

Bodangora Wind Farm

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

**Prepared for
Bodangora Wind Farm Pty Ltd**

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Nature Advisory

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1. Introduction

Development consent (DA MP10_0157) was originally granted in August 2013 for the Bodangora Wind Farm (BWF), comprising 33 wind turbines and associated infrastructure.

The Bodangora Wind Farm (BODW1) project near Wellington in the Central West Slopes of New South Wales (NSW) received planning approval in August 2013 from the Minister for Planning and Infrastructure (Development Application MP10_0157). The wind farm is approximately two kilometres north-east of Bodangora, 20 kilometres north-east of Wellington and 40 kilometres south-east of Dubbo.

As a condition of approval, the proponent must prepare a ‘Bird and Bat Adaptive Management Program’ (BBAMP) for the wind farm, consistent with the requirements of condition of approval C6, presented below.

“Bird and Bat Monitoring - 06. Prior to the commencement of construction, the Proponent shall prepare and submit for the approval of the Secretary a Bird and Bat Adaptive Management Program, which takes into account bird and bat monitoring methods identified in the current editions of AusWEA Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia and Wind Farms and Birds: Interim Standards for Risk Assessment. The Program shall be prepared and implemented by a suitably qualified expert, approved by the Secretary. The Program shall incorporate monitoring, and a decision matrix that clearly sets out how the Proponent will respond to the outcomes of monitoring.

The ‘Bird and Bat Adaptive Management Program’ (BBAMP) for Bodangora Wind Farm (BWF) was approved in June 2017. The BBAMP will operate for the life of the BWF. The first two years of operation of the BWF will provide focussed monitoring to inform impacts and mortality estimates on birds and bats at the wind farm.

Section 3.5 of the BBAMP indicates that reports will be submitted to the Secretary and Biodiversity Conservation Division (BCD) as per the project approval conditions. Matters to be addressed in the report include, but will not be limited to:

- A description of the BBAMP activities undertaken during the reporting year;
- A summary of search methodologies and searches undertaken;
- Details and results of the mortality detection;
- Observations from the Grey-crowned Babbler monitoring;
- Observations from the Superb Parrot surveys;
- Any identified impact triggers and / or recommended updates to the BBAMP risk assessment; and
- Any recommended changes to survey effort based on the results of the surveys.

This report is the first annual report. At the end of the second year of post-construction monitoring, an overall assessment will be made of all the data obtained during the first two years of BBAMP implementation, details of the management practices implemented, as well as recommended adjustments. The results of the review and its implications will be reviewed with BCD.

Bodangora Wind Farm Pty Ltd engaged Nature Advisory (formerly Brett Lane and Associates) to implement the approved BBAMP for the BWF.

The mortality detection at BWF commenced in June 2019. This report covers the period of 12 months from June 2019 to May 2020. Specifically, the implementation of the BBAMP included:

- Bird and bat mortality detection program;
- Monitoring ‘at risk’ groups of birds;
 - Grey-crowned Babbler;
 - Superb Parrot;
 - Raptors (birds of prey); and
 - White-throated Needletail.

This report is divided into the following sections:

Section 2 provides the methods and results of the mortality detection program.

Section 3 provides the methods and results of the monitoring ‘at risk’ bird species.

Section 4 discusses the conclusions of the first year of monitoring at BWF.

This investigation was undertaken by a team from Nature Advisory, comprising Mick Callan (Zoologist), Eamon O’Meara (Zoologist), Curtis Doughty (Senior Zoologist), Bernard O’Callaghan (Senior Ecologist and Project Manager) and Brett Lane (Principal Ecologist).

2. Mortality detection

This section of the report discusses the mortality detection program. The mortality detection program has been implemented to determine the impact the wind farm is having on birds and bats at the site. Birds and bats are known to collide with operating turbines and this program has been designed to monitor this impact.

3.1 Methods

3.1.1 Mortality detection – standard search

Section 3.2 of the BBAMP outlines the procedures for mortality detection at BWF. This report covers the first-year monitoring period from June 2019 to May 2020. In line with the approved BBAMP to ensure a valid dataset for statistical analysis, the mortality detection search was based on 16 turbines (representing almost half the turbines at the BWF). Turbines were selected randomly to ensure representativeness and are listed in Table 1.

Mortality detection was undertaken at each of 16 turbines twice every month during a five-day period. The turbines were searched to a radius of 100 metres once per month followed by a 60-metre radius “pulse” search 2-3 days after the first search in the same month (Figure 1). The process of undertaking the searches is:

- The inner zone: walking transects are spaced six 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 Hull and Muir 2010); and
- The outer zone: between 60 and 100 metres radius from the turbine tower base to detect the medium and larger bodied birds; walking transects are spaced twelve metres apart.

Table 1: List of turbines searched

Turbine number	Turbine Number	Turbine Number	Turbine Number
T02	T12	T19	T25
T04	T13	T20	T30
T05	T14	T23	T31
T09	T15	T24	T33

When a dead bird or bat was recorded under a turbine, a report was completed and a photograph of the carcass was taken. When only feathers were recorded this was recorded as a feather spot. It is likely that feather spots represent a bird that collided with a turbine and was later scavenged.

On finding a dead bird, feather-spot or dead bat, the searcher:

- 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, or identity verified and used later in observer efficiency and scavenger trials (see below).

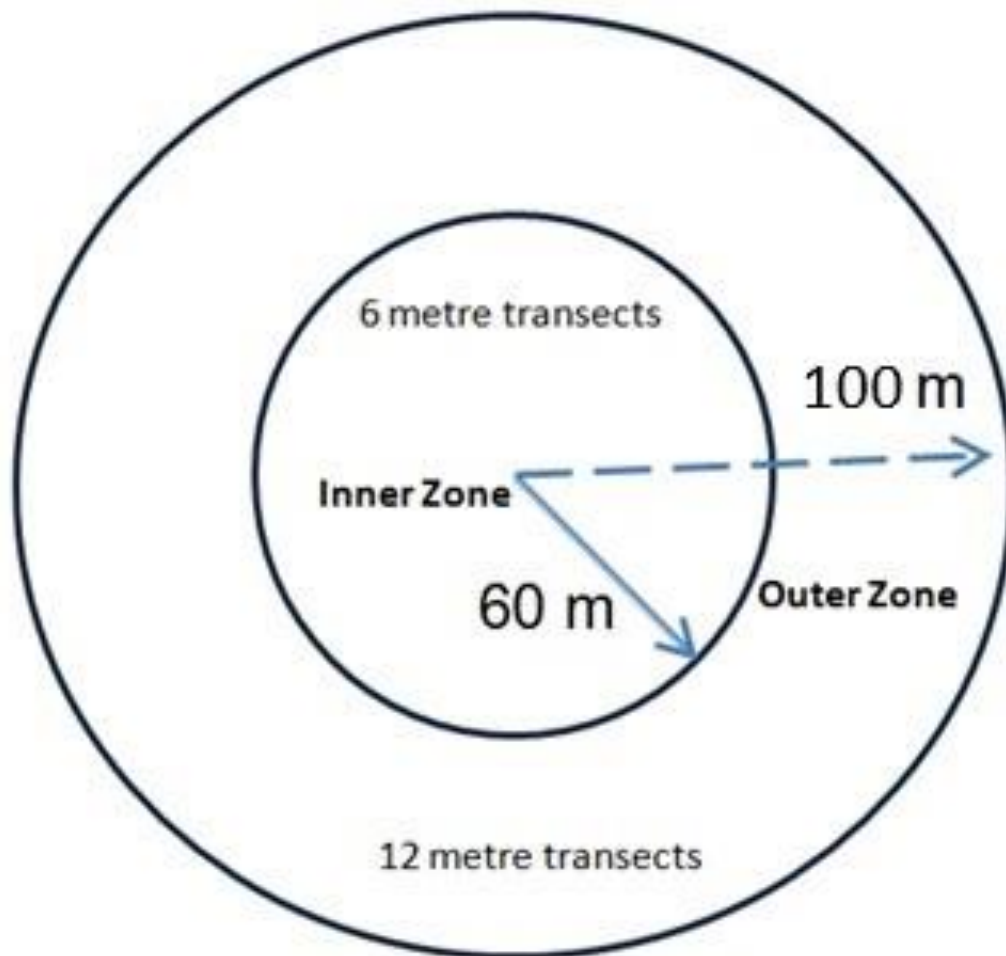


Figure 1: Diagram of inner and outer search zones at turbines

An incidental record is a carcass that was found under a turbine outside of the formal mortality detection program (e.g. by wind farm personnel during routine inspections of infrastructure or during turbine searches under a turbine not selected for monthly searches).

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

3.1.1 Additional Turbine searches

In addition, the BBAMP details the requirement for a “selection of turbines to be included in the mortality detection program should be revised periodically to ensure that all turbines are sampled for at least 12 months during their first 2 years of operation”, i.e. 100% of turbines searched for at least 12 months (50% of the 24-month monitoring).

Thus, in addition to the turbines searched above, all other turbines are searched to ensure that all turbines are searched to ensure 100% of all turbines will be searched at least 12 times in the first 24 months of operation. The turbines and how many replicates they have been searched in the first 12-month monitoring period is shown in Table 2. The remaining searches will be picked up in the second year of monitoring.

Table 2: Number of replicates the additional turbines were searched

Turbine	T01	T03	T06	T07	T08	T10	T11	T16	T17
Replicates	3	3	4	7	2	3	7	4	4
Turbine	T18	T21	T22	T26	T27	T28	T29	T32	
Replicates	2	3	4	4	3	3	3	2	

3.1.2 Detectability trials

Detectability trials are intended to determine the probability with which the searcher is likely to detect a carcass on the ground. All personnel who have carried out monthly mortality searches at BWF will undertake detectability trials. The searcher is referred to as the person who regularly undertakes the mortality detection. The assessor is the person who sets up the trials and assesses the searcher.

The first detectability trial was undertaken on the 24th July 2020 when grass heights was long. This trial was delayed due to COVID-19 restrictions.

Twenty Carcasses were placed under turbines that were searched each month. They were randomly placed on the ground within 60 metres of the turbine. The searcher records each species that was found as usual. After the searcher completed searching each turbine the assessor would check to see what carcasses were missed and then checked to see if they were still on the ground or had already been taken by a scavenger.

The BBAMP (BL&A 2017) states that four searcher efficiency trials will be conducted over the two-year monitoring period, two trials when grass height is short and two when grass height is long. These requirements will be met in the remaining monitoring program timeframe or thereafter depending on relevant Covid-19 related restrictions. This will be two trials during spring/summer period and two trials during autumn/winter period.

3.1.1 Scavenger trials

Scavenger trials ascertain the rate at which carcasses are removed by scavengers. This is used to develop a 'correction factor' for the estimate of the numbers of birds and bats affected by the wind farm. Scavengers can include ground-dwelling animals, such as foxes and rats (more likely to detect carcasses by scent), as well as aerial scavengers such as birds of prey and ravens (more likely to detect them visually).

Section 3.2.4 of the BBAMP details the process for scavenger trials. The approach detailed in the BBAMP places carcass in the search area and then an observer comes back regularly to check on whether the carcass has been scavenged.




A modified methodology has been adopted for the scavenger trials where a motion sensor camera is used to monitor scavenger activity taking place. A camera will be attached to a tree, fence post or star picket approximately 3–4 metres away from each randomly placed carcass. The camera will record any scavenging activity.

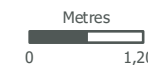
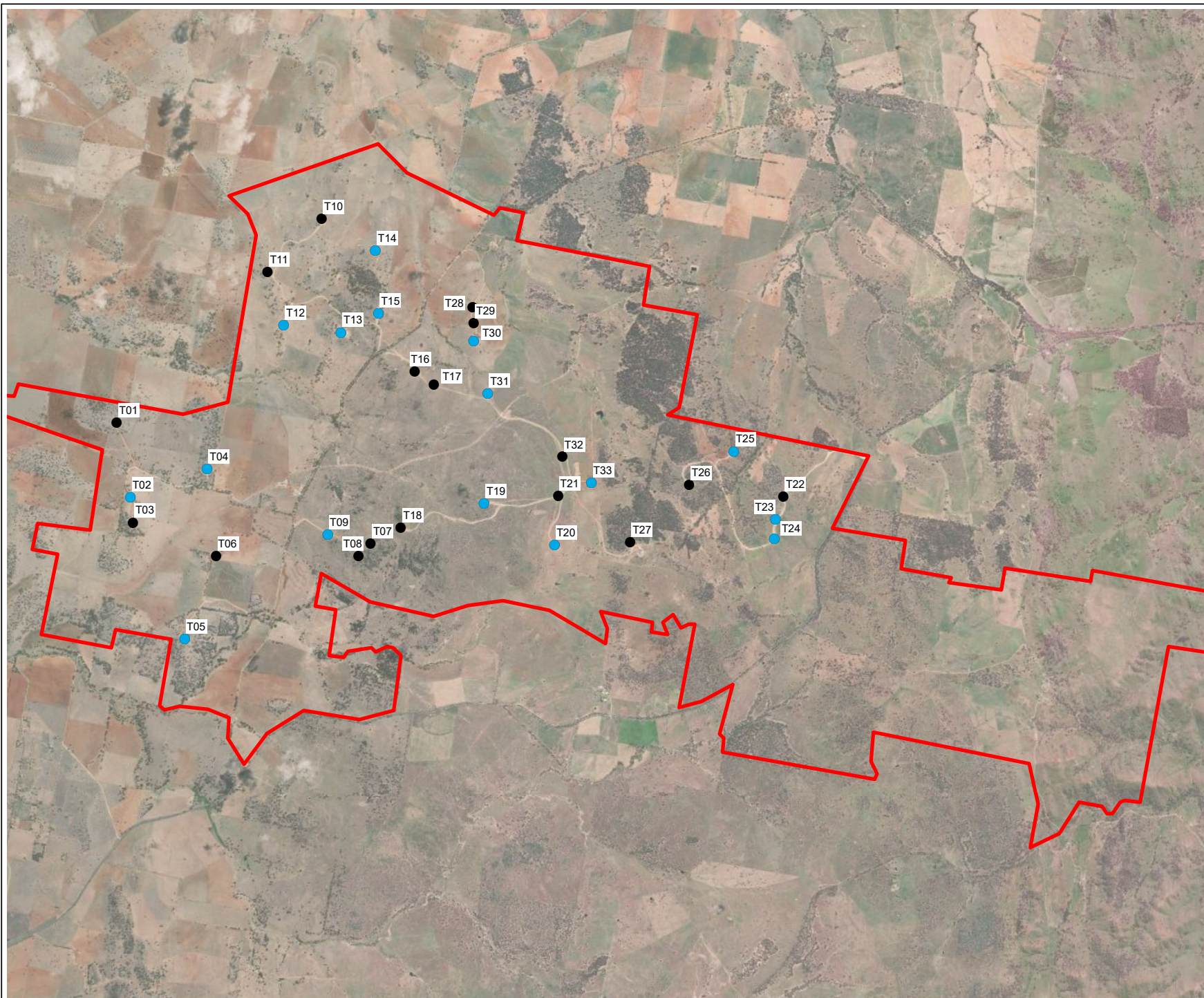
The carcass will then be left for a period of 30 days after which the camera will be collected and scavenging activity reviewed. If the carcass still remains at day 30 it will be recorded as being scavenged at day 30. The information recorded will capture the exact time and date and provide a photograph of which scavenger, if any, has taken the carcass. This is an extension to the method detailed in the BBAMP and will provide better quality information for the more detailed mortality analysis.

Trials were planned to be undertaken during the later portion of the first year as carcasses accumulated from the mortality detection. However, due to logistical constraints with the fires and later Covid-19 restrictions, these were delayed. Trials were initiated using motion detection cameras in July 2020. These will continue monthly and will be ongoing to meet the target number of carcasses in the BBAMP. Results will be outlined in the second annual report and also used in statistical analysis.

Figure 2 : Survey locations for monthly carcass searches

Project: Bodangora Wind Farm
Client: Infigen Energy
Date: 31/07/2020

-  Wind Farm boundary
-  Turbines
-  Turbines searched



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3.2 Results

3.2.1 Mortality detection

A total of 88 bird and bat remains – comprising 47 bird and 41 bat remains – were recorded beneath turbines at BWF during the first-year monitoring period. The first-year monitoring period was from June 2019 – May 2020. This figure includes 15 incidental records comprising five bird and ten bat remains.

Three additional carcasses – one Black Falcon, one Grey-headed Flying-fox and a forest bat – were found prior to the first-year monitoring period which commenced in June 2019 and as such are not included within the total sum of remains found in the first-year monitoring period.

The results of formal bird and bat mortality detection at BWF in 2019-2020 are summarised in Table 3.3. The table shows the number of carcasses and feather spots found during formal searches, and incidentally. Formal searches refer to the 16 turbines searched monthly in the first-year monitoring period that will be included in the statistical analysis at the end of the two-year monitoring period. The monthly spread of carcass findings during the formal searches is shown in Figure 3.

Table 3: Summary of mortality detection results for bird and bats at BWF from April 2019 – May 2020

Search Type	Season	Month	Bird	Bat	Feather Spot	Total
Monthly turbines (16)	Winter	Jun '19	2		4	6
		Jul '19	1	1	4	7
		Aug '19	4	8	3	15
	Spring	Sept '19	4	5	1	10
		Oct '19	6	1		7
		Nov '19	2		1	3
	Summer	Dec '19	1		1	2
		Jan '20	1		1	2
		Feb '20	2	2		4
	Autumn	Mar '20			10	10
		Apr '20			6	6
		May '20	2			2
Totals of Formal Searches			25	33	15	73
Incidental Finds	Autumn	Apr '19	1	2		3
	Winter	Jun '19	1	2		3
		Jul '19		3		3
	Spring	Nov '19	1			1
	Autumn	Mar '20	2	2		4
Apr '20		3	1		4	
Totals of Incidental Records			8	10	0	18
Combined Total Records			33	43	15	91

Notes: Incidental finds outside of the formal monitoring period are highlighted in grey.

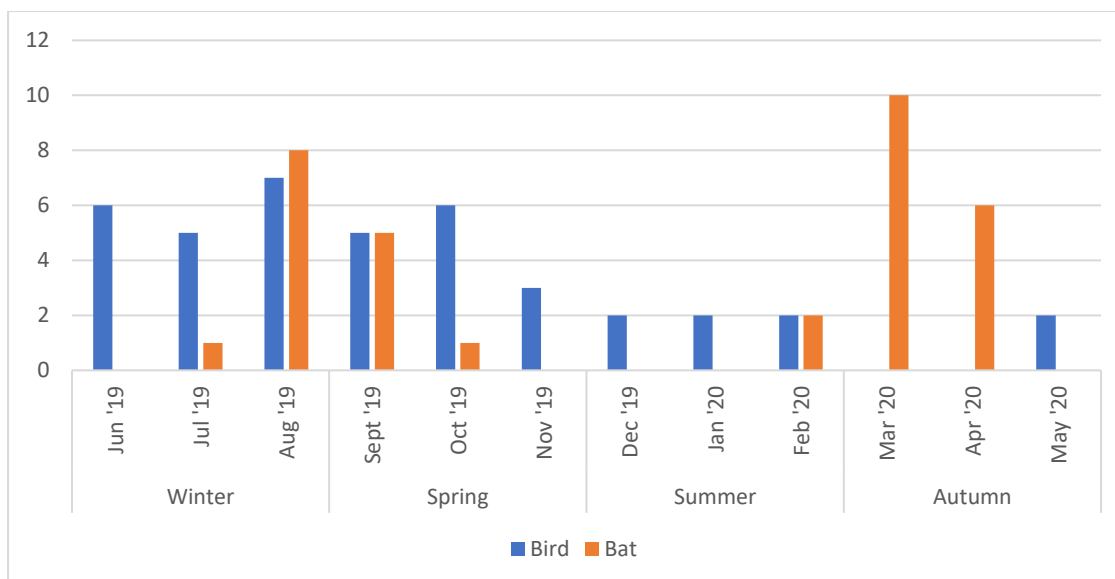


Figure 3: Number of carcasses found during formal searches in each month during the first year of monitoring

Birds

A total of 47 bird strikes were recorded within the BWF site during its first-year monitoring period and an additional bird strike was recorded prior to the commencement of the first-year monitoring period. Forming the bulk of this total, 35 carcasses were discovered during formal searches, comprising 25 partial or intact carcasses and 15 feather spots. As is standard practice, it has been assumed that feather spots discovered beneath turbines are the result of an initial turbine collision, with scavengers such as Red Fox or ravens later consuming the carcass and leaving feather remains. None to seven bird remains were recorded each month during formal searches, with August 2019 having the highest count.

Eight additional carcasses were discovered incidentally beneath turbines by wind farm personnel or under turbines outside the 16 searched each month including one species found prior to the first-year monitoring period.

Detected bird mortality at BWF is summarised in Table 4 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 2019-2020 can be found in Appendix 1.

Table 4: Summary of detected bird mortality across the BWF up until May 2020

Species	Formal searches	Feather spot	Incidentals	Totals
Australian Magpie	5	2	1	8
Nankeen Kestrel	7		1	8
Noisy Miner	1	4		5
Wedge-tailed Eagle	2		3	5
Raven	2	2		4
Brown Falcon	2	1		3
Eastern Rosella	1	1		2
Galah	1	1		2
Pied Currawong	1	1		2
Red-rumped Parrot	2			2
Apostlebird		1		1

Species	Formal searches	Feather spot	Incidentals	Totals
Australian Hobby	1			1
Black Falcon			1	1
Crested Pigeon			1	1
Grey Butcherbird		1		1
Grey Fantail			1	1
Magpie-lark		1		1
Total	25	15	8	48

Notes: Totals include one incidental find of a Black Falcon prior to the commencement of first-year monitoring period.

One threatened species, the Black Falcon was found under a turbine prior to the commencement of the first-year monitoring period. No other threatened birds were found to collide with turbines at BWF.

A total of eight Australian Magpie and eight Nankeen Kestrel were found under turbines during the first-year monitoring period, seven of each were found in formal searches and one of each incidentally. These two species are common and widespread species typically associated with farmland habitats and often fly at Rotor Swept Area (RSA) height and are at risk of collision with turbines.

Five Noisy Miner were recorded beneath turbines during formal searches. This species is most frequently sighted flying below RSA height. This species has a preference for habitats that have been opened up by vegetation clearing and can become quite aggressive towards other bird species and is considered a pest in some areas.

The Wedge-tailed Eagle was recorded as a causality on five occasions, two during formal searches and three incidentally. This species is a large raptor and is easily observed when on the ground under the turbine and is not often missed. The Wedge-tailed Eagle was frequently observed flying at the wind farm site. The entire wind farm site provides suitable habitat for Wedge-tailed Eagle, with the undulating topography on-site producing updraft winds suitable for soaring. Whilst the species was commonly observed flying across the wind farm throughout the year, no breeding or nesting activity was recorded.

Brown Falcon, a commonly encountered species across farmland habitats, was identified beneath turbines on three occasions. Blade strike of this species was anticipated, given their common flight behaviour at RSA height and frequent collisions at other wind farms within their large.

One Australian Hobby was found below a turbine in October 2019. This species is known to fly at RSA height frequently, and blade strike of this species was anticipated.

The remainder of species subject to blade strike were those commonly found in farm landscapes and associated woodland habitats. These species were; raven species, Eastern Rosella, Galah, Pied Currawong, Red-rumped Parrot, Apostlebird, Crested Pigeon, Grey Butcherbird, Grey Fantail and Magpie-lark. These species, to varying extents, disperse across open country to other woodland habitats.

Threatened birds

One threatened species, the Black Falcon was recorded under a turbine prior to the commencement of the first-year monitoring period. No other threatened birds were found to collide with turbines at BWF.

The Black Falcon, listed as ‘Vulnerable’ in New South Wales (BC Act), was found in April 2019 incidentally by wind farm staff. It was initially identified as an eagle by wind farm personnel but was

later correctly identified as Black Falcon on 17th June 2019 by ecologists when they first arrived on site and inspected the carcass. Due to a threatened species being found under a turbine this initiated an impact trigger.

A report was lodged with Office of Environment (OEH) Regional Office in Dubbo on the 19th June 2019 to inform of the impact trigger being met. An investigation was undertaken to determine the potential impact on the species. The response and findings of the impact trigger is as follows:

- A notification was provided to OEH on the 19th of June – within two days of the species being identified;
- The immediate investigation was initiated and an assessment was undertaken and found the following:
 - The mortality was due to turbine collision;
 - The species is nomadic – mainly confined to arid and semi-arid areas; and
 - There is a low risk of future impacts on this species.
- Thus, the cause of the fatality is deemed to be likely a one-off occurrence. It is unlikely to be significant at a population scale.
- Further action should be undertaken in the following manner:
 - Continuation of the carcass monitoring for two years as detailed in the BBAMP;
 - Sightings of raptors recorded during the monthly monitoring; and
 - In the annual reporting the risk ranking of this species within the BBAMP may be reviewed.

In summary, the findings concluded that the *risk of likelihood of reoccurrence is considered to be very low*.

An individual Black Falcon was seen flying at the site on one occasion during formal searches in May 2020 (Section 4.4.2).

Bats

A total of 41 bat strikes were recorded within the BWF site during its first-year monitoring period and an additional two bat strikes were recorded prior to the commencement of the first-year monitoring period. Forming the bulk of this total, 33 carcasses were discovered during formal searches. None to ten bat remains were recorded each month during formal searches, with March 2020 having the highest count (Figure 3).

Ten additional bat carcasses were discovered incidentally beneath turbines by wind farm personnel or under turbines outside of formal searches including two species found prior to the first-year monitoring period.

Detected bat mortality at BWF is summarised in Table 5 below, with species listed in ranked order of the number of carcasses found. Detailed information on each bat carcass and incidental record during 2019-2020 can be found in Appendix 2.

Table 5: Summary of bat carcass records across BWF up until May 2020

Species	Formal searches	Incidental	Total
Gould's Wattled Bat	8	3	11
Southern Freetail Bat	8	1	9
White-striped Freetail Bat	8	1	9
Forest Bat species	2	2	4
Southern Forest Bat	4		4
Grey-headed Flying-Fox		3	3
Chocolate Wattled Bat	1		1
Lesser Long-eared Bat	1		1
Yellow-bellied Sheathtail Bat	1		1
Total	33	10	43

Notes: Totals include two incidental bat finds prior to the commencement of first-year monitoring period.

Two threatened species of bat, the Grey-headed Flying-fox and Yellow-bellied Sheathtail Bat were found under turbines at BWF. Three Grey-headed Flying-fox were found incidentally, one prior to the commencement of the first-year monitoring period and two during July. Four Forest bat carcasses have been sent to the Museum of Sydney for identification to species level, there is possibility that they may be Inland Forest Bat, identification has not been confirmed at this stage. No other threatened birds were found to collide with turbines at BWF.

A total of 11 Gould's Wattled Bat were found under turbines during the first-year monitoring period, eight were found in formal searches and three incidentally. This species are common and widespread species typically associated with woodland habitats and often fly at RSA height and are at risk of collision with turbines.

A total of nine Southern Freetail Bat and nine White-striped Freetail Bat were found under turbines during the first-year monitoring period, eight of each were found in formal searches and one of each incidentally. These two species are common and widespread species found in a wide range of habitats and often fly at RSA height and are at risk of collision with turbines.

Four forest bat species were found under turbines that could not be identified to species level in the field due to the level of decay. These species have been provided to the Museum of Sydney for identification. It is possible that they could be Inland Forest Bat that is listed as a threatened species in NSW. Once identification is confirmed the results will be incorporated into the reporting.

Four Southern Forest Bat were found under turbines during the first-year monitoring period during formal searches. One carcass of each Chocolate Wattled Bat and Lesser Long-eared Bat were found under turbines during the first-year monitoring period during formal searches. These species are common and secure and occur in woodland habitats.

Threatened bats

Two threatened species of bat, the Grey-headed Flying-fox and Yellow-bellied Sheathtail Bat was found under turbines at BWF. An additional four forest bat carcasses have been handed to the Museum of Sydney for identification.

Three Grey-headed Flying-fox carcasses were found by wind farm personnel; one carcass was found prior to the commencement of the first-year monitoring period in April 2019 and two were found in July 2019. The Grey-headed Flying-fox, listed as 'Vulnerable' in New South Wales (BC Act)

and nationally (EPBC Act). Due to threatened species being found under turbines this initiated an impact trigger.

A report was lodged with Office of Environment (OEH) Regional Office in Dubbo to inform of the impact trigger being met. An investigation was undertaken to determine the potential impact on the species. The response and findings of the impact trigger is as follows:

- A notification was provided to OEH on the 19th of June – within two days of the species being identified;
- The immediate investigation was initiated and an assessment was undertaken and found the following:
 - The mortalities were due to turbine collision;
 - The closest monitored camp to the wind farm site was located in Wellington on the confluence of the Bell River and Macquarie River approximately 17 kilometres to the south of the wind farm. The bats were thought to traverse from this camp to the wind farm site to feed on flowering eucalypt trees;
 - Up to 30 Grey-headed Flying-fox were found foraging after dark at the wind farm site from three patches of eucalypt that were in heavy flower;
 - It was considered unlikely that the bats were migrating through the area in great numbers given the distance from other known, permanent camps;
 - The GHFF does not move about in groups, with movements generally involving lone individuals;
 - At Wellington, a camp of 500 flying-foxes were found roosting during the day in the confluence of the Bell River and Macquarie River (year-round) and appeared to fly each night to the north to forage, but did not pass over the direct flight path to the Bodangora Wind Farm, suggesting it may forage within the town of Wellington and nearby;
 - Habitat suitable for GHFF camps occurs on or near the wind farm based on inspection of treed habitats within 17 kilometres of the wind farm;
- Thus, the risk of further collisions by this species is considered to be possible, in particular while there is food in the area. Whilst individuals may move through the wind farm in the future while foraging, it is likely the number will be in response to available foraging resources or suitable habitat for a camp in or near the area;
- The loss of three individuals in a population of over 600,000 is not a significant impact on this species population;

One Yellow-bellied Sheathtail Bat was found during formal searches on the 16th April 2020. This species is listed as vulnerable in NSW (BC Act). Due to a threatened species being found under a turbine, this initiated an impact trigger.

A report was lodged with BCD Regional Office in Dubbo on the 17th April 2020 to inform of the impact trigger being met. An investigation was undertaken to determine the potential impact on the species. The response and findings of the impact trigger is as follows:

- A notification was provided to BCD on the 17th of April – the day after the species was recorded;
 - The immediate investigation was initiated and identified: The mortality was likely due to turbine collision;

- The turbine at which this carcass was found (Turbine 4) is more than six kilometres west of a remnant vegetated area;
 - The species is believed to be nomadic and migratory;
 - “Though infrequently encountered, the conservation status of the Yellow-bellied Sheath-tailed bat is categorised as of least concern, because the species is both widespread and versatile in its habitat selection, thus is considered unlikely to decline rapidly. Conservation status at the state level is more cautious, most likely due to insufficient population data.” (ALA 2020); and
 - There is no evidence indicating a high risk of future impacts on this species.
- Thus, the cause of the fatality is deemed to be an irregular occurrence and is unlikely to be significant at a population scale.

3.2.2 Detectability trial

Mick Callan is a zoologist at Nature Advisory and has completed the majority of the searches and undertook the detectability trial at BWF. The ground cover at the time of the trial was long grass. Sites used in the trial were generally grazed pasture, some with scattered trees or woodland areas.

Mick Callan detected 75% of carcasses after the initial placement of carcasses (Table 6). Mick detected 12 of the carcasses in the trial. Three bats and one bird were missed by the observer. Four carcasses were removed by scavengers before Mick undertook the search for them.

Carcasses used in the trial and the turbine they were placed under is listed in Table 6 below.

Table 6: Detectability results

Turbine	Searcher	Carcass	Detected
		Long grass	
27	Mick C	Australian Magpie	✓
27	Mick C	Grey-headed Flying-fox	✓
27	Mick C	Yellow-bellied Sheath-tail Bat	⊘
27	Mick C	White-striped Freetail Bat	⊘
18	Mick C	Magpie-lark	\
18	Mick C	Brown Falcon	✓
18	Mick C	White-striped Freetail Bat	\
18	Mick C	Gould's Wattled Bat	\
21	Mick C	Australian Raven	⊘
21	Mick C	Brown Falcon	✓
21	Mick C	Grey Fantail	✓
21	Mick C	Gould's Wattled Bat	✓
32	Mick C	Nankeen Kestrel	✓
32	Mick C	Australian Magpie	✓
32	Mick C	White-striped Freetail Bat	✓
32	Mick C	Gould's Wattled Bat	⊘
17	Mick C	Nankeen Kestrel	✓
17	Mick C	Nankeen Kestrel	\
17	Mick C	Eastern Rosella	✓
17	Mick C	White-striped Freetail Bat	✓

Turbine	Searcher	Carcass	Detected
		Long grass	
		Average	75%

Notes: ✓ = carcass found; ⊖ = Carcass missed; \ = Carcass scavenged before searcher could search the area.

4 Monitoring ‘at risk’ groups

4.1 Introduction

The BBAMP outlines key “at risk” groups have been identified through the risk assessment (see section 2) and discussions with BCD. The groups highlighted for monitoring were:

- Woodland birds – two species, Grey-crowned Babbler and Superb Parrot;
- Birds of Prey (Raptors) – the risk assessment considered raptors at moderate (Wedge-tailed Eagle) and low (others) risk; and
- White-throated Needletail a migratory species that demonstrates a flight behaviour that puts it at risk of collision with turbines.

Specific methods were adopted for monitoring the presence of these species at BWF. Any mortality of these species will be identified through monthly mortality detection to be undertaken during the first two years of operation.

The monitoring of each of these species is outlined below.

4.2 Grey-crowned Babbler

The Grey-crowned Babbler (GCB) is a ground dwelling bird that inhabits open woodlands and forest. It is a communal bird living together in small family groups. Pre-construction surveys in July 2017 identified that the GCB was recorded in three locations within BWF. One location was away from turbines and associated wind farm infrastructure (the Old Railway group), the other two groups were located along the ridge near proposed turbine T7, T8 and T9 and the other group at T19 in a White Cypress Pine woodland habitat on a granite outcrop.

Impacts on the GCB could result from the following sources:

- Direct impact through fatal collision with operating turbines; and
- Indirect impact through displacement due to disturbance, particularly during the construction phase of the wind farm project.

The study provided an indication of the range of the group of GCBs in the vicinity of T9. This group has been monitored post-construction to determine their status during operation of BWF.

The findings of the pre-construction surveys are as follows:

- Given that the home range of the GCB varies hugely from 1–50 hectares (Higgins and Peter 2002) and was estimated to be approximately 50 hectares for the group inhabiting the T7, T8, and T9 ridge; it may be difficult to determine the “indirect” disturbance during the construction and operational phases of Bodangora WF as there would be ample space for dispersal within their home range to avoid disturbance;
- Breeding activity was not observed during the initial survey, though old nests were found within the territory, these can be monitored to determine future use of these nests; and
- It is noted that the literature emphasized the importance of habitat clearance on the decline of the GCB population, however does not provide data on the impact of direct disturbance on the babbler population. Thus, the operational surveys will provide an insight into impacts during wind farm operation to determine if adverse effects may have occurred.

The approved BBAMP required monthly surveys for the GCB for a 12 month period during operation of the wind farm to determine whether any changes of GCB numbers, behaviour or occurrence took place to the group around T8 after construction of the turbines.

4.2.1 Methods

Post-construction surveys were undertaken for the Grey-crowned Babbler. Monthly targeted surveys were conducted for a period of 12 months from August 2019 to July 2020 referred to as the monitoring period. The monitoring consisting of walking through remnant vegetation in the vicinity of Turbine 8 where nesting populations of Grey-crowned Babbler have been previously recorded. The total distance covered during the survey is 0.6 kilometres over a period of 20 minutes. Any incidental sightings were also recorded during other monitoring activities. The information recorded included:

- Date, time and location;
- Number of birds;
- Flight height above ground, distance and direction flown;
- Other occasional behaviours included feeding, territorial displays, fighting and perching;
- Habitat and terrain; and
- Other behaviour including foraging or breeding.

4.2.2 Results

A total of seven observations, consisting of between five and nine individuals, were recorded during the first year of formal surveys and incidentally across the site (Table 7). Five of these observations were adjacent to Turbine 8, where previous surveys had found that this species had multiple nests, and the two observations were incidental observations in Cypress pine, one of which the birds were observed constructing a nest.

Nesting behaviour was observed in November 2019 at turbine 8, with seven individuals within close proximity (Figure 4). However, at one of the nests an observed in December 2020, a Grey Butcherbird was observed at the entrance, indicating potential nest predation.

In addition, six Grey-crowned Babbler were recorded opportunistically adjacent to Gillinghall Road on the morning of 15 December 2019, demonstrating that there is an additional group of birds on site.

Table 7: Grey-crowned Babbler records for 2019-20

Site	Date	Time	Number	Height	Distance	Direction	Habitat flown from	Habitat flown to	Habitat crossed	Terrain	Behaviour
T8	12/8/19	10:20	5	0-30	50	SW	Woodland edge	Woodland edge	Open paddock	P.C.	foraging
T8	12/10/19	8:05	9	10	25	S	Callitris	Boxthorn	Open paddock	S	Foraging
T8	14/11/2019	16:05	7	8	10	S	Ground	Cypress	N/A	Callitris	Moving up tree to nest
T8	9/1/20	8:08	7	0	40	266	Ground	Tree	Rocky outcrop	S	Foraging
G.R.	3/12/2020	9:16	6	5	15	W	Cypress Pine	Cypress Pine	Cypress Pine	Ridge	Nest construction
GR	29/3/2020	11:05	6	4	10	N	Cypress Pine	Cypress Pine	Cypress Pine	Slope	foraging
T8	17/04/2020	9:05	6	8	40	N	Ground	Tree	N/A	Ridge	Socialising

Notes: G.R. denotes Gillinghall Road

In summary, it appears that the GCB continues to utilise the site around Turbine 8 with GCB recorded at the site in over 5 months of the 12 months of survey and active nest building being recorded.


Figure 4: Grey-crowned Babbler nests and observations

Project: Bodangora Wind Farm


Client: Infigen Energy


Date: 31/07/2020

 Wind Farm boundary


 Turbines

Pre-construction


 Active nest

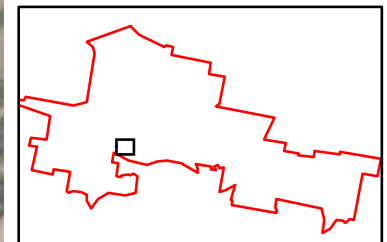
 Observation

Post-construction

 Active nest

 Inactive nest

 Observation



N



Metres



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4.3 Superb parrot

Introduction

Section 3.1.1 of the BBAMP outlines the requirements for the pre-construction surveys for the Superb Parrot for BWF.

These surveys were undertaken to build upon information already obtained from pre-approval surveys undertaken by BL&A (mid-October 2015) and KMA (mid-July 2011), which confirmed limited numbers of Superb Parrots on both occasions.

Brett Lane and Associates Pty Ltd (BL&A) (now Nature Advisory) were commissioned to undertake a targeted survey for the threatened Superb Parrot at the proposed Bodangora Wind Farm site in June 2017. The specific survey requirement for this pre-construction *Targeted Superb Parrot Survey* are outlined in Section 3.1.1 of the approved BODW1 BBAMP.

The definition for the Superb Parrot of “Risk” behaviour is defined for the purpose of the BBAMP as “consistent observations of ten or more flights per day of flocks of ten or more birds between turbines at a height that would result in levels of collision of potential consequence for the regional and wider population of the species” (BL&A 2017).

The pre-construction surveys were conducted in Spring 2017 and Summer/Autumn 2018 survey. The results of the surveys are outlined in the report by Brett Lane and Associates 2018, Bodangora Wind Farm, targeted Superb Parrot survey, Report No. 15124 (6.3), May 2018 (BL&A 2018).

The BBAMP states: “*an initial one year of monitoring is proposed for the Superb Parrot*”. It includes a number of specific approaches for:

- Summer – Autumn Migration (1 February to 30 April 2017)
- Spring Migration (1 September and 30 October 2017)

The 2017 preconstruction study provided additional insights into the movement of the Superb Parrot in and around BWF. The study confirmed:

- Except for a few individuals, there was no evidence from the weekly surveys in the spring of 2017 that the Superb Parrot moved through or in the vicinity of the BWF during the southward migration;
- There is evidence that the vicinity of the BWF is used during the northward migration of the Superb Parrot and that there is possibly maybe a pulse of Superb Parrot moving though the area;
- The evidence suggests that Superb Parrot move through the area in groups at and around tree canopy height. This was evidenced through their observations being made primarily at survey sites four and five which are south east of the wind farm area and not within close vicinity to where turbines will be installed;
- There was no evidence of any flights higher than 30 metres during the periods of observations;

In summary, the observations from the pre-construction study did not meet the definition of risk behaviour, i.e. consistent observations of ten or more flights per day of flocks of ten or more birds between turbines at a height that would result in levels of collision of potential consequence for the regional and wider population of the species. Thus, the BBAMP definition of risk behaviour as outlined above was not triggered.

Methods

Incidental reporting of all Superb Parrot observed was conducted across the entirety of each field visit. Incidental monitoring includes observations made by a zoologist while traversing around the site, between turbines and while conducting mortality detection. This amounted to at least 30 hours per month over the first 12 months of operation of the BWF. All Superb Parrot that were observed were recorded. Information recorded included:

- Date, time and location;
- Number of birds;
- Flight height above ground, distance and direction flown;
- Other occasional behaviours included feeding, territorial displays, fighting and perching;
- Habitat and terrain; and
- Other behaviour including foraging or breeding.

Results

A total of 21 observations, consisting of between 2– 10 individuals, were recorded during the first-year monitoring period across the site (Table 8). The majority of these observations were in the western section of the wind farm, in association with flowering eucalyptus trees.

The following is noted from the records of the Superb Parrot:

- Nineteen of the 21 observations occurred between June and August of 2019 which is considered to be towards the southward migration of the Superb Parrot;
- The observations between June and August of 2019 were of small groups of Superb Parrot with up to 10 per flock;
- There were two observations in January of 2020;
- There were no observations of Superb Parrot between August and December of 2019 during the breeding season.

There was a single observation of a group of 10 Superb Parrots on the 15th July 2019 at a height of 50 metres. This was at 17:15 in the afternoon. The location of the observation was approximately two kilometres SSE of Turbine 5 with the Superb Parrot recorded flying across open paddocks. This did not meet the definition of risk behaviour at it was approximately two kilometres from the nearest turbine and was not considered flying between turbines.

There were no signs of Superb Parrot conducting at risk behaviour at the BWF during the first-year monitoring period.

Table 8: Superb Parrot observations at Bodangora Wind Farm during the first-year monitoring period

Site	Turbine	Date	Time	Number	Height	Distance	Direction	Habitat flown from	Habitat flown to	Habitat crossed	Terrain
SP1	6	18/06/2019	12:30	3	15	30	W	Open woodland	Open woodland/ grazing	Open woodland/ grazing	Flat
SP2	2	18/06/2019	14:10	10	8	70	S	Paddock trees	Paddock trees	Open grazing	Undulating
SP3	4	18/06/2019	14:40	3	12	80	N	Paddock trees	Open woodland/ grazing	Grazing/ paddock trees	Undulating
SP4	33	19/06/2019	10:00	heard		120	N	Paddock trees	Sitting in tree	Sitting in tree	Undulating
SP5	12	19/06/2019	13:30	1	20	142	SW	Paddock trees	Unknown	Open Paddock	Slope
SP6	11	19/06/2019	13:35	6	30	400	W	Unknown	Unknown	Wooded Paddock	Ridge
SP7	15	21/06/2019	8:42	7	10	100	S	Paddock trees	Paddock trees	Hardstand	Flat
SP8	27	21/06/2019	11:11	2	10	93	S	Open forest	Open forest	Hardstand	Slope
SP9	33	15/07/2019	11:25	2	15	120	NNE	Paddock tree	Woodland	Paddock	Slope
SP10	2	15/07/2019	15:50	4	20	150	S	Paddock tree	Woodland	Paddock	Plains
SP11		15/07/2019	17:15	10	50	200	W			Paddock	Plains
SP12		16/07/2019	8:10	8	10	100	SW	Woodland	Woodland	Paddock	Ridge
SP13	5	17/07/2019	9:10	7	10	30	NE-SW	Open Woodland	Open woodland	Open woodland	Plains
SP14	12	19/07/2019	8:00	2	0	20	E	Paddock tree	Paddock trees	Pasture	Plains
SP15	12	19/07/2019	8:20	9	1.5	100	S	Open woodland	Open woodland	Paddock	Slope
SP16		8/08/2019	9:00	1	5-10	10		Ironbark tree	Ironbark tree	Woodland	Plains
SP17		8/08/2019	12:35	6	10	60	NE	Open Woodland	Pasture	Pasture	Plains
SP18		10/08/2019	13:23	1	15	10	NW		Woodland	Woodland	Plains
SP19	5	11/08/2019	10:05	1	8	15	W	Pasture	Pasture	Pasture	Ridge
SP20		9/01/2020	8:52	8	20	80	289	Ground	Tree	Paddock	Slope
SP21		9/01/2020	10:22	7	15	5	160	Open paddock	Open paddock	Open paddock	Ridge

4.4 Raptors

Monthly monitoring of raptor flights and breeding activity was required for 12 months to determine whether operating turbines affect the behaviour of raptors. The monitoring will inform the level of risk of the local population to possible impacts from the BWF. The raptor monitoring was incorporated into the monthly mortality detection monitoring.

4.4.1 Methods

Incidental reporting of all raptors observed is conducted across the entirety of each field visit. Documentation of all raptor flights observed was plotted on a map. The following data was documented for each flight observed during the monitoring program.

- Species name
- Number of birds
- Time first observed
- Time the bird/s flew out of sight or landed
- Distance and bearing from observer
- The location of the bird (either Air, perched or ground)
- Height of the bird when first observed
- The height range of the bird (minimum and maximum heights)
- Elevation of the fixed point
- The landscape the bird was observed in (either valley, slope or ridge)
- Flight direction (either toward, away, parallel to ridge or circling), and
- Flight behaviour (either soaring, gliding, hovering, flapping, display, resting, mobbing or foraging).

4.4.2 Results

Eight species of raptor have been observed flying at the BWF site during the first-year monitoring period and are listed in Table 9. A total of 51 movements from 57 individuals were recorded from the BWF site during the first-year monitoring period. The raw data for the raptor observations is presented in Appendix 3. A summary of the observations is presented in Table 9. Flight paths have been plotted in Figure 5.

Table 9: Summary of raptor flights observed at BWF

Species	Number of raptors
Wedge-tailed Eagle	22
Nankeen Kestrel	17
Brown Falcon	10
Australian Hobby	2
Black-shouldered Kite	2
Peregrine Falcon	2
Black Falcon	1
Whistling Kite	1
Grand Total	57

The Wedge-tailed Eagle, Nankeen Kestrel and Brown Falcon are the three most abundant raptor species found in farmland across south-eastern Australia. They were also the three most abundant raptors recorded at BWF and there were records of fatalities of all three species at BWF during the first-year monitoring period.

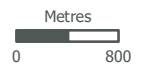
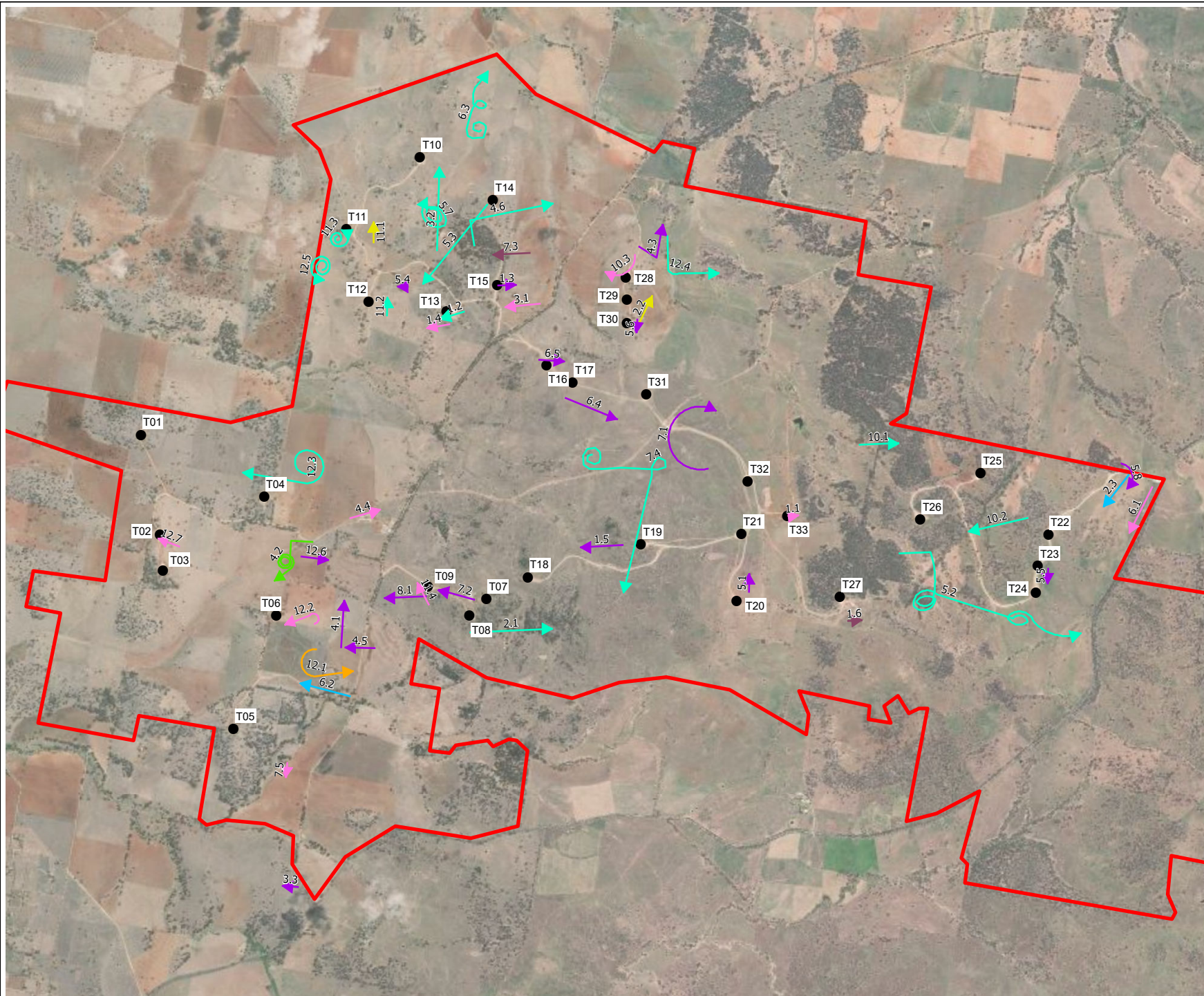
Figure 5: Raptor flight paths

Project: Bodangora Wind Farm
Client: Infigen Energy
Date: 31/07/2020

- Wind Farm boundary
- Turbines

Species

- Australian Hobby
- Black Falcon
- Black-shouldered Kite
- Brown Falcon
- Nankeen Kestrel
- Peregrine Falcon
- Wedge-tailed Eagle
- Whistling Kite



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The Wedge-tailed Eagle was the most commonly recorded raptor species at BWF site. A total of 22 individuals of Wedge-tailed Eagle were observed. The Wedge-tailed eagle was observed flying along ridges, valleys and across open country. Typical behaviour of Wedge-tailed Eagle was soaring at height using thermals and also gliding, flapping and territorial display. No breeding activity of the Wedge-tailed Eagle was observed at the site.

There were 17 individual records of Nankeen Kestrel. This species was usually observed foraging across the site feeding on invertebrates and mice.

There were 10 individual records of Brown Falcon observed during the first-year monitoring period. This species prefers open country with scattered trees.

The Black Falcon is listed as vulnerable under the BC Act. Only one individual of Black Falcon was recorded and was likely moving through the area. Unfortunately, there was one strike of Black Falcon in April 2019. Due to this species being a listed threatened species this triggered a response and formal raptor surveys were initiated to determine the status of this species at the BWF site.

Other raptor species were observed at the BWF in low densities including the Australian Hobby, Black-shouldered Kite, Peregrine Falcon and Whistling Kite. It is noted that the reporting period coincided with drought, fires and heavy summer rains.

4.5 White-throated Needletail

The White-throated Needletail was identified as a species at risk of collision with turbines at BWF due to its flight behaviour and flying within the range of RSA heights. An incidental monitoring program was initiated at BWF during the first-year monitoring period.

4.5.1 Methods

Incidental reporting of White-throated Needletail observed is conducted across the entirety of each field visit. Documentation of all White-throated Needletail observed was plotted on a map. The following data was documented for each flight observed during the monitoring program.

- Date, time and location;
- Number of birds;
- Flight height above ground, distance and direction flown;
- Other occasional behaviours included feeding, territorial displays, fighting and perching;
- Habitat and terrain; and
- Other behaviour including foraging or breeding.

4.5.2 Results

No observations were made of White-throated Needletail during the first-year monitoring period at BWF.

5 Summary and adaptive management

Post-construction bird and bat mortality detection for the first year of the operation of BWF were undertaken in accordance with the approved BBMP (BL&A 2017).

5.1 Bird summary

5.1.1 Mortality detection

A total of 47 bird strikes were recorded within the BWF site during its first-year monitoring period and an additional bird strike was recorded prior to the commencement of the first-year monitoring period. Forming the bulk of this total, 35 carcasses were discovered during formal searches, comprising 25 partial or intact carcasses and 15 feather spots. Eight additional carcasses were discovered incidentally beneath turbines by wind farm personnel or under turbines outside the 16 searched each month including one species found prior to the first-year monitoring period.

The highest mortality rate of birds recorded under turbines were from the Australian Magpie, Nankeen Kestrel, Noisy Miner and Wedge-tailed Eagle. The Wedge-tailed Eagle, Nankeen Kestrel and Brown Falcon were the top three most abundant raptors at the wind farm site and had the highest mortality rate of all raptors. These species are common occurring birds in farmland and often fly at RSA heights.

Bird fatalities were higher during the winter months and low during the autumn months.

One threatened species, the Black Falcon, was found under a turbine prior to the commencement of the first-year monitoring period. This initiated an impact trigger and immediate investigation. The findings concluded that the risk of likelihood of reoccurrence of another strike is considered to be very low. Black Falcon was observed once in May 2020 while traversing around the site.

No other threatened birds were found to collide with turbines at BWF.

5.1.2 At risk species

Five species or groups of birds were identified in the BBAMP as being at risk of impacts or being indirectly impacted by BWF. These include the following:

- Wedge-tailed Eagle;
- Other raptors;
- Superb Parrot;
- Grey-crowned Babbler; and
- White-throated Needletail.

Grey-crowned Babbler

The Grey-crowned Babbler was recorded at the BWF prior to construction and there was concern that the turbines may impact on the local population by causing disturbance. Survey were undertaken pre-construction and observations of locations and nesting sites Grey Crowned Babbler was observed regularly and consistently in previously recorded nesting locations were recorded to compare with results from post-construction surveys. Post constructions surveys recorded Grey-crowned utilising the same area under Turbine 8 at BWF. The turbines do not appear to have caused any disturbance to the local population as they have still been observed in the area under turbines and were also observed nest building.

There have been no fatalities of Grey-crowned Babbler associated with the wind farm and collision is not expected with this species as they do not fly at RSA heights.

Superb Parrot

The Superb Parrot is known to occur in the BWF. There were concerns that the BWF may impact on this species by colliding with turbines as they can fly at RSA heights particularly when migrating from breeding grounds to non-breeding grounds and vice versa. Surveys were undertaken to identify if the Superb Parrot were displaying risk behaviour. Incidental observations of Superb Parrot were made during the first-year monitoring period.

Superb Parrot was observed from June to August of 2019, and not again until January of 2020. As the breeding season is from September to December this suggests that this species utilises the area for foraging resources and does not breed in the area. The Superb Parrot was seen across a variety of habitats within the study area, and was associated primarily with flowering eucalypts. Flight heights observed were usually at tree height. There was one observation at heights of 50 meters though this was well away from turbines and did not meet the definition of risk behaviour. There were no collisions between turbines and Superb Parrot recorded.

Raptors

A total of 17 raptors have been recorded as colliding with turbines at BWF up until May 2020. Eight of these were Nankeen Kestrel, five Wedge-tailed Eagle, three Brown Falcon, one Black Falcon and one Australian Hobby. It is considered likely that raptor collisions are due mainly to their soaring habits and preference to the type of habitat (windy with uplifting air currents) at the wind farm.

To gain a better understanding of how these species are using the site, ongoing monitoring has been undertaken and flight paths were plotted on a map. The Wedge-tailed Eagle, Nankeen Kestrel and Brown Falcon were the three most abundant raptors recorded at BWF during the first-year monitoring period.

White-throated Needletail

No white-throated Needletail were found as fatalities under turbines or seen flying over the BWF site.

5.2 Bat summary

5.2.1 Mortality detection

A total of 41 bat strikes were recorded within the BWF site during its first-year monitoring period and an additional two bat strikes were recorded prior to the commencement of the first-year monitoring period. Forming the bulk of this total, 33 carcasses were discovered during formal searches. Ten additional bat carcasses were discovered incidentally beneath turbines by wind farm personnel or under turbines outside of formal searches including two species found prior to the first-year monitoring period.

The highest mortality rate of bats recorded under turbines were from the Gould's Wattled Bat, Southern Freetail Bat and White-striped Freetail Bat. These species are common occurring bats in farmland and often fly at RSA heights. It was expected that there would be some fatalities of these species and the low numbers of fatalities reported is not expected to impact on their populations.

Bat fatalities were higher in autumn and low in summer. There were no bats detected from November 2019 to January 2020, this may have been due to the hot and dry conditions at that time with less bat activity at the site.

Four fatalities from two threatened bat species has been reported at BWF up until May 2020. This includes three Grey-headed Flying-fox and one Yellow-bellied Sheath-tail Bat. In addition, four forest bat

carcasses have been supplied to the Museum of Sydney for identification. There is potential for these bats to be Inland Forest Bat, a threatened species in NSW, although this is yet to be confirmed.

The Grey-headed Flying-fox was reported on three occasions once in April 2019 prior to the first-year monitoring period commencing and twice in July 2019. This initiated an impact trigger and immediate investigation.

The investigation found a camp of 500 flying-foxes at were found roosting during the day in the confluence of the Bell River and Macquarie River in Wellington (year-round) and appeared to fly each night to the north to forage. This camp was located 17 kilometres to the south of BWF. The flying-foxes generally move about at night solitary rather than in large groups. Eucalypts were in flower at the BWF in winter 2019 and this attracted the Grey-headed Flying-fox to the site to forage in these flowering trees. Nocturnal surveys recorded up to 30 individuals at the site during these flowering events.

The findings concluded that the risk of further collisions by this species is considered to be possible, in particular while the eucalypts are in flower in the area. Whilst individuals may move through the wind farm in the future while foraging, it is likely the number will be in response to available foraging resources or suitable habitat for a camp in or near the area.

Given this new information a review of the risk assessment is warranted. Given that we now know Grey-headed Flying-fox are utilising the area when eucalypts are in flower and there have already been three reported collisions with turbines the likelihood of a collision occurring is considered to be ‘almost certain’ – meaning it is more probable than not that the risk event could occur in any year (>50%). The consequence of collisions is considered to be ‘low’ – meaning repeated loss of small numbers of individuals but no reduction in local or regional population viability. The review of the risk assessment now considers that there is a ‘Low risk’ associated with Grey-headed Flying-fox colliding with turbines.

The loss of three individuals in a population of over 600,000 is not considered a significant impact on the species population.

One Yellow-bellied Sheathtail Bat was found during formal searches on the 16th April 2020. This initiated an impact trigger and immediate investigation. The findings concluded that the collision was deemed to be an irregular occurrence and is unlikely to be significant at a population scale. Bat surveys have been requested by BCD in summer / autumn 2021.

5.3 Adaptive management recommendations

The mortality detection is scheduled to continue for another 12 months. There are no changes proposed for the monitoring program.

Grey-crowned Babbler monitoring found that the disturbance from the operation of turbines has not had an impact on the local population as Grey-crowned Babbler have still been observed at turbine locations and have been observed nest building in close proximity to turbines. No further monitoring of Grey-crowned Babbler is required.

The Superb Parrot is present on site outside of the breeding season. Continued monitoring and mortality detection is recommended. Due to the species residing at the BWF site at certain times of the year continued monitoring of this species to identify any kind of risk behaviour observed at the BWF site.

There have been 17 reported raptor collisions at BWF including one threatened species the Black Falcon. Continued monitoring and mortality detection is recommended. Recording flight paths and actively searching for breeding sites is recommended to gain a better understanding of the risk posed by the wind farm. A review of the risk assessment may be required at the end of the second-year monitoring period.

No White-throated Needletail have been observed at the BWF or been recorded as fatalities associated with the wind farm. Continued monitoring is recommended in the instance they do arrive on site.

With three collisions with turbines reported for the Grey-headed Flying-fox there is a possibility that collision may occur again when eucalypts attract the species to the wind farm site. Continue monitoring through the mortality detection program. Should further mortality occur develop a more comprehensive approach to addressing potential impact on the Grey-headed Flying-fox.

It was reported that a Yellow-bellied Sheathtail Bat collided with a turbine. Continuation of the carcass monitoring for the full two years as detailed in the BBAMP. The on-going risk to the species will be monitored through this method for any increase. Additional bat surveys are recommended during autumn in 2021 in the form of surveys using echo location. A review of the risk assessment of this species within the BBAMP at the end of the second-year monitoring period and conclusion of these studies.

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Appendix 1: Bird mortality data obtained during the first year of monitoring in 2019-2020.

Date	Common name	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
18/04/2019	Black Falcon	Vulnerable (BC Act)	33	34 - 48	W	INC 1904-1	Carcass found in two pieces, relatively intact.
14/06/2019	Nankeen Kestrel		13	22	NNE	INC 1906-1	Carcass intact.
18/06/2019	Australian Magpie		2	71	350	FS 1906-1	Ten feathers.
19/06/2019	Raven		20	52	NW	R 1906-2	Wing only.
19/06/2019	Raven		33	30	S	FS 1906-3	Top of batter.
19/06/2019	Nankeen Kestrel		33	55	W	R 1906-4	Wing
20/06/2019	Brown Falcon		7	67	S	FS 1906-5	Three feather clumps.
20/06/2019	Noisy Miner		9	41	15	FS 1906-6	Feather spot, possibly raptor kill.
15/07/2019	Magpie-lark		19	98	30	FS 1907-1	Feather spot.
15/07/2019	Apostlebird		20	19 - 82	83 - 281	FS 1907-2 and 3	Feather spot in two patches
15/07/2019	Pied Currawong		33	25	172	FS 1907-4	Feather spot located on steep bank.
15/07/2019	Raven		33	70	250	R 1907-5	Wing
15/07/2019	Grey Butcherbird		2	98	SW	FS 1907-6 and 7	Feather spot - may be associated with 1907-7
8/08/2019	Raven		30	98	348	FS 1908-1	Feather spot
8/08/2019	Eastern Rosella		13	102	18	FS 1908-3	Feather spot
8/08/2019	Noisy Miner		15	86	115	FS 1908-4	Feather spot
9/08/2019	Noisy Miner		4	26	66	R 1908-7	Wing only
9/08/2019	Nankeen Kestrel		4	24	24	R 1908-8	Intact
10/08/2019	Pied Currawong		33	59	80	R 1908-10	Wing only
11/08/2019	Australian Magpie		9	55	0	R 1908-12	Partially scavenged - many feathers intact
16/09/2019	Red-rumped Parrot		2	4	237	R 1909-1	Very short tail feathers indicate juvenile bird
16/09/2019	Galah		15	85	272	FS 1909-4	Feather spot
16/09/2019	Australian Magpie		12	10	28	R 1909-5	Intact, significant injury to its back.
16/09/2019	Nankeen Kestrel		12	68	145	R 1909-6	Intact.

Date	Common name	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
17/09/2019	Australian Magpie		20	50	55	R 1909-7	In several parts.
10/10/2019	Australian Hobby		33	25	70	R1910-1	Damage to back of neck
10/10/2019	Nankeen Kestrel		30	72	356	R1910-2	Head almost completely removed
11/10/2019	Australian Magpie		14	62	170	R1910-3	Both wings present - has been scavenged
11/10/2019	Red-rumped Parrot		15	3	117	R1910-4	Wing and some connected bones
11/10/2019	Galah		15	58	151	R1910-5	Wing only
13/10/2019	Wedge-tailed Eagle		14	35	44	R 1910-6	Intact, adult.
14/11/2019	Nankeen Kestrel		25	44	21	R1911-1	Wing only
16/11/2019	Noisy Miner		20	70	333	FS 1911-1	Feather spot
16/11/2019	Brown Falcon		5	49	330	R1911-2	Intact - damage to head
18/11/2019	Wedge-tailed Eagle		21	40	79	INC 1911-1	Carcass found in two pieces, relatively intact
12/12/2019	Nankeen Kestrel		19	72	301	R1912-1	Largely intact minus head
12/12/2019	Australian Magpie		33	36	135	FS1912-1	Feather spot - head remaining
9/01/2020	Nankeen Kestrel		23	60	72	R2001-1	Wing only
11/01/2020	Noisy Miner		9	69	317	FS2001-1	Feather spot
3/02/2020	Wedge-tailed Eagle		25	63	296	R 2002-1	Carcass in 3 separate distinct pieces.
3/02/2020	Brown Falcon		5	53	210	R2002-2	Right wing only.
11/03/2020	Wedge-tailed Eagle		22	50	324	INC 2003-1	Intact - not collected due to advanced decay
29/03/2020	Wedge-tailed Eagle		29	45	208	INC 2003-12	Intact - at least 2 weeks old
17/04/2020	Crested Pigeon		24	4	164	INC 2004-1	Intact but highly decomposed
19/04/2020	Grey Fantail		22	69	3	INC2004-7	Intact
20/04/2020	Australian Magpie		17	5	N	INC 2004-2	Intact

Date	Common name	Threatened Status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Report (R)/ Feather spot (FS)/ Incidental (INC)	Notes
16/05/2020	Australian Magpie		30	0	192	R2005-1	Intact adult male. Bleeding from bill
29/05/2020	Eastern Rosella		14	31	249	R2005-2	Juvenile, intact. Damage to tail and right wing

Appendix 2: Bat mortality data obtained during the first year of monitoring in 2019-2020.

Date	Common name	Threatened status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Report (R)/ Incidental (INC)	Notes
24/05/2019	Forest Bat		33	5	E	INC 1905-1	Intact
24/05/2019	Grey-headed Flying-Fox	Vulnerable (EPBC Act and BC Act)	14	25	E	INC 1905-2	Intact, adult.
21/06/2019	Gould's Wattled Bat		27	41	135	INC1906-1	Abdominal injury, adult male.
21/06/2019	Gould's Wattled Bat		27	41	SE	INC 1906-1	Full carcass - abdominal injury
11/07/2019	Grey-headed Flying-Fox	Vulnerable (EPBC Act and BC Act)	16	40	E	INC 1907 - 1	Partially scavenged
12/07/2019	Grey-headed Flying-Fox	Vulnerable (EPBC Act and BC Act)	31	40	SE	INC 1907 - 2	Intact, adult.
18/07/2019	Gould's Wattled Bat		4	30	190	R 1907-8	Intact
18/07/2019	White-striped Freetail Bat		7	12	S	INC 1907-3	Intact, found by WF personnel.
8/08/2019	White-striped Freetail Bat		13	6	95	R 1908-2	Intact, adult.
8/08/2019	Southern Forest Bat		15	27	325	R 1908-5	Intact, adult.
9/08/2019	Gould's Wattled Bat		4	28	146	R 1908-6	Intact - abdominal injury
9/08/2019	Gould's Wattled Bat		23	55	50	R 1908-9	Intact, adult.
9/08/2019	White-striped Freetail Bat		13	42	148	R1909-9	Intact
9/08/2019	White-striped Freetail Bat		20	10	112	R1909-10	Half carcass - scavenged
10/08/2019	White-striped Freetail Bat		31	25	60	R 1908-11	Intact
11/08/2019	Gould's Wattled Bat		19	24	135	R 1908-13	Intact
16/09/2019	Southern Freetail Bat		4	5	172	R 1909-2	Intact, broken wing.
16/09/2019	Southern Freetail Bat		13	19	55	R 1909-3	Damage to head/ear.
17/09/2019	White-striped Freetail Bat		31	30	180	R 1909-8	Intact body.
19/09/2019	White-striped Freetail Bat		13	42	148	R 1909-9	Intact body.
19/09/2019	White-striped Freetail Bat		20	10	12	R 1909-10	Intact, partially scavenged.
14/10/2019	Southern Forest Bat		24	59	145	R1910-07	Intact but internals consumed by insects
3/02/2020	Chocolate Wattled Bat		2	24	320	R2002-3	Intact carcass.
4/02/2020	Southern Freetail Bat		20	43	350	R2002-4	Intact carcass.
12/03/2020	Southern Freetail Bat		31	46	204	R2003-02	Intact
14/03/2020	Southern Freetail Bat		9	28	102	R2003-03	Intact

Date	Common name	Threatened status	Turbine number	Distance from turbine (m)	Bearing from turbine (°)	Report (R)/ Incidental (INC)	Notes
14/03/2020	Gould's Wattled Bat		9	5	189	R2003-04	Intact
14/03/2020	Gould's Wattled Bat		19	28	111	R2003-05	Intact
14/03/2020	Southern Freetail Bat		19	31	76	R2003-06	Intact
14/03/2020	Southern Freetail Bat		19	43	97	R2003-07	Intact
14/03/2020	Southern Freetail Bat		20	19	84	R2003-08	Intact
14/03/2020	Gould's Wattled Bat		33	32	266	R2003-09	Intact
14/03/2020	Forest Bat		33	26	263	R2003-10	Intact - broken wing
14/03/2020	Southern Freetail Bat		21	31	262	INC 2003-01	Intact
14/03/2020	Gould's Wattled Bat		31	19	181	R2003-11	Intact
29/03/2020	Forest Bat		27	47	187	INC 2003-13	Intact - broken wing
15/04/2020	Southern Forest Bat		14	14	252	R2004-1	Intact
15/04/2020	Southern Forest Bat		15	36	324	R2004-2	Intact
16/04/2020	Lesser Long-eared Bat		19	6	206	R2004-3	Intact - some blood
16/04/2020	Forest Bat		4	35	177	R2004-4	Intact
16/04/2020	Yellow-bellied Sheathtail Bat	Vulnerable (BC Act)	4	0	320	R2004-5	Intact
17/04/2020	White-striped Freetail Bat		9	52	19	R2004-6	Damage to chest - open wound
24/04/2020	Gould's Wattled Bat		21	7	145	INC 2004-8	Intact

Appendix 3: Raptor observation at BWF during first-year monitoring period

Point location	Species	Number	Date	Start time	End time	Distance	Bearing	Location	Height	Height range	Elevation	Landscape	Direction	Behaviour
1.1	Brown Falcon	1		9:55		130	WNW	Perched	15	15		Slope		Resting
1.2	Wedge-tailed Eagle	1		12:25	12:28	1000	WNW	Air	200	150-200		Valley	Circling, parallel with ridge	Soaring
1.3	Nankeen Kestrel	1		13:00		250	NW	Perched	20	20		Valley	Toward	Resting
1.4	Brown Falcon	1		13:50	13:53	500	S	Air	50	50		Valley	Parallel to ridge	Flapping
1.5	Nankeen Kestrel	1		13:20	12:23	100	NW	Air	15	0-15		Slope	Parallel to ridge	Foraging
1.6	Peregrine Falcon	1		11:50	11:56	250	S-E	Air, perched	30	10-30		Slope, ridge	Toward, away	Flapping, gliding, foraging
2.1	Wedge-tailed Eagle	1	15/07/2019	13:50		250	WNW	Air	100	80-100	560	Slope	Parallel to ridge	Soaring
2.2	Australian Hobby	1	18/07/2019	8:00	8:03	25	85	Air	10	0-25	550	Ridge	North	Foraging
2.3	Black-shouldered Kite	1	18/07/2019	11:00	11:02	60	220	Air	25	20-30	535	Slope	South	Flapping
3.1	Brown Falcon	1	8/08/2019	8:45	8:46	15	W	Air	20	20-40		Slope	Parallel to ridge	Flapping
3.2	Wedge-tailed Eagle	1	8/08/2019	12:30	12:33	200	NW	Air	40	40-150		Slope	Parallel to ridge	Soaring
3.3	Nankeen Kestrel	1	8/09/2019	10:40	10:41	60	W	Air	40	30-60		Slope	Away	Soaring, hovering, foraging
4.1	Nankeen Kestrel	1	16/9/19	6:45	6:45	6	300	Perched	1	1	477	Slope	N/A	Resting
4.2	Whistling Kite	1	16/9/19	9:44	9:48	70	165	Air	30	30-150	492	Slope	Away, circling, away	Powered, soaring, Foraging, Powered
4.3	Nankeen Kestrel	1	17/9/19	14:02	14:04	20	160	Air	10	10-40	516	Ridge	Parallel to ridge	Soaring, hovering, foraging
4.4	Brown Falcon	1	18/9/19	14:19	14:23	80	330	Perched, ground	1	0-25	494	Slope	Away	Resting, foraging
4.5	Nankeen Kestrel	1	18/9/19	16:10	16:12	100	34	Air	60	60-80	500	Slope	Parallel to ridge	Soaring, foraging, soaring
4.6	Wedge-tailed Eagle	2	19/9/19	9:20	9:36	500	180	Air	150	150-400	512	Ridge	Parallel to ridge	Soaring
5.1	Nankeen Kestrel	1	10/10/2019	10:40	10:42	80	326	Air	20	0-30	592	Ridge	Parallel to ridge	Soaring, Foraging, Soaring, Resting
5.2	Wedge-tailed Eagle	2	10/10/2019	11:00	11:03	500	60	Air	200	200-300	598	Ridge	Circling, Away	Soaring
5.3	Wedge-tailed Eagle	1	10/11/2019	7:50	7:50	40	115	Air	20	20-30	483	Ridge	Away	Powered
5.4	Nankeen Kestrel	1	10/11/2019	11:17	11:19	350	51	Air	60	0-80	515	Valley	N/A	Hovering, Foraging
5.5	Nankeen Kestrel	1	10/12/2019	11:10	11:11	50	49	Air	2	0.5-8	638	Ridge	Parallel to ridge	Soaring, Foraging
5.6	Nankeen Kestrel	1	13/10/2019	9:48	9:54	80	125	Air	60	0-60	548	Ridge	Toward	Hovering, Foraging, Powered, Hovering, Foraging
5.7	Wedge-tailed Eagle	1	13/10/2019	11:50	11:52	180	192	Air	200	200-300	485	Ridge	Circling	Soaring
5.8	Nankeen Kestrel	1	14/10/2019	10:09	10:15	250	63	Air	20	0-60	548	Valley	Circling	Soaring, hovering, foraging
6.1	Brown Falcon	1	15/11/2019	16:04	16:04	100	160	Air, perched	30	30	522	Valley	Parallel to ridge	Powered, Resting
6.2	Black-shouldered Kite	1	15/11/2019	16:22	16:23	300	218	Air	45	45	466	Valley	Parallel to ridge	Powered
6.3	Wedge-tailed Eagle	1	16/11/2019	8:36	8:41	650	332	Air	200	200-400	511	Valley	Away	Soaring
6.4	Nankeen Kestrel	1	17/11/2019	14:21	14:24	200	210	Air	10	2 to 50	537	Ridge	Away	Hovering, Soaring, Gliding
6.5	Nankeen Kestrel	1	18/11/2019	8:46	8:48	70	200	Air, perched, Air	8	0-25	530	Ridge	Parallel to ridge	Hovering, Powered, Resting, Foraging, Resting
7.1	Nankeen Kestrel	1	12/12/2019	10:45	10:48	25	233	Perched	10	5-15	528	Valley	Parallel to ridge	Resting, Foraging, Powered Flight, Resting
7.2	Nankeen Kestrel	1	13/12/2019	7:55	8:10	35	247	Perched, Air	10	0-15	504	Ridge	Away	Resting, Foraging, Gliding, Resting
7.3	Peregrine Falcon	1	13/12/2019	8:35	8:35	60	6	Air	15	10 to 20	519	Slope	Parallel to ridge	Powered Flight, Foraging
7.4	Wedge-tailed Eagle	1	14/12/2019	12:29	12:33	350	214	Air	150	150-250	544	Valley	Parallel to ridge, Away	Soaring, Gliding
7.5	Brown Falcon	1	15/12/2019	6:28	6:28	8	283	Perched	1.5	1.5	462	Valley	N/A	Resting
8.1	Nankeen Kestrel	1	1/11/2020	10:42	10:43	100	273	Air	15	10 to 20	548	Slope	Parallel to ridge	Powered Flight
10.1	Wedge-tailed Eagle	1	3/12/2020	13:20	13:21	1000	92	Air	250	250-300	554	Slope	Away	Soaring
10.2	Wedge-tailed Eagle	1	13/3/2020	13:23	13:24	800	243	Air	300	250-350	589	Ridge	Away	Soaring
10.3	Brown Falcon	1	29/3/2020	11:17	11:24	110	216	Perched, Air	1.5	1.5-10	525	Slope	Towards, Away	Resting, Powered, Resting, Powered, Resting
11.1	Australian Hobby	1	15/4/2020	8:55	9:02	70	64	Perched	25	10-25	508	Ridge	Parallel to ridge	Powered Flight, Resting
11.2	Wedge-tailed Eagle	1	15/4/2020	10:56	10:57	300	289	Air	10	10-20	533	Valley	Parallel to ridge	Powered Flight
11.3	Wedge-tailed Eagle	2	15/4/2020	11:15	11:19	2000	301	Air	180	180-350	523	Ridge	Circling	Soaring
11.4	Brown Falcon	1	18/4/2020	15:35	15:35	40	204	Air	20	20	576	Slope	Away	Powered Flight
12.1	Black Falcon	1	13/5/2020	6:52	6:53	25	243	Perched, Air	8	4-20	613	Valley	Parallel to ridge	Resting, Powered
12.2	Brown Falcon	1	14/5/2020	11:08	11:11	20	189	Perched, Air	18	4-30	490	Slope	Away	Resting, Powered, Gliding
12.3	Wedge-tailed Eagle	1	14/5/2020	13:34	13:36	300	308	Air	120	120-240	505	Valley	Parallel to ridge	Soaring, Gliding
12.4	Wedge-tailed Eagle	4	16/5/2020	11:23	11:30	80	228	Air	50	10-150	521	Ridge	Circling	Displaying
12.5	Wedge-tailed Eagle	1	28/5/2020	13:50	13:54	300	303	Air	180	180-300	511	Valley	Circling	Soaring
12.6	Nankeen Kestrel	1	28/5/2020	14:45	14:45	120	215	Air	10	10-20	502	Ridge	Parallel to ridge	Powered Flight
12.7	Brown Falcon	1	29/5/2020	14:10	14:13	150	184	Air, Perched	8	8-16	479	Slope	Parallel to ridge	Powered Flight, Resting