Oaklands Hill Wind Farm

Bird and Bat Mortality Monitoring

May 2019 to May 2020

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EXECUTIVE SUMMARY

Additional bird and bat mortality monitoring at the Oaklands Hill Wind Farm is being undertaken to address deficiencies noted by DELWP Environment in the first monitoring program. Such monitoring is to focus only on the mortality of two threatened species: the Brolga and Southern Bent-wing Bat and is to be undertaken over two consecutive years. This report details the results of the first 12 months of mortality monitoring from May 2019 to May 2020.

Mortality monitoring commenced in May 2019 following a clearing search four weeks earlier to remove any carcasses that had previously accumulated in the search areas. This monitoring consisted of undertaking carcass searches at a sample of 16 turbines (50% of all turbines). From May through to the end of August when bats were mostly inactive, carcass searches were conducted once every four weeks along transects spaced at 12m intervals in a search area within 115m from the turbine base, primarily to focus on detecting large birds. From the start of September to end of April when bats are usually active, the frequency and intensity of carcass searches was increased to weekly along transects spaced at 4m intervals within a smaller search area 65m from the turbine base. The outer search area from 65 to 115m from the turbine base continued to be searched once every four weeks along transects of 12m intervals.

To account for scavenging and searcher efficiency bias, trials were undertaken in each season to examine the rate of scavenging and efficiency of searchers in detecting carcasses of large birds and bats. Turkeys and mice were used as substitutes for Brolga and bats, respectively.

Over the 12 months of monitoring, 48 bird fatalities including 40 feather spots and eight carcasses were found. Magpies and Brown Falcons were the most common fatalities. The remains of one Wedge-tailed Eagle were found in the initial clearing search but no other large bird fatalities were found during the monitoring period. As such, the annual mortality of large birds was zero. Two bat carcasses, a White-striped Freetail Bat and a Gould's Wattled Bat, were found. When correction factors for scavenging rate and searcher efficiency were applied, annual mortality of bats was estimated at 0.91 ± 0.66 bats per turbine equating to a total of 29.12 ± 21.12 bats over all 32 turbines. No threatened bird or bat species were found to be killed by the blades of wind turbines.

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1.0 INTRODUCTION

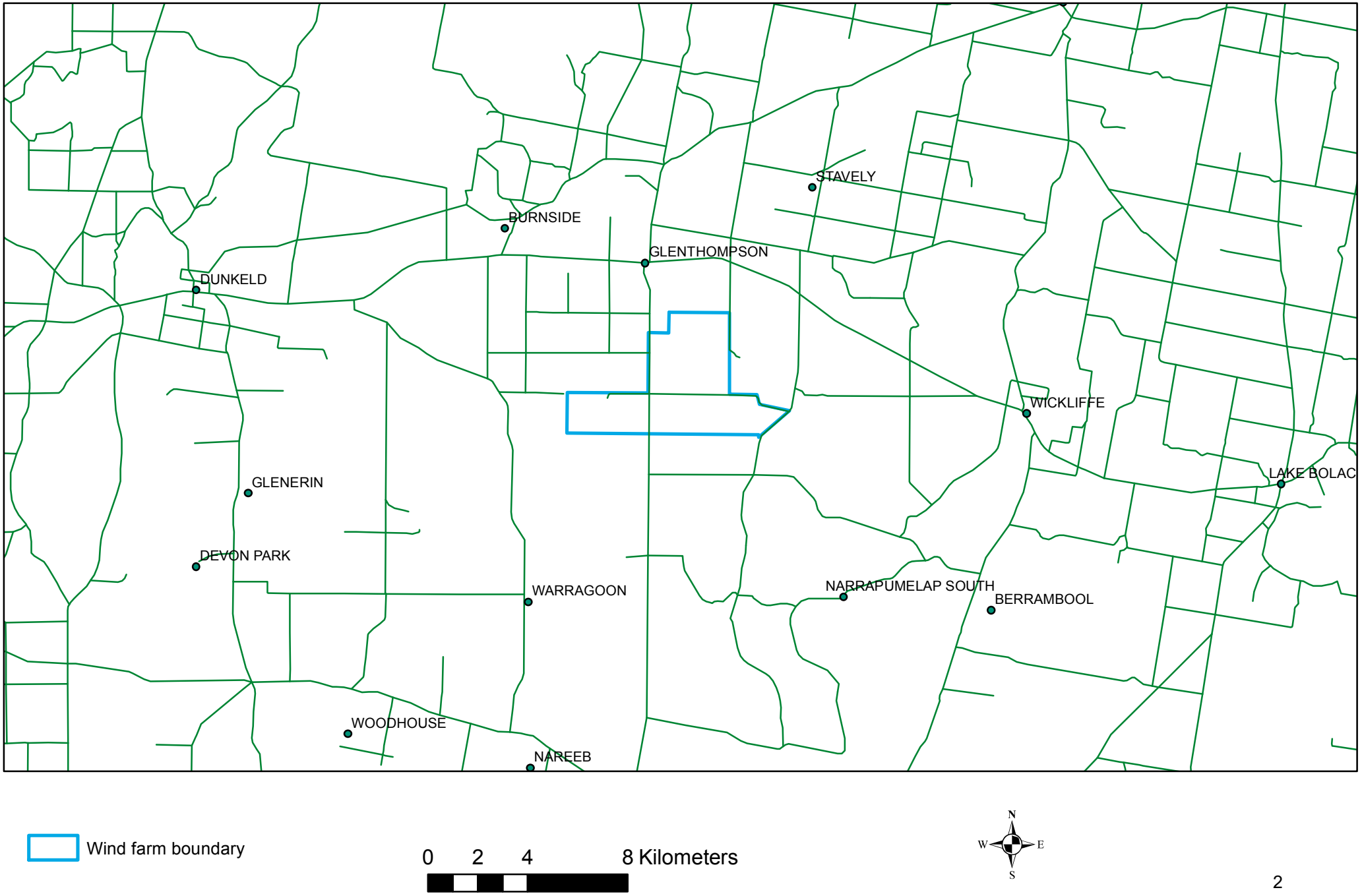
AGL Energy Limited engaged Suzlon Energy Australia Pty Ltd to build the Oaklands Hill Wind Farm. This wind farm consists of 32 wind turbines and is located on three privately owned properties on the east and west of Glenthompson-Caramut Road, approximately 8 km south of Glenthompson and covers an area of approximately 2,320 ha (Figure 1). All properties within the wind farm boundary consist primarily of pastoral land on rolling hills and valleys, elevated from the surrounding plains, and are primarily used for grazing cattle and sheep.

In accordance with the Planning Permit conditions and the endorsed Bat and Avifauna Management Plan of the Oaklands Hill Wind Farm, a monitoring program to assess bird and bat mortality resulting from collision with the blades of wind turbines was required to be undertaken for at least two years following completion of construction and commissioning of the wind farm. This monitoring program was initially undertaken by staff and service technicians of Suzlon Energy Australia following commissioning of the wind farm. However, DELWP Environment noted deficiencies in the mortality monitoring undertaken and requested that an additional two years of monitoring be undertaken, but to focus on large birds and bats to specifically examine the impact on Brolga and the Southern-Bent-wing Bat.

A revised Bat and Avifauna Management Plan was prepared by Australian Ecological Research Services Pty Ltd in June 2018 (Wood 2018) primarily to outline the goals and procedures for the additional bird and bat mortality monitoring. The BAM Plan also details reporting obligations including the preparation of an annual report following the first 12 months of mortality monitoring.

The following report details the results of bird and bat mortality monitoring undertaken at the Oaklands Hill Windfarm from May 2019 to May 2020, documenting the bird and bat fatalities recorded during this period and estimates the seasonal and annual mortality of large birds and bats attributable to collision with the blades of wind turbines.

Figure 1. Location of the Oaklands Hill Wind Farm



2.0 METHODS

Mortality of birds and bats resulting from collision with the blades of wind turbines were investigated by searching the ground under and around wind turbines for carcasses or other evidence of bird or bat mortality. In combination with correction factors for searcher efficiency and scavenging rates, the number of dead birds and bats, including any remains such as feather spots, found under wind turbines were used to calculate an estimate of seasonal and annual mortality. Estimates of mortality were only calculated for large birds and bats as were correction factors for searcher efficiency and scavenging rates.

2.1 Carcass Searches

A total of 16 turbines (50% of all turbines) were selected for carcass searches. The selection was random as far as practicable but those turbines which were located near tree plantations were avoided where possible. These plantations, mostly in the form of fenced windbreaks, would have created an obstruction to travel when walking transect lines and may have also impacted the likelihood of finding carcasses if they were to get caught in the tree canopies. Turbines selected for carcass searches are shown in Figure 2.

GIS software (Arcmap) was used to create a spatial layer of parallel transect lines within a circular search area spanning out to a radius of 115m from the turbine base at each of the selected turbines. The size of the search area was determined following recommendations by Hull and Muir (2010) relative to the height of the turbines and length of blades. Given that large birds hit by turbine blades can be projected greater distances from a turbine than smaller birds and bats and that the probability of finding larger carcasses is greater than for smaller carcasses (Hull and Muir 2010), the search area was divided into an inner and outer search area; the inner search area was located within a 65m radius of the turbine base and the outer search area was located between 65 and 115m from the turbine base. Transect lines within the inner search area were spaced at 4m intervals for the purposes of undertaking intensive searches for bats whilst transect lines in the outer search area were spaced at 12m intervals to focus on finding carcasses of large birds such as Brolga and Wedge-tailed Eagles. Transect lines were uploaded to GPS units which were used in the field to navigate along transect lines during carcass searches. An example of the layout of transect lines within search areas is provided in Figure 3.

Carcass searches consisted of using the GPS to navigate and slowly walk along transect lines, searching the ground for carcasses of birds and bats, or remains of such, at least halfway across to the adjacent transect line. Two field workers worked together during each carcass search to comply with the occupational health and safety requirements of the wind farm site.

From the start of May to end of August, carcass searches were undertaken once every four weeks along transect lines spaced at 12m intervals throughout the entire search area within a radius of 115m from the turbine base. As bats are inactive during this time of year, intensive searches along transects spaced at 4m intervals was not necessary. Carcass searches focused purely on detecting large birds during this period and as such a less intensive survey was sufficient.

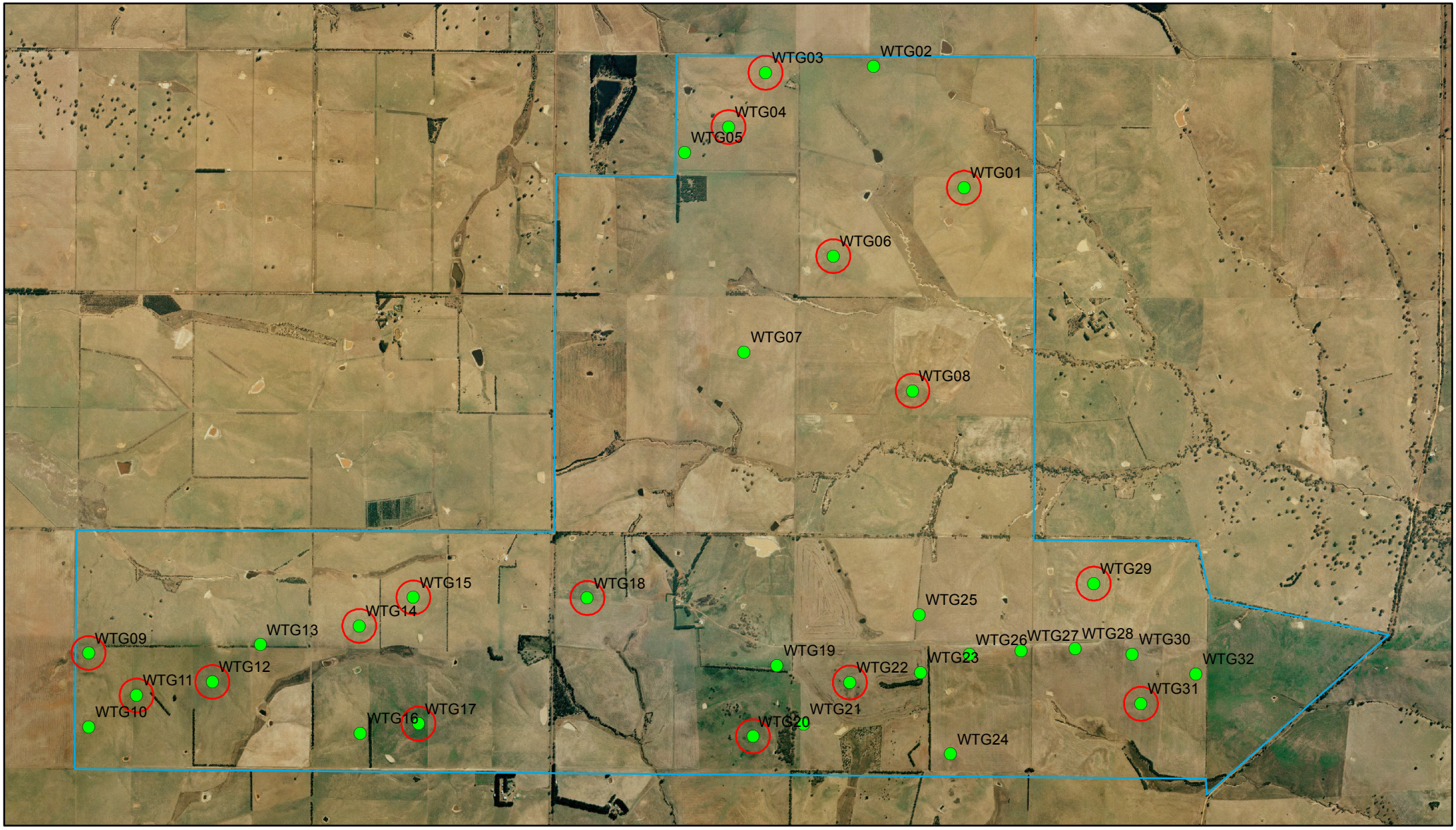
From the start of September to end of April, when bats are typically active, more intensive carcass searches were undertaken within the inner search area along transect lines spaced at 4m intervals on a weekly basis. Once every four weeks, an additional search was undertaken in the outer search area at 12m transect intervals to search for large birds that may have been killed during the previous four weeks.

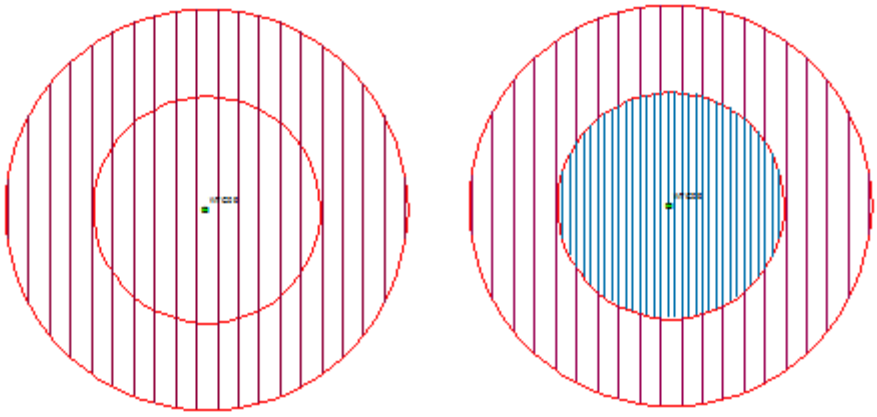
Carcass searches were undertaken according to a schedule, attempting as far as possible to maintain the same schedule and time interval between consecutive searches of the same turbine. When turbine maintenance interfered with the schedule or extreme weather conditions postponed surveys, the next turbines on the list were searched and those which had been missed were searched at the next opportunity.

Carcass search data sheets were completed for each carcass search, regardless of whether a carcass was found. The data sheet is provided in Appendix 1. Site information including the turbine number, date of search, presence of stock, and pasture cover and structure was recorded for all carcass searches. When a carcass or remains of a carcass, such as a feather spot or body part, was found the following details were noted: species (if identifiable), type of remains (carcass / feather spot), any signs of injury, estimated age of carcass and time since death, any evidence of scavenging, distance and bearing from turbine base, substrate conditions within 1m² of the carcass, distance from observer to carcass when first located, and perpendicular distance from transect line. A photograph was taken of the carcass / feather spot as found before it was placed in a sealed plastic bag and later transferred to a freezer.

Any carcasses found within carcass search areas but not during scheduled carcass searches were noted but left undisturbed so that it was potentially available to be found during the next formal carcass search, providing it was not removed by a scavenger within that time. Any carcasses found by maintenance personnel near turbines that were not searched as part of the carcass search program were photographed, collected and placed in a chest freezer on site. The incidental find was reported to site management using an “Incidental bird or bat carcass find report” form.

Figure 2. Distribution of turbines used for carcass searches at the Oaklands Hill Wind Farm





a) Transect intervals of 12m within the inner and outer search areas

b) Transect intervals of 4m within the inner search area and 12m in the outer search area

Figure 3. Representation of transect locations within carcass search areas

To enable a correction factor to be applied to calculations of bird and bat mortality which accounted for deficiencies of searches in detecting carcasses, searcher efficiency trials were undertaken to provide an estimate of the probability of a carcass being found. Similarly, scavenger trials were undertaken to estimate the duration a carcass remains in situ or is still detectable by a searcher before being removed by a scavenger. The combination of these factors was used to develop a correction factor for calculations of mortality which estimate the probability of a carcass being found should it be available (i.e. not removed by a scavenger). Searcher efficiency and scavenger trials were conducted each season other than winter during the first 12 months of the monitoring period to account for variation in the visibility of carcasses in periods of different vegetation cover and rates of scavenging. Due to difficulties in obtaining Turkeys in the first winter of 2019, scavenger and searcher efficiency trials for the winter season have been postponed to the following winter of 2020.

2.2 Searcher Efficiency Trials

Estimates of searcher efficiency were used to adjust the number of carcasses found during carcass searches in calculations of mortality to account for deficiencies of searchers in detecting carcasses. Searcher efficiency trials were undertaken during the middle of each season at a sample of 10 turbines scheduled for carcass searches.

As this monitoring programme focused on the mortality of bats and Brolga, small and medium sized birds were not used in searcher efficiency or scavenger trials. Where bats were in short supply, brown mice were used as substitutes as they were of similar size and colour to most bat species that occur on the wind farm. As Brolga carcasses were not available for use in the trials, Slate Grey Turkeys were used as substitutes. These turkeys closely resembled a Brolga in colouration and size. All carcasses were frozen and thawed on the day of the trial. The location and number of carcasses placed at each turbine was not known by the searcher undertaking the trial.

Just prior to commencement of the trial, between one and three carcasses of mice and one turkey were randomly placed within the search area of turbines to be searched that day. All mice were placed within the inner search area and the turkey was placed in the outer search area. It was assumed that all large birds would be found if placed within the inner search area given the more intensive search effort.

After each carcass had been placed within the search plot, the searchers followed the same procedure used for formal carcass searches. At the end of each carcass search, the number and proportion of all carcasses found was recorded. The efficiency of detecting carcasses was estimated separately for large birds and bats / mice and averaged over all ten carcass searches.

2.3 Scavenger Trials

Scavenger trials were undertaken to estimate the time a carcass remains in situ before it is removed by a scavenger. The average carcass removal time was used to adjust calculations of mortality for removal bias. Scavenging rates were estimated separately for large birds and bats as well as separately for each season to account for seasonal differences in forage availability and visibility of carcasses in varying height and density of vegetation. As with the searcher efficiency trials, Slate-grey Turkeys were used as substitutes for Brolga and mice were used to substitute bats. Whole feathered turkeys were purchased fresh from a Turkey Farm in western Victoria and transported via refrigerated courier directly to the wind farm the morning after being euthanised. Mice were not used in the winter trial as it was not expected to find bats during winter due to their inactivity at this time of year.

Scavenger trials were undertaken over 30 consecutive days during approximately the middle of each season. Each trial consisted of randomly placing one turkey and one mouse within 100m of each of 10 turbines that were used for carcass searches. The same 10 turbines were used for scavenger trials in each season. The locations of carcasses were recorded on a GPS and remote cameras were setup to capture photos of scavengers feeding on the carcasses.

All carcasses were checked each day over 30 consecutive days to determine whether they had been scavenged, either completely removed or partially, noting evidence of scavenging, such as movement of carcass, tearing or pecking, and remains of body parts. Where a carcass was removed by a scavenger, notes were recorded as to whether evidence of the carcass still remained such as feather spots or body parts which would most likely be detected during a carcass search. Carcasses or remains of such were checked daily until there was no further remains detectable or until the end of the trial. The scavenger trial data sheet is provided in Appendix 2.

2.4 Data Analyses

Searcher efficiency trials

Searcher efficiency rates are expressed as p, the proportion of trial carcasses that are detected by searchers.

Scavenger trials

Estimates of scavenging rates was used to adjust carcass counts for removal bias. The correction factor was expressed as the mean carcass removal time ($\bar{t}$), which was the average number of days a carcass remains at the site before it is removed. This was calculated following the formula:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{S - S_c}$$

, where t_i is the removal time of the ith carcass, s is the number of carcasses used in the trials, and s_c is the number of carcasses remaining at the end of the trial. (Source: Erickson *et al.* 2003). Carcass removal time was defined as the time taken for all evidence of the carcass such as feathers and body parts to be no longer detectable.

A correction factor for scavenging rate was determined separately for large birds and mice / bats by the average carcass removal time ($\bar{t}$), for each carcass type.

Estimation of mortality

An estimate of mortality (m_1) for large birds and bats at each turbine was calculated as follows:

$$m_1 = \frac{c}{\pi_1},$$

where c = the number of carcasses found in carcass searches,

$$\pi_1 = \frac{\bar{t} \cdot p}{I}$$

where p is the estimated searcher efficiency rate, $\bar{t}$ is the estimated carcass removal time, and I is the average interval (in days) between consecutive carcass searches (Source: Erickson *et al.* 2003). Different searcher efficiency and scavenging rates were used according to the season in which the carcass search was undertaken. Where the average carcass removal time determined by the scavenger trials exceeded the search interval between consecutive carcass searches, the average removal time was adjusted to the same time as the search interval.

Mortality was estimated separately for large birds and bats per turbine per season and per turbine per year. The mean seasonal and annual mortality was calculated from weekly estimates in each season and from all weeks combined. Total annual mortality for large birds and bats at each turbine was calculated by summing weekly mortality.

3.0 RESULTS

3.1 Carcass Searchers

A total of 41 carcass searches, including two clearing searches, were undertaken at each of the 16 turbines from 20 May 2019 to 22 May 2020 equating to 656 carcass searches over all 16 turbines. Including the clearing search of late August 2019, 35 of the 41 carcass searches at each of the 16 turbines were undertaken weekly along transects spaced at 4m intervals to focus on detecting bats. The remaining six carcass searches, including the first clearing search, were undertaken during the colder months from the start of the project on 20 May to the end of August 2019.

3.1.1 Bird fatalities

A total of 48 bird fatalities were found during carcass searches, consisting of 40 feather spots and 8 carcasses that were either intact or partially scavenged. Nine bird species were identified in fatalities although 17 feather spots could not be identified to species level (Table 1). The Magpie was the most common fatality found (50% of carcasses and 27.5% of feather spots), followed by the Brown Falcon and Magpie Lark (20% and 5% of feather spots respectively). Other species included the New Holland Honeyeater, Crimson Rosella, Sacred Kingfisher, Sulphur Crested Cockatoo and Wedge-tailed Eagle. No other bird fatalities were found incidentally when not conducting carcass searches.

3.1.2 Bat fatalities

A total of two bat carcasses, one Gould's Wattle Bat and one White-stripe Freetail Bat, were found.

Table 1. Summary of bird and bat fatalities found during carcass searches

Common name	Scientific name	No. carcasses	No. feather spots	Total
Australian Magpie	*Cracticus tibicen*	4	11	15
Brown Falcon	*Falco beringora*	0	8	8
New Holland Honeyeater	*Phylidonyris novaehollandiae*	1	0	1
Magpie Lark	*Grallina cyanoleuca*	0	2	2
Crimson Rosella	*Platycercus elegans*	1	0	1
Sacred Kingfisher	*Todiramphus sanctus*	1	0	1
Sulphur-crested Cockatoo	*Cacatua galerita*	1	0	1
Galah	*Eolophus roseicapilla*	0	1	1
Wedge-tailed Eagle	*Aquila audax*	0	1	1
Unidentified bird species		0	17	17
Avian Sub-total		**8**	**40**	**48**
Gould's Wattled Bat	*Chalinolobus gouldii*	1	0	1
White-striped Freetail Bat	*Tadarida australis*	1	0	1
Bat Sub-total		**2**	**0**	**2**

Note that five of the Brown Falcon feather spots and that of the Wedge-tailed Eagle were found during the initial clearing search prior to formal monitoring.

3.2 Searcher Efficiency Trials

Searcher efficiency trials were conducted at ten turbines in each season for each field worker. These trials were unable to commence in winter of 2019 due to a lack of turkeys available at the time and therefore commenced the following season of spring 2019.

The overall efficiency of searchers, noted as the proportion of turkeys or mice found, for each trial is shown in Table 2. The type and number of each carcass used at each turbine and whether the carcass was found during the searcher efficiency trials are detailed separately for each season in Appendices 3 - 6.

Table 2. Efficiency of searchers in detecting turkeys and mice in each trial.

Season	Searcher	Number of turkeys available	Number of mice available	Proportion of turkeys found	Proportion of mice found
Spring 2019	Emma	9	31	**1.0**	**0.81**
	James	9	31	**1.0**	**0.58**
Summer 2020	Emma	10	32	**1.0**	**0.87**
	James	10	32	**1.0**	**0.83**
Autumn 2020	Emma	10	25	**1.0**	**0.72**
	Katiesha	10	21	**1.0**	**0.71**

3.3 Scavenger Trials

Scavenger trials were conducted at the same 10 turbines in each season. The average carcass duration for turkeys and bats/mice was calculated separately for each season. Carcass duration was defined as the average time a carcass, or any post scavenging remains, was still detectable. Carcass duration was calculated separately for carcasses only and for carcasses including any post scavenging remains, either from partly scavenged carcasses or feather spots.

The rate at which carcasses were removed by scavengers as well as the number of days for any remains such as feather spots to be no longer detectable for each carcass type in each season is shown in Figures 4 - 9. The average duration for carcass to be removed and any post-scavenging remains to be undetectable for each carcass type in each season is detailed in Table 3. Mice carcasses were completely removed relatively quickly particularly in autumn when all 10 mice were taken within one day. Turkey carcasses were also quickly scavenged but usually continued to be fed upon in the following days. Feather spots and post scavenging remains most often remained until the end of the trial. Only four of the 30 turkey carcasses used throughout the trials were not detectable at the end of the trial.

Table 3. Average duration of carcass types in each season

Season	Carcass type	Average duration of carcasses only (days)	Average duration of carcasses and any post-scavenging remains (days)
Spring 2019	Turkey (n = 10)	11.3	30
	Bat (n = 10)	2.8	2.8
Summer 2020	Turkey (n = 10)	6.5	28.1
	Bat (n = 10)	1.9	1.9
Autumn 2020	Turkey (n = 10)	5.0	27.2
	Bat (n = 10)	1.0	1.0

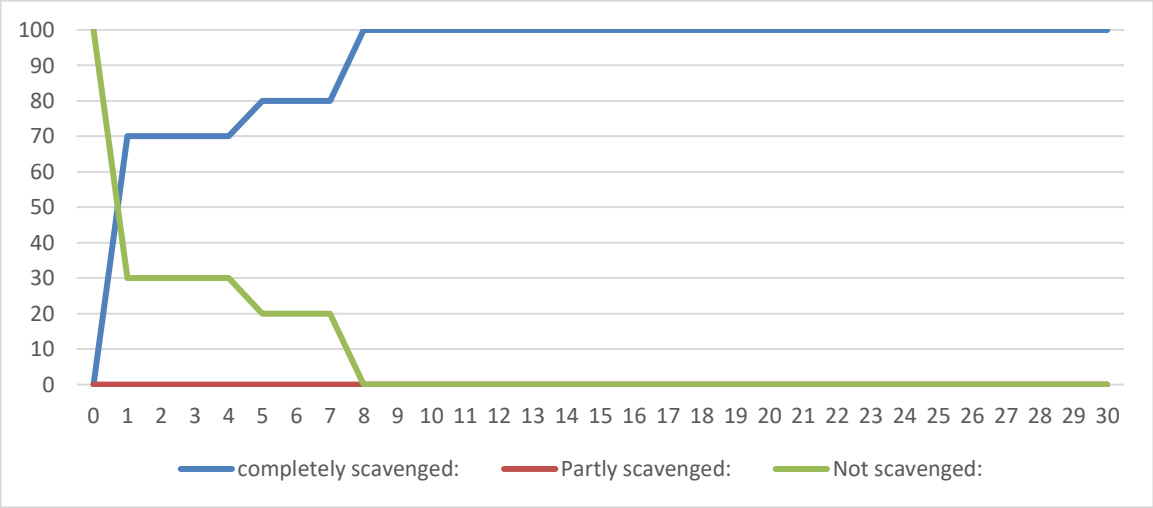


Figure 4. Rate of carcass removal for Mice – Spring 2019

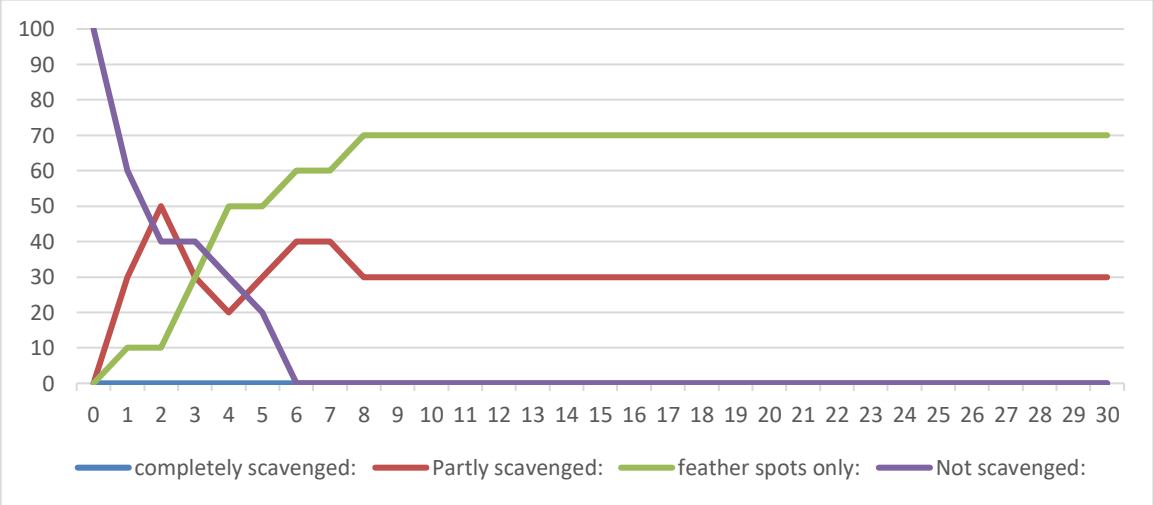


Figure 5. Rate of carcass removal for Turkeys – Spring 2019

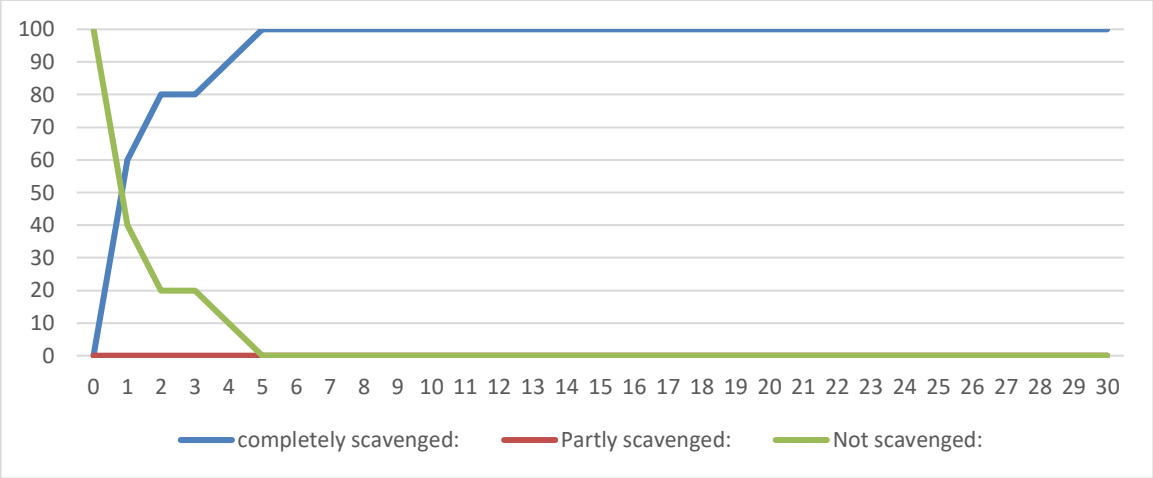


Figure 6. Rate of carcass removal for Mice – Summer 2020

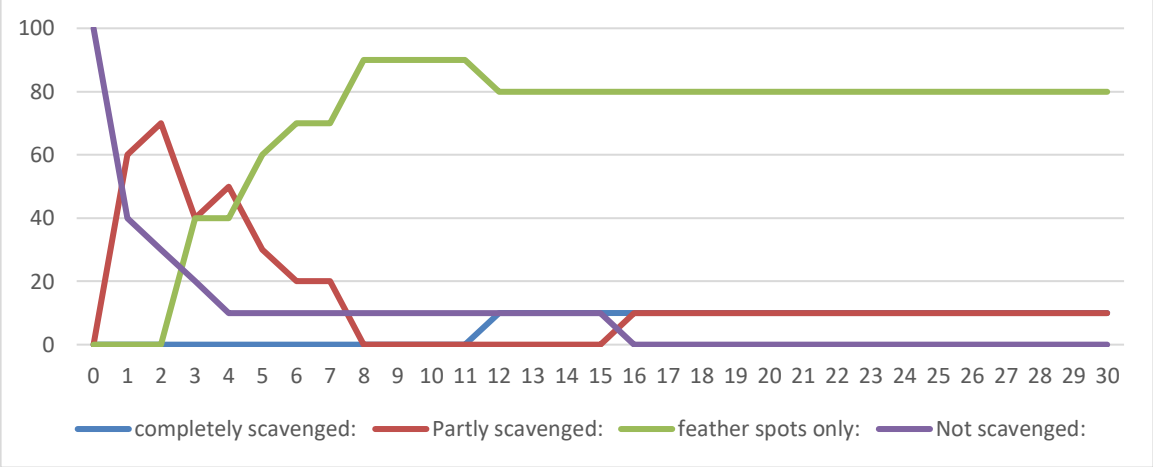


Figure 7. Rate of carcass removal for Turkeys – Summer 2020

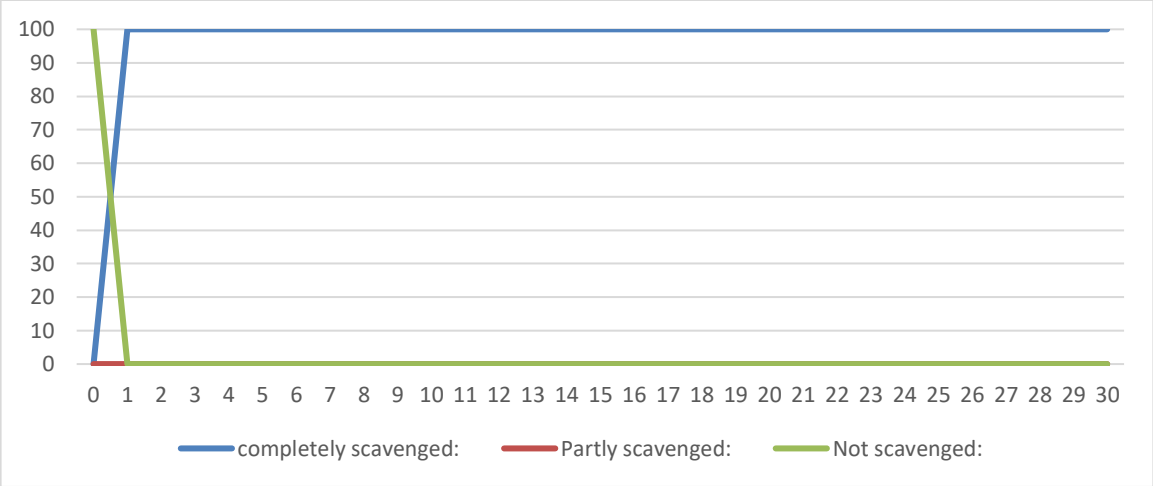


Figure 8. Rate of carcass removal for Mice – Autumn 2020

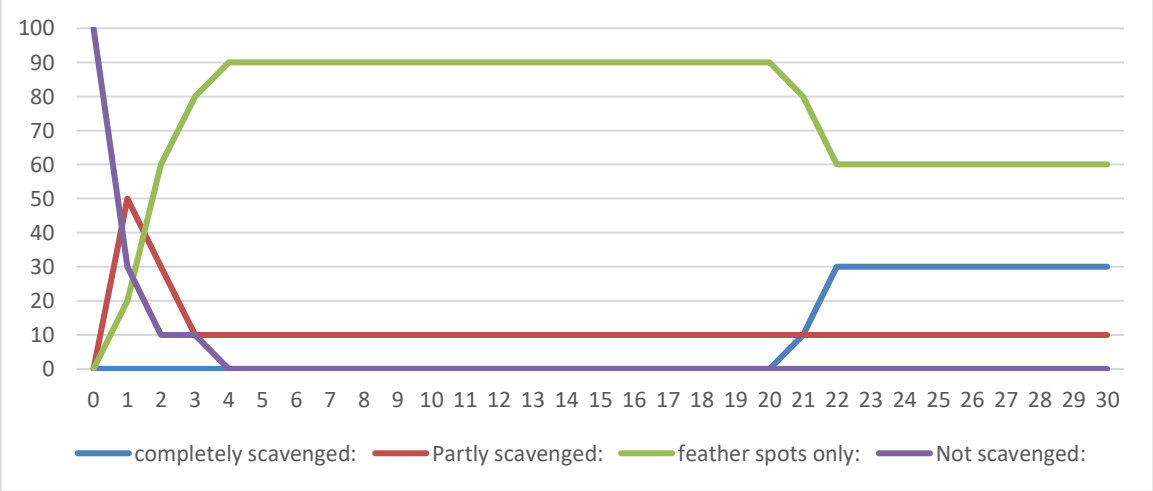


Figure 9. Rate of carcass removal for Turkeys – Autumn 2020

3.4 Estimates of Mortality

No large birds were found and only two bats, a White-striped Freetail Bat and Gould's Wattled Bat, were found

3.4.1 Large bird mortality

The annual and seasonal mortality of large birds was zero.

3.4.2 Bat mortality

Annual mortality

When accounting for correction factors of searcher efficiency and scavenging rates, the mean (± S.E.) number of bats killed per turbine per year was estimated at 0.91 ± 0.66. When extrapolated over the entire wind farm of 32 turbines this equates to a total of 29.12 ± 21.12 bat mortalities per year over the wind farm.

Seasonal mortality

The carcass of one bat was found in summer and the other found in autumn 2020. Due to differences in scavenging rates between seasons, the mean bat mortality per turbine in summer was estimated at 0.30 and that in autumn was 0.61. No bat mortalities were detected in winter or spring. Table 4 details estimates of seasonal and annual bat mortality at the wind farm.

Table 4. Estimates of seasonal and annual bird and bat mortality

Season	Group	No. of fatalities found	Mean mortality per turbine	95% Confidence Interval		Total mortality estimate (all turbines)	95% Confidence Interval	
				Lower limit	Upper limit		Lower limit	Upper limit
Spring 2019	Large birds	0	0	0	0	0	0	0
	Bats	0	0	0	0	0	0	0
Summer 2020	Large birds	0	0	0	0	0	0	0
	Bats	1	0.30	0	0.95	9.60	0	30.40
Autumn 2020	Large birds	0	0	0	0	0	0	0
	Bats	1	0.61	0	1.90	19.52	0	60.80
Winter 2020	Large birds	0	0	0	0	0	0	0
	Bats	0	0	0	0	0	0	0
All seasons	Large birds	0	0	0	0	0	0	0
	Bats	2	0.91	0	2.32	29.12	0	74.24

4.0 DISCUSSION

The first 12 months of bird and bat mortality monitoring at the Oaklands Hill Wind Farm has indicated that the likelihood of Brolga being impacted is extremely low. No Brolga have ever been observed on the wind farm site and no suitable habitat for Brolga occurs on the site. Should a Brolga be struck by the blades of wind turbines, it is most likely that the carcass or at least a feather spot would be found during carcass searches at monthly intervals given the majority of turkey carcasses, used to substitute Brolga, were still detectable after 30 days of each scavenger trial and all carcasses were found during searcher efficiency trials. As such, it is recommended to continue monitoring for Brolga mortality at the current frequency and intensity over the next 12 months.

Whilst two mortalities of bats were recorded during the first 12 months of monitoring, it is likely that more were killed but removed by scavengers prior to the next carcass search given the high rate of scavenging evidenced in the scavenger trials and lower efficiency of searchers in detecting bats. Ideally, more frequent carcass searches would reduce the probability that bat carcasses are removed by scavengers prior to the next carcass search but the time taken to undertake more intensive surveys would require additional field workers or the number of turbines searched would need to be reduced. As estimates of mortality are adjusted for scavenging and searcher efficiency bias, it is recommended to continue monitoring bat mortality at the current frequency and intensity.

5.0 REFERENCES

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Hull C.L. and Muir S. (2010). Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. *Australasian Journal of Environmental Management.* **17**: 77 - 87.

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6.0 APPENDICES

Appendix 1. Carcass search data sheet

Oaklands Hill Wind Farm - Carcass search data sheet.

Site details:

Turbine number:		Date:	
Observer:		Time:	
% cover of bare ground:		% cover of short/sparse vegetation (<10 cm):	
% cover of long/dense vegetation (>10 cm):		Stock access: (yes / no)	

Carcass details:

Carcass species (if identifiable in field)	Carcass condition (intact carcass, partly scavenged carcass, bones, feather spot)	Estimated age of carcass	Sex of carcass (M, F, ?)	Estimated no days since death	Signs of injury?	Vegetation cover within 1 m² of carcass (bare ground, short/sparse, long/dense)	Location of carcass (inner or outer search area)	Distance from turbine	Bearing from turbine	Distance to carcass when first sighted	Coordinates (GDA 94) Easting	Northing	Photo #

Appendix 2. Oaklands Hill Wind Farm - Scavenger trial data sheet.

Turbine ID number:			Date of initial carcass placement:	
Number of carcasses placed at site:	Large birds		Medium birds	
	Small birds		Bats	

Date of observation:

Carcass species:	Carcass ID No.	Carcass type: (large bird, medium bird, small bird, bat)	Condition at placement (fresh, frozen, state of decay)	Substrate conditions within 1m² of placement (high / low vegetation, bare ground, rocks etc)	Scavenged (Yes / No)	If scavenged, was there complete or partial removal?	Partial removal:		
							Note animal parts remaining (bone, feathers)	Scavenging observations? (tearing, pecking)	Type of scavenger (mammalian or avian)