0	1
Sacred Kingfisher	0	0	1

We also note a number of carcasses were found opportunistically. We don't include these in our formal estimate of mortality, but we do report them in Table 4 for completeness.

Table 4: Informal carcass finds.

Species	Count
Wedge-tailed Eagle	4
Crested Pigeon	3
Little Eagle	1
Australian Magpie	1
Eastern Rosella	1
Australian Wood Duck	1
White-striped Freetail Bat	1

Bat mortality estimate – results

During the 31 months of surveys a total of 10 bats were found during formal surveys (Table 3). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 166 and a median of 158 bats lost on site over the 31 months.

Table 5 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 166 bats over the survey period, and are 95% confident that fewer than 252 individuals were lost.

Table 5: Percentiles of estimated total bat losses over the 31 months of surveys.

0%	50% (median)	90%	95%	99%	99.9%
60	158	231	252	326	381

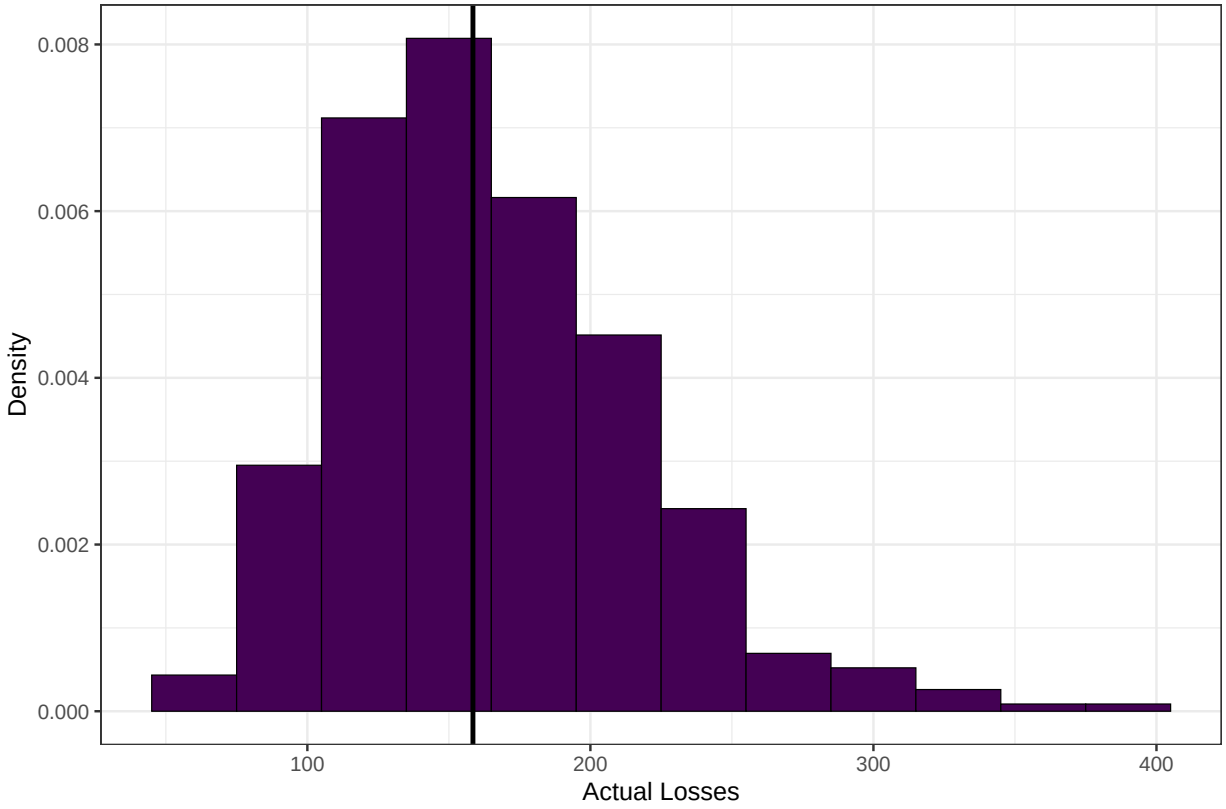

Figure 2: Histogram of the total losses distribution (bats), given 10 were detected on-site. The black solid line shows the median.

Bird mortality estimate - results

During the 31 months of surveys a total of 25 birds (excluding WTEs, which are analysed separately due to their unique scavenger rate profile) were found during formal surveys (Table 3). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 457 and a median of 442 birds lost on site over the 31 months.

Table 6 and Figure 3 display the percentiles of the distribution, to show the confidence interval in this average.

In addition, a total of 2 WTEs were found during formal surveys. The resulting estimate of total mortality is an expectation (mean) of 13 and a median of 121 WTEs lost on site over the 31 months.

Table 7 and Figure 4 display the percentiles of the distribution, to show the confidence interval in this average.

In determining these estimates, 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 457 birds (excluding WTEs) over the survey period, and are 95% confident that fewer than 658 individuals were lost.

For WTEs, we expect that there was a total site loss of around 13 WTEs over the survey period, and are 95% confident that fewer than 27 individuals were lost.

Table 6: Percentiles of estimated total bird losses (excluding WTEs) over the 31 months of survey period.

0%	50% (median)	90%	95%	99%	99.9%
241	442	611	658	766	846

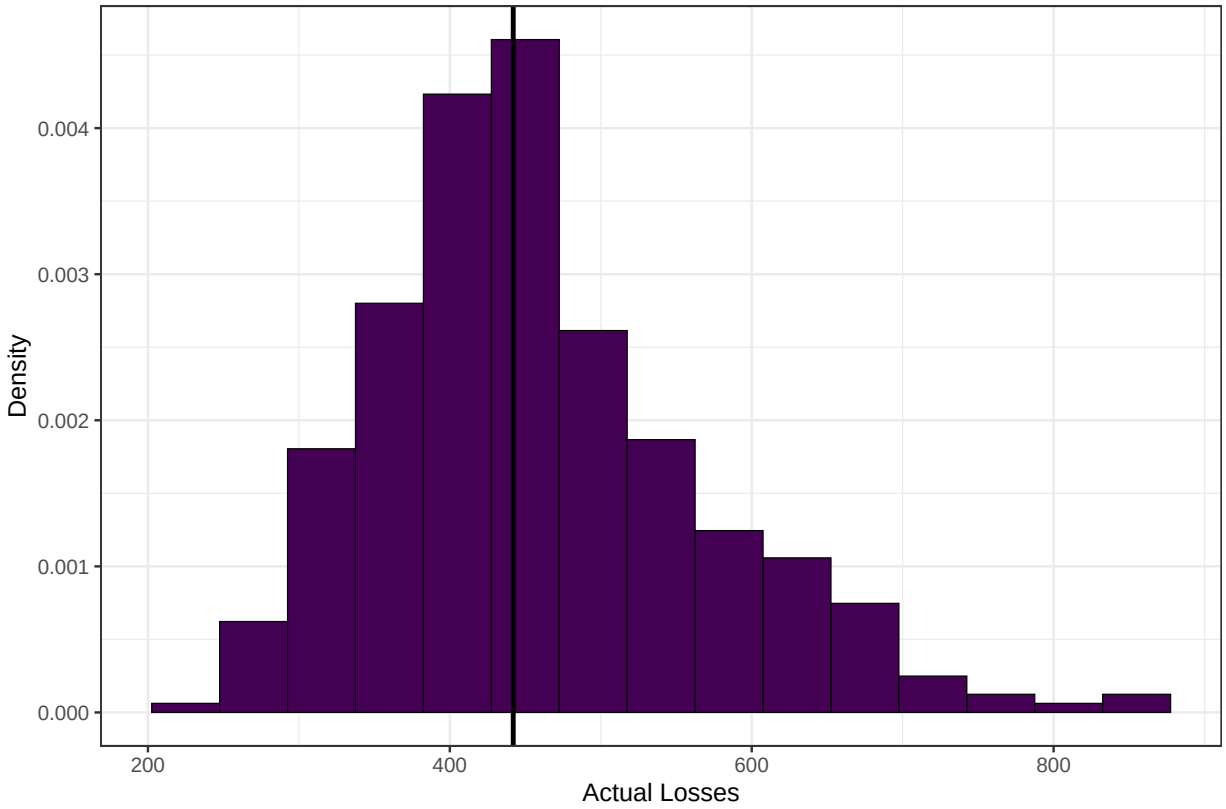

Figure 3: Histogram of the total losses distribution (birds, excluding WTEs), given 25 were detected on-site. The black solid line shows the median.

Table 7: Percentiles of estimated total WTE losses over the 31 months of surveys.

0%	50% (median)	90%	95%	99%	99.9%
2	12	24	27	37	45

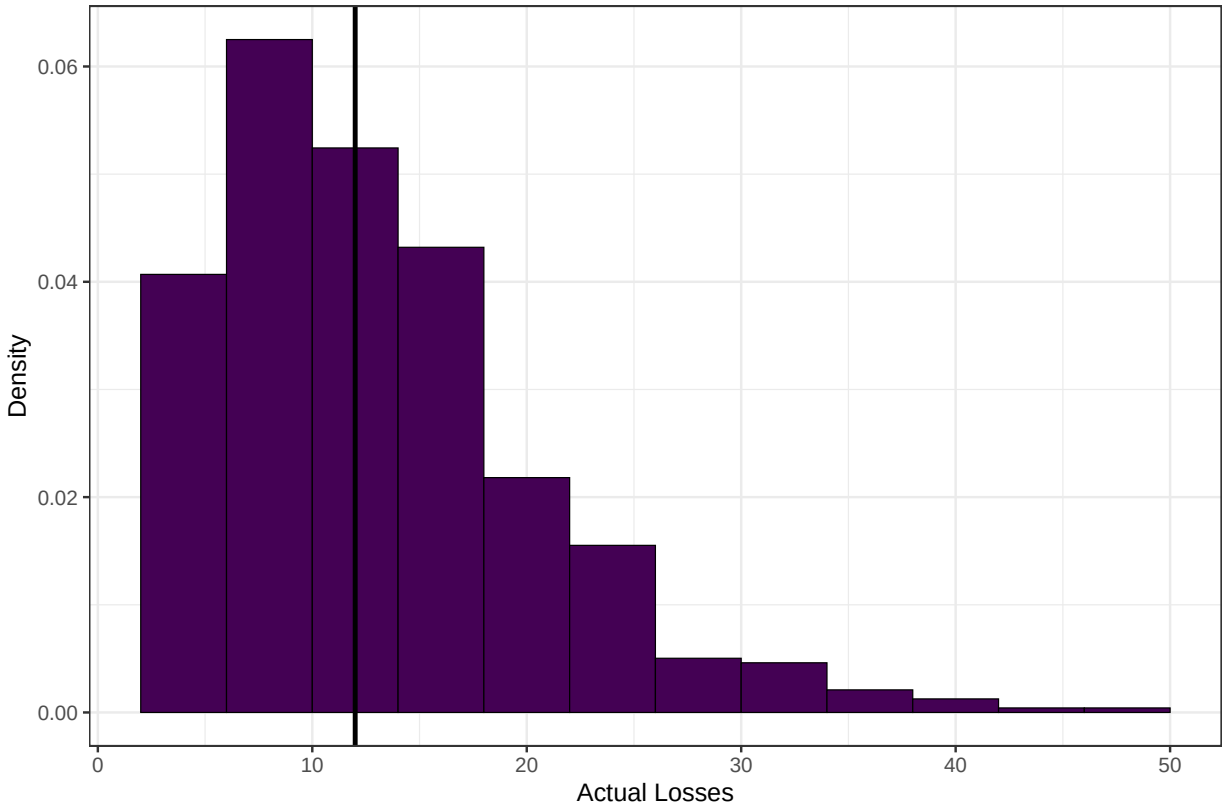

Figure 4: Histogram of the total losses distribution (WTEs), given 2 were detected on-site. The black solid line shows the median.

Comparison of year one and year two results

Bat results

During the first year of surveys (2018-06-26 to 2019-07-31) a total of 1 bat was found during formal surveys. The resulting estimate of total mortality is an expectation (mean) of around 33 bats over the survey period, and we are 95% confident that fewer than 81 individuals were lost.

In comparison, in the second year of surveys (2019-08-01 to 2020-07-31) a total of 3 bats were found during formal surveys. The resulting estimate of total mortality an expectation of 53 bats over the survey period, and we are 95% confident that fewer than 103 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 is not significantly different from the distribution of year two mortalities (the test statistic $D = 0.33$ is lower 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 is not significantly different from the number of losses in year two.

Bird results

Birds - general

During the first year of surveys a total of 3 birds (excluding WTEs) were found during formal surveys. The resulting estimate of total mortality is an expectation of around 80 birds over the survey period, and we are 95% confident that fewer than 161 individuals were lost.

In comparison, in the second year of surveys a total of 10 birds (excluding WTEs) were found during formal surveys. The resulting estimate of total mortality an expectation of 162 birds over the survey period, and we are 95% confident that fewer than 264 individuals were lost.

Using the Kolmogorov-Smirnov test, we find the distribution of bird mortalities (excluding WTEs) of the first year to be shifted left, compared to the distribution of year two mortalities (the test statistic $D = 0.64$ 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 (excluding WTEs) losses in year one was significantly lower than the number of losses in year two.

WTEs

Additionally, a total of zero WTEs were found during formal surveys in the first year. The resulting estimate of total mortality is an expectation of around five WTEs over the survey period, and we are 95% confident that fewer than 14 individuals were lost.

In comparison, in the second year of surveys a total of two WTEs were found during formal surveys. The resulting estimate of total mortality an expectation of 12 birds over the survey period, and we are 95% confident that fewer than 14 individuals were lost.

We find the distribution of WTE mortalities of the first year to be shifted left, compared to the distribution of year two mortalities (the test statistic $D = 0.53$ is greater than the critical value $D^* = 0.35$ at the 0.05 significance level).

This suggests that the true total number of WTE 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 4: Raw data for the Spring 2021 impact and reference BUS points at Sapphire Wind Farm

Impact points

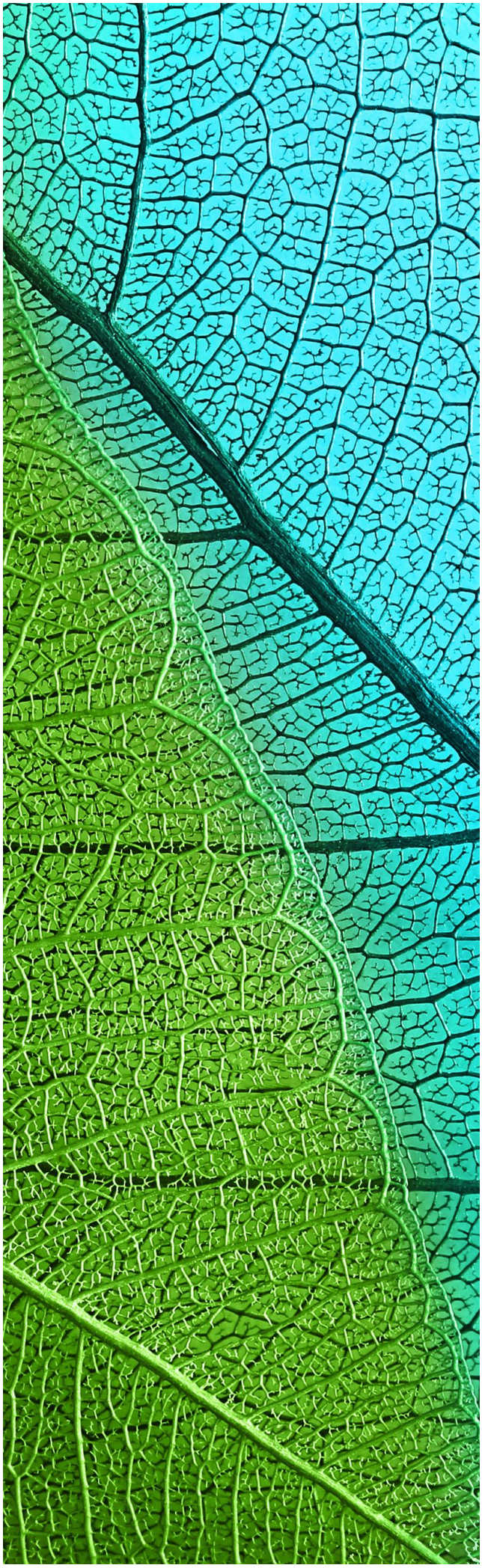
Site	BUS1									BUS2										BUS3										BUS4							
Replicate	1		2	3	4	5	6	7	8	1		2	3	4	5	6		7	8		1	2	3	4		5	6	7		8	1	2	3	4	5	6	7	8
Height class	A	B	A	A	A	A	A	A	A	A	B	A	A	A	A	A	B	A	A	B	A	A	A	A	B	A	A	A	B	A	A	A	A	A	A	A	A	A
Australian King Parrot																															1							
Australian Magpie			3	2	4	4	3	1				3	1	3	1	2		2	1			3	1	2		1	3			1		3	3	2	2	5	2	1
Australian Raven	3												1	1	2								1												1			
Black-faced Cuckoo-shrike			1			1				1																1	1						1					
Brown Falcon																																						
Brown Goshawk																													1									
Crested Pigeon				2									2																									
Crimson Rosella			1			2	1																								3	6	1		2			
Double-barred Finch								2																														
Eastern Rosella	2		4	1	2	5	6	2	2	2		6	16	3	9	6		7	8		2	4		3		2				1	2	1	2	1	2	2	2	
Galah			2		12					4		2	4	1	5			2				1	3	1								5				4	2	1
Grey Butcherbird					1							1	1	1	1			1				1		1		1	1	1				1						1
Grey Fantail					1																																	
Grey Shrike-thrush									1																													
Laughing Kookaburra					1							2	2						1		1																	
Little Corella													1																		1							
Little Eagle																	1																					
Magpie-lark			1			1																																
Maned Duck																		1																				
Mistletoe-bird						3			3																													
Musk Lorikeet				4		6		2	2	6																						1	3					
Nankeen Kestrel										1																												
Noisy Friarbird	1		4	1		3	1		2																		1	1									
Noisy Miner	8		6	8	3	5	8	5	8	3		3	5	4	7	6		4	3		9	5	5	3		4		5		1	5	9	8	5	4	3	7	2
Peaceful Dove																																						
Pied Currawong	1		5		1	1		1	1																			1			1						
Rainbow Lorikeet			6			2																										2						
Red Wattlebird			1		1	1	1		1																						1						
Red-rumped Parrot			2			4	1			8		4	14	14	2	10		14	5																		
Restless Flycatcher							1																															
Speckled Warbler					3																																	
Spotted Pardalote			1	2																		1															
Striated Pardalote			4			2		2	1				1								2		2								2							
Striated Thornbill			3		4																																	
Sulphur-crested Cockatoo		1	3	28	5	2					13	4	20	4	4	1		11		1						2	7										1	
Superb Fairywren					2			2																		3	7			3								
Wedge-tailed Eagle																									2													
Weebill			3	3	4	2	4	3				2		2								3	3			2	2			1	6							

Site	BUS1									BUS2										BUS3									BUS4							
White-faced Heron																															1					
White-throated Gerygone																																				
White-throated Treecreeper					2																						2									
White-winged Chough																																				
Willie Wagtail			1			1			1												1									1			1			
Yellow-rumped Thornbill					2																															
rand Total	15	1	51	51	48	45	26	20	22	25	13	27	68	33	31	25	1	42	18	1	14	19	15	10	2	16	24	8	1	7	23	28	19	8	10	16	14	5

Reference points

Site	RF1									RF2								
Replicate	1	2	3		4	5	6	7	8	1	2	3		4	5	6	7	8
Height class	A	A	A	B	A	A	A	A	A	A	A	A	B	A	A	A	A	A
Australian King Parrot											2							
Australian Magpie		8	1		4	1	2	3			4	1		1	1	3		
Australian Raven							2								2	1		
Black-faced Cuckoo-shrike											1							
Brown Falcon																		1
Brown Goshawk		1				1												
Crested Pigeon									1							2		
Crimson Rosella		1						2	1			2				2		
Double-barred Finch																		
Eastern Rosella	16	6	4		8	3	4	8	6	4	9	9		2	1	2	3	1
Galah	2		2			2	3	1			13	1				1		
Grey Butcherbird		2	1		1	1	1	1		1	1	1			1	1	1	
Grey Fantail																		
Grey Shrike-thrush			1															
Laughing Kookaburra		1				1	1	1		5	1							
Little Corella																		
Little Eagle																		
Magpie-lark					1		1	1										
Maned Duck								4			1							
Mistletoe-bird																		
Musk Lorikeet							4											
Nankeen Kestrel																		
Noisy Friarbird			1												1			
Noisy Miner	7	6	8		8	8	9	6	7	8	13	13		5	2	9	13	3
Peaceful Dove									1									
Pied Currawong	1	1			3	1	1				1	2			1			1
Rainbow Lorikeet			2		2		2				1							
Red Wattlebird																1		
Red-rumped Parrot														4	2			
Restless Flycatcher																		
Speckled Warbler																		
Spotted Pardalote																		
Striated Pardalote						2					3	2						
Striated Thornbill																		
Sulphur-crested Cockatoo	5	8	2			4	21	9		1	5	4			1	2	8	
Superb Fairywren											3	3					4	
Wedge-tailed Eagle				1									1					
Weebill										6	3	3		2		1	2	

Site	RF1									RF2								
White-faced Heron																		
White-throated Gerygone										3	1						1	
White-throated Treecreeper		1						1										1
White-winged Chough											6							
Willie Wagtail									1		1							
Yellow-rumped Thornbill																		
Grand Total	31	35	22	1	27	24	51	37	17	28	69	41	1	14	12	25	32	7



Sapphire Wind Farm

Third Year Annual Report on the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for SWF1 Operations Pty Ltd

March 2022
Report No. 16045 (28.1)

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1. Introduction

Sapphire Wind Farm (SWF) is located in the Kings Plain District, 24 kilometres west of Glen Innes and 28 kilometres east of Inverell in the northern tablelands of New South Wales (NSW) (Figure 1). The wind farm currently comprises of 75 turbines and associated infrastructure. The site has been mostly cleared of its original native vegetation and is predominately being utilised for grazing.

SWF proposed a 159-turbine wind farm in the northern Tablelands of NSW in 2007. The NSW Department of Planning and Infrastructure (DPI) and the Commonwealth Department of the Environment (DotE) approved the wind farm in June 2013 and December 2014 respectively. In January 2016, Sapphire Wind Farm Pty Ltd requested a modification to the approval to reduce the number of turbines from 159 to up to 109 turbines and increase the maximum tip height to 200 metres above the ground and rotor diameter to 126 metres. The DPE and the DotE approved the Modification request in June 2016. The project completed construction in late 2018 with a refined design which involved the construction of 75 turbines at locations approved in the Modification.

Condition C6 of the NSW approval required the preparation of a Bird and Bat Adaptive Management Program (BBAMP), these requirements have been outlined in the following section. Element (d) required the proponent to identify 'at risk' bird and bat groups, seasons and/or areas within the project site which may attract high levels of mortality. The BBAMP was prepared by Brett Lane & Associates Pty Ltd, predecessor of Nature Advisory Pty Ltd (BL&A 2017) and approved by the Director-General of DPI.

Sapphire Wind Farm Pty Ltd engaged Nature Advisory to implement the approved Bird and Bat Adaptive Management Program (BBAMP) for the SWF. Specifically, the scope of the work included:

- Operational bird and bat carcass (mortality) monitoring program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

The first phase of the monitoring program began in the partial-operational phase in July 2018 and in total comprised 31 months of monitoring and 24 months of fully operational surveys, concluding in January 2021. The findings of the second-year annual (Nature Advisory 2021) report are summarised below:

No threatened or non-threatened management triggers occurred as a result of the monitoring program. It is unlikely that the results from the monitoring program or the mortality estimates suggest a significant impact on any of the species identified as mortalities. Each is a relatively common and widespread species to farmland landscapes in NSW and other parts of Australia, and each is considered secure and not in decline. It is unlikely that SWF would have a significant impact on any populations regionally, on a state level or overall.

The report also acknowledged that WTE, nominated as an 'at risk species' in the BBAMP initially, was relatively more highly impacted than other bird species. As such, the report detailed a number of recommendations, based on the findings of the BBAMP 31 months implementation, for the continued implementation of the BBAMP, which are summarised below:

- The cessation of the carcass search program,
- Incidental monitoring of carcasses and feather spots continue to be reported
- Inclusion of any incidental finds in annual reporting for the first five years of operation,
- Continuation of carrion removal, limiting lambing and stock feeding close to turbines.

In line with Sapphire Wind Farm Condition C6, ongoing information collation should be included in reports submitted to the Director-General and OEH on an annual basis for the first five years of operation as outlined in Condition C6 of the Project Approval. This report comprises the third annual report, covering all monitoring activities during the third year of official operation of SWF from February 2021 to January 2022.

As per Section 4.7 of the BBAMP, the third annual report includes, but is not limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- Incidental carcass observations;
- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework and relevant adaptive management measures.
- A summary of livestock carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs and their timing;
- A discussion of the results, including:
    - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.
    - Bird risk reduction measures.
    - Any further recommendations for reducing mortality, if necessary.
    - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
    - Recommendations for further monitoring.

This report is divided into the following sections:

Section 3 provides the methods of the third year of monitoring.

Section 4 presents the results of the third year of monitoring.

Section 5 discusses the conclusions of the third year of monitoring.

Section 7 provides recommendations for future monitoring.

This report was developed by a team from Nature Advisory, comprising Kaitlyn Spooner (Zoologist), Jackson Clerke (Zoologist and Project Manager), and Bernard O'Callaghan (Director).

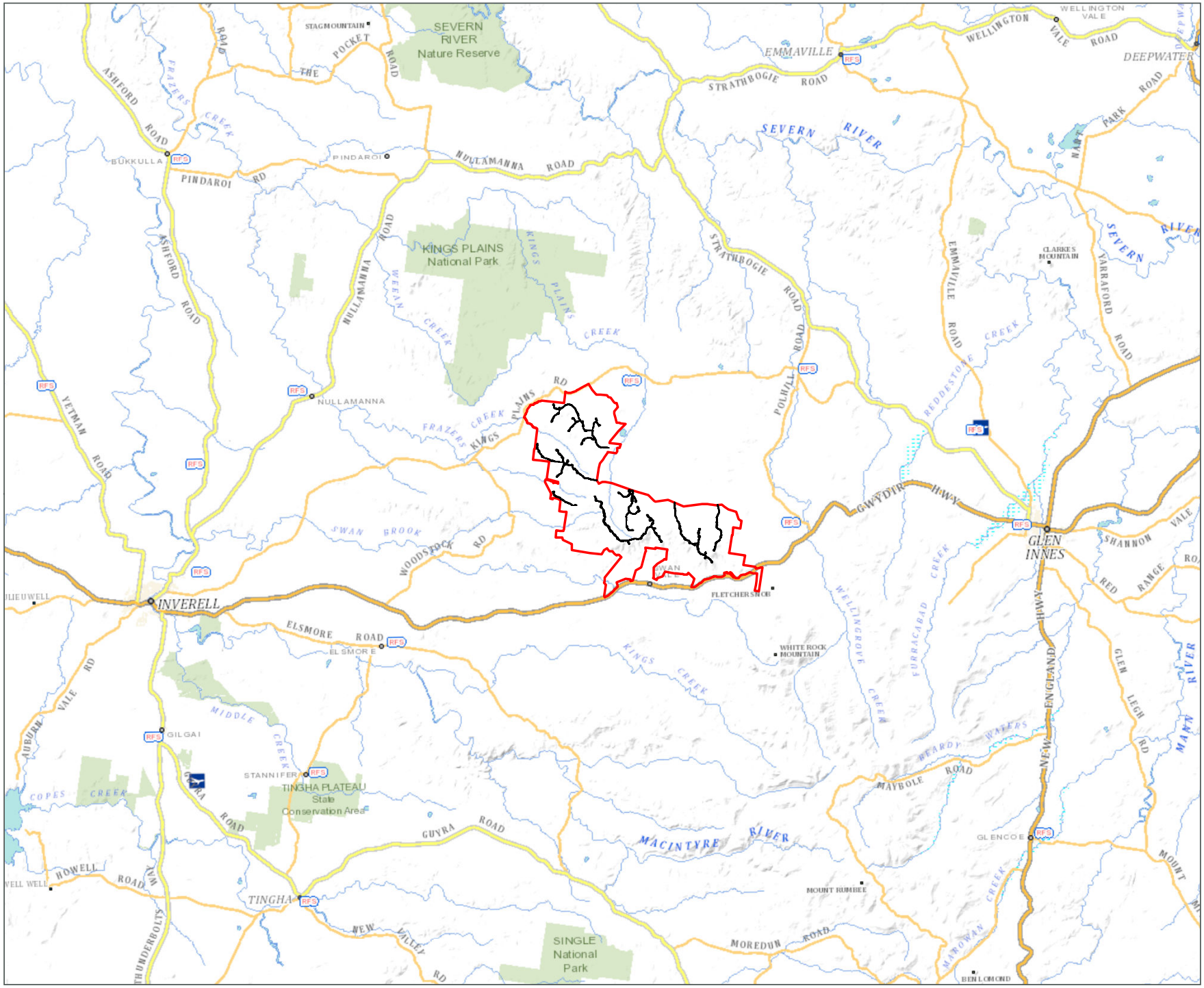

Figure 1: Locality map

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

Study area
Turbines
Access tracks

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Layers - Created by: - \\Blagis01\e\GIS\2016 Jobs\16045\16045 FIG 1 Locality 160826.mxd

2. Methods

2.1. Incidental carcass finds

Any carcasses or feather spots found by wind farm personnel are to be recorded on a datasheet, photographed and stored in the freezer on the wind farm site in line with the BBAMP. This data can then be provided to Nature Advisory remotely to identify, if required.

This approach will continue to provide some indication of on-going impacts to birds and bats at the wind farm, particularly for the WTE which is easily identifiable and visible from a distance. Data on incidental monitoring is tabulated annually.

2.2. Carrion removal program

As WTE (and some other raptors) forage for carrion, a regular carrion removal program has been implemented to reduce the attractiveness of the site to raptors and therefore reduce the potential for fatal collisions. This program consists of a designated Carrion Removal Coordinator conducting monthly inspections of the wind farm site for any carcasses that may attract raptors (e.g., kangaroos, pigs, rabbits, dead stock). Any carcasses or remains found within 200 m of turbines, whether during searches by the Carrion Removal Coordinator or incidental finds, are collected and disposed of as soon as possible in a manner that will avoid attracting raptors close to turbines. Carcass occurrence and removal is recorded in a 'management log book' maintained by the SWF asset manager.

2.3. Lambing restriction and grain feeding control

Consultations with landholders are to be held to request that lambing and grain feeding be restricted in the vicinity of turbines if possible.

2.4. Pest control

If a large active rabbit presence is observed, subject to landholder approval, an integrated rabbit control program to reduce site attractiveness to WTE is completed. Methods to control rabbits include burrow destruction and shooting. Any rabbit control program will require cooperation and agreement from the landowner.

3. Results

All results of the monitoring requirements were provided to Nature Advisory by SWF.

3.1. Incidental carcass finds

One incidental carcass find was made by SWF staff. The details are provided in the Table 1.

Table 1: Incidental finds by SWF staff during year 3 of BBAMP implementation

Date	Time	Species	Turbine	Distance (metres)	Bearing (degrees)	Notes
8/12/21	14:30	Wedge-Tailed Eagle	T4	10m	180	NE wind (8m/s) in previous 24hrs, very old carcass, >3 weeks.

3.2. Carrion removal program

Observations of carrion around turbines was reviewed during monthly inspections of project site. Consultation occurred as per the BBAMP.

3.3. Lambing and grain restriction

Lambing was requested to be restricted and was undertaken at landholder discretion.

Higher rainfall occurred during the area during Year 3 which resulted in higher feed availability therefore limited grain feeding was observed throughout the project site.

3.4. Pest control

No pest control was required to be undertaken in conjunction with landholders. Any pest control undertaken was done so at landholder discretion as part of their normal operations.

4. Conclusions

The single WTE mortality detected by SWF staff during December 2021 is indicative of the low, albeit continuing impacts on the species. The results provided to date do not indicate an increase of impacts of the species at SWF or a significant one.

Recommendations for a continued monitoring program into Year 4 are provided below.

5. Recommendations

CWP Renewables received a response to the Second Annual Report from the Biodiversity and Conservation Division (BCD) on the 20th July 2021 putting forward a number of additional mitigation measures and monitoring suggestions. A subsequent meeting was held between BCD, CWP Renewables and Nature Advisory to discuss these further.

The result of the discussion was that additional mitigation measures to further reduce ongoing risk to bird and bat species at SWF be considered and revised methods for the ongoing BBAMP implementation be proposed.

The following sections outline the revised monitoring program designed to specifically target impacts to WTE and assess the effectiveness of such mitigation measures.

5.1. Carcass searches

Data collected by Nature Advisory during scavenger trials across many wind farms in New South Wales (NSW) and Victoria, in addition to targeted WTE scavenging trials at a wind farm in NSW, show that WTE are not typically scavenged, with the vast majority of WTE carcasses remaining in situ until they completely dispose (Nature Advisory unpub. data).

Carcass monitoring will be completed at all SWF turbines every six months (or twice a year) in accordance with the search protocol outlined in Section 4.4.2 of the BBAMP. During the initial post-construction carcass monitoring program, carcass searches were conducted at 18 turbines. The revised carcass search program will see the inner and outer zone of all 75 turbines at SWF searched with no follow up pulse searches completed.

One search will aim to take place in the months following the breeding period (generally Oct-Dec) after the young have fledged. Juveniles tend to disperse during this time and may be at higher risk of collision than adults. The second search will take place six months after the first.

During the period between the formal carcass searches, incidental carcass monitoring will continue to take place by wind farm personnel with any bird or bat carcasses identified reported and recorded in accordance with Section 4.4.5 of the BBAMP.

5.2. WTE incidental monitoring and nest monitoring

In addition to the revised carcass search regime, at the commencement of the revised operational monitoring program, a nest search will be completed at SWF to identify any potential WTE nests inside the project area. The nests identified during this search will be recorded and monitored on an annual basis during October to December to record breeding activity and utilisation. The intention of this monitoring is to monitor utilisation for breeding purposes and utilisation in general.

Incidental monitoring of WTE flight paths will be undertaken during any site visit by ecologists. Observations will contribute to monitoring site usage and WTE numbers.

Increased or decreased breeding activity or site utilisation may provide additional insight into the impacts on WTE and effectiveness of mitigation measures. These findings will be included in reporting

5.3. Reporting

Findings of the revised monitoring program will be reported in annual reporting and recommendations for amendments to the plan or further measures will be made in conjunction with BCD.

5.4. Revised risk reduction measures

The following provides amendments and improvements to Section 5 of the BBAMP mitigation measures to improve the implementation of measures and enable assessment and review in annual reporting. The aim of the revised program is to track implementation of mitigation measures at SWF and their outcomes and then assess this against the findings of the revised monitoring program and potential impacts on WTE throughout the operation of SWF.

Land-use and stock management below and around turbines can influence the presence and behaviour of native birds on site. Examples include:

- Grain feeding can be an "attractant" for parrots; and
- Carrion and rabbits can be an "attractant" to raptors in the area.

Thus, this section proposes possible mitigation measures to address these matters.

A moderate risk to WTE has been identified for SWF. The WTE and other raptors forage for carrion (dead and decaying flesh of an animal) and also on small mammals, rabbits etc. In order to reduce the risk of raptors colliding with turbines, a formalised carrion monitoring and removal program will be implemented during operations, to reduce the attractiveness of the site to raptors (specifically WTE) and therefore reduce the potential for fatal collisions by this group of birds. This program will focus on an area of a minimum of 200 metres around turbines, where safe, feasible and practical. The procedures below will be adopted:

- The SWF Site Manager has been appointed to perform the function of Carrion Removal Coordinator who will undertake the activities described below. In the event the SWF Site Manager is not available, an alternative suitable person will be appointed to undertake this function.
    - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g., kangaroo, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars to look for large carcasses within 200 metres of each turbine. Results from inspections will be documented and the following information collected each month:
        - Date of inspection,
        - Person undertaking the inspection,
        - Any carrion identified and location (e.g., Turbine ID),
        - Any carrion still present from previous inspection,
        - Action taken (e.g., consultation with landholders or removal of carrion)
        - Pest animal activity or presence,
        - Lambing activity (when applicable),
        - Any incidental observations by landowners or SWF staff.
    - Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be address by operator and landowner protocols and information included in monthly inspection data

- Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines. If a carcass is not removed, it's visibility during the next monthly inspection should be recorded.
- Consult with landowner or wind farm staff in relation to the appropriate disposal of collected carrion, to be located at least 200 metres away from the closest turbine. Results of consultations will be logged and the locations of any carrion dumps active or planned noted. This can be assessed against any potential WTE mortality locations.
- Carcass occurrence and removal will be recorded in monthly inspection records maintained by SWF Project Manager.

- During lambing season (usually late autumn/winder) young lambs are susceptible to death. Therefore, if possible and subject to agreement of landowners, lambing will be restricted in paddocks at least 200 metres away from turbines, where practicable, to reduce the risk that raptors (WTE in particular) are attracted close to the turbines.
- A consultation log with landholders will be maintained and used to inform ongoing success of mitigation measures. Consultation will be had with landholders requesting that they keep lambing to paddocks without access to turbines where possible. Actual locations of lambing activity will be recorded during monthly inspections to map actual land use activity during operation. This can be compared with any potential WTE mortality identified during carcass searches.
- In order to reduce collision risks to birds, where practical and with landowner agreement, the practice of grain feeding of stock within 200 metres of turbines should be minimised as it could cause draw additional parrots and other birds to the site.
- Any feral animal control on the wind farm site should involve the removal and appropriate disposal of resulting carcasses in a timely manner.
- If a large active presence of rabbits is observed during monthly inspections near turbines, subject to landholder approval, an integrated rabbit control program (to reduce site attractiveness to WTE) will be completed within 200 metres of turbines. Methods to control rabbits include burrow destruction and shooting. Any rabbit control program will require cooperation and agreement from the landowner.
- Monthly inspection data, actual land use and land holder consultations covering the information requirements above, will be reported on in accordance with the BBAMP reporting requirements and provided to BCD covering 12 months of implementation from the date of the approval of this addendum.

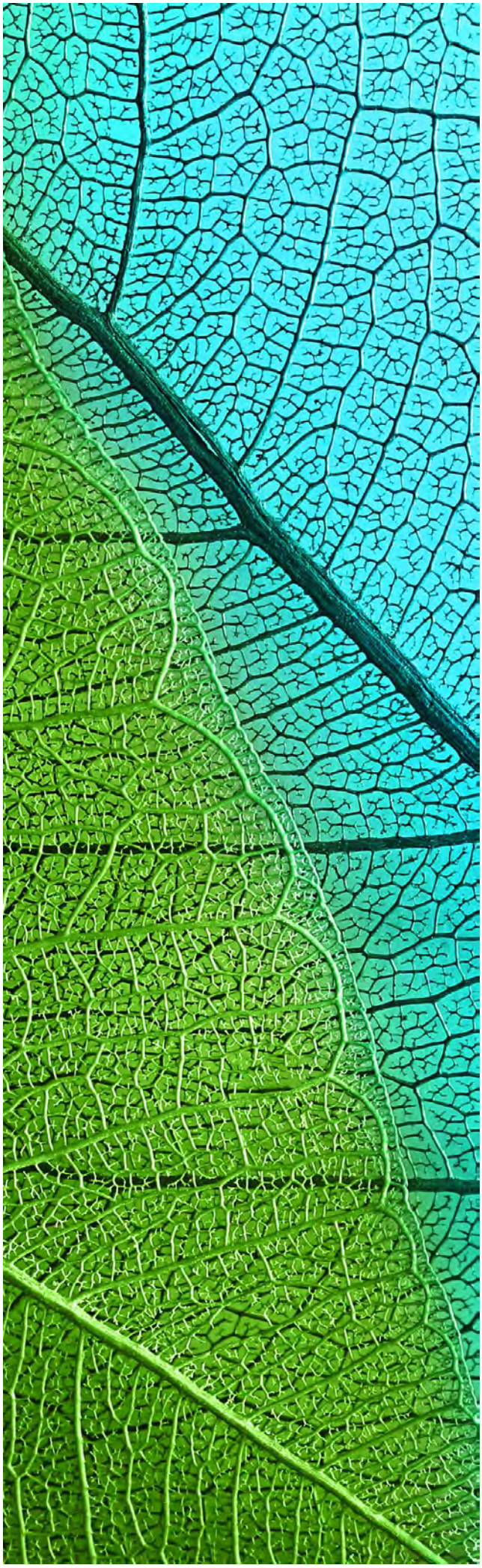
Using the information collected above, the efficacy of the mitigation measures implemented will be assessed. This will include assessment against; carrion occurrence rates, removal requests and actual removal undertaken and actual land use (lambing and carrion dump locations) using WTE carcass search data and site utilisation data.

The program will be reviewed in accordance with the BBAMP reporting requirements. If, for example, WTE mortality increases when compared to the initial 24-month operational monitoring period, then the need for continuation or refinement or additional mitigation measures will be discussed, in consultation with BCD/DPIE.

6. References

Brett Lane & Associates (BL&A) 2017, *Sapphire Wind Farm Bird and Bat Adaptive Management Program* – Report No. 16045 (3.3), Brett Lane & Associates Pty Ltd, Hawthorn East, consultant report prepared for CWP Renewables Pty Ltd.

Nature Advisory, 2021. Second Year Annual Report of the Implementation of the Bird and Bat Adaptive Management Plan. Prepared for SWF1 Operations Pty Ltd. June 2021. Report No. 16045 (26.1).



Sapphire Wind Farm

Fourth Year Annual Report on the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for Sapphire Wind Farm 1 Operations Pty Ltd

March 2023
Report No. 16045.4 (1.1)

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1. Introduction

1.1. Project Background

Sapphire Wind Farm (SWF) is located in the Kings Plain District, 24 kilometres west of Glen Innes and 28 kilometres east of Inverell in the northern tablelands of New South Wales (NSW) (Figure 1). The site has been mostly cleared of its original native vegetation and is predominately being utilised for grazing. The wind farm currently comprises 75 turbines and associated infrastructure.

The history of the SWF commenced in 2007, with the proposition of a 159-turbine wind farm. Development applications were approved in June 2013 and December 2014 by the NSW Department of Planning and Environment (DPE) and the former Commonwealth Department of the Environment (DotE) (now Department of Climate Change, Energy, Environment and Water (DCCEEW) respectively. In January 2016, Sapphire Wind Farm Pty Ltd requested a modification to the approval to reduce the number of turbines from 159 to no more than 109 turbines whilst increasing the maximum tip height to 200 metres above the ground and rotor diameter to 126 metres. The DPE and the DotE approved the modification request in June 2016. The project completed construction in late 2018 with a refined design which involved the construction of 75 turbines at locations approved in the modification.

Condition C6 of the DPE approval required the preparation of a Bird and Bat Adaptive Management Program (BBAMP), these requirements have been outlined in the following section. Specifically, Condition C6(d) required the proponent to identify 'at risk' bird and bat groups, seasons and/or areas within the project site which may attract high levels of mortality. The BBAMP (BL&A 2017) was prepared by Brett Lane & Associates Pty Ltd, predecessor of Nature Advisory Pty Ltd and approved by the Director-General of DPE.

Sapphire Wind Farm Pty Ltd engaged Nature Advisory to implement the approved Bird and Bat Adaptive Management Plan (BBAMP) for the SWF. Specifically, the scope of the work included:

- Operational bird and bat carcass (mortality) monitoring program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

1.2. Previous monitoring and recommendations

The first phase of the monitoring program began during the partial-operational phase in July 2018. In total, this comprised 31 months of monitoring and 24 months of fully operational surveys, concluding in January 2021. The second year of the monitoring program was conducted from February 2020 to January 2021, the second annual report (Nature Advisory 2021) for this period is summarised below:

No management triggers occurred during the monitoring program. The results from the monitoring program and the mortality estimates suggested it was unlikely that mortalities of any species identified at the site would significantly impact these populations on a state level, regional level or overall. The report acknowledged that Wedge-tailed Eagle (*Aquila* audax) (WTE), nominated as an 'at risk species' in the BBAMP, had higher observed mortalities relative to other bird species during the monitoring period. The report concluded that the carcass monitoring program to date had provided a sufficient baseline of the impacts SWF has on birds and bats and further carcass searches should not be required as part of ongoing BBAMP implementation. Future BBAMP implementation would include:

- Incidental monitoring of carcasses and feather spots continue to be reported;
- Inclusion of any incidental finds in annual reporting for the first five years of operation;

- Continuation of carrion removal, limiting lambing and stock feeding close to turbines;
- Integration a rabbit control program (as appropriate); and
- Annual reporting.

The third-year annual report (Nature Advisory 2022a) reported on the above activities during February 2021 to January 2022. One WTE carcass was reported as an incidental find and the report recommended the program continue as described above and, in addition; included the proposed Addendum described below.

1.3. Addendum to the BBAMP

The Biodiversity and Conservation Division (BCD), as the regulator to whom annual reporting is submitted under the BBAMP reporting obligations, provided response via letter on the 20th July 2021 to the second annual report on the requirements of the continued implementation of the BBAMP, and recommended that:

"1. Carcass monitoring should continue at the Sapphire Wind Farm in accordance with the Bird and Bat Adaptive Management Plan.

2. Additional measures to mitigate bird and bat strike should be considered and documented in the Bird and Bat Adaptive Management Plan.

3. Trials of these additional impact mitigation measures should be implemented at the Sapphire Wind Farm, where appropriate, and presented in future monitoring reports along with the results of the carcass monitoring."

An Addendum to the BBAMP (Nature Advisory 2022b) was prepared (3rd of March 2022) in response to the BCD letter and received a response from BCD on the 22nd March 2022 supporting the proposed mitigation measures and monitoring suggestions. Approval was given by DPE for the addendum to officially form part of the BBAMP in November 2022.

The addendum provided an adaptive monitoring program targeting WTE, as a high-risk species, consisting of a search of all 75 turbines at SWF, searched at six monthly intervals, as opposed to the initial monthly carcass searches outlined in the BBAMP. One search will take place after the breeding period (generally Oct-Dec) after the young have fledged; the second search would take place six months after the first. The methods and justification for this modified regime are provided in Section 2 below. A WTE breeding and flight activity survey was also undertaken as part of the monitoring effort.

In line with SWF Project Approval Condition C6, ongoing information should be collated and included in reports submitted to the Director-General (now the Secretary of Planning) and OEH (now BCD) on an annual basis for the first five years of operation. This report comprises the fourth annual report, covering all monitoring activities during the fourth year of official operation of SWF from February 2022 and January 2023.

As per Section 4.7 of the BBAMP, and the Addendum, the fourth annual report includes, but is not limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- The survey methods (including list of observers, dates and times of observations);
- Results of carcass searches and incidental carcass observations;
- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework and relevant adaptive management measures.

- A summary of livestock carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs and their timing;
- A discussion of the results, including:
    - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.
    - Bird risk reduction measures.
    - Any further recommendations for reducing mortality, if necessary.
    - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
    - Recommendations for further monitoring.

This report is divided into the following sections:

Section 3 provides the methods of the fourth year of monitoring.

Section 4 presents the results of the fourth year of monitoring.

Section 5 discusses the conclusions of the fourth year of monitoring.

Section 7 provides recommendations for future monitoring.

This investigation was undertaken by a team from Nature Advisory, comprising Divyang Rathod (Zoologist), Joshua Brown (Zoologist), Rachel Charles (Zoologist), Gavin Thomas (Senior Ecologist), Jackson Clerke (Senior Zoologist and Project Manager), and Bernard O'Callaghan (Director).

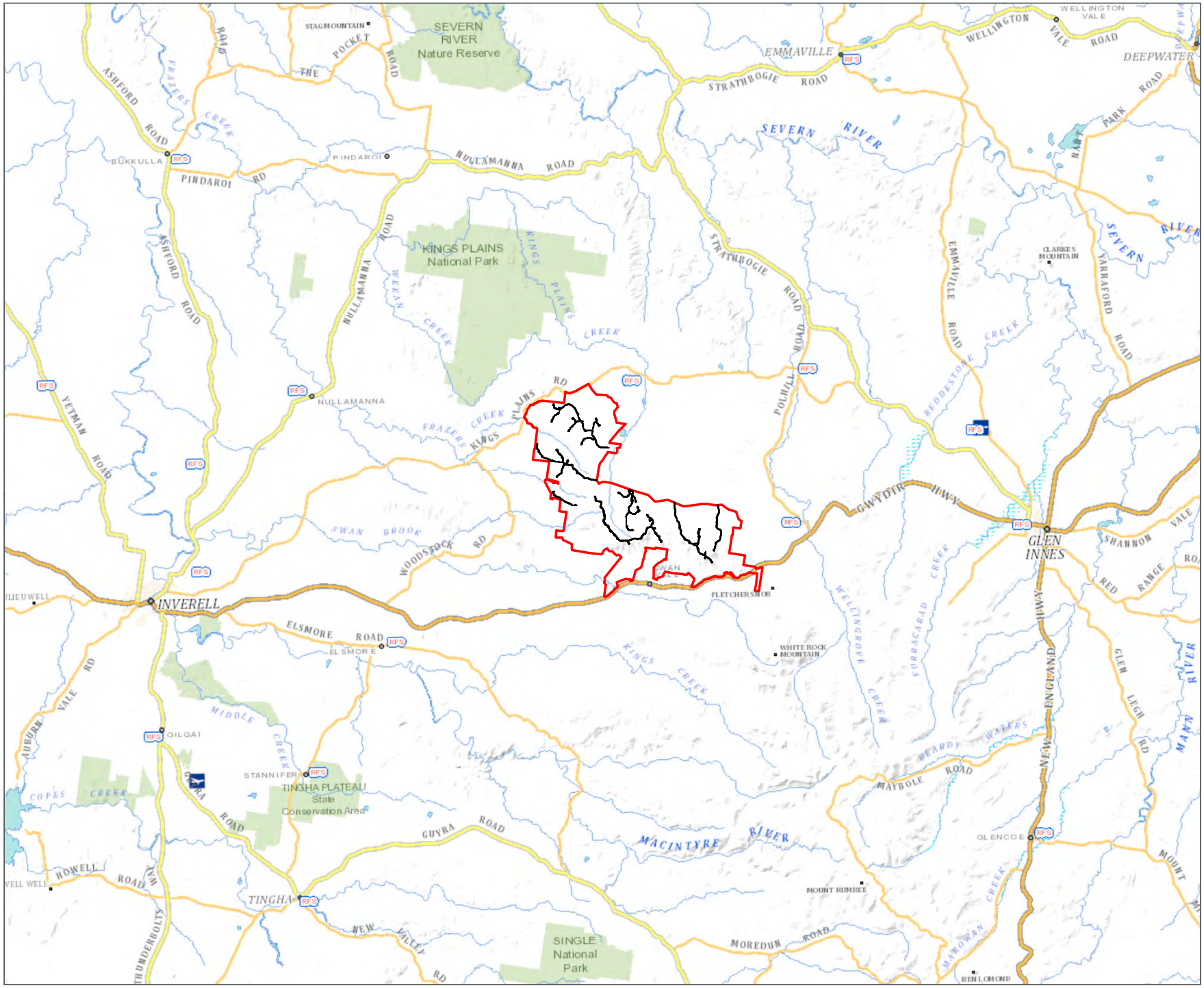

Figure 1: Locality map

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 23/03/2020

- Study area
- Turbines
- Access tracks

N

Kilometers
0 5.5

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2. Methods

2.1. Carcass search program

During the initial operational carcass monitoring program under the BBAMP and outlined in Section 1, carcass searches were conducted at 18 selected turbines at monthly intervals, with repeated searches ("pulse searches") occurring at each of these turbines within three days of the monthly search, in order to detect any rapidly scavenged species.

No carcass searches were undertaken during year three and the Year Three Annual Report, in consultation with BCD regarding the yet to be approved addendum methods, recommended that only WTE carcass searches would be carried out at all 75 turbines with no follow up pulse searches. One search would take place in the months following the breeding period (generally Oct-Dec) after the young have fledged. The second search would take place six months after the first.

Monitoring of other bird species would be recorded via incidental carcass finds reported by the Wind Farm site personnel.

Symbolix (2020) assessed combined scavenger rate data across 10 wind farms in Victoria which showed that WTE carcasses can persist on average for 287 days, meaning that WTE are typically not scavenged. Based on this information, it is expected that WTE carcasses would remain in situ and be detected prior to complete decomposition by searching all turbines at six monthly intervals.

A modified search method was adopted to target WTE; a 100-metre-radius zone surrounding each designated turbine was searched at 12-meter intervals walked on foot by human searchers from the base of the turbine. Given the large size of WTE ensuring they have a very high detectability for searchers, smaller intervals or an inner search zone were not considered necessary. All mortalities of other species were also recorded.

During the six monthly carcass survey, mortalities were classed as either a bird carcass, a feather spot, or a bat carcass. If carcasses were found outside the scheduled search period (i.e., finds by wind farm personnel), these were recorded as an incidental find. It is likely that feather spots represent a bird that has collided with a turbine and has later been scavenged. When a dead bird or bat was recorded under a turbine, data from a pro-forma was collected (BBAMP, appendix 2), carcass numbered, and an in situ photograph of the carcass was taken.

On finding a bird carcass, feather-spot or bat carcass, the finder:

- Completed a casualty report;
- Removed it from the site to avoid re-counting; and
- Transferred fresh carcasses to a freezer at the site office for storage.

According to Section 6 of the BBAMP, an 'impact trigger' occurs when *"A threatened bird/bat species (or recognisable parts thereof) listed under the Commonwealth EPBC Act or NSW Threatened Species Conservation Act 1995, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel."*

In this situation, an investigation must be started within 10 days of the find to determine the cause of the impact, the likelihood of re-occurrence, the most effective mitigation measures to be implemented (if needed) and if any additional species specific monitoring would be required.

In the case of non-threatened species carcass finds, an impact trigger is defined as:

> *"A total of four or more bird or bat carcasses, or parts thereof, of the same species in two successive searches at the same turbine of a non-threatened species (excluding ravens, magpies, White Cockatoos, corellas, pipits and introduced species.*

Carcass searches were conducted by two zoologists from Nature Advisory between 23rd to the 30th of January 2023.

Limitations

Given the amended BBAMP search regime was approved during November 2022, one 75 turbine search effort has been completed during this reporting period.

2.2. WTE activity and nest monitoring

Within the SWF boundary, WTE nest utilisation (including breeding activity) and general activity was assessed at SWF from 15th to the 18th of November, in accordance with the Year Three BBAMP recommendations and approved Addendum of November 2022.

WTE nests were searched in the treed habitat within the SWF boundary and identified via observing surrounding treed landscape from 20 vantage points and via transects walked through the large patches of woodland. Any nests identified were GPS located and will be monitored on an annual basis (with a review of monitoring requirements undertaken in each annual reporting) between October to December to record breeding activity and utilisation.

WTE activity within the WF boundary was assessed from 20 vantage points across the site from 15-18th November 2022 (Figure 2). The area surrounding the vantage points was surveyed (via binoculars once each for 15 minutes to observe the presence of any WTE and their activity at any nests.

Observations of WTE flights were plotted on a map and the following data recorded:

- Species,
- numbers,
- start and end time of observations,
- date,
- flight heights,
- location and
- behaviour.

2.3. Incidental raptor observations

Incidental observations of raptors occurred whilst moving throughout the SWF and during the six monthly carcass searches. These incidental observations were recorded and plotted on a map collecting the same data as outlined above.

2.4. Carrion removal program

Under the BBAMP, SWF is required to undertake carrion inspections and keep a log book of findings and actions undertaken to remove any deceased livestock from within 200 meters of turbines. The third annual report for BBAMP recommended revised risk reduction measures in regards to carrion removal:

Monthly inspections/searches by site personnel for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g., kangaroo, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using

binoculars to look for large carcasses within 200 metres of each turbine. Results from inspections will be documented and the following information collected each month:

- Date of inspection,
- Person undertaking the inspection,
- Any carrion identified and location (e.g., Turbine ID),
- Any carrion still present from previous inspection,
- Action taken (e.g., consultation with landholders or removal of carrion)
- Pest animal activity or presence,
- Lambing activity (when applicable),
- Any incidental observations by landowners or SWF staff.

3. Results

3.1. Carcass search results

A total of eight carcasses were recorded under turbines during the fourth year of the post-construction monitoring period. Detailed information on search activity and carcass finds are kept on file by Nature Advisory and can be made available on request. Table 1 summarises the carcass find results.

No incidental mortalities were reported during the monitoring program.

3.1.1. Limitations

Carcass searches were conducted across all 75 turbines. However, some searches were considered as "partial searches" due to steep, rocky, or otherwise dangerous terrain, along with barbed fencing, which presented high OHS risks to zoologists undertaking searches. Therefore, the full search radius of some turbines could not be safely completed.

Areas not able to be searched were checked visually from a safe vantage point for WTE carcasses. It is not expected that some partial searches would significantly impact the viability of the monitoring across 75 searches.

3.2. WTE activity and nest monitoring results

A total of six WTE observations were recorded during the survey, with a group of four individuals being recorded in a single observation. Flight heights ranged from 20 meters above the ground to 200 meters. One WTE nest was found to be active with a juvenile present (Figure 2). Another raptor nest was discovered; however, it was empty.

Geographically, WTE observations were recorded mostly around the southern section of the wind farm, particularly around the woodland adjacent to turbines numbered 63 through 73. This is to be expected as the active WTE nest was also observed in this area.

WTE observations are provided in Table 2 and observations and nest platform locations are provided in Figure 3.

3.3. Incidental raptor observations

Two species of raptor were recorded flying at the wind farm during the carcass monitoring period, these were WTE and Nankeen Kestrel. Most incidental observations were WTE with a maximum number observed at one time being two individuals. Flight height ranged from 20 meters to 130 meters. Data collected for each raptor flight path is presented in Table 3 and presented Figure 4.

3.4. Carrion removal program

No carrion removal has been reported.

Table 1: Carcass search results during year 4

Date	Common name	Scientific name	Turbine no.	Distance from turbine (m)	Carcass (C)/ Feather spot (FS)/ Incidental (INC)	Notes
25/01/2023	White-striped Free-tail bat	*Tadarida australis*	47	63	C.23.1.1	forearm = 6cm, deteriorated/damaged face, back, less than a week old
25/01/2023	Crimson Rosella	*Platycercus elegans*	48	10	FS.23.1.1	11cm feather, no body found
26/01/2023	Grey Teal	*Anas gracilis*	57	92	FS.23.1.2	feathery spot, no body
26/01/2023	Crested Pigeon	*Ocyphaps lophotes*	61	1	C.23.1.2	less than 12 hours old, adult, got hit at the back of the neck
26/01/2023	Crimson Rosella	*Platycercus elegans*	58	59	FS.23.1.3	around 10 feathers left, under eucalypt canopy
26/01/2023	Wedge-tailed Eagle	*Aquila audax*	58	74	C.23.1.3	many large wing clumps, 3 main clumps, bones, almost full size skull
26/01/2023	Crimson Rosella	*Platycercus elegans*	55	60	FS.23.1.4	found under eucalypt canopy
26/01/2023	Wedge-tailed Eagle	*Aquila audax*	28	60	C.23.1.4	more than 5 days old, feathers and intact bones present

Table 2: WTE activity observations

Observation number	Species	Scientific name	Date	Start time	Finish time	No. of birds	Flight height (m)	Min height (m)	Max height (m)	Flight direction	Flight behaviour	Comments
1	Wedge-tailed Eagle	*Aquila audax*	15/11/2022	14:18	14:21	2	160	160	400	SW	Soaring	2 adult birds in spiralling flight rising to 400 plus the drifting SE away from observer
2	Wedge-tailed Eagle	*Aquila audax*	16/11/2022	10:15	10:16	1	120	80	120	SE	Gliding	1st year bird.
3	Wedge-tailed Eagle	*Aquila audax*	16/11/2022	11:20	11:22	1	60	60	100	N	Gliding	1st year bird.
4	Wedge-tailed Eagle	*Aquila audax*	16/11/2022	12:08	12:08	4	200	160	400	W	Displaying	4 birds (2 pairs)
5	Wedge-tailed Eagle	*Aquila audax*	17/11/2022	12:45	12:45	2	100	80	220	SE	Soaring	2 birds soaring and circling before breaking out of thermal and heading SE
6	Wedge-tailed Eagle	*Aquila audax*	17/11/2022	14:05	14:05	1	400	400	600	E	Soaring	single bird in soaring flight

Figure 2: WTE active nest

Figure 3: Wedge-tailed Eagle activity and nest observations

Project: *Sapphire Wind Farm* Client: *CWP Renewables Pty Ltd* Date: *24/02/2023*

- Study area
- Turbines
- Raptor platform
- WTE PTM
- WTE flight path
- WTE observation

N

Metres

0 800

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Table 3: Incidental raptor observations

Species	Scientific name	Date	Start time	Finish time	No. of birds	Flight height (m)	Min height (m)	Max height (m)	Flight direction	Flight behaviour	Comments
Wedge-tailed Eagle	*Aquila audax*	24/01/2023	10:20	10:25	2	100	20	100	NE	Circling	Circling over valley, height range of +100m
Wedge-tailed Eagle	*Aquila audax*	25/01/2023	9:50	9:55	1	Perched	NA	NA	NA	Perched on tree and then soared away	Perched on dead tree
Wedge-tailed Eagle	*Aquila audax*	26/01/2023	12:07	12:11	2	100	80	100	SW	Circling	Height range of 80-100m
Wedge-tailed Eagle	*Aquila audax*	26/01/2023	12:35	12:50	2	120	120	130	NW	Soaring and circling	flown over plains, height range of 120-130m north of T59 flying NW
Nankeen Kestrel	*Falco cenchroides*	27/01/2023	15:27	15:30	1	40	30	50	NW	Flapping	flew next to electric wire, height range of 30-50m. North of T28 flying NW
Nankeen Kestrel	*Falco cenchroides*	28/01/2023	9:52	9:53	1	Perched	NA	NA	NA	Resting then took off	E of T2 resting on a log heard the car and took off

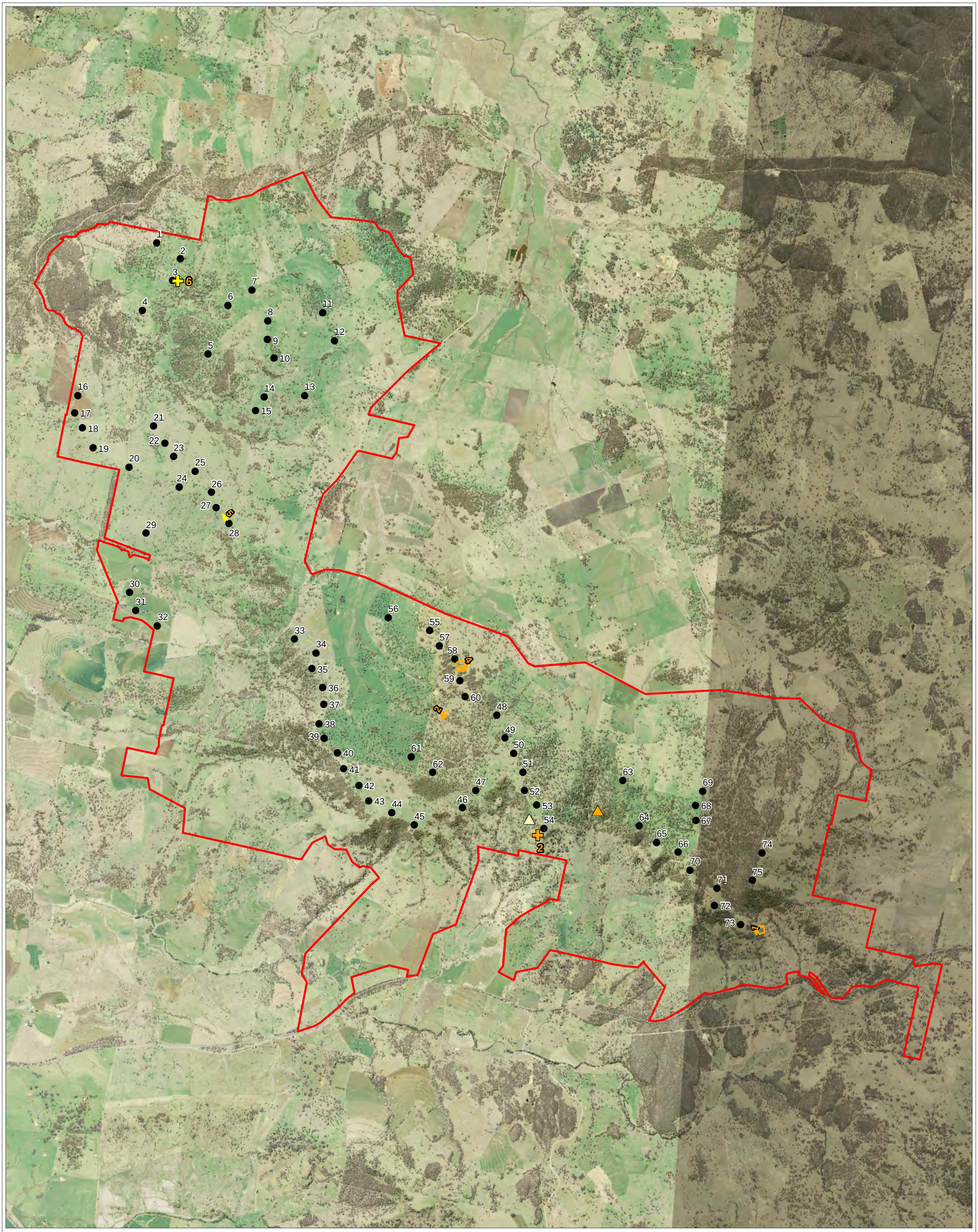

Figure 4: Wedge-tailed Eagle incidental observations

Project: *Sapphire Wind Farm* Client: *CWP Renewables Pty Ltd* Date: *23/02/2023*

- Study area
- Turbines
- BUS and reference points
- Possible breeding area
- Raptor platform
- WTE PTM

Species

- Nankeen Kestrel
- Wedge-tailed Eagle

Perched observation

- Nankeen Kestrel
- Wedge-tailed Eagle

N

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4. Discussion

Years One and Two carcass monitoring results included two formal finds of WTE during targeted carcass searches and four incidental finds. Mortality estimates presented in the Year Two report also predicted an average potential impact, based on formal carcass search results, of approximately five mortalities during the first 12 months of monitoring and 12 during the second year of monitoring. Year Three incidental finds reported by SWF included one WTE mortality, and no formal WTE carcass finds.

Year Four monitoring results have included two WTE mortalities detected across one full carcass search of all 75 turbines and no incidental mortalities reported. The results obtained during the fourth year of monitoring appear consistent with the findings of the first three years of monitoring, and do not indicate an increase of impacts at SWF.

The notes on WTE carcass find "C.23.1.3" show that a skull and bones were present, indicating an advanced state of decomposition of the carcass. This supports the findings of Symbolix (2020) in that WTE carcasses remain in situ until decomposition, and supports the BBAMP addendums methods that such remains will be detectable during six monthly searches.

Three other bird species were identified during carcass searches: the Crimson Rosella, Grey Teal and Crested Pigeon. Only one bat carcass was found; the White-striped Free-tail bat. Each is a relatively common and widespread species to farmland landscapes in NSW and other parts of Australia, and the populations of each is considered secure and not in decline.

The observation of one active WTE nest indicates at least one resident pair of WTE utilising the site. Observations of four adult individuals simultaneously may indicate a second resident pair on, or in, the vicinity of SWF. This, in addition to the recorded flight paths, indicates a regular and continued use of the site by WTE for breeding and general activity. The majority of WTE observations tended to occur around the southern area of SWF, particularly around turbines numbered 63 through to 73, this is likely to be related to nesting occurring in the adjacent woodlands.

No carrion within 200m of a turbine has been reported or removed by SWF personnel. Considering turbine impacts on WTE remain largely the same thus far, it is unclear what effect the carrion removal program is having, or whether it is required. Without information on inspection frequency, numbers of carrion observed and the ability to remove them from near turbines, the effectiveness of a carrion removal program cannot be assessed for relevance or improvement. Recommendations are provided below.

Recommendations for a continued monitoring program into Year Five are provided below.

5. Recommendations

5.1. Carcass search program

Carcass monitoring will continue to be completed at all SWF turbines every six months (or twice a year) for an additional year (Year Five). All 75 turbines at SWF will be searched at 12-meter intervals to a radius of 100 meters with no follow up pulse searches completed.

During the period between the formal carcass searches, incidental carcass monitoring will continue to take place by wind farm personnel. Any bird or bat carcasses identified will be reported and recorded in accordance with Section 4.4.5 of the BBAMP.

Incidental monitoring of WTE flight paths will be undertaken during carcass searches by zoologists collecting the same data as outlined in Section 2.2. Observations will contribute to monitoring site usage and WTE numbers.

5.2. WTE activity and nest monitoring

A WTE nest and activity survey will be undertaken during Year Five at SWF during October – December 2023 to monitor breeding activity at the active WTE nest identified. Searches will also be conducted for additional potential nests throughout the site. Nest searches will also include observations of WTE flights and activity recorded and plotted on maps capturing the data outlined in the methodology section 2.2.

The nests identified during this search will be recorded and monitored on an annual basis during October to December to record breeding activity and utilisation. The intention of this monitoring is to monitor utilisation for breeding purposes and utilisation in general. The need for continued monitoring of WTE will be reviewed in annual reporting and in consultation with BCD.

Increased or decreased breeding activity or site utilisation may provide additional insight into the impacts of SWF on WTE and the effectiveness of revised risk reduction measures, outlined below.

5.3. Revised risk reduction measures

The approved addendum to the BBAMP (Nature Advisory 2022b) provides revised mitigation measures to improve the implementation of the previous BBAMP measures and enable assessment and review in annual reporting. These are reiterated below and are the responsibility of SWF to implement and record.

The aim of the revised program is to track implementation of mitigation measures at SWF and their outcomes and then assess this against the findings of the revised monitoring program and potential impacts on WTE throughout the operation of SWF.

Land-use and stock management underneath and around turbines can influence the presence and behaviour of native birds on site. Examples include:

- Grain feeding can be an “attractant” for parrots; and
- Carrion and rabbits can be an “attractant” to raptors in the area.

Thus, this section proposes possible mitigation measures to address these matters.

A moderate risk to WTE has been identified for SWF in the BBAMP. The WTE and other raptors forage for carrion (dead and decaying flesh of an animal) and also on small mammals, rabbits etc. In order to reduce the risk of raptors colliding with turbines, a formalised carrion monitoring and removal program will be implemented during operations. This will reduce the attractiveness of the site to raptors (specifically WTE) and therefore reduce the potential for fatal collisions by this group of birds. This program will focus on an

area of a minimum of 200 metres around turbines, where safe, feasible and practical. The procedures below will be adopted:

- The SWF Site Manager has been appointed to perform the function of Carrion Removal Coordinator who will undertake the activities described below. In the event the SWF Site Manager is not available, an alternative suitable person will be appointed to undertake this function.
    - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g., kangaroo, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars to look for large carcasses within 200 metres of each turbine. Results from inspections will be documented and the following information collected each month:
        - Date of inspection,
        - Person undertaking the inspection,
        - Any carrion identified and location (e.g., Turbine ID),
        - Any carrion still present from previous inspection,
        - Action taken (e.g., consultation with landholders or removal of carrion)
        - Pest animal activity or presence,
        - Lambing activity (when applicable),
        - Any incidental observations by landowners or SWF staff.
    - Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be address by operator and landowner protocols and information included in monthly inspection data.
    - Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines. If a carcass is not removed, its visibility during the next monthly inspection should be recorded.
    - Consultation with landowner or wind farm staff in relation to the appropriate disposal of collected carrion. This is to be disposed of at least 200 metres away from the closest turbine. Results of consultations will be logged and the locations of any carrion dumps (active or planned) to be noted. This can be assessed against any potential WTE mortality locations.
    - Carcass occurrence and removal will be recorded in monthly inspection records maintained by SWF Project Manager.
- During lambing season (usually late autumn/winder) young lambs are susceptible to death. Therefore, if possible and subject to agreement of landowners, lambing will be restricted to paddocks at least 200 metres away from turbines, where practicable, to reduce the risk that raptors (WTE in particular) are attracted close to the turbines.
- A consultation log with landholders will be maintained and used to inform ongoing success of mitigation measures. Consultation with landholders to be undertaken requesting that they keep

lambing to paddocks without access to turbines where possible. Locations of lambing activity will be recorded during monthly inspections and mapped to reflect actual land use activity during WF operation. This can be compared with any potential WTE mortality identified during carcass searches.

- In order to reduce collision risks to birds, where practical and with landowner agreement, the practice of grain feeding of stock within 200 metres of turbines should be minimised as it could cause draw additional parrots and other birds to the site.
- Any feral animal control on the wind farm site should involve the removal and appropriate disposal of resulting carcasses in a timely manner.
- If a large active presence of rabbits is observed during monthly inspections near turbines, subject to landholder approval, an integrated rabbit control program (to reduce site attractiveness to WTE) will be completed within 200 metres of turbines. Methods to control rabbits include burrow destruction and shooting. Any rabbit control program will require cooperation and agreement from the landowner.
- Monthly inspection data, actual land use and land holder consultations covering the requirements above, will be reported on in accordance with the BBAMP reporting requirements and provided to BCD in annual reporting.

Using the information collected above, the efficacy of the mitigation measures implemented will also be assessed annually. This will include an assessment of WTE carcass search data and site utilisation data against: carrion occurrence rates, removal requests, removal undertaken and actual land use (lambing and carrion dump locations)

The program will be reviewed in accordance with the BBAMP reporting requirements. If, for example, WTE mortality increases annually when compared to the initial 24-month operational monitoring period, then the need for continuation, refinement or additional mitigation measures will be discussed, in consultation with BCD/DPIE.

5.4. Reporting

Findings of the revised monitoring program will be reported in the 5th year Annual Report, at this time any further recommendations for amendments will be made in consultation with BCD.

6. References

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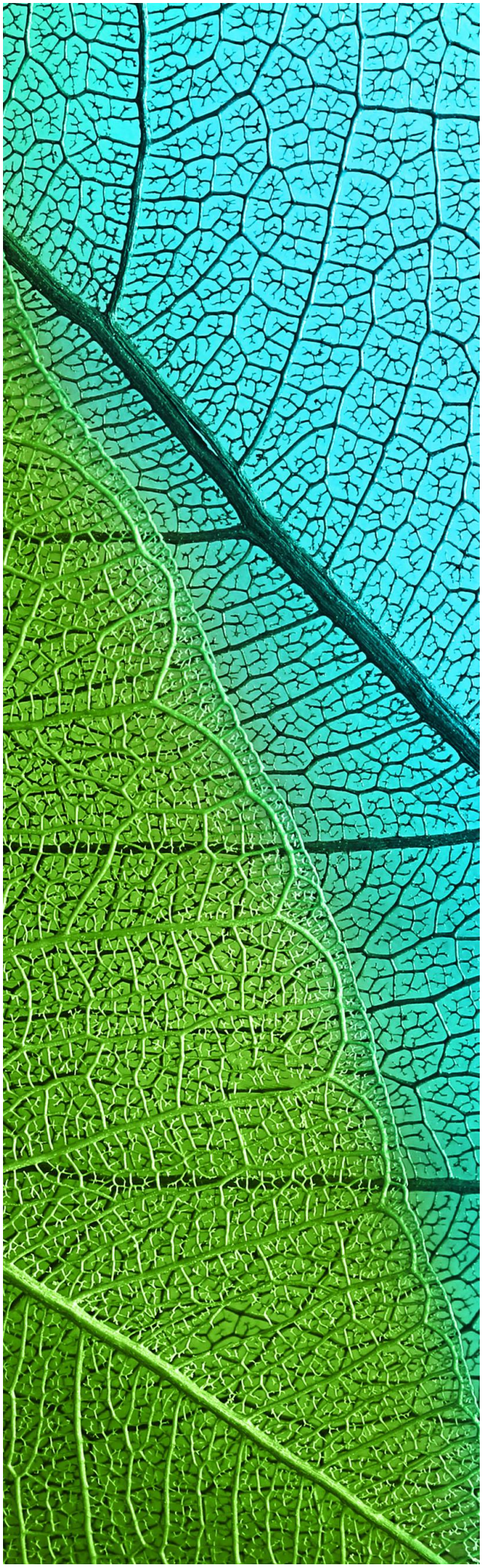

Sapphire Wind Farm

Five Year Annual Report on the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for Sapphire Wind Farm 1 Operations Pty Ltd

March 2024
Report No. 16045.4 (2.1)

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Contents

Tables

Figures

1. Introduction

1.1. Project Background

Sapphire Wind Farm (SWF) is located in the Kings Plain District, 24 kilometres west of Glen Innes and 28 kilometres east of Inverell in the northern tablelands of New South Wales (NSW) (Figure 1). The site has been mostly cleared of its original native vegetation and is predominately being utilised for grazing. The wind farm currently comprises 75 turbines and associated infrastructure.

The history of the SWF commenced in 2007, with the proposition of a 159-turbine wind farm. Development applications were approved in June 2013 and December 2014 by the NSW Department of Planning and Environment (DPE) (now Department of Planning, Housing and Infrastructure, DHPI) and the former Commonwealth Department of the Environment (DotE) (now Department of Climate Change, Energy, Environment and Water (DCCEEW) respectively. In January 2016, Sapphire Wind Farm Pty Ltd requested a modification to the approval to reduce the number of turbines from 159 to no more than 109 turbines whilst increasing the maximum tip height to 200 metres above the ground and rotor diameter to 126 metres. The DPHI and the DCCEEW approved the modification request in June 2016. The project completed construction in late 2018 with a refined design which involved the construction of 75 turbines at locations approved in the modification.

Condition C6 of the DPHI approval required the preparation of a Bird and Bat Adaptive Management Program (BBAMP), these requirements have been outlined in the following section. Specifically, Condition C6(d) required the proponent to identify 'at risk' bird and bat groups, seasons and/or areas within the project site which may attract high levels of mortality. The BBAMP (BL&A 2017) was prepared by Brett Lane & Associates Pty Ltd, predecessor of Nature Advisory Pty Ltd and approved by the Director-General (now Secretary of Planning) of DPHI.

Sapphire Wind Farm Pty Ltd engaged Nature Advisory to implement the approved BBAMP for the SWF. Specifically, the scope of the work included:

- Operational bird and bat carcass (mortality) monitoring program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

1.2. Previous monitoring and recommendations

The first phase of the monitoring program began during the partial-operational phase in July 2018. In total, this comprised 31 months of monitoring and 24 months of fully operational surveys, concluding in January 2021. The second year of the monitoring program was conducted from February 2020 to January 2021, the second annual report (Nature Advisory 2021) for this period is summarised below:

No management triggers occurred during the monitoring program. The results from the monitoring program and the mortality estimates suggested it was unlikely that mortalities of any species identified at the site would significantly impact these populations on a state level, regional level or overall. The report acknowledged that Wedge-tailed Eagle (*Aquila* audax) (WTE), nominated as an 'at risk species' in the BBAMP, had higher observed mortalities relative to other bird species during the monitoring period. The report concluded that the carcass monitoring program to date had provided a sufficient baseline of the impacts SWF has on birds and bats and further carcass searches should not be required as part of ongoing BBAMP implementation. Future BBAMP implementation would include:

- Incidental monitoring of carcasses and feather spots continue to be reported;
- Inclusion of any incidental finds in annual reporting for the first five years of operation;

- Continuation of carrion removal, limiting lambing and stock feeding close to turbines;
- Integration a rabbit control program (as appropriate); and
- Annual reporting.

The third-year annual report (Nature Advisory 2022a) reported on the above activities during February 2021 to January 2022. One WTE carcass was reported as an incidental find and the report recommended the program continue as described above and, in addition; included the proposed Addendum described below.

The fourth-year annual report (Nature Advisory 2023) reported on the above activities by finding two WTE carcasses across one full carcass search of 75 turbines, no incidental mortalities were reported and the report recommended the program continue as described in the Addendum described below.

1.3. Addendum to the BBAMP

The Biodiversity and Conservation Division (BCD) (now the Biodiversity, Conservation and Science Group (BCS) of the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW), as the regulator to whom annual reporting is submitted under the BBAMP reporting obligations, provided response via letter on the 8th December 2022 to the fourth annual report on the requirements of the continued implementation of the BBAMP, and recommended:

"1. Two carcass searches under all 75 turbines at six monthly intervals.

2. A Wedge-tailed Eagle Breeding Survey.

3. In addition to the foregoing 'core' activities, the detection of impact triggers during the implementation of the BBAMP addendum (e.g., for threatened species) may require implementation of contingency investigation and mitigation measures."

An Addendum to the BBAMP (Nature Advisory 2022b) was prepared (8th of December 2022) in response to the BCS letter. The addendum provided an adaptive monitoring program targeting WTE, as a high-risk species, consisting of a search of all 75 turbines at SWF, searched at six monthly intervals, as opposed to the initial monthly carcass searches outlined in the BBAMP. One search will take place after the breeding period (generally Oct-Dec) after the young have fledged; the second search would take place six months after the first. The methods and justification for this modified regime are provided in Section 2 below. A WTE breeding and flight activity survey was also undertaken as part of the monitoring effort.

In line with SWF Project Approval Condition C6, ongoing information should be collated and included in reports submitted to the Secretary of Planning and OEH (now BCS) on an annual basis for the first five years of operation. This report comprises the fifth annual report, covering all monitoring activities during the fifth year of official operation of SWF from February 2023 and January 2024.

As per Section 4.7 of the BBAMP, and the Addendum, the fifth annual report includes, but is not limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- The survey methods (including list of observers, dates and times of observations);
- Results of carcass searches and incidental carcass observations;
- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework and relevant adaptive management measures.
- A summary of livestock carcass removal for the purposes of predator reduction;

- Details of any landowner feral animal control programs and their timing;
- A discussion of the results, including:
    - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.
    - Bird risk reduction measures.
    - Any further recommendations for reducing mortality, if necessary.
    - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
    - Recommendations for further monitoring.

This report is divided into the following sections:

Section 2 provides the methods of the fifth year of monitoring.

Section 3 presents the results of the fifth year of monitoring.

Section 4 discusses the conclusions of the fifth year of monitoring.

Section 5 provides recommendations for future monitoring.

This investigation was undertaken by a team from Nature Advisory, comprising Divyang Rathod (Zoologist), Emma Fitzsimmons (Zoologist), Jess Johnson (Zoologist), Philip Allen (Zoologist), Ahmad Barati (Zoologist), Gavin Thomas (Senior Ecologist), Jackson Clerke (Senior Zoologist and Project Manager), and Bernard O'Callaghan (Director).

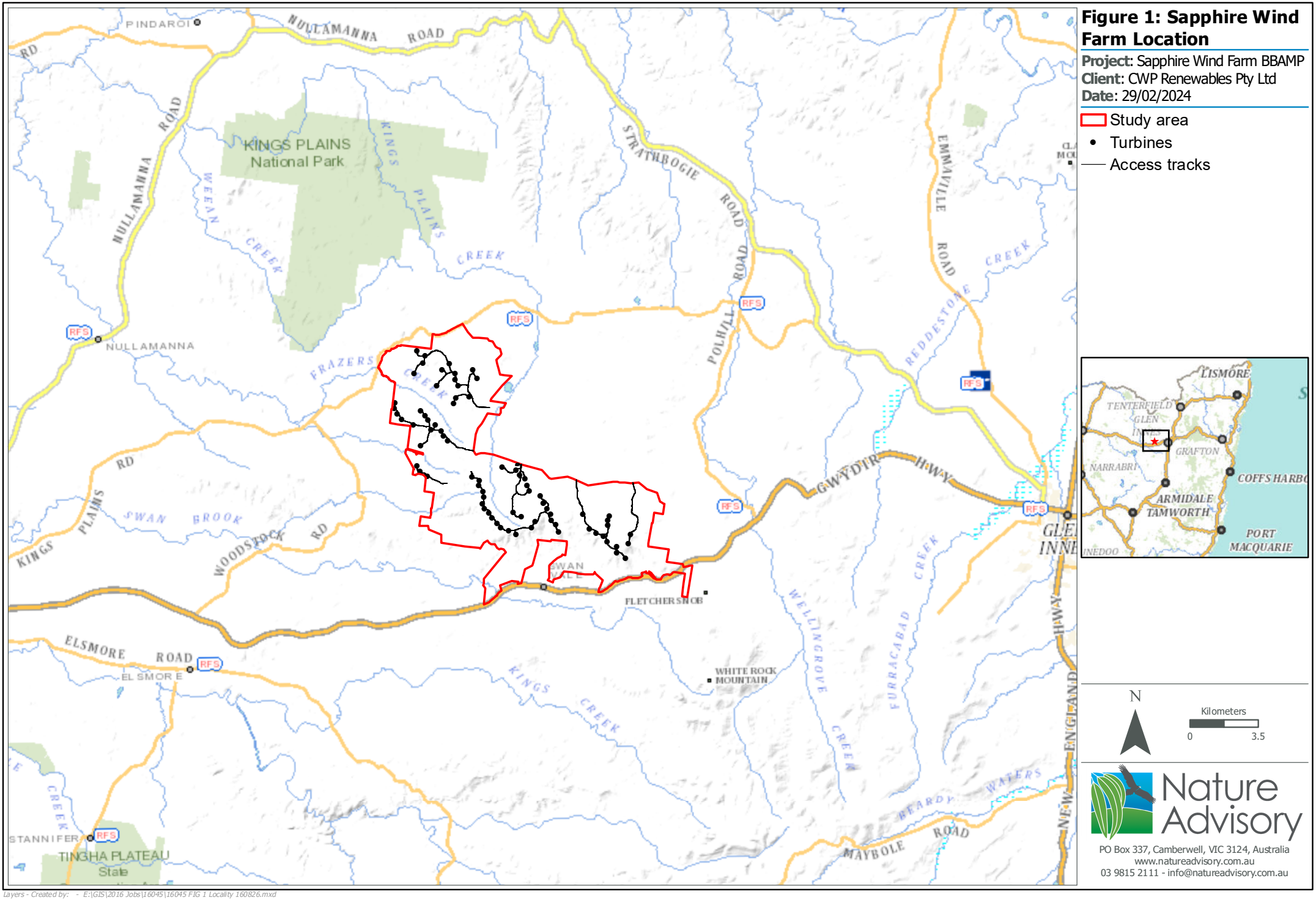

Figure 1: Sapphire Wind Farm Location

Project: Sapphire Wind Farm BBAMP
Client: CWP Renewables Pty Ltd
Date: 29/02/2024

- Study area
- Turbines
- Access tracks

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2. Methods

2.1. Carcass search program

During the initial operational carcass monitoring program under the BBAMP and outlined in Section 1, carcass searches were conducted at 18 selected turbines at monthly intervals, with repeated searches ("pulse searches") occurring at each of these turbines within three days of the monthly search, in order to detect any rapidly scavenged species.

No carcass searches were undertaken during year three and the Year Three Annual Report, in consultation with BCD regarding the yet to be approved addendum methods, recommended that only WTE carcass searches would be carried out at all 75 turbines with no follow up pulse searches. One search would take place in the months following the breeding period (generally Oct-Dec) after the young have fledged. The second search would take place six months after the first.

Monitoring of other bird species would be recorded via incidental carcass finds reported by the Wind Farm site personnel.

Symbolix (2020) assessed combined scavenger rate data across 10 wind farms in Victoria which showed that WTE carcasses can persist on average for 287 days, meaning that WTE are typically not scavenged. Based on this information, it is expected that WTE carcasses would remain in situ and be detected prior to complete decomposition by searching all turbines at six monthly intervals.

A modified search method was adopted to target WTE; a 100-metre-radius zone surrounding each designated turbine was searched at 12-meter intervals walked on foot by human searchers from the base of the turbine. Given the large size of WTE ensuring they have a very high detectability for searchers, smaller intervals or an inner search zone were not considered necessary. All mortalities of other species were also recorded.

During the six-monthly carcass survey, mortalities were classed as either a bird carcass, a feather spot, or a bat carcass. If carcasses were found outside the scheduled search period (i.e., finds by wind farm personnel), these were recorded as an incidental find. It is likely that feather spots represent a bird that has collided with a turbine and has later been scavenged. When a dead bird or bat was recorded under a turbine, data from pro-forma was collected (BBAMP, appendix 2), carcass numbered, and an in-situ photograph of the carcass was taken.

On finding a bird carcass, feather-spot or bat carcass, the finder:

- Completed a casualty report;
- Removed it from the site to avoid re-counting; and
- Transferred fresh carcasses to a freezer at the site office for storage.

According to Section 6 of the BBAMP, an 'impact trigger' occurs when *"A threatened bird/bat species (or recognisable parts thereof) listed under the Commonwealth EPBC Act or NSW Threatened Species Conservation Act 1995, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel."*

In this situation, an investigation must be started within 10 days of the find to determine the cause of the impact, the likelihood of re-occurrence, the most effective mitigation measures to be implemented (if needed) and if any additional species-specific monitoring would be required.

In the case of non-threatened species carcass finds, an impact trigger is defined as:

> *"A total of four or more bird or bat carcasses, or parts thereof, of the same species in two successive searches at the same turbine of a non-threatened species (excluding ravens, magpies, White Cockatoos, corellas, pipits and introduced species.*

Carcass searches were conducted by two zoologists from Nature Advisory between 23rd to the 30th of January 2023.

2.2. WTE activity and nest monitoring

Within the SWF boundary, WTE nest utilisation (including breeding activity) and general activity was assessed at SWF from 5th to the 8th of December 2023 (Figure 2), in accordance with the Year Four BBAMP recommendations and approved Addendum of November 2022.

WTE nests were searched in the treed habitat within the SWF boundary and identified via observing surrounding treed landscape from 20 vantage points and via transects walked through the large patches of woodland. The area surrounding the vantage points was surveyed (via binoculars once each for 15 minutes) to observe the presence of any WTE and their activity at any nests. Any nests identified were GPS located and will be monitored on an annual basis (with a review of monitoring requirements undertaken in each annual reporting) between October to December to record breeding activity and utilisation.

Observations of WTE flights were plotted on a map and the following data recorded:

- Species,
- numbers,
- start and end time of observations,
- date,
- flight heights,
- location and
- behaviour.

2.3. Incidental raptor observations

Incidental observations of raptors occurred whilst moving throughout the SWF and during the six-monthly carcass searches. These incidental observations were recorded and plotted on a map collecting the same data as outlined above.

2.4. Carrion removal program

Under the BBAMP, SWF is required to undertake carrion inspections and keep a log book of findings and actions undertaken to remove any deceased livestock from within 200 meters of turbines. The third annual report for BBAMP recommended revised risk reduction measures in regards to carrion removal, the fourth annual report had no reports of any carrions removed.

Monthly inspections/searches by site personnel for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g., kangaroo, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars (if available) to look for large carcasses within 200 metres of each turbine. Results from inspections will be documented and the following information collected each month:

- Date of inspection,

- Person undertaking the inspection,
- Any carrion identified and location (e.g., Turbine ID),
- Any carrion still present from previous inspection,
- Action taken (e.g., consultation with landholders or removal of carrion)
- Pest animal activity or presence,
- Lambing activity (when applicable),
- Any incidental observations by landowners or SWF staff.

3. Results

3.1. Carcass search results

A total of 27 carcasses from 11 bird species and one bat species were recorded under turbines during the fifth year of the post-construction monitoring period. Detailed information on search activity and carcass finds are kept on file by Nature Advisory and can be made available on request. Table 1 summarises the carcass find results.

No incidental mortalities were reported during the monitoring program.

Year Four monitoring results have included two WTE mortalities detected across one full carcass search of all 75 turbines and no incidental mortalities reported.

Year Five monitoring results have included five WTE mortalities detected across two full carcass searches of all 75 turbines and no incidental mortalities reported. Further there were seven Eastern Rosella mortalities, two mortalities each for Australian Magpie, Australian Wood Duck, Crimson Rosella, Galah and one mortality each for Crested Pigeon, Magpie Lark, Noisy Miner, Pied Currawong, Sulphur-crested Cockatoo, an unknown bird species and White-striped Freetail bat.

Associated notes from a WTE carcass found on the 26th of January 2023 describe the presence of a skull and bones, indicating an advanced state of decomposition. This supports the findings of Symbolix (2020) in that WTE carcasses remain in situ until decomposition and supports the BBAMP addendums methods that such remains will be detectable during six monthly searches.

3.1.1. Limitations

Carcass searches were conducted across all 75 turbines. However, some searches were considered as "partial searches" due to steep, rocky, or otherwise dangerous terrain, along with barbed fencing, which presented high OHS risks to zoologists undertaking searches. Therefore, the full search radius of some turbines could not be safely completed. During the formal searches held in December there was a heatwave which may have impacted the carcass finding ability.

Areas not able to be searched were checked visually from a safe vantage point for WTE carcasses. It is not expected that some partial searches would significantly impact the viability of the monitoring across 75 searches.

3.2. WTE activity and nest monitoring results

A total of twelve WTE observations were recorded in flight during the survey, with a group of nine individuals being recorded in a single observation. Flight heights ranged from 30 meters above the ground to 500 meters.

The WTE nest with a juvenile present in it from previous WTE survey (Sapphire Wind Farm – 4th Report BBAMP Implementation) was no longer active and remained empty throughout the survey period. No new WTE nests were seen or observed during this survey period.

Geographically, majority of WTE observations were recorded in the southern section of the wind farm, particularly around the woodland adjacent to turbines numbered 63 through 73, and few observations were made in the central section of the windfarm. WTE observations are provided in Table 2 and observations and nest platform locations are provided in Figure 3.

3.3. Incidental raptor observations and Threatened Species

Three species of raptor were recorded flying at the wind farm during the carcass monitoring period, these were WTE, Black Kite and Nankeen Kestrel. Most incidental observations were WTE with a maximum number observed at one time being two individuals. Flight height ranged from 1 meter to 500 meters. Data collected for each raptor flight path is presented in Table 3 and presented Figure 3.

One threatened species, the Little Lorikeet (*Glossopsitta pusilla*) was observed in two different instances during the July searches. Data collected has been presented in Table 3 and Figure 4.

3.4. Carrion removal program

Monthly inspections by SWF staff were carried out by the operations manager and ad hoc by the technical team when doing maintenance at the wind farm. No carrion was observed during the reporting period. The visual checks are limited to the hardstand and visible areas of the land around the WTG. Under the lease agreement with the landowner, the monitoring responsibilities of SWF are restricted to the footprint of the lease area, and their ability to act on issues within the lease area, that would affect the land and grazing activities, is only with the permission of the landowner.

No landholder consultation was undertaken for carrion removal in the reporting period, as no issues with regards to carrion or grain feeding or lambing were raised.

No feral animal control was required or requested to be undertaken on the leased land during the reporting period. SFW notes that feral animal control by the wind farm operator is restricted to asset protection (hardstands and O&M). Any baiting, trapping or shooting of feral animals on the leased land can only be done by the landowner, at their discretion.

There are no feeding troughs located near the WTGs. There were no observations made of any grain feeding during the reporting period, as such no discussions with landowner on this issue in the reporting period.

Table 1: Carcass search results at Sapphire Wind Farm during year five

Date	Common name	Scientific Name	Turbine number	Distance from turbine (m)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
18/07/2023	Crimson Rosella	*Platycercus elegans*	74	24	FS	feather spot
18/07/2023	Australian Magpie	*Gymnorhina tibicen*	72	96	FS	feathery spot, adult bird plumage, fresh, approx. 2 days old
18/07/2023	Eastern Rosella	*Platycercus eximius*	67	36	FS	feathery spot
18/07/2023	Eastern Rosella	*Platycercus eximius*	64	70	FS	feathery spot
18/07/2023	Magpie Lark	*Grallina cyanoleuca*	63	48	FS	feathery spot, feathers few meters apart
19/07/2023	Pied Currawong	*Strepera graculina*	62	24	FS	feathery spot, feathers dispersed over few meters, scavenged at 24m
19/07/2023	Sulphur-crested Cockatoo	*Cacatua galerita*	57	60	FS	feathery spot
19/07/2023	Crested Pigeon	*Ocyphaps lophotes*	32	12	FS	feathery spot
20/07/2023	Australian Wood Duck	*Chenonetta jubata*	48	14	FS	feather spot
20/07/2023	Australian Wood Duck	*Chenonetta jubata*	50	4	FS	feathery spot
20/07/2023	Wedge-Tailed Eagle	*Aquila audax*	50	96	C	carcass, very old
20/07/2023	Eastern Rosella	*Platycercus eximius*	51	82	FS	feathery spot
20/07/2023	Eastern Rosella	*Platycercus eximius*	51	60	FS	feathery spot

Date	Common name	Scientific Name	Turbine number	Distance from turbine (m)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
20/07/2023	Unknown bird		47	72	FS	feather spot, 8 feathers, not enough information
20/07/2023	Eastern Rosella	*Platycercus eximius*	43	12	FS	found few underbelly feathers
21/07/2023	Noisy Miner	*Manorina melanocephala*	40	96	FS	feathery spot
21/07/2023	Galah	*Eolophus roseicapilla*	37	55	FS	feathery spot
21/07/2023	Galah	*Eolophus roseicapilla*	37	48	FS	feathery spot
22/07/2023	Wedge-Tailed Eagle	*Aquila audax*	24	98	C	Old carcass remains, predominantly feathers, dispersed approx. 10m radius
23/07/2023	Wedge-Tailed Eagle	*Aquila audax*	4	57	C	old carcass, no feathers only bones remaining, approx. 6 months old
24/07/2023	Wedge-Tailed Eagle	*Aquila audax*	4	51	C	old carcass, no feathers only bones remaining, approx. 6 months old
25/07/2023	Australian Magpie	*Gymnorhina tibicen*	5	60	C	about a week old, adult

Date	Common name	Scientific Name	Turbine number	Distance from turbine (m)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
26/07/2023	Eastern Rosella	*Platycercus eximius*	8	100	FS	feathery spot
5/12/2023	Crimson Rosella	*Platycercus elegans*	68	72	FS	6-7 feathers seen
6/12/2023	Eastern Rosella	*Platycercus eximius*	53	21	FS	Feather spot, adult
7/12/2023	Wedge-tailed Eagle	*Aquila audax*	36	86	C	Adult, likely three weeks old carcass
11/12/2023	White-striped Freetail Bat	*Tadarida australis*	55	25	C	No age, head chopped off

Table 2: Wedge-tailed Eagle activity observations at Sapphire Wind Farm during year five surveys

Observation number	Species	Scientific name	Date	Start time	Finish time	No. of birds	Distance (m)	Min height (m)	Max height (m)	Flight direction	Flight behaviour	Comments
1	Wedge-tailed Eagle	*Aquila audax*	5/12/2023	10:11:38 AM	10:12:00 AM	1	700	200	400	Away	Gliding	Adult observed gliding into the woodlands.
4	Wedge-tailed Eagle	*Aquila audax*	5/12/2023	12:10:00 PM	12:12:12 PM	1	300	100	300	Away	Gliding	Adult observed circling and soaring initially and then lost elevation while gliding away
5	Wedge-tailed Eagle	*Aquila audax*	5/12/2023	2:28:00 PM	2:30:50 PM	9	2000	100	500	Circling	Gliding	Group seen circling together and scouting the area, observed it for two mins and looked like they were all together
6	Wedge-tailed Eagle	*Aquila audax*	5/12/2023	4:09:00 PM	4:10:55 PM	1	300	100	300	Toward	Gliding	Adult observed gliding and losing elevation, likely foraging.
7	Wedge-tailed Eagle	*Aquila audax*	6/12/2023	9:01:00 AM	9:03:00 AM	2	500	100	150			
8	Wedge-tailed Eagle	*Aquila audax*	6/12/2023	10:36:59 AM	11:15:00 AM	3	200	60	100	Away	Gliding	Observed gliding, likely a breeding pair, the pair was displaying
9	Wedge-tailed Eagle	*Aquila audax*	6/12/2023	1:14:00 PM	1:15:16 PM	1	500	80	100	Parallel to observer	Gliding	Caught a glimpse as it was gliding, lost vision because of woodland
10	Wedge-tailed Eagle	*Aquila audax*	7/12/2023	7:52:58 AM	7:53:00 AM	1	100	30	70	Away	Powered (flapping) flight	Individual was chased away by three magpies
12	Wedge-tailed Eagle	*Aquila audax*	9/12/2023	10:23:27 AM	10:24:00 AM	1	2000	150	200	Circling	Foraging (hunting)	Adult

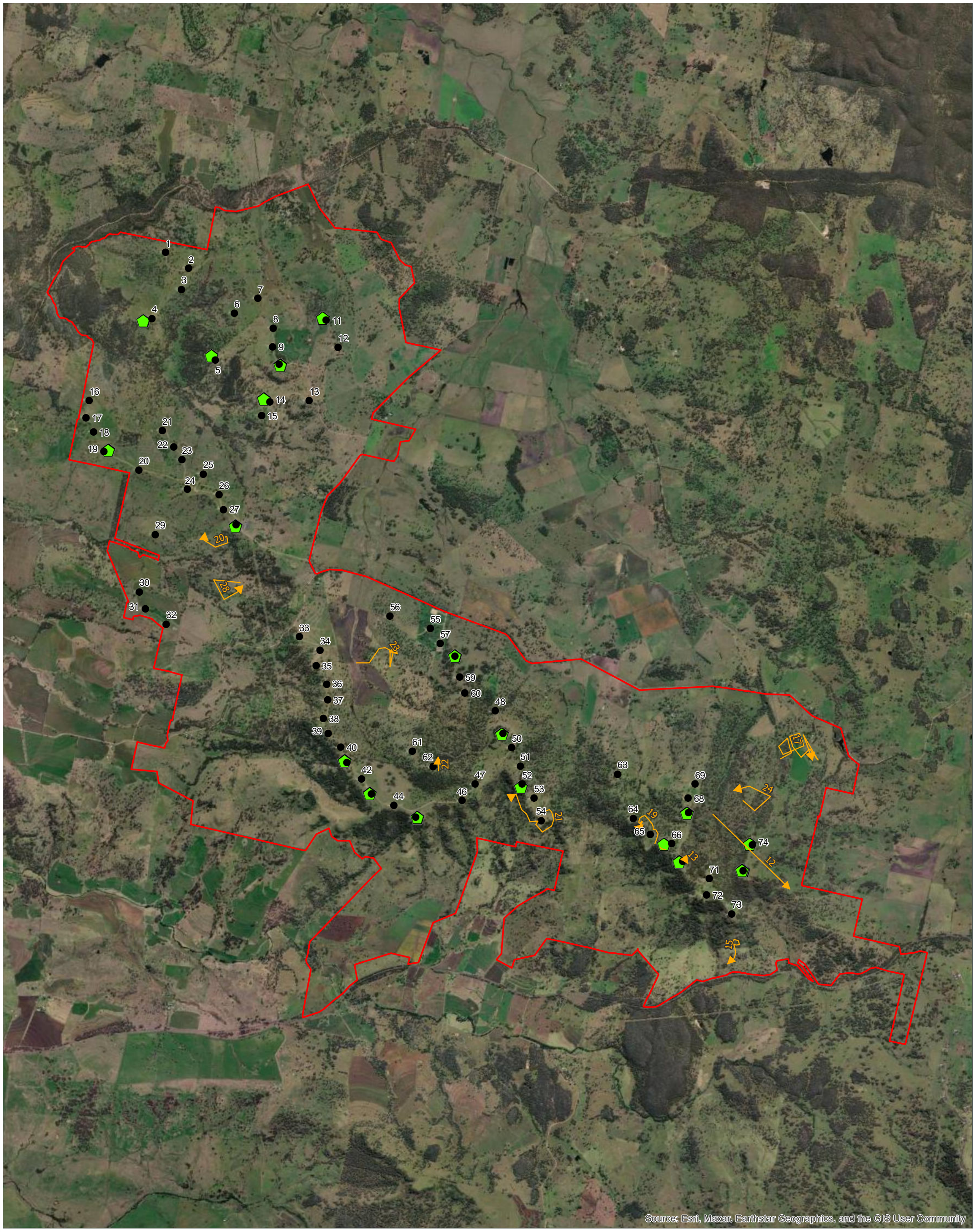

Figure 2: Wedge-tailed Eagle activity and nests

Project: Sapphire Wind Farm **Client**: CWP Renewables Pty Ltd **Date**: 29/02/2024

Study area

Turbines

Wedge-tailed Eagle Platform

Flight path

Wedge-tailed Eagle

N

Metres

0 1,000

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Table 3: Incidental raptor and threatened species observations at Sapphire Wind Farm during year five surveys

Species	Scientific name	Date	Start time	Finish time	No. of birds	Distance (m)	Min height (m)	Max height (m)	Flight direction	Flight behaviour	Comments
Nankeen Kestrel	*Falco cenchroides*	18/07/2023	9:25:00 AM	9:27:44 AM	1	40	5	20	Toward	Hovering	
Nankeen Kestrel	*Falco cenchroides*	18/07/2023	10:50:00 AM	10:51:00 AM	1	10			Away	Hovering	Outside gate 6
Little Lorikeet	*Glossopsitta pusilla*	19/07/2023	11:55:00 AM	11:55:00 AM	5	20	10	10	Away	Powered (flapping) flight	20m away from observer, 100 m from turbine 57. Flying at 10m into woodland. Vocalising in flight, rapid wing beats, obvious red head and green body.
Wedge-tailed Eagle	*Aquila audax*	19/07/2023	12:38:00 PM	12:40:00 PM	1	500	150	200	Circling	Soaring	
Nankeen Kestrel	*Falco cenchroides*	19/07/2023	1:44:00 PM	1:48:00 PM	1	50	20	50	Away	Hovering	Gliding, hovering, soaring flew around T30
Nankeen Kestrel	*Falco cenchroides*	19/07/2023	2:13:11 PM	2:15:00 PM	1	150	100	100		Resting	Resting on one of the electric poles
Wedge-tailed Eagle	*Aquila audax*	19/07/2023	2:25:00 PM	2:30:30 PM	2	1000	100	150	Circling	Soaring	Near T33
Wedge-tailed Eagle	*Aquila audax*	19/07/2023	2:25:21 PM	2:30:00 PM	1	1000	100	150	Circling	Soaring	
Wedge-tailed Eagle	*Aquila audax*	20/07/2023	3:30:00 PM	3:33:22 PM	1	200	100	150	Away	Soaring	
Little Lorikeet	*Glossopsitta pusilla*	21/07/2023	1:00:00 PM	1:00:00 PM	8	50	10	10	Away	Powered (flapping) flight	Vocalising, quick flight, near T#37
Wedge-tailed Eagle	*Aquila audax*	21/07/2023	1:50:00 PM	1:55:00 PM	3	150	150	350	Away	Gliding	2 adults, 1 juv, displaying & soaring, mobbed by ravens. 1 adult flew over T35
Wedge-tailed Eagle	*Aquila audax*	22/07/2023	10:50:00 AM	10:52:00 AM	1	1000	150	200		Gliding	Near t21, gliding, chased by magpie and then rested
Wedge-tailed Eagle	*Aquila audax*	23/07/2023	10:31:00 AM	10:37:00 AM	1	200	150	300	Away	Gliding	

Species	Scientific name	Date	Start time	Finish time	No. of birds	Distance (m)	Min height (m)	Max height (m)	Flight direction	Flight behaviour	Comments
Wedge-tailed Eagle	*Aquila audax*	24/07/2023	12:10:00 PM	12:13:01 PM	2	1000	200	200	Toward	Soaring	Flew toward T28
Wedge-tailed Eagle	*Aquila audax*	5/12/2023	11:43:00 AM	11:47:00 AM	2	300	50	150	Circling		
Wedge-tailed Eagle	*Aquila audax*	5/12/2023	11:50:00 AM	11:55:47 AM	3	500	50	100			
Nankeen Kestrel	*Falco cenchroides*	5/12/2023	1:55:47 PM	1:56:00 PM	1	400	40	60	Away	Gliding	Observed circling and then lost vision
Black Kite	*Milvus migrans*	5/12/2023	2:42:00 PM	2:54:15 PM	1	100	60	100	Toward	Gliding	Observed going into the woodland, scouted the area and then took off
Nankeen Kestrel	*Falco cenchroides*	7/12/2023	12:39:00 PM	12:47:49 PM	1	100	20	70	Away	Powered (flapping) flight	Adult seen foraging, flapping and perched on a tree
Wedge-tailed Eagle	*Aquila audax*	7/12/2023	1:38:17 PM	1:38:21 PM	1	500	100	200			
Nankeen Kestrel	*Falco cenchroides*	9/12/2023	7:30:12 AM	7:31:00 AM	1	50	1	20	Away	Powered (flapping) flight	It was perched on the gate, and then took off as the car came closer
Nankeen Kestrel	*Falco cenchroides*	9/12/2023	10:20:42 AM	10:21:00 AM	1	1000	50	70	Parallel to observer	Powered (flapping) flight	

*Bold text represents threatened species

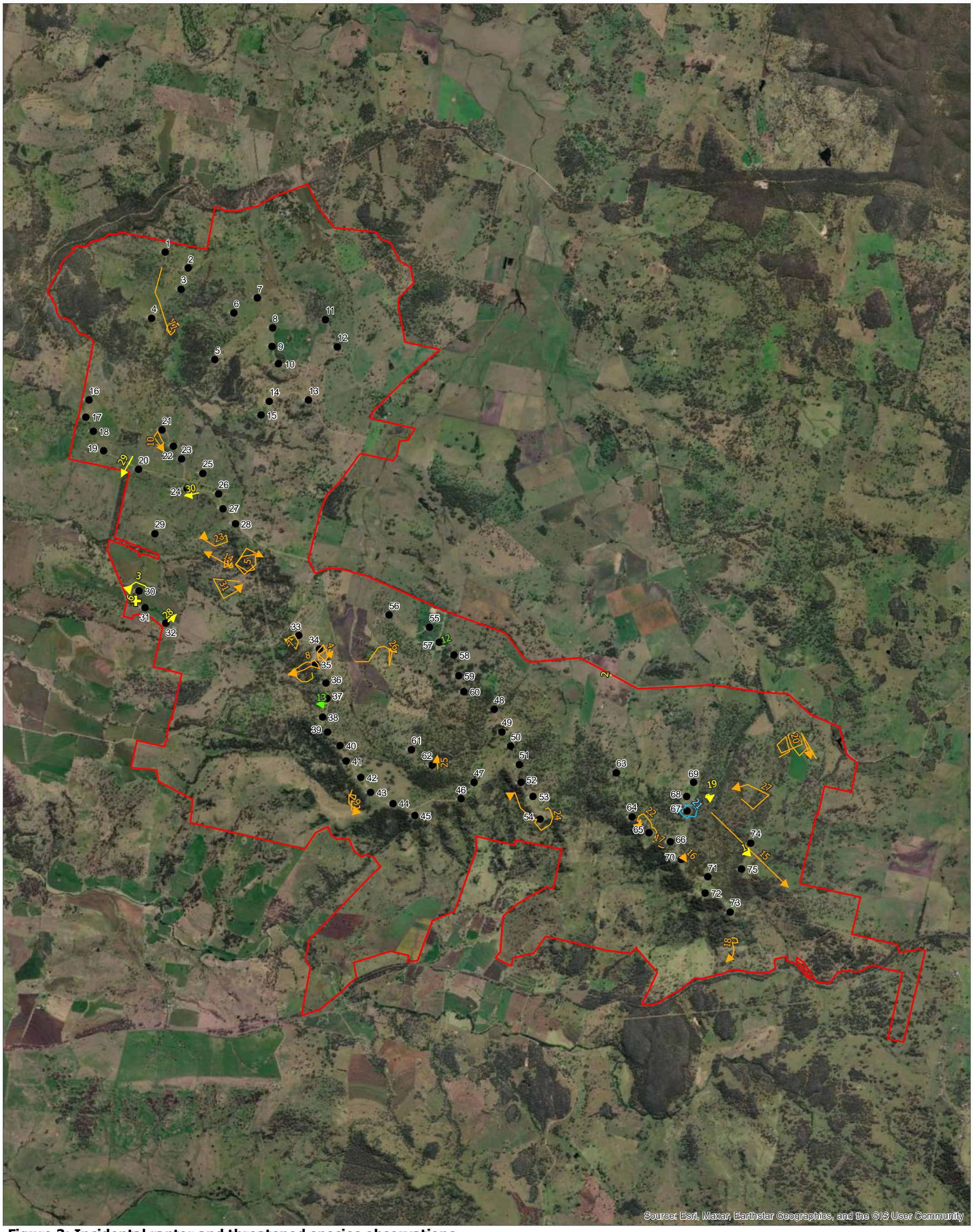

Figure 3: Incidental raptor and threatened species observations

Project: Sapphire Wind Farm **Client**: CWP Renewables Pty Ltd **Date**: 29/02/2024

Study area

Turbines

Perched observation

Nankeen Kestrel

Species

Black Kite

Little Lorikeet

Nankeen Kestrel

Wedge-tailed Eagle

N

Metres

0 1,000

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4. Discussion

Years One and Two carcass monitoring results included two formal finds of WTE during targeted carcass searches and four incidental finds. Mortality estimates presented in the Year Two report also predicted an average potential impact, based on formal carcass search results, of approximately five mortalities during the first 12 months of monitoring and 12 during the second year of monitoring. Year Three incidental finds reported by SWF included one WTE mortality, and no formal WTE carcass finds.

The results obtained during the fourth year of monitoring appear consistent with the findings of the first three years of monitoring prior to the addendum being implemented, however as of July 2023 there appears to be an increase in mortality at SWF (Figure 4). This increase may be an artifact of no surveys being undertaken during 2022, providing more carcasses to find during the more recent search period. A recent study found that carcasses of WTE persist between 199 and 567 days (Elmoby Ecology Bennett 2019; 2020; 2021).

No observation of active WTE nest indicates that the juveniles were mature enough to fledge (minimum 4 months old) (Cherriman, 2007). Based on previous experience from a Nature Advisory zoologist, observation of nine WTE individuals together could possibly be because of an undetected carcass present or because of presence of a water body or a combination of both, out of nine individuals 2 of them were seen displaying and soaring at the same time. The 'active' WTE nest observed last year (in a gully to the east of and equidistant between T63 and T64) showed no current activity and appeared to be abandoned during this survey. The majority of the WTE activity occurred in the southern part of the wind farm with few observations made in the central section.

4.1. Analysis of WTE population dynamics and the significance of impacts at SWF

Losses of apex predators can have negative consequences for biodiversity and ecosystem function in the long-term (Colman et al., 2014), as they act to maintain populations of native and introduced prey species, including mesopredators such as cats or foxes (Wallach et al., 2015). During five years of monitoring at SWF, a total of 15 individual WTE carcasses were discovered below operational turbines. It is important to understand the significance of these numbers for the local and regional population of eagles. Mortality estimates (provided by Symbolix) show with 95% confidence that fewer than 27 individuals have been lost to turbine strike (Symbolix, 2021). This number represents an upper limit for what is potentially missed through survey effort, however the methods employed at SWF under the BBAMP addendum suggest that the results are accurate from our searches given the persistence of WTE carcasses in the field. The mortality estimate also works under the assumption that there is an endless source of carcasses to find, which is not always the case when put into ecological context.

The WTE is a long-lived (20 years or more (DELWP, 2018), reproductively conservative species, that takes six to seven years to mature to breeding age (Ridpath & Brooker, 1986). Juvenile birds are competent flyers at four months post-fledging, when they leave their home range to wander great distances (up to 1200km (Cherriman, 2007)) until they become of breeding age (Debus et al., 2007). Breeding pairs in south-eastern Australia have a success rate of 0.8 to 1.0 young per pair per year (Debus et al., 2007; Fuentes et al., 2007; Marchant & Higgins, 1993; Dennis, 2006) and the proportion of breeding-aged adults in a population ranges between 25% to 67% (Ridpath & Brooker, 1986). Characteristic of species with slow life histories such as this is low demographic resilience; the resistance of populations to change after disturbance. For example, recolonisation of an area takes far longer than it would for short-lived, rapidly breeding species

Eagles of the *Aquila* genus generally occupy a range of 29 to 42 km^2, with considerable variation based on available food resources and landscape topography (Cherriman, 2007). A breeding pair may have two up to ten nests within their territory which they alternate between each year (Cherriman, 2007).

SWF covers an area of approximately 89.231 km², and one active and one inactive nest were recorded in early 2023 (Nature Advisory, 2023), which have subsequently both become inactive. These two nests were 1160m apart and located in the southeast of the wind farm. A rough estimate of one (known) local resident breeding pair is proposed, which at any given time would comprise between two and not exceed three individuals (if each pair has one fledged young). However, on-ground observations of site utilisation by the species (Section 3.2), as well as mortality observations (Section 3.1) and estimations (Symbolix 2023), suggest sources from a greater local population. It is possible that a large proportion of individuals observed within the study area are wandering juveniles, or adults from other territories in the region congregating along ridgelines to soar, hunt, or socialise (display). Comparing the rate of collision observed at SWF with the known rate of breeding success for the species and the estimated home range occupation suggests potential for some impact to both the local and the regional population of WTE.

Consequently, the predicted mortality rate, based on actual detected rates, of WTE at SWF over 30 years has the potential to have low impacts on population stability and resilience locally (1-5 years), but it is unclear how those impacts would extend to a regional scale. The potential for further-reaching impacts, such as at a national scale, is difficult to quantify due to the dearth of research regarding long-distance movements of WTE on the mainland. Section 5 discusses the suggested progression from such findings and provides recommendations on possible mitigation measures to be implemented to prevent further significant impacts to local and regional WTE populations, as well as to biodiversity and ecosystem function.

4.2. Revised risk for WTE at SWF

In 2016 OEH (now BCS) recommended that the likelihood of a turbine strike for WTE be raised to 'Certain', from 'Almost Certain'. The associated probability of a strike to these likelihood criteria were >95% and >50% respectively, that an event could occur in any year. In the response to the suggestion of increasing the likelihood of an event occurring, Nature Advisory advised at the time that the likelihood of an event was assessed correctly for this species at 'Almost Certain' (>50% likelihood).

Since the development of the SWF BBAMP in 2016, the risk assessment process has been revised within Nature Advisory, with some changes made to the names of criteria but not the probability ratings. The term 'Certain' was not in line with an objective assessment process, as we can only be statistically 95% confident in a result, rather than 100%. This likelihood rating was changed to read 'Almost certain', and the previous 'Almost certain' rating was changed to 'Likely'. As stated, no probability ratings were altered in this revision, so all current work is compliant and in line with BBAMP requirements. The Consequence criteria were also revised, but only in document structure. The current consequence ratings are still compliant with the BBAMP. The most recent likelihood probabilities, consequence ratings and risk matrix are attached as appendix 1.

We recommend following the most recent versions of these tables to assess overall risk to a species. With this context, we advise that based on the current data, the likelihood of an impact be raised to Almost certain (probability of >95%) with a Consequence rating of Low, resulting in an overall risk rating of Low. This assessment and reduction in overall risk rating is based on the very low numbers of individuals found to be struck annually. This rating aligns with the risk rating applied to this species at similar locations.

WTE are not considered to meet the criteria of a vulnerable species under either state or federal legislation. The range of the species is extensive across the continent, but the population is not well understood. There is an assumption that the population is increasing, but there is little data to work from in this context. The impacts to local or regional populations of WTE, without adequate estimates are difficult to measure. The suggested continued survey effort may aid in further assessment of the risk posed to this species' population.

5. Recommendations

5.1. Carcass search program

Incidental carcass monitoring will continue to take place by wind farm personnel. Any bird or bat carcasses identified will be reported and recorded in accordance with Section 4.4.5 of the BBAMP. We recommend that formal searches by Zoologist may optionally be concluded, as the increasing trend is potentially an artifact of the lack of survey effort in 2022. This increase in carcass detection may also be a result of the increased search effort, i.e., all 75 turbines were searched as opposed to only 18 turbines searched previously. Continued bi-annual searching would provide further information on whether the increase in strikes is an authentic representation of activity and incident at SWF or a result of data gap from 2022. Carcass finds of common birds like Eastern Rosella, Crimson Rosella, Australian Magpie, Galah are unlikely to be an issue as their distribution is Australia-wide, with their population number consistently increasing.

5.2. WTE activity and nest monitoring

A WTE nest and activity survey is proposed to be undertaken during Year Six and Year Seven at SWF during October – December 2024/2025 to monitor breeding activity at the active WTE nests identified. Searches will also be conducted for additional potential nests throughout the site. Activity surveys will include observations of WTE flights and activity recorded and plotted on maps capturing the data outlined in the methodology section 2.2.

The nests identified during this search will be recorded and monitored on an annual basis for two years (2024 and 2025) during October to December to record breeding activity and utilisation. The intention of this survey effort is to monitor habitat utilisation during nesting and breeding and to record flight behaviours displayed at SWF. Changes to breeding activity or site utilisation may provide additional insight into the impacts of SWF on WTE and the effectiveness of revised risk reduction measures, outlined below. The need for continued monitoring of WTE will be reviewed through reporting and in consultation with BCS.

5.3. Continued mitigation measures

The approved addendum to the BBAMP (Nature Advisory 2022b) provides revised mitigation measures to improve the implementation of the previous BBAMP measures and enable assessment and review in annual reporting. These are reiterated below and are the responsibility of SWF to implement and record.

The aim of the revised program is to track implementation of mitigation measures at SWF and their outcomes and then assess this against the findings of the revised monitoring program and potential impacts on WTE throughout the operation of SWF.

No carrion within 200m of a turbine was observed and therefore removed by SWF personnel. Considering turbine impacts on WTE increased in year five, and despite the risk reduction measures being enacted, it remains unclear what effect the carrion removal program is having, or whether it is required since there was no carrion detected to remove in year five. Recommendations are provided below.

Land-use and stock management underneath and around turbines can influence the presence and behaviour of native birds on site. Examples include:

- Grain feeding can be an “attractant” for parrots; and
- Carrion and rabbits can be an “attractant” to raptors in the area.

Thus, this section proposes possible mitigation measures to address these matters.

The WTE and other raptors forage for carrion (dead and decaying flesh of an animal) and on small mammals, rabbits etc. To reduce the risk of raptors colliding with turbines, a formalised carrion monitoring and removal program will be continued during operations. This will reduce the attractiveness of the site to raptors (specifically WTE) and therefore reduce the potential for fatal collisions by this group of birds. This program will focus on an area of a minimum of 200 metres around turbines, where safe, feasible and practical for SWF personnel. The procedures below will be adopted:

- The SWF Site Manager has been appointed to perform the function of Carrion Removal Coordinator who will undertake the activities described below. In the event the SWF Site Manager is not available, an alternative suitable person will be appointed to undertake this function.
    - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal (e.g., kangaroo, pigs, goats, foxes, rabbits, dead stock). and bird carcasses (to be recorded as incidental finds) that may attract raptors. This search will be undertaken via vehicle and visual checks in addition to using binoculars (where available) to look for large carcasses within 200 metres of each turbine. Results from inspections will be documented and the following information collected each month:
        - Date of inspection,
        - Person undertaking the inspection,
        - Any carrion identified and location (e.g., Turbine ID),
        - Any carrion still present from previous inspection,
        - Action taken (e.g., consultation with landholders or removal of carrion)
        - Pest animal activity or presence,
        - Lambing activity (when applicable),
        - Any incidental observations by landowners or SWF staff.
    - Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be addressed by operator protocols and information included in monthly inspection data.
    - Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines. If a carcass is not removed, its visibility during the next monthly inspection should be recorded.
    - Carcasses should be disposed of at least 200 metres away from the closest turbine. Results of any consultations will be logged and the locations of any carrion dumps (active or planned) to be noted. This can be assessed against any potential WTE mortality locations.
    - Carcass occurrence and removal will be recorded in monthly inspection records maintained by SWF Project Manager.
- During lambing season (usually late autumn/winder) young lambs are susceptible to death. Therefore, if possible and subject to agreement of landowners, lambing will be restricted to paddocks at least 200 metres away from turbines, where practicable, to reduce the risk that raptors (WTE in particular) are attracted close to the turbines.

- In order to reduce collision risks to birds, where practical and with landowner agreement, the practice of grain feeding of stock within 200 metres of turbines should be minimised as it could draw additional parrots and other birds to the site.
- Any feral animal control on the wind farm site should involve the removal and appropriate disposal of resulting carcasses in a timely manner.
- If a large active presence of rabbits is observed during monthly inspections near turbines, subject to landholder approval, an integrated rabbit control program (to reduce site attractiveness to WTE) will be completed within 200 metres of turbines. Methods to control rabbits include burrow destruction and shooting. Any rabbit control program will require cooperation and agreement from the landowner.
- Monthly inspection data, covering the requirements above, will be reported on in accordance with the BBAMP reporting requirements and provided to BCS in annual reporting.

Using the information collected above, the efficacy of the mitigation measures implemented will also be assessed annually. This will include an assessment of WTE carcass search data and site utilisation data against carrion occurrence rates, removal requests, and removal undertaken.

The program will be reviewed in accordance with the BBAMP reporting requirements. If, for example, WTE mortality increases annually when compared to the initial 24-month operational monitoring period, then the need for continuation, refinement or additional mitigation measures will be discussed, in consultation with BCS.

5.4. Reporting

Findings of the revised and continued monitoring program will be reported in the 7th year biennial Report (year 6 and 7), at this time any further recommendations for amendments will be made in consultation with BCS.

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Appendix 1 Risk Matrices

Likelihood criteria

Likelihood	Across a 12 month period:	
	Description	*Approximate probability (%)*
Very rare	Very improbable that impact could occur	<5
Less likely	Less probable than more probable that impact could occur	5 to < 50
Possible	Equally probable that impact could or could not occur	50
Likely	More probable than not that impact could occur	>50 to 95
Almost certain	Very probable that impact could occur	>95

Consequence criteria

Predicted to seriously disrupt an ecological significant proportion of the:		Consequence
Total population annually	*Population in the study area and surrounds for the life of the wind farm*	
No	None	**Negligible**
No	Short-term	**Low**
No	Medium-term	**Moderate**
Yes	Medium-term	**High**
Yes	Long-term	**Severe**

Risk ratings

		Consequence				
		Negligible	Low	Moderate	High	Severe
Likelihood	Very rare	Very low	Very low	Very low	Low	Low
	Less likely	Very low	Very low	Low	Medium	High
	Possible	Very low	Low	Medium	High	High
	Likely	Very low	Low	Medium	High	Very high
	Almost certain	Very low	Low	High	Very high	Very high