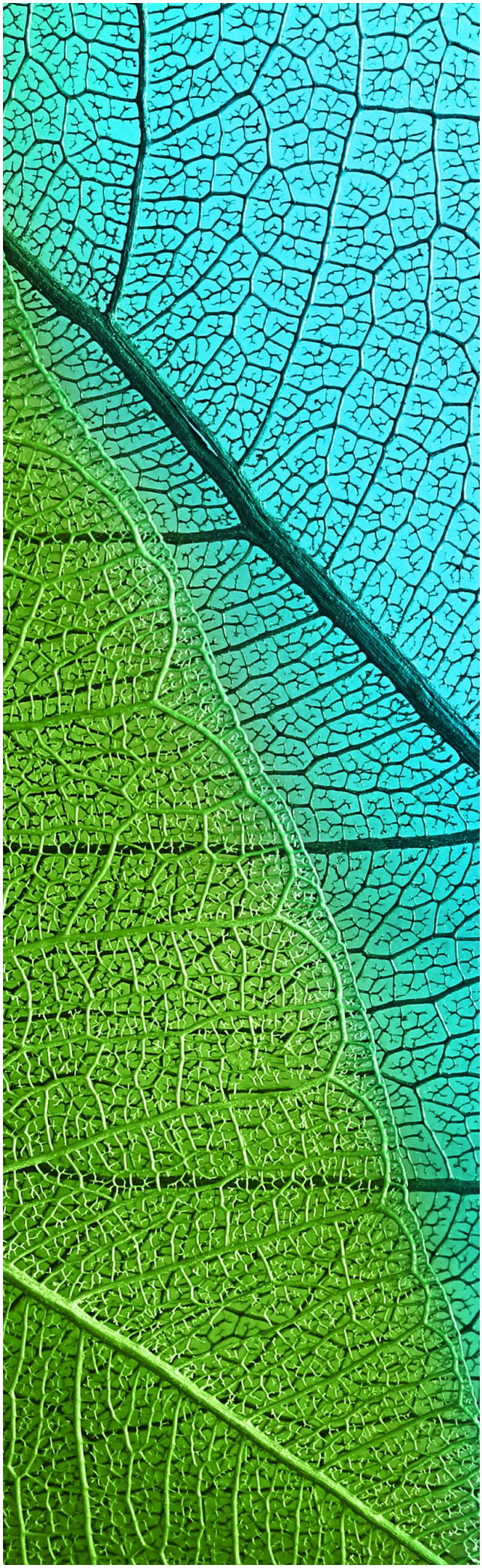

Sapphire Wind Farm

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)

Nature Advisory
(Formerly Brett Lane & Associates Pty Ltd)
5/61-63 Camberwell Road
Hawthorn East, VIC 3123
PO Box 337, Camberwell VIC 3124
(03) 9815 2111
www.natureadvisory.com.au

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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).

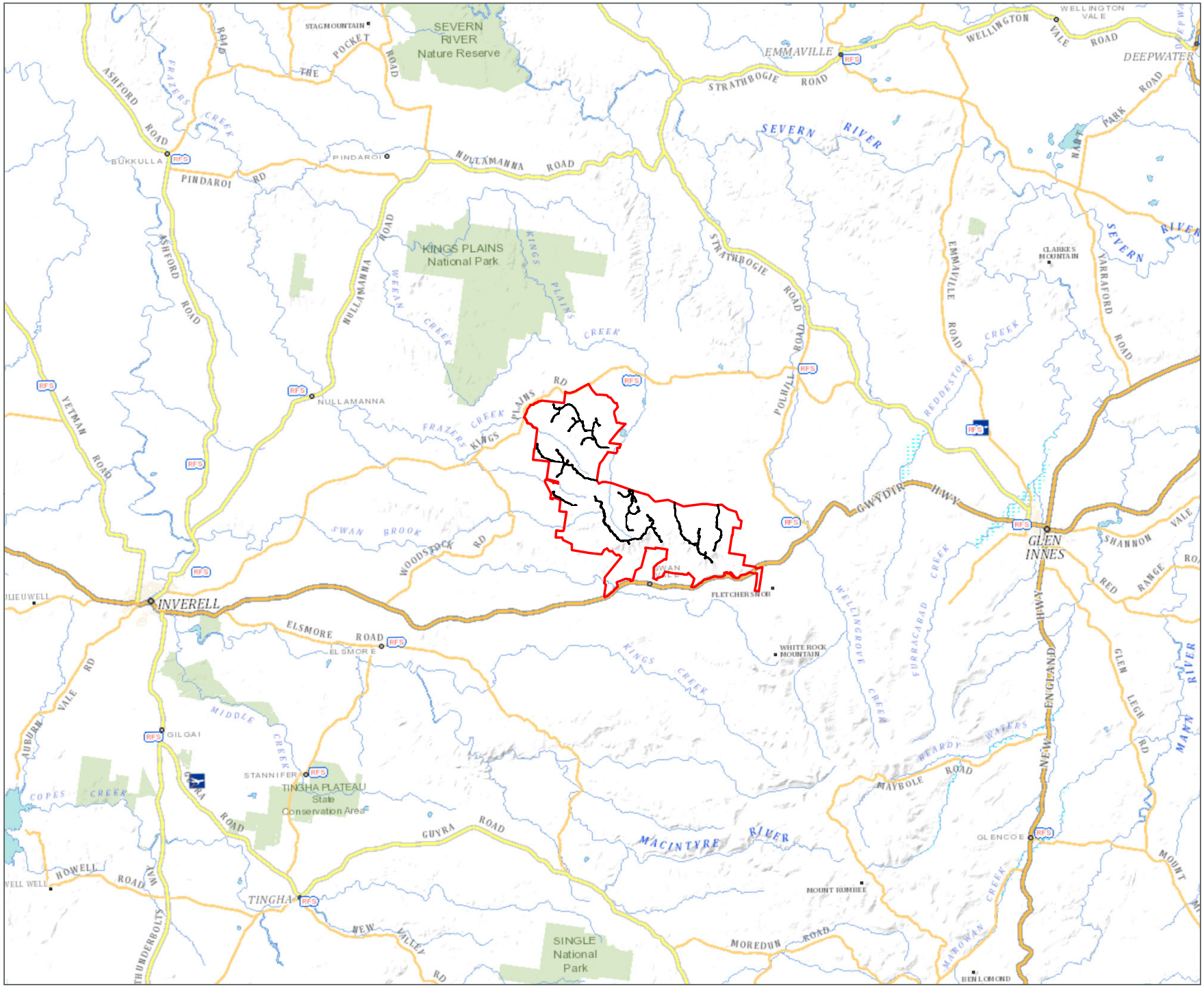

Figure 1: Locality map

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

Study area
Turbines
Access tracks

N

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

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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.

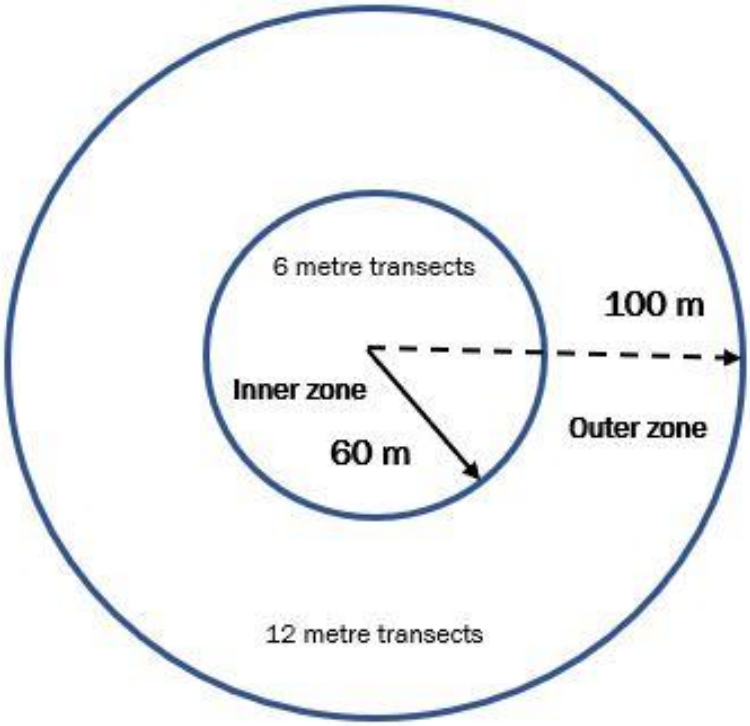

Figure 2. Diagram of inner and outer search zones at turbines

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:

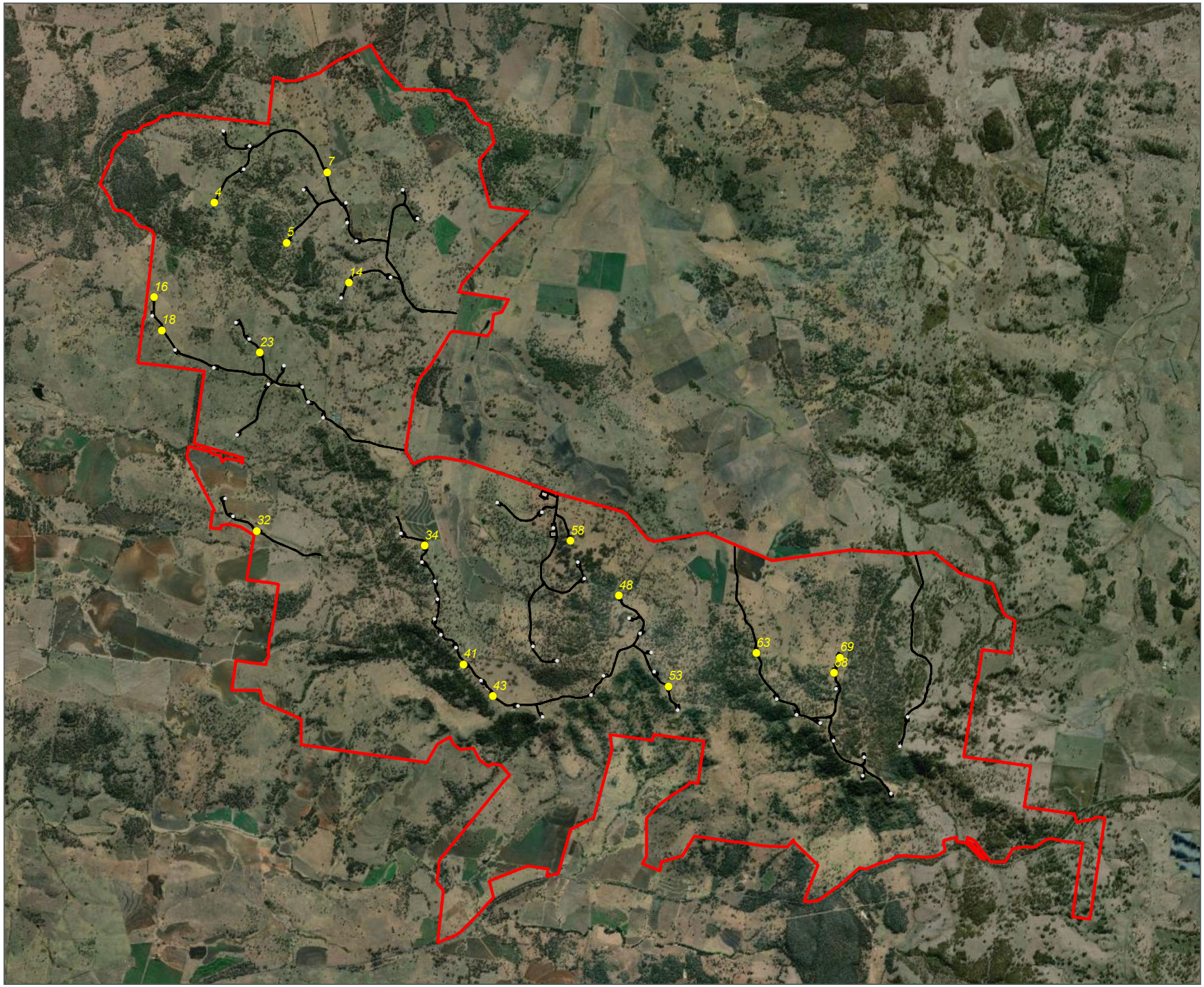

Figure 2: Sapphire Wind Farm turbine layout

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**

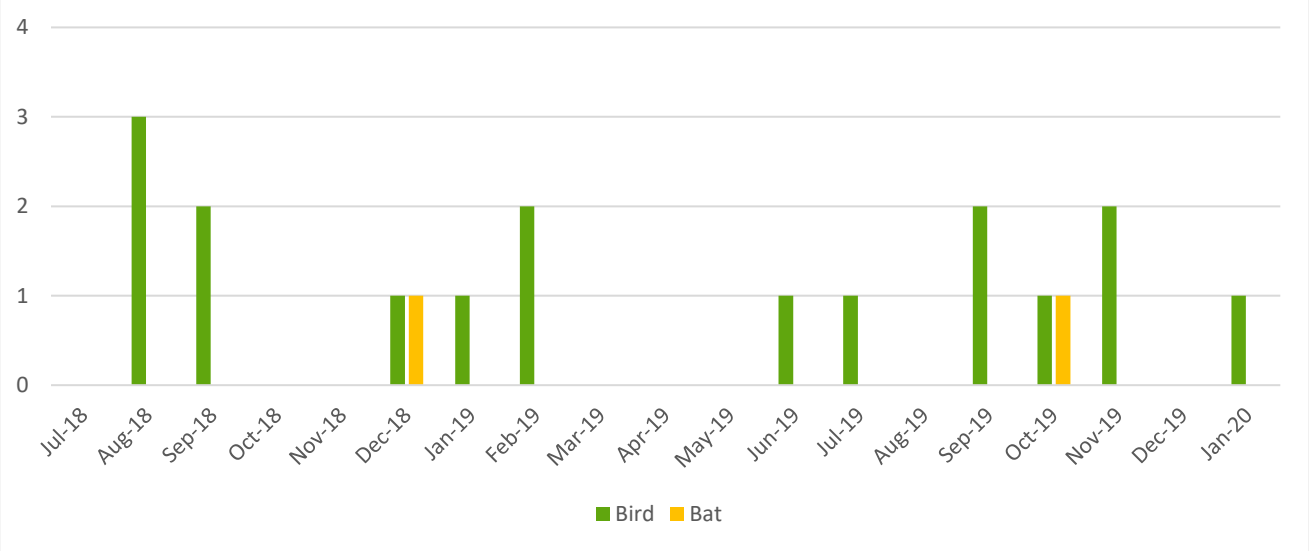

Figure 4. Number of carcasses found in each month during the monitoring period at SWF

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).

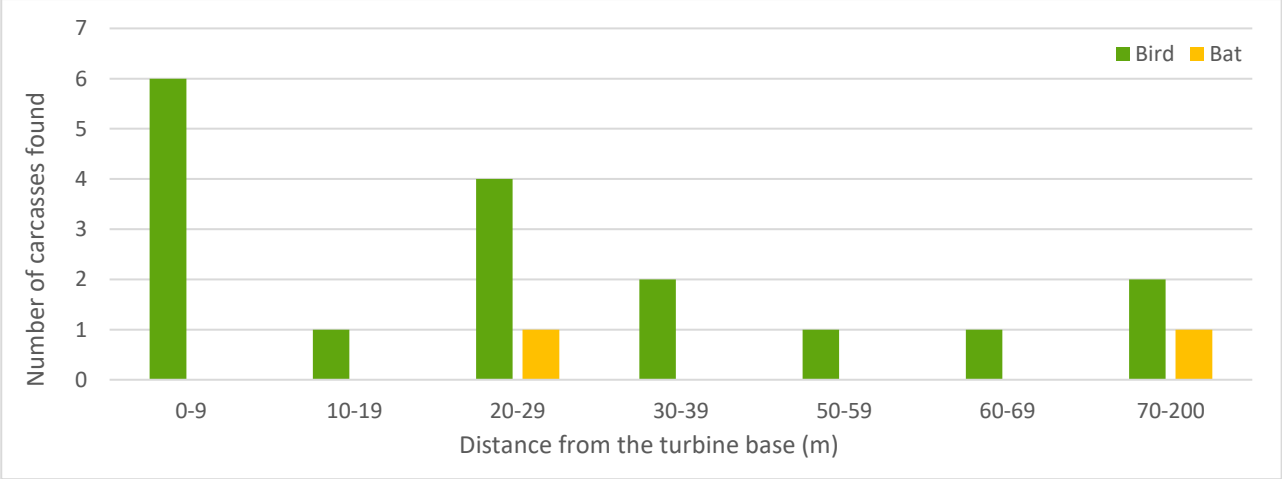

Figure 6. Distribution of carcasses found at distance categories from the turbine

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).

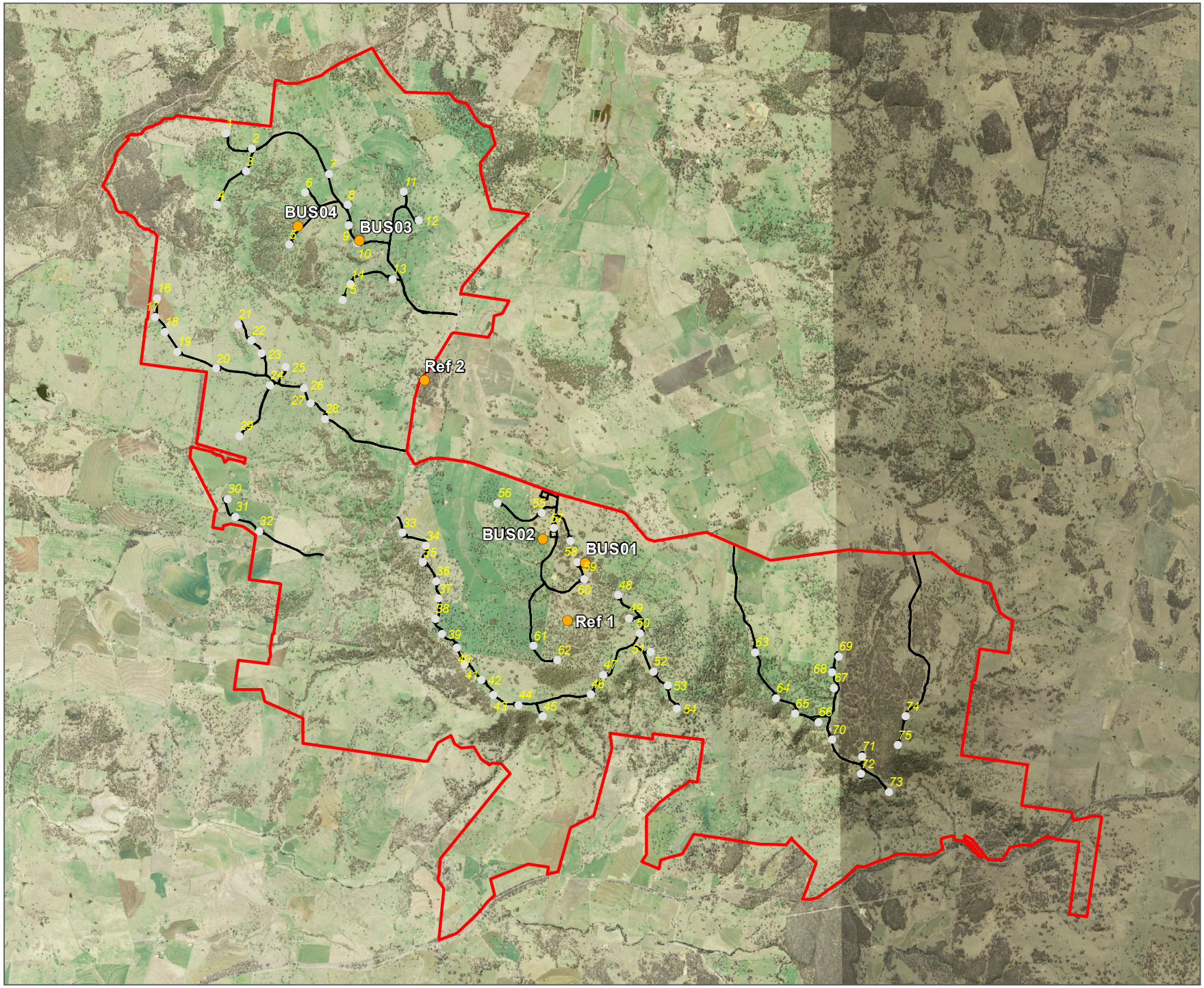

Figure 8: Location of BUS points at Sapphire Wind Farm

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

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

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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.

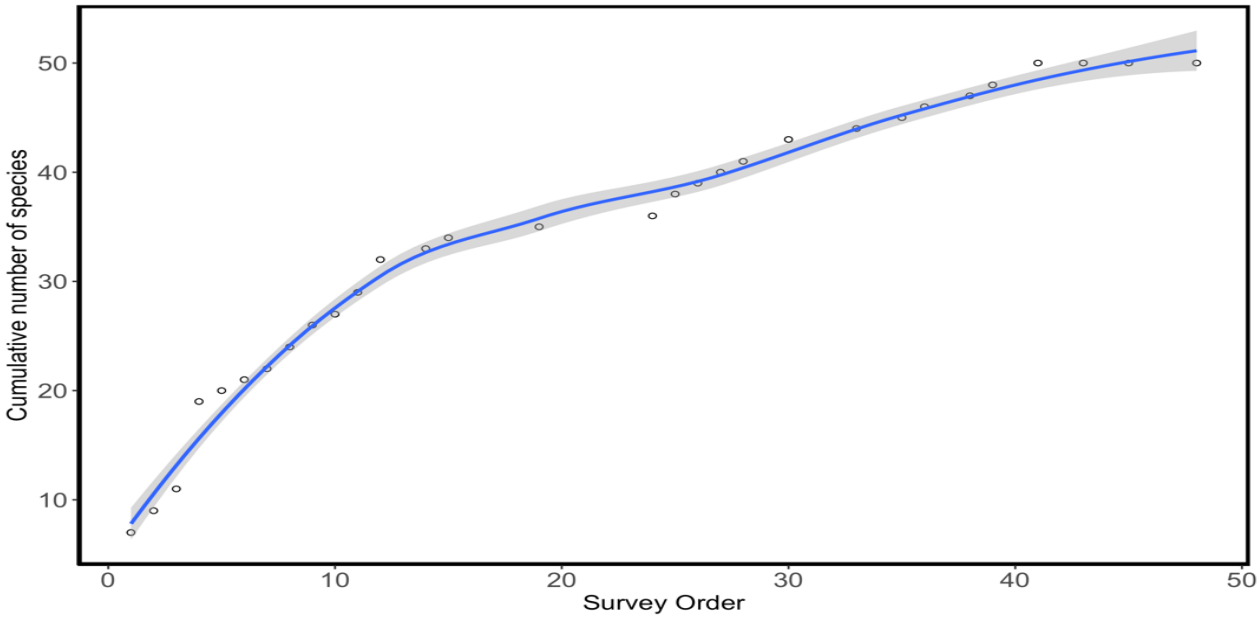

Figure 9. The cumulative number of species of birds recorded during consecutive counts at the BUS points at SWF

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).

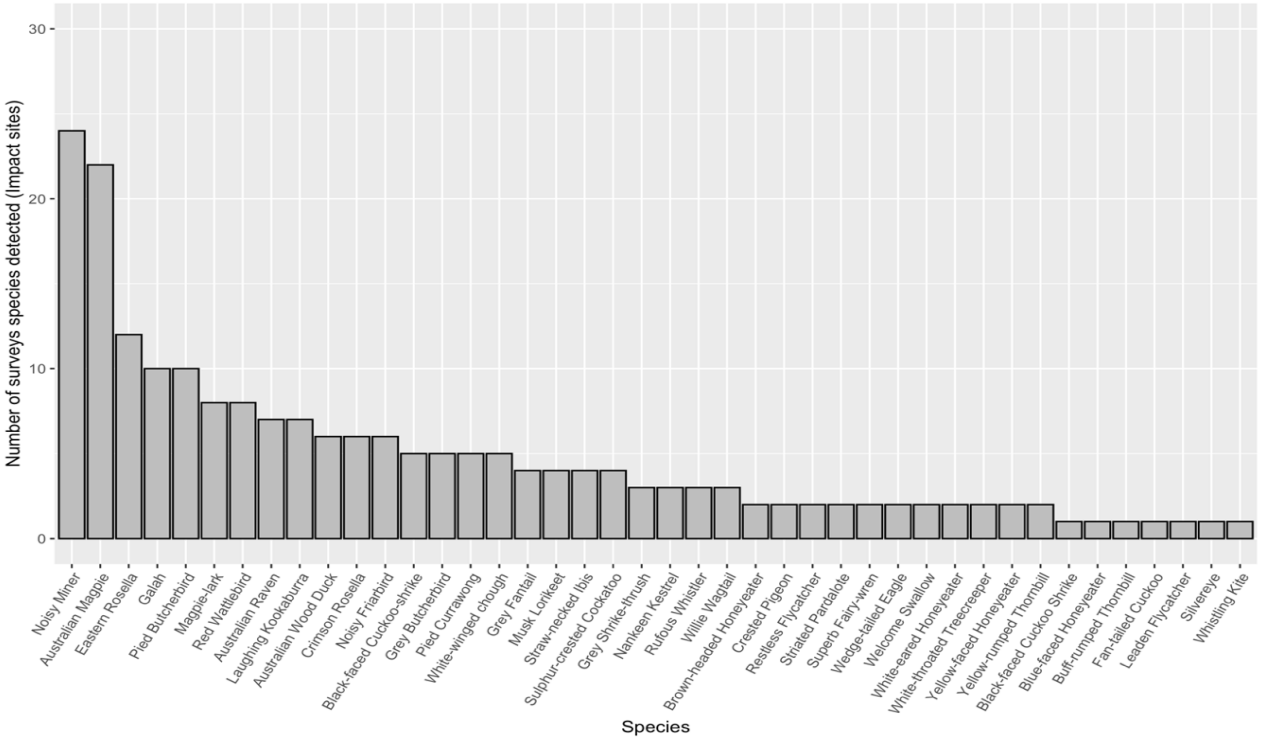

Figure 10: Frequency of species detection in impact sites at SWF. Values represent the number of surveys that a given species was observed

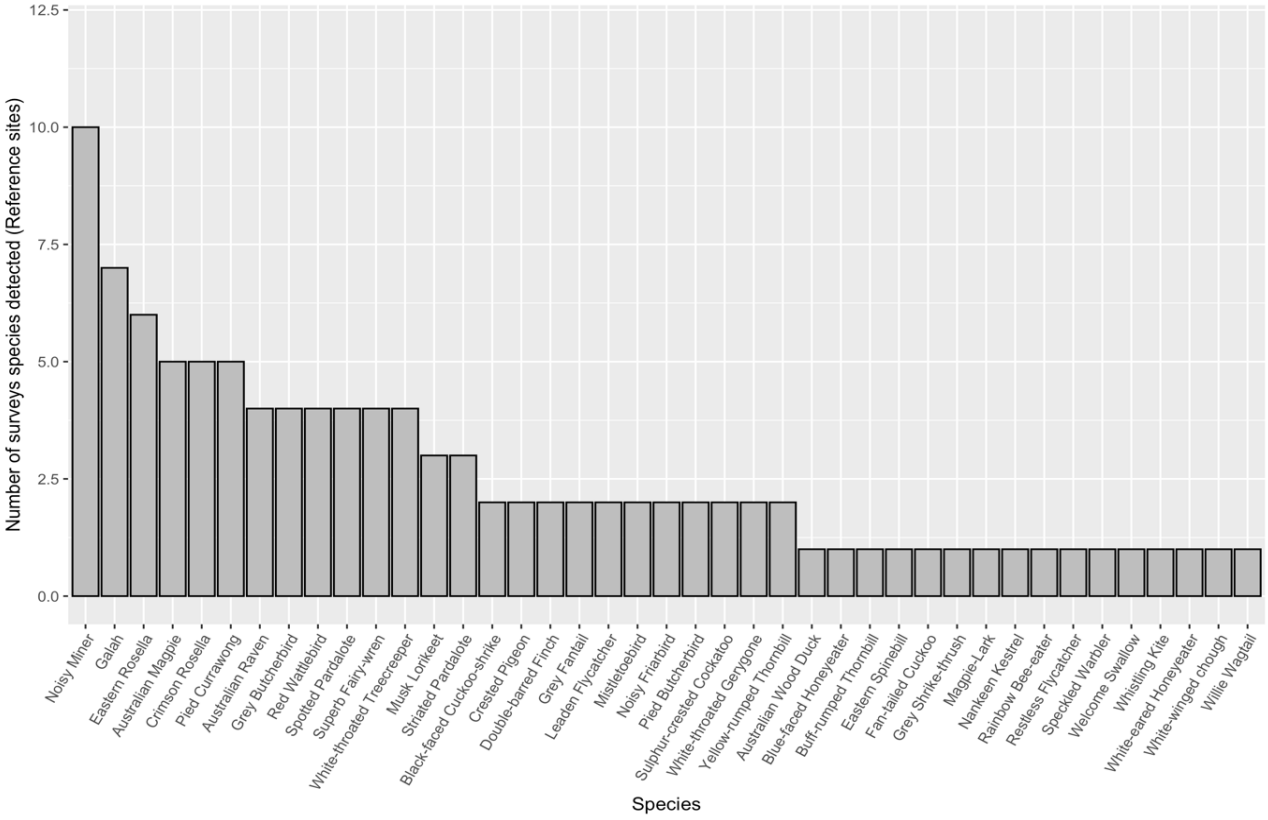

Figure 11: Frequency of species observed at reference sites. Values represent number of surveys that a given species was detected.

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

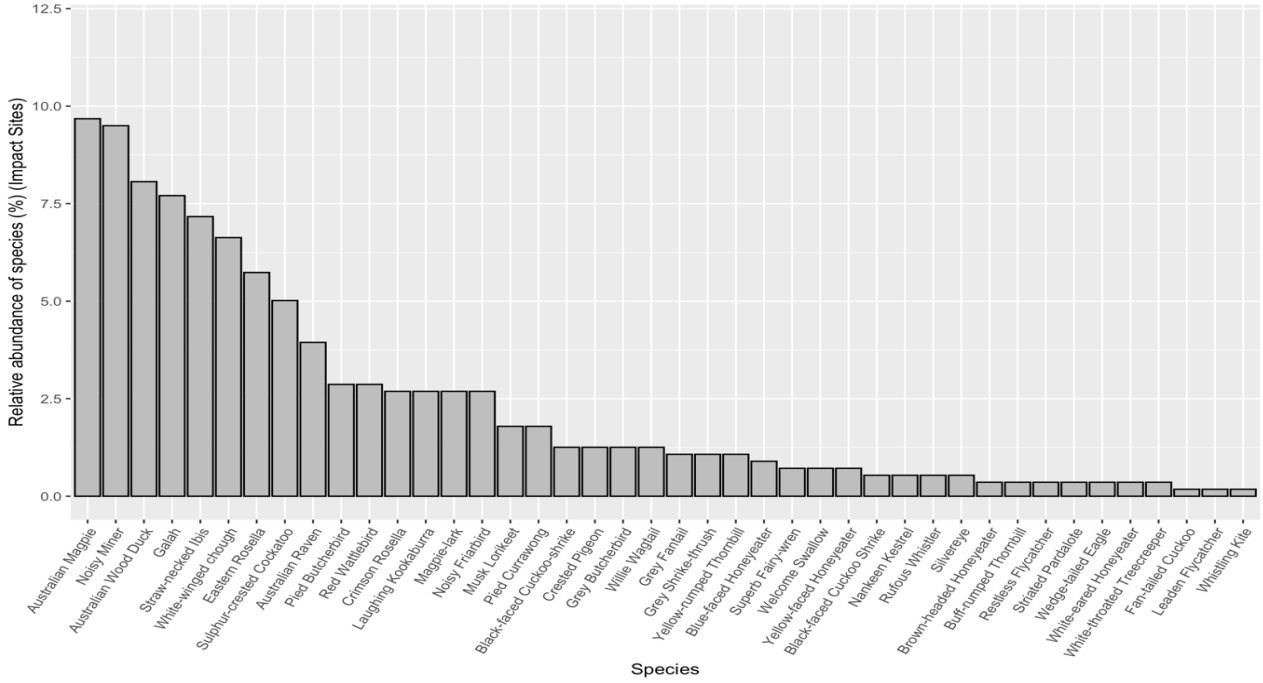

Figure 12: Relative abundance of species observed in impact sites at SWF. Values represent percentages of individual of a given species

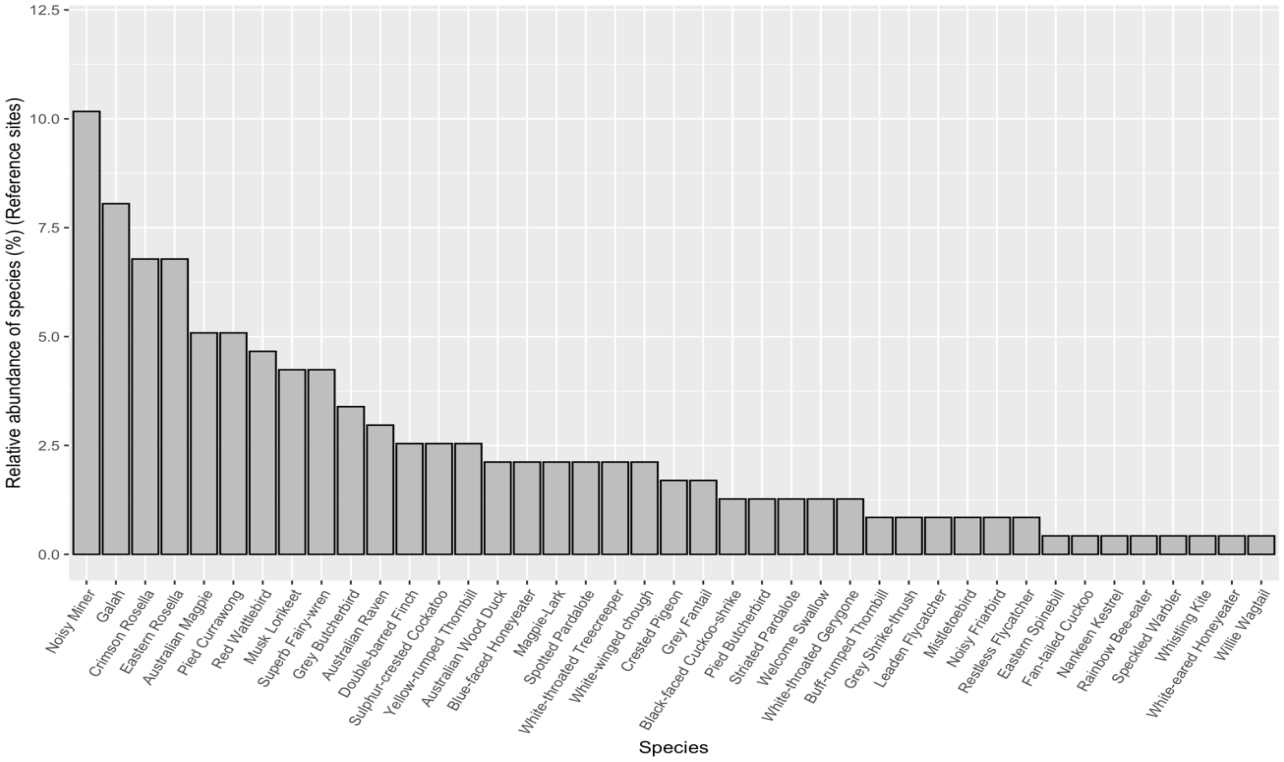

Figure 13: Relative abundance of species observed in reference sites at SWF. Values represent percentages of individual of a given species

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.

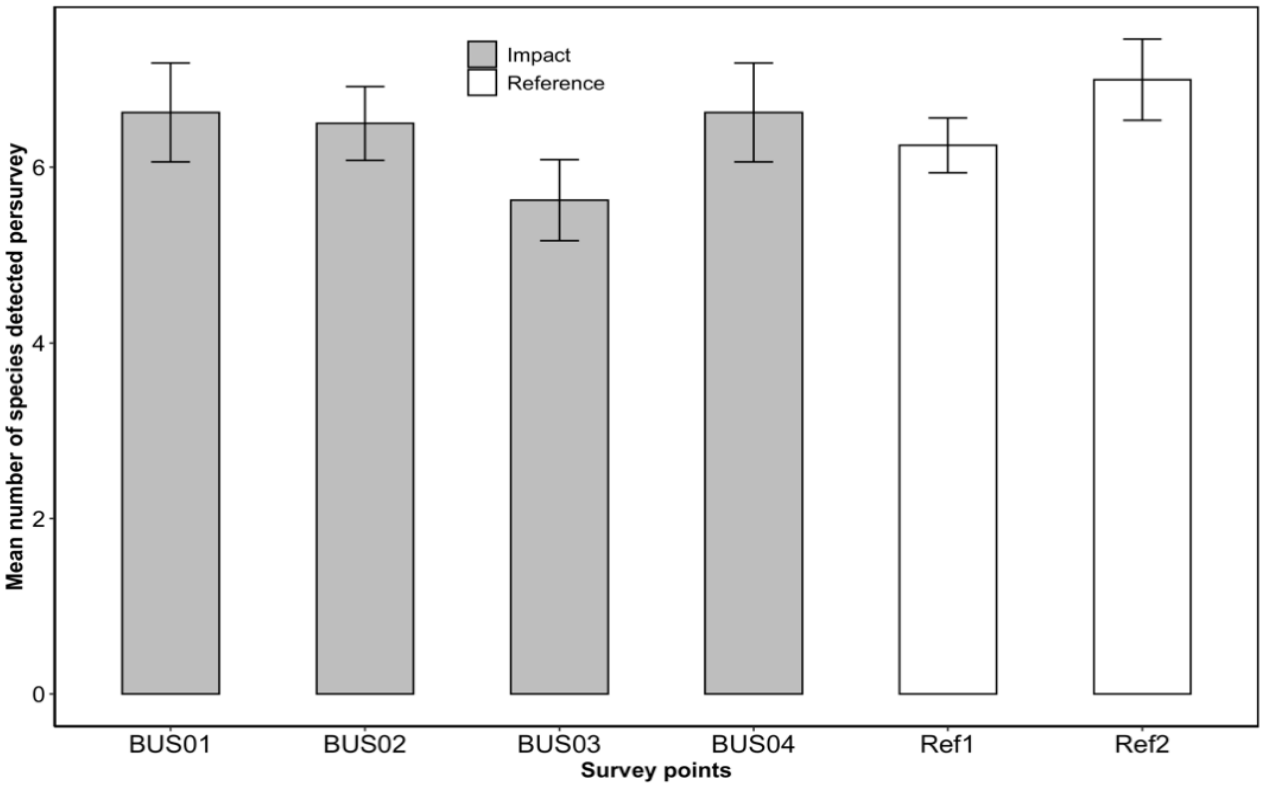

Figure 14. Mean diversity (number of species per survey) of birds among impact and references survey points

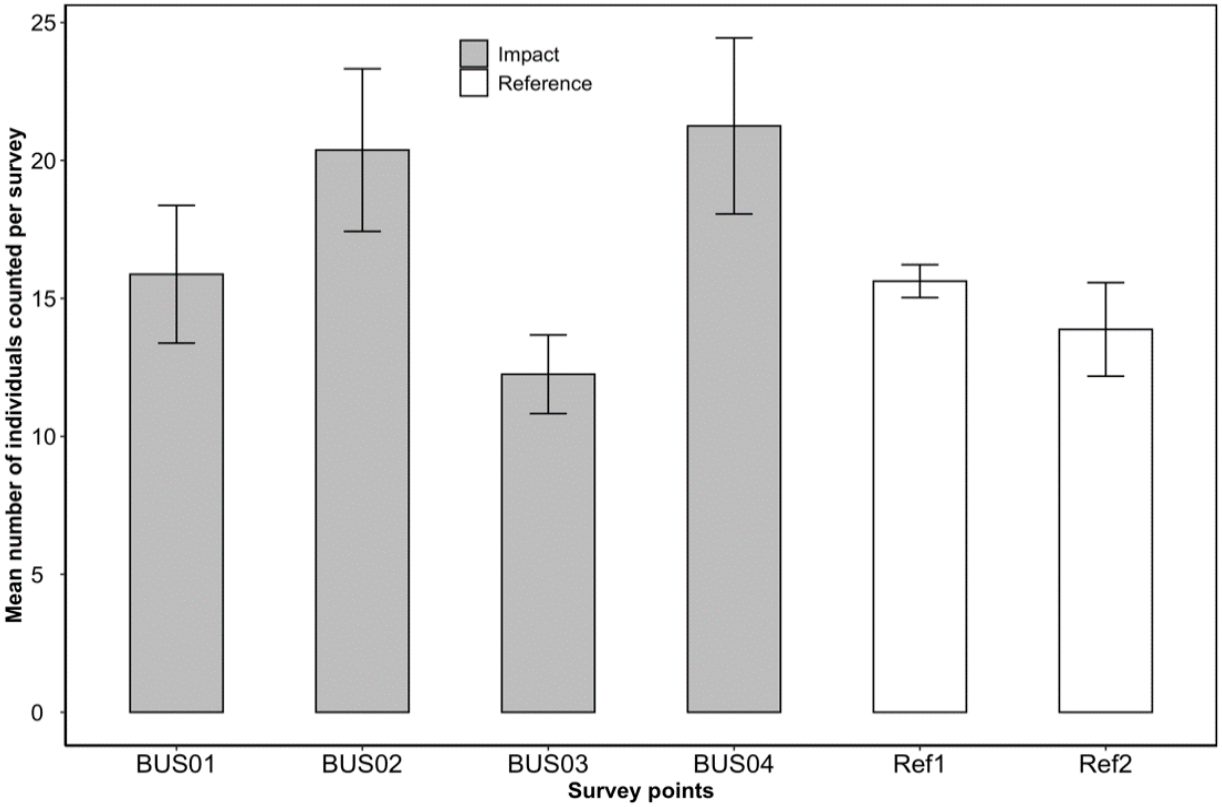

Figure 15. Mean abundance (number of birds recorded per survey) at impact and survey points

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.

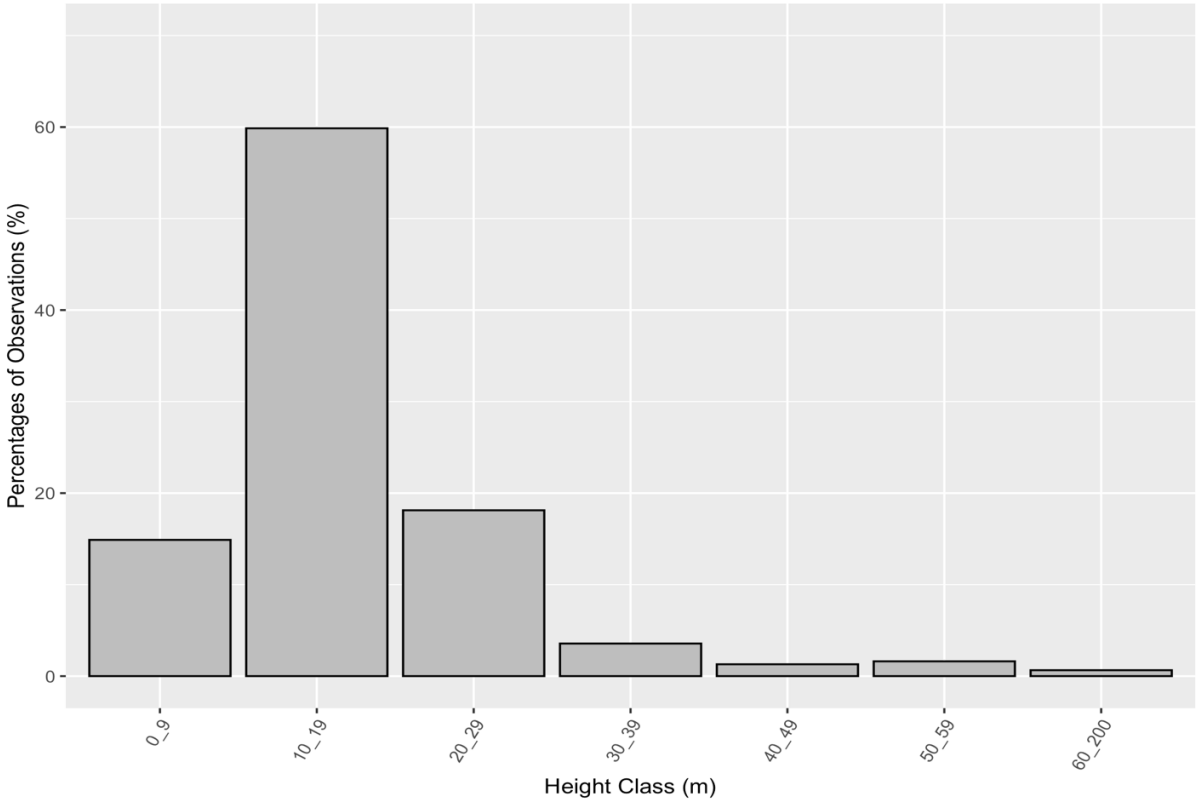

Figure 16. The distribution of bird heights as recorded during BUS at SWF

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