Report

Post Construction Bird and Bat Monitoring Results,

Year 2: July 2019 to June 2020

Yaloak South Wind Farm, Victoria

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for

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ELMOBY ECOLOGY

SUMMARY

Introduction

Elmoby Ecology was commissioned by Pacific Hydro to undertake post construction bird and bat monitoring at the Yaloak South Wind farm near Ballan, Victoria. The purpose of this report is to summarise the findings of the second-year of the post construction monitoring program (July 2019 – June 2020).

Methods

The methods for the following tasks undertaken in accordance with the approved BAM plan are provided in Section 2 below:

- Carcass persistence (section 2.2)
- Observer Efficiency (section 2.3)
- Post construction carcass searches (section 2.4)

Data Analysis

Statistical analysis for the year two monitoring data was undertaken by Symbolix Pty Ltd. The mortality estimation is done via Monte-Carlo simulations which provides a comparable mortality estimator for complex survey designs.

Results

Searcher Efficiency

There was no measurable difference between the detection of birds and bats, nor between different dog/handler teams, therefore a single estimate of 90% with a confidence interval of [84%,94%] was applied.

Carcass Persistence (year 1)

There was evidence of differences between the scavenging rate of bats, eagles and other birds and therefore different estimators are applied to account for this. There was also evidence of differences between seasons and this variability is captured within the standard error. Thus, the mean times to total loss due to scavenging are:

- Bats is 3.4 days with a 95% confidence it is between [2.4, 4.9] days.
- Birds (not including eagles) is 8.3 days with a 95% confidence it is between [5.9, 11.6] days.
- Eagles is 394.8 days with a 95% confidence it is between [148.2,1057.9] days.

Mortality Detection Surveys

During the second year of surveys a total of 48 finds were recorded during formal surveys, 35 bats and 13 birds. This was comprised of 4 different species of native birds, 2 species of introduced birds and 1 unable to be identified to species level. There were 2 wedge tail eagles found during routine surveys. An additional 3 bats and 2 birds were found outside of the 60m survey area including 1 wedge tail eagle. All species found are considered secure in their range.

On average we estimate the number of bats impacted during the period of this report was 171 with a 95% confidence that fewer than 233 individuals were lost. During the same period, the average impact estimate for birds is 42 with a 95% confidence that fewer than 62 individuals were lost. We estimate the total site loss for wedge tail eagles is 3 and are 95% confident that fewer than 4 were lost.

Contents

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarise the findings of the second year of post construction bird and bat monitoring at the Yaloak South Wind Farm in accordance with the approved Bat and Avifauna Management Plan (BAMP). This plan was developed by Biosis Pty Ltd in accordance with Conditions 19 and 20 of Planning Permit PA2010002-2 for Yaloak South Wind Farm issued under the Moorabool Planning Scheme (Permit No: P2010002), as amended on 18 January 2019 by Order of the Victorian Civil and Administrative Tribunal (VCAT Reference No. P1333/2018 issued 4 January 2019). The BAMP was originally approved on 16 September 2015 and was revised in line with the amended permit conditions. The revised BAMP was endorsed by Moorabool Shire Council, in consultation with the Department of Environment, Land, Water and Planning (DELWP), on 15 May 2019.

Collection and use of specimens were conducted under the *Wildlife Act 1975* Research Permit number 10007321 which allows for the collection and storage of dead birds of bats found within the wind farm site and along state roadsides for the purpose of scavenger and searcher efficiency trials.

1.2 Scope and Objective

As outlined in the Bat and Avifauna Management Plan, the primary scope of the bird and bat monitoring program is to:

> *To ensure operations of the wind farm do not result in net significant or lasting impacts on the viability or conservation status of populations of Wedge-tailed Eagles, Bent-wing Bats or other listed threatened or migratory species.*

1.3 Study Area

The study area is located an hour west of Melbourne, approximately 15km south of Ballan off Glenmore Road. The project has been built in the southern section of the Yaloak Estate overlooking the Parwan Valley. The project site is predominantly cleared agricultural land used for cropping and livestock grazing. Each turbine is included in the study.

Figure 1: Location of turbines for Yaloak South Wind Farm. Image courtesy of Google Maps

2 METHODS

2.1 Data Analysis Overview

Quantifying bird and bat mortality from turbine collision are an ongoing management issue for wind energy facilities and different sites present different risks. Different monitoring requirements apply across Victoria means that data analysis must account for differences in survey effort, survey detection success and scavenger efficiency. Data analysis was undertaken by Symbolix Pty Ltd using Monte-Carlo simulations, which account for differences in survey effort.

2.2 Carcass Persistence Trials

Persistence trials were undertaken at the commencement of the BAMP program, predominantly in year 1, to determine the rate at which carcasses persist within the survey area. The primary method of removal of carcasses is scavenging by foxes, raptors, magpies and crows. Quantifying the rate of removal by scavengers is essential to understand how many carcasses are available for detection by observers and to provide correction factors for subsequent impact estimates.

Four carcass persistence trials were conducted, predominantly in Year 1, using a collective total of 89 carcasses, although some data was lost due to camera difficulties, giving a final total number used for analysis of 84 observations (table 1).

Table 1. Type and timing of for the deployment of carcasses during the carcass persistence trials.

Species Type	Sep (2018)	Jan (2019)	Apr (2019)	Jul (2019)
Bat	4	4	4	4
Bird of Prey	4	2	0	4
Eagle	5	4	4	3
Medium Bird	2	4	4	6
Mouse	4	3	4	4
Small Bird	4	4	3	0

Monitoring of carcasses occurred for 31 days except for the eagles which were monitored until no evidence of the carcass was available. All carcasses were placed within the survey area of the turbines during the September trial, however, following the discovery of eagles as the primary scavengers of other eagles, eagle carcasses were placed greater than 200m from the turbine base to reduce the risk of collisions for subsequent trials.

In accordance with the approved BAMP, four additional persistence trials are scheduled to commence quarterly from July 2020 in year 3 of the program.

2.2.1 Data Analysis

Survival analysis was used to determine the average time carcasses remained in the field before scavenging. As an exact time of removal is not known for all carcasses, survival analysis provides an interval in which the scavenge event has occurred and fits a curve to the data which is used to estimate the average survival percentage after a given length of time. Survival analysis is used to fit a curve to the data which provides an estimate of the survival percentage after a given length of time (full details in appendix 2).

2.3 Searcher Efficiency

Searcher efficiency trials were conducted in year 1 of the study to determine the likelihood of the survey team detecting a carcass during surveys if one is present. Trials for Year 2 were repeatedly delayed at in the first half of the program and ultimately not completed due to the complications imposed by Covid. Statewide data for the same dog and handler teams were compiled to increase the confidence around searcher efficiency and were included in statistical analysis. Further trials will be conducted in year 3 and will be compared to year one to ensure searcher efficiency for the dog and handler teams have remained consistent throughout this study. This comparison of detection dog handlers across seasons and sites is a methodology adopted at other windfarms and approved by DELWP to increase the sample size and confidence around searcher efficiency. Methodology used is consistent at Yaloak South and other wind farms sites as outlined below.

Carcasses are randomly distributed throughout the survey area at least 1 hour prior to the arrival of the search team. To ensure dogs are not tracking human footsteps, carcasses are thrown from a randomly designated point and allowed to land naturally. GPS coordinates of the throw location and direction of throw are recorded, and an indirect path is walked back to the vehicle. Whilst handlers are aware of the trial being undertaken, the trial is still considered blind as handlers are unaware of the number and type of carcasses present, which turbines are baited, nor which turbines remain unbaited thus providing sufficient blinding to validate the testing. To ensure additional effort is not made by dogs and handlers, GPS tracking of the dogs and handlers records survey duration which can be compared to standard surveys to ensure the dog team does not spend longer looking in the present of an efficiency trial.

2.3.1 Data Analysis

Observer efficiency data was provided to Symbolix to allow for correction based on observational bias. The dog and handler teams engaged at Yaloak South Wind Farm are simultaneously engaged in work at other wind energy facilities within Victoria and all searcher efficiency data was provided to Symbolix. Trials conducted at Yaloak South in year one \of the program were compared with additional trials conducted on the same team at different wind farms during the same time period and analysed for differences using binomial regression and stepwise AIC selection.

2.4 Carcass Searches

Carcasses surveys have been conducted by trained detection dogs and their handlers monthly from July 2018 until June 2020 at all 14 turbines to a radius of 60m. Additional "pulse" surveys were conducted between November and May in years 1 and 2 of the BAMP program for the detection of bats. Pulse surveys occur 3 days after the scheduled survey and reduce the influence of survey frequency on final mortality estimates. The number of surveys per month has varied from initial weekly surveys to fortnightly surveys from June 2019 and then to standard monthly surveys from December 2019 in consultation with DELWP. Full details of the number of surveys can be found in Table 2.

Table 2 Number of surveys per month

	Month	Number of surveys
2018	July	70
	August	46
	September	46
	October	83
	November	69
	December	84
2019	January	69
	February	69
	march	70
	April	68
	May	42
	June	28
	July	42
	August	28
	September	28
	October	42
	November	42
	December	28
2020	January	28
	February	28
	March	28
	April	28
	May	14
	June	14

2.4.1 Data Analysis

The mortality estimation is done via two Monte-Carlo simulations, one for bats and one for birds. Each used 25,000 simulations of the survey design. Random numbers of virtual mortalities were constructed, along with the scavenge loss time and searcher efficiency (based on the measured confidence intervals) and correction factors for area surveyed were applied based on estimates from Hull and Muir (2010) which assumes a 60m survey covers the fall zone of 95% of bats and 61% of birds. The proportion of virtual carcasses that were “found” was recorded for each simulation. Finally, those trials that had the same outcome as the reported survey detections were collated, and the initial conditions (i.e. how many true losses) were reported on.

This simulator has been found to perform comparably to other theoretical estimators, but more easily incorporates changing or complex survey designs. Full details of the analysis can be found in appendix 1.

3 RESULTS

3.1 Searcher Efficiency

Searcher efficiency was undertaken in year 1. Searcher efficiency trials were carried out at Yaloak South Wind Farm and three other wind farms during the same time period on the same dog/ handler teams. There was no evidence that searcher efficiency differed between the sites, the dog team or the target (different sized birds or bat), thus data was aggregated into a single estimate to provide a stronger confidence of the mean. Searcher efficiency was 90% with a 95% confidence interval of [84%, 94%] (Table 3).

Table 3 Detection efficiency combined

Variable	Combined estimate
Number found	135
Number placed	150
Mean detectability proportion	0.9
Detectability lower bound (95% confidence interval)	0.84
Detectability upper bound (95% confidence interval)	0.94

3.2 Carcass persistence trials

Four carcass persistence trials were conducted in each season of the first year[1] with a total of 84 carcasses with complete data used for analysis. There were 14 carcasses remaining at 30 days (considered the end of the trials), 12 of which were eagles. During analysis it was found that separating bats and mice did not improve model selection, and thus they were combined as an aggregate. It was also found that the model favoured combining small birds, medium birds and birds of prey (excluding eagles) into a single category. Thus, three different scavenging rates were determined.

Survival curves fitted to the scavenge data shows a difference between the scavenge rate of bats (and mice), birds and eagles with the assumption that all scavengers are "perfect" (Figure 2). The average time for loss of bats and mice is 3.4 days with a 95% confidence interval of [2.4, 4.9]. The average time for birds (not including eagles) is 8.3 days with a 95% confidence interval of [5.9, 11.6].

[1] Noting that the fourth trial extended into the second year (See Section 2.2).

For eagles, the mean time to total loss by scavengers is 394.8 days, with a 95% confidence interval of [148.2, 1051.9]. Total loss refers to a loss of all evidence including feather spots.

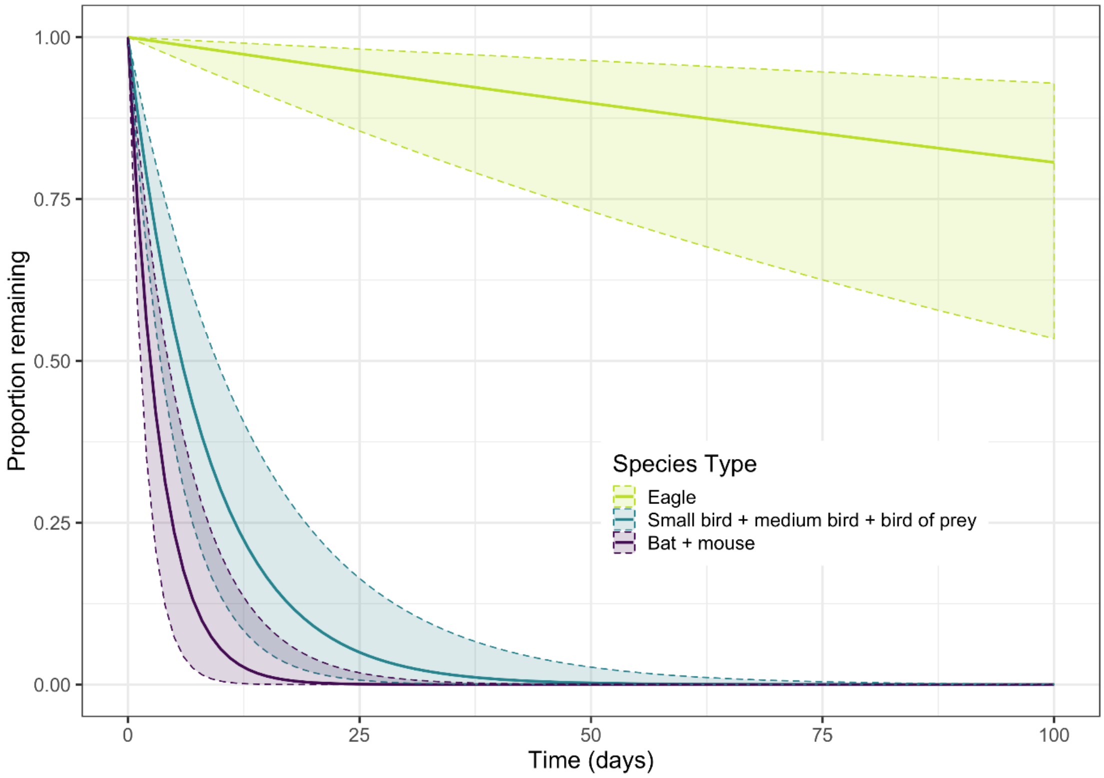

Figure 2 Survival curve showing difference persistence for eagles, birds and bats.

The probability of an eagle remaining in the field for a given length of time was calculated and it was found that there was some seasonal variability in persistence time (Table 4). Incorporating season as a factor resulted in a slightly better fitting model for eagles with the July trial showing a slightly faster scavenge rate and the September trial shows a slightly slower rate (relative to January).

Table 4 Probability of an Eagle carcass remaining after 30 or 60 days

Statistic	Sep	Jan	Apr	Jul
Probability that the carcass remains after 30 days	0.97	0.94	0.90	0.81
Probability that the carcass remains after 60 days	0.93	0.88	0.81	0.65

3.3 Carcass Searches

Carcass searches for year 2 were carried out between July 2019 and June 2020 at every turbine. In total 336 turbine searches were carried at the 14 turbines (Table 2).

A total of 35 bats and 13 birds or feather spots were found during routine mortality searches (Table 5) with an additional 2 birds and 3 bats found outside routine surveys (Table 6). No threatened species were found during surveys. Three wedge tail eagle carcasses, considered a species of interest at this site, were found during the 12 months of the study, two during routine surveys and one incidentally.

Table 5 Summary of species found during carcass searches in year 2

	Species	Count
bats	Eastern falsistrelle	3
	Gould's wattled bat	7
	White striped freetail bat	11
	Lesser long eared bat	5
	Little forest bat	1
	Southern forest bat	4
	Unknown forest bat	1
	Unidentifiable bat	3
birds	Bronze Wing Pigeon	2
	Wedge tailed eagle	2
	Australian magpie	3
	Sparrow	1
	Cockatoo	1
	Unidentifiable bird	4

Table 6 Incidental finds found outside routine survey area

Species	Distance from Turbine	Turbine	Month	Condition
Wedge Tail Eagle	68m	13	Nov 2019	complete
Eastern falsistrelle	70m	13	Mar 2020	complete
Starling	71m	1	Mar 2020	complete
White Striped Freetail	67m	4	Apr 2020	Complete
Unknown Forest Bat	79m	10	Apr 2020	Well scavenged

3.3.1 Mortality estimation for bats

During the second year survey period, a total of 35 bats were found at Yaloak South with two thirds of finds detected during standard surveys, and one third during pulse surveys. Bat finds only occurred between October and June, with half of all bats found during the 2 month period of March and April. The resulting estimate, taking into consideration scavenger removal and searcher efficiency, is a mean loss of 171 bats for the year. Based on the detected carcasses there is 95% confidence that fewer than 234 individual bats were lost across the site (Figure 3).

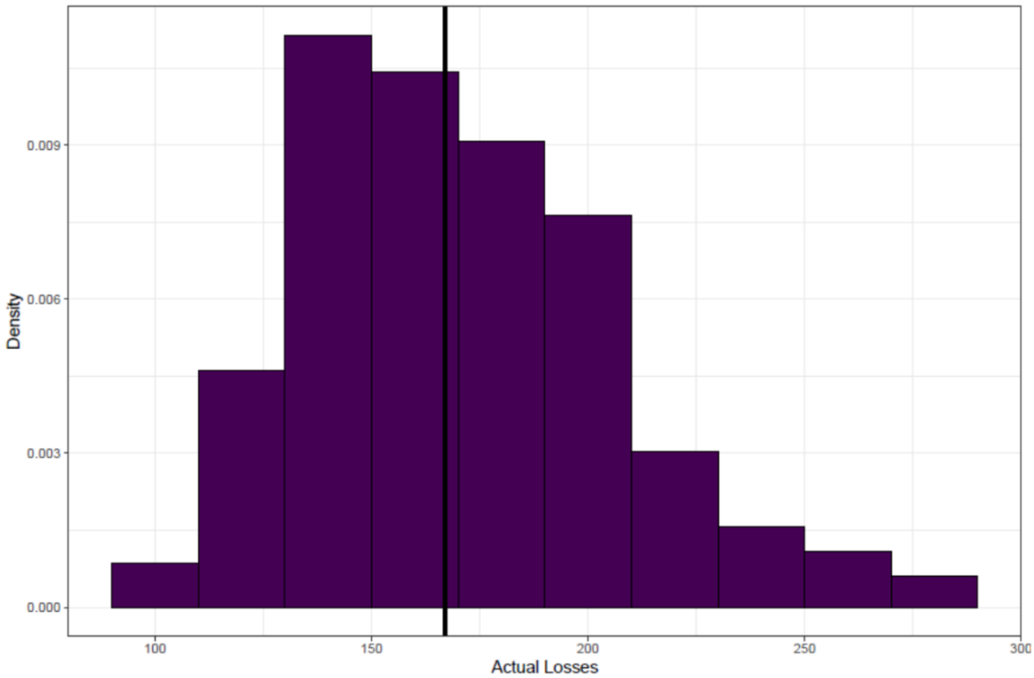

Figure 3 Histogram of bat losses at Yaloak South Wind Farm. The solid black line indicates the median

3.3.2 Mortality estimation for birds

During the routine mortality surveys, a total of 11 birds (and 2 wedge tail eagles) were found at Yaloak South Wind Farm. The resulting estimate taking into consideration scavenger removal and searcher efficiency is a mean loss of 43 birds for the period (excluding wedge tail eagles). This estimation also includes correction factors for a 60m search area and is thus accounting for birds missed outside the survey area (Hull and Muir 2010). Based on the detected carcasses there is 95% confidence that fewer than 63 birds (Figure 4) were lost.

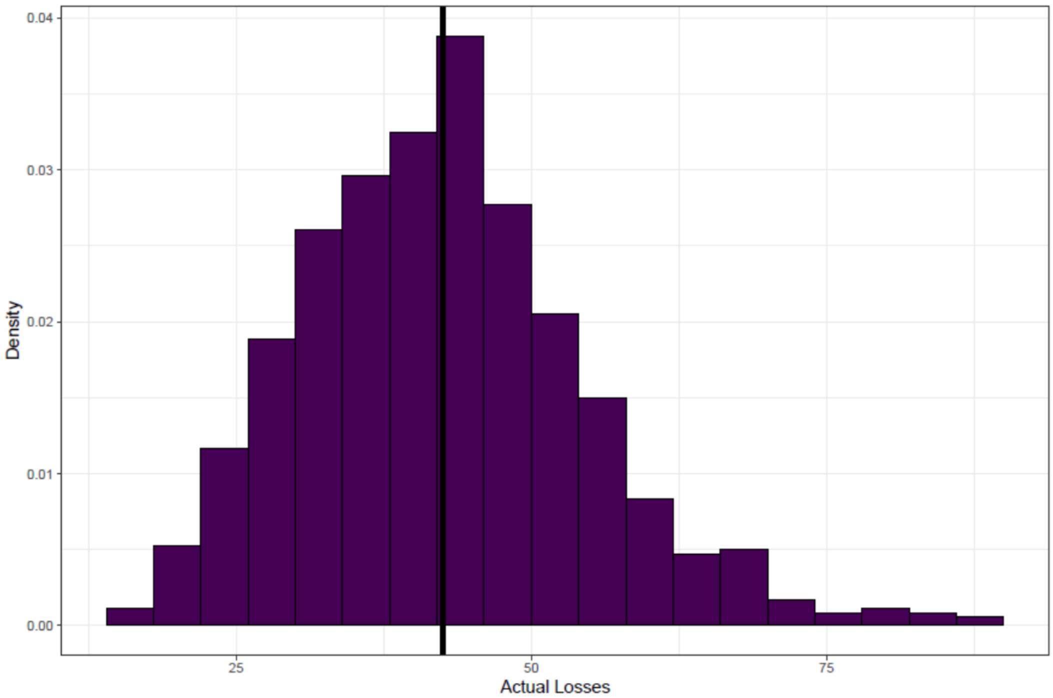

Figure 4 Histogram of bird losses at Yaloak South Wind Farm. The solid black line indicates the median.

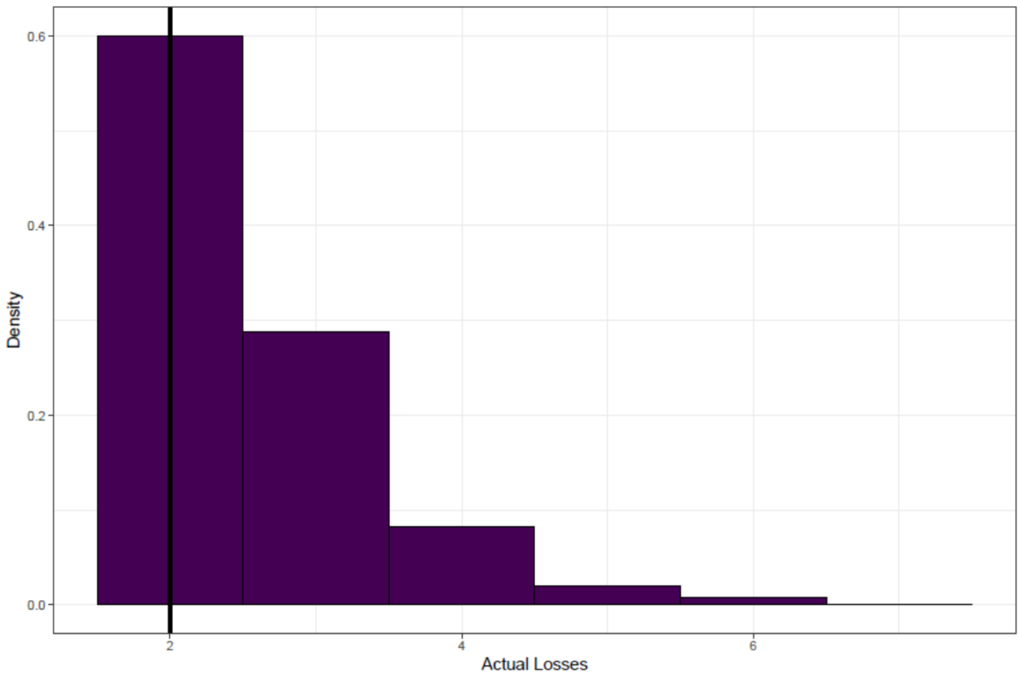

Figure 5 Histogram of wedge tail eagle losses at Yaloak South Wind Farm. The solid black line indicates the median.

3.3.3 Mortality estimation for eagles

During the routine mortality surveys a total of 2 wedge tail eagles were found at Yaloak South Wind Farm. Incidentally another eagle was found outside the survey area. Taking into consideration carcass persistence and searcher efficiency, for wedge tail eagles there is an expected mean loss of 3 birds over the 12 month study period. Based on these estimates we can be 95% confident that fewer than 4 eagles were lost (Figure 5). Given the persistence of eagles and the ease of eagle carcass detection, it is likely that these 3 eagles represent all eagles killed at Yaloak South Wind Farm during the survey period.

4 DISCUSSION

4.1 Searcher Efficiency

Results for the detection of both birds and bats is 90% [84%, 94%] and is consistent with other sites utilising the same dog/ handler teams. There was no difference in the detectability of birds and bats by the dog/ handler teams and this is primarily driven by the dogs' use of olfactory detection rather than visual based searches. The use of dogs is particularly advantageous for small targets such as bats and small birds where evidence suggests that humans have low detection rates (Mathews et al. 2013).

4.2 Carcass Persistence

In the first year[2] of this study, it was demonstrated that the persistence of carcasses in the landscape does vary by size and type, with the best fit model also determining that season contributed as an influence to scavenging rates. Bats and mice were scavenged at a faster rate than smaller or similar sized birds, whilst there was no measurable difference in the scavenging rates of medium birds, birds of prey such as kestrels, or small birds such as quail or sparrows. Significantly, it was demonstrated that the persistence of wedge tail eagles is much greater than that of other birds or bats, with all carcasses persisting for longer than 30 days and that on average there was still an 90% probability of a carcass persisting past 30 days. Carcass persistence was incorporated into the model based on the size and type of carcass providing a more realistic approach to persistence than a single removal rate for all birds, bats and eagles.

[2] Noting that the fourth trial extended into the second year (See Section 2.2).

4.3 Carcass Searches

Overall mortality estimates for birds and bats at Yaloak South Wind Farm are 95% confident that no more than 234 bats and 63 birds were impacted during the second year of monitoring. The average number of bats likely to be impacted per turbine per year is 12, with 95% confidence that less than 16.5 bats will be impacted. Considering the temporal patterns of bats, around half of all bats impacted are likely to occur during late Autumn, with little to no impacts occurring from winter to mid spring.

The diversity of bat species found at Yaloak South Wind Farm is indicative of the location of the site. The proximity of forests within Brisbane Ranges National Park and the open farm land of the wind farm itself provides an intersection of forest and open landscapes. Species such as white striped freetail bats (*Tadarida australis*) are typical of farm lands and open areas, whilst the forest bats (*Vespadelus species*) are more frequently associated with forested sites. In comparison with other sites in western Victoria, bat impacts are slightly above the state average, although it needs to be considered that survey methods at Yaloak are more likely to detect bats than other facilities which are not engaging dogs or undertaking pulse surveys.

The average number of birds likely to be impacted per turbine for year two is 3 birds, with a 95% confidence that less than 4.5 birds per turbine will be impacted. The number of eagles impacted was 3, with 95% confidence that fewer than 4 eagles were impacted across the entire site during the year. These figures take into consideration the 60m search area, searcher efficiency and carcass persistence and are a robust estimation of the true impact. State averages for Victoria have been estimated but are not publicly available at the time of this report, however the estimates for both years 1 and 2 at the Yaloak South Wind Farm are less than the state average for birds impacted per turbine. In addition, experience suggests that the reported range of bird impacts at Yaloak South Wind Farm is low relative to other wind farms in South Eastern Australia.

4.4 Comparison of Years 1 and 2

There were no measurable differences in the impact to bats between years 1 and 2 with a 95% confidence that less than 235 (year 1) and 234 (year 2) bats were lost across the site. The reduced survey frequency in year 2 did not result in different estimates and statistical testing using the Kolmogorov-Smirnov test did not determine a difference between the 2 modelled distributions. In comparison, the difference of 7 birds detected in year 1 and 11 birds detected in year 2 (excluding eagles) and the reduced survey effort suggested that the impact to birds was lower in year 1 relative to year 2. Whilst this statement is true if all assumptions within the model are held as true, the low number of finds must be taken into consideration. The difference between the year 1 mean impact of 1.2 birds per turbine and the year 2 mean impact of 3 birds per turbine is influenced by the additional 4 carcasses found and the reduction in survey frequency. Such low number of finds mean that statements of differences cannot be made with confidence and that true values may not truly differ.

The total number of eagles found during the first two years of the survey is 7, with 4 found in the first year and 3 found in the second year. Given the information obtained through the scavenger trials this is likely to represent all eagles impacted at the site and is well below the threshold for further action as outlined in the BAM plan. The number of eagles impacted at this site will not impact the population viability of wedge tail eagles.

4.5 Significant Impacts

Events considered or defined as a significant impact are outlined in section 3, Volume 1 of the endorsed Bat and Avifauna Management Plan for Yaloak South Wind Farm. No species listed as threatened or migratory under the Commonwealth EPBC Act, listed as threatened under Victoria's FFG Act or species listed as vulnerable, endangered or critically endangered under the Advisory list of threatened vertebrate fauna in Victoria (DSE 2013) were found during the second year of carcass searches at Yaloak South Wind Farm.

Wedge tail eagles are not considered to be under any level of threat on the Australian mainland, however the level of impact presented to individuals at Yaloak South Wind Farm is a primary consideration of the post construction mortality monitoring program. Modelled projections of up to 6.7 Wedge Tail Eagles was considered to pose no threat to the species' population[3]. The 3 eagles impacted in the second year of operation is less than this modelled projection and is therefore considered to have a negligible impact to the population of eagles.

5. RECOMMENDATIONS

5.1 Searcher Efficiency

Searcher efficiency trials have demonstrated high detection for both birds and bats. Ongoing trials for searcher efficiency are conducted routinely on the dog and handler teams at Yaloak South and a number of other sites across Victoria. Pooling data from both Yaloak South and other sites enables stronger confidence of the data and demonstrates consistency in search methods for the search team. Two additional trials will be conducted at Yaloak South in year 3 to ensure on going quality assurance and to confirm that searcher efficiency has remained consistent throughout the three years of the program.

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[3] Yaloak South Wind Energy Facility – Advisory Committee Report, September 2010 (Permit Application Ref 2010/002, Application for Review Ref P664/2010)

5.2 Carcass Persistence

The carcass persistence trials undertaken at Yaloak South Wind Farm have been completed to a high standard and provide insight into the different scavenging rates of different types of carcasses. These trials will be repeated in year 3 and it is recommended that the information obtained from this BAMP program be prepared into a scientific summary and submitted to a peer reviewed journal for publication. This study provides valuable insights and information into the different rates of scavenging of different carcasses, especially as relates to eagles and would be a useful addition to the citable literature.

5.3 Mortality Survey

The low number of bird impacts at Yaloak South Wind Farm suggests that monthly searching outside of bat season is an adequate search interval for bird detection, particularly given eagles are the primary species of interest and their long persistence rates have been demonstrated. The pulse search effort employed for the detection of bats from October through to April is justified to increase the certainty associated with bat impacts due to the high scavenging rates of bats and the high proportion of finds detected during the pulse surveys. There is no precedent to extend mortality monitoring passed the third year of surveys due to the low levels of impacts occurring at this site. Impacts to wedge tail eagles have been consistently lower than the thresholds included in the endorsed BAMP[4] and if year 3 is consistent with years 1 and 2 than further investigation is not warranted or justified.

[4] Bat and Avifauna Management Plan (BAMP) for Yaloak South Wind Farm: Volume 1 Background & Rationale, 1 May 2019 (as endorsed by DELWP 15 May 2019) – Section 3.3.2 sets thresholds of an annual mean estimated mortality of 10 wedge-tailed eagles in any 12-month period or an annual estimated mortality of 7 (or more) wedge-tailed eagles over two (or more) years.

6. REFERENCES

Hull, C. L., and S. Muir. 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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7. APPENDIX

1. Symbolix Report Yaloak Wind Farm Mortality Estimate Year 2
2. Symbolix Report Eagle Scavenger Trial Analysis
3. List of finds years 1 and 2

Appendix 1

Yaloak South Wind Farm Mortality Estimate - Year 2

Prepared for Elmoby Ecology, 28 October 2020, Ver. 1.0

This report outlines an analysis of the mortality data collected at the Yaloak South Wind Farm from 2018-07-02 to 2020-06-02. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – Trials were conducted at Yaloak South Wind Farm in April 2019
  - Elmoby Ecology also provided data from detectability trials conducted at three other Victorian wind farms (using identical field techniques). We pooled the data (after confirming there was no statistically significant difference) to generate a more precise estimate of detectability.
- Scavenger loss rates – consisting of trials starting on: 2018-09-20, 2019-01-08, 2019-04-30, 2019-07-02
- Mortality estimates - based on monthly surveys at all 14 turbines, from 2018-07-02 to 2020-06-02

The data was collected and provided by Elmoby Ecology. A brief summary of the data is provided below, and the ultimate focus of this report is a discussion of the potential mortality.

Available data

The data analysed was collected, verified and provided to us from Elmoby Ecology[1].

Methodology overview

Mortality through collision is an ongoing environmental management issue for wind facilities. Different sites present different risk levels; consequently different sites have different monitoring requirements. In order to estimate the mortality loss at a given site (in a way that is comparable with other facilities) we must account for differences in survey effort, searcher and scavenger efficiency. We used a Monte-Carlo simulation to achieve this.

The analysis used survey data to estimate the average time to scavenge loss and searcher

[1] DATA for symbolix YS Y2.xlsx, Yaloak scav trial complete.xlsx, detection combined.xlsx

efficiency (and related confidence intervals). The algorithm then simulated different numbers of virtual mortalities. We could then estimate how many carcasses were truly in the field, given the range of searcher and scavenger efficiencies, and the survey frequency and coverage, and the true "found" details. After many simulations, we can estimate the likely range of mortalities that could have resulted in the recorded survey outcome.

This method has been benchmarked against analytical approaches (Huso (2011), Korner-Nievergelt et al. (2011)). Its outputs are equivalent but it is able to robustly model more complex survey designs (e.g. pulsed surveys, rotating survey list).

Searcher efficiency

Six searcher efficiency trials were held (2019-04-15) at Yaloak South. The data provided for this analysis included the Yaloak South trial and data from three other Victorian Sites (collected using identical field techniques).

A range of bird and bat sizes were used. Canine searchers were used for all trials.

The detectability at Yaloak South was not significantly different to the other sites, so the mean and confidence intervals used in the model were based on pooled data. This provides a more precise estimate (i.e. smaller confidence interval).

We also found no evidence (using binomial regression) that the searcher efficiency differed between species types (via stepwise AIC selection). We therefore aggregated all trials into a single estimate of searcher efficiency rate.

Table 1 summarises the result.

Detectability is 90%, with a 95% confidence interval of [84%, 94%].

Table 1: Detection efficiency combined.

Variable	Combined estimate
Number found	135
Number placed	150
Mean detectability proportion	0.9
Detectability lower bound (95% confidence interval)	0.84
Detectability upper bound (95% confidence interval)	0.94

Scavenger efficiency

Survival analysis (Kaplan and Meier (1958)) was used to determine the average time until complete loss from scavenge. Survival analysis was required to account for the fact that we do not know the exact time of scavenge loss, only an interval in which the scavenge event happened. By performing survival analysis we can estimate the average survival percentage after a given length of time, despite these unknowns.

Based on these surveys there is evidence (via AIC) of a difference in scavenger rates between bats, Wedge-tailed Eagles, and other birds. Therefore, in our final analysis we separate them. There was also evidence that scavenger rates differ in different months. In particular, the July trial's mean time to scavenge was the lowest, and the September trial's mean time to scavenge was the highest.

To determine an annual mortality rate we wish to encompass this variability so have combined the seasons into an annual rate and a standard error (the standard error accounts for the seasonal variation).

Figure 1 shows a survival curve fitted to cohorts of bats, Wedge-tailed Eagles, and other birds. All data was collected at the Yaloak South Wind Farm. The survival curves (solid lines) show the estimated proportion of the sets remaining at any given time. The shaded portions are the 95% confidence intervals on the estimates. For example, we see that we expect around 1% to 13% of bat carcasses to remain after ten days with the expectation being around 5%.

Under these assumptions, for bats, the mean time to total loss via scavenge is 3.4 days, with a 95% confidence window of [2.4, 4.9] days. For birds (not including Wedge-tailed Eagles), the mean time to total loss via scavenge is 8.3 days, with a 95% confidence window of [5.9, 11.6] days. For Wedge-tailed Eagles, the mean time to total loss via scavenge is 394.8 days, with a 95% confidence window of [148.2, 1051.9] days.

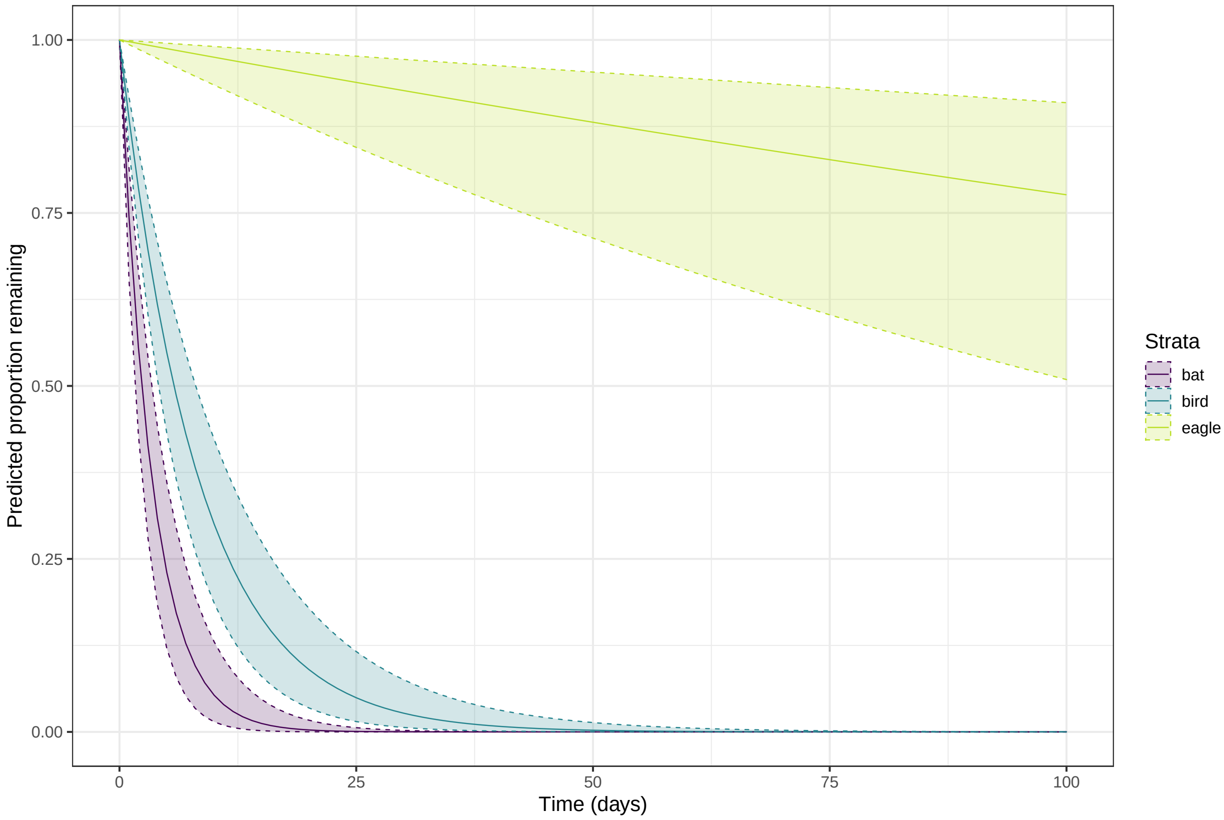

Figure 1: Combined survival curves for birds (excluding Wedge-tailed Eagles), Wedge-tailed Eagles, bats, with 95% confidence interval shaded.

Because the scavenger rates for Wedge-tailed Eagles and other birds are different, we provide separate mortality estimates for Wedge-tailed Eagles and other birds. For more information on Yaloak South scavenger rate, see Symbolix (2019a).

Other scavenger patterns

There are three general types of scavenger behaviour:

- "perfect"
- "olfactory"; and
- "visual"

These names are classifiers only, and not necessarily accurate descriptions of the actual processes employed by the scavenger. A "perfect" scavenger will find the carcass with constant efficiency, irrespective of the amount of time it has lain on the ground. "Visual" scavengers are more efficient in the earlier period post-mortem, and are less likely to find a carcass the longer it has lain there. "Olfactory" scavengers are the opposite of "visual" scavengers. They require the carcass to lie for some period, before their efficiency of detection increases.

Due to the small number of trials, we have focused on the mean loss rate, and not the shape. This means that we have assumed all scavengers to be “perfect”, which is the middle of the two other types.

Mortality projection inputs

Carcass search data

The mortality estimate was based on a dated list of turbine surveys. The survey frequency is summarised in Table 2. All fourteen turbines were surveyed five times each month until May 2019 when the frequency was reduced with DELWP’s consent. All were surveyed out to a radius of 60 metres.

Table 2: Number of surveys per month.

Date	Number of surveys
2018 Jul	70
2018 Aug	46
2018 Sep	46
2018 Oct	83
2018 Nov	69
2018 Dec	84
2019 Jan	69
2019 Feb	69
2019 Mar	70
2019 Apr	68
2019 May	42
2019 Jun	28
2019 Jul	42
2019 Aug	28
2019 Sep	28
2019 Oct	42
2019 Nov	42
2019 Dec	28
2020 Jan	28
2020 Feb	28
2020 Mar	28
2020 Apr	28
2020 May	14
2020 Jun	14

Mortality estimate

Mortality estimation – methodology

With estimates for scavenge loss and searcher efficiency we then converted the number of bat and bird carcasses detected into annual estimates of mortality at Yaloak South Wind Farm over the the first and second years of surveying, from 2018-06-02 to 2020-06-02 (we allow for collisions to occur up to a month prior to the first survey). We report the second year's mortality estimate, and compare it to the first year's estimate.

The mortality estimation is done via Monte-Carlo simulation. We used 25000 simulations with the survey design simulated each time. Random numbers of virtual mortalities were simulated, along with the scavenge time and searcher efficiency (based on the measured confidence intervals). The proportion of virtual carcasses that were "found" was recorded for each simulation. Finally, those trials that had the same outcome as the reported survey detections were collated, and the initial conditions (i.e. how many true losses there were) reported on.

The complete set of model assumptions are listed below.

- There were 14 turbines on site.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 2 for a summary).
- Mortalities were allowed to occur up to a month before the initial survey (2018-07-02) and until the final surveyed date (2020-06-02).
- Birds are on-site at all times during this period.
- Bats are on-site at all times during this period.
- Finds are random and independent, and not clustered with other finds.
- There was equal chance of any turbine individually being involved in a collision / mortality.
- We assumed an exponential scavenge shape ("perfect" scavengers).
- We took scavenge loss and search efficiency rates as outlined above.
- All turbines were surveyed, and were searched out to a (usually) 60 metre radius. We estimated the "coverage factor" for the survey – i.e. the total fall zone surveyed for birds and bats (using estimates from Hull and Muir (2010)) and adjusted this to account for the percentage of the search area that was actually searched in each survey. We assumed that the coverage factor was 61% for birds (excluding Wedge-tailed Eagles), 46% for Wedge-tailed Eagles, and 93% for bats.

Mortality projection results

After running the simulation we investigated the distribution of mortalities that could have resulted in the actual numbers found during the surveys. The breakdown of found carcasses per species are summarised in Table 3.

Table 3: Carcasses found during formal surveys over two years.

Year	Species	Bat	Bird	Feather Spot
1	White Striped Freetail	26	0	0
1	Goulds Wattled Bat	14	0	0
1	Lesser Long Eared Bat	13	0	0
1	Eastern Falsistrelle	9	0	0
1	Southern Forest Bat	3	0	0
1	Unknown - Bat	3	0	0
1	Large Forest Bat	2	0	0
1	Little Forest Bat	2	0	0
1	Chocolate Wattled Bat	1	0	0
1	Crested Pigeon	0	1	0
1	European Goldfinch	0	1	0
1	Silvereye	0	1	0
1	Welcome Swallow	0	1	0
1	Unknown - Bird	0	0	2
1	Magpie	0	0	1
2	White Striped Freetail	11	0	0
2	Goulds Wattled Bat	7	0	0
2	Lesser Long Eared Bat	5	0	0
2	Southern Forest Bat	4	0	0
2	Eastern Falsistrelle	3	0	0
2	Unknown - Bat	3	0	0
2	Small Forest Bat	1	0	0
2	Unknown Forest Bat	1	0	0
2	Bronze Wing Pigeon	0	2	0
2	Wedge-tailed Eagle	0	2	0
2	Unknown - Bird	0	1	3
2	Magpie	0	1	2
2	Sparrow	0	1	0
2	Cockatoo	0	0	1

There were also a small number of "incidental" finds (see Table 4), which were carcasses found outside the formal survey area. These finds are not included in the formal mortality estimate.

Table 4: Incidental finds (carcasses found outside the 60 m search area).

Species	Date	Year
Cockatoo	2018-07-16	1
Wedge-tailed Eagle	2018-08-13	1
Wedge-tailed Eagle	2018-09-24	1
Wedge-tailed Eagle	2018-09-24	1
Wedge-tailed Eagle	2019-03-25	1
Wedge-tailed Eagle	2019-11-19	2
Eastern Falsistrelle	2020-03-03	2
Starling	2020-03-06	2
White Striped Freetail	2020-04-07	2
Unknown Forest Bat	2020-04-07	2

Year two results

Bird results

During the second year of surveys a total of 11 birds (excluding Wedge-tailed Eagles) and 2 Wedge-tailed Eagles were found during formal surveys (Table 3). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 42 and a median of 41 birds (excluding Wedge-tailed Eagles) lost on site over the twelve months. For Wedge-tailed Eagles, the estimate is an expectation (mean) of of 3 and a median of 2 birds. Note: as there was a low count of Wedge-tailed eagles found, the results should be taken with caution.

Tables 5 and 6 and Figures 2 and 3 display the percentiles of the distributions to show the confidence interval in these averages.

In determining the estimate, we have used the standard practice of assuming that all carcasses and all feather spots (regardless of size or composition) are attributable to the wind turbines.

Based on the detected carcasses and feather spots and measured detectability and scavenge rate, we expect that there was a total site loss of around 42 birds (excluding Wedge-tailed Eagles) and around 3 Wedge-tailed Eagles over the survey period, and are 95% confident that fewer than 62 birds (excluding Wedge-tailed Eagles) and 4 Wedge-tailed Eagles were lost.

Table 5: Percentiles of estimated total bird losses (excluding Wedge-tailed Eagles) over year two of surveying.

0%	50% (median)	90%	95%	99%	99.9%
19	41	57	62	74	83

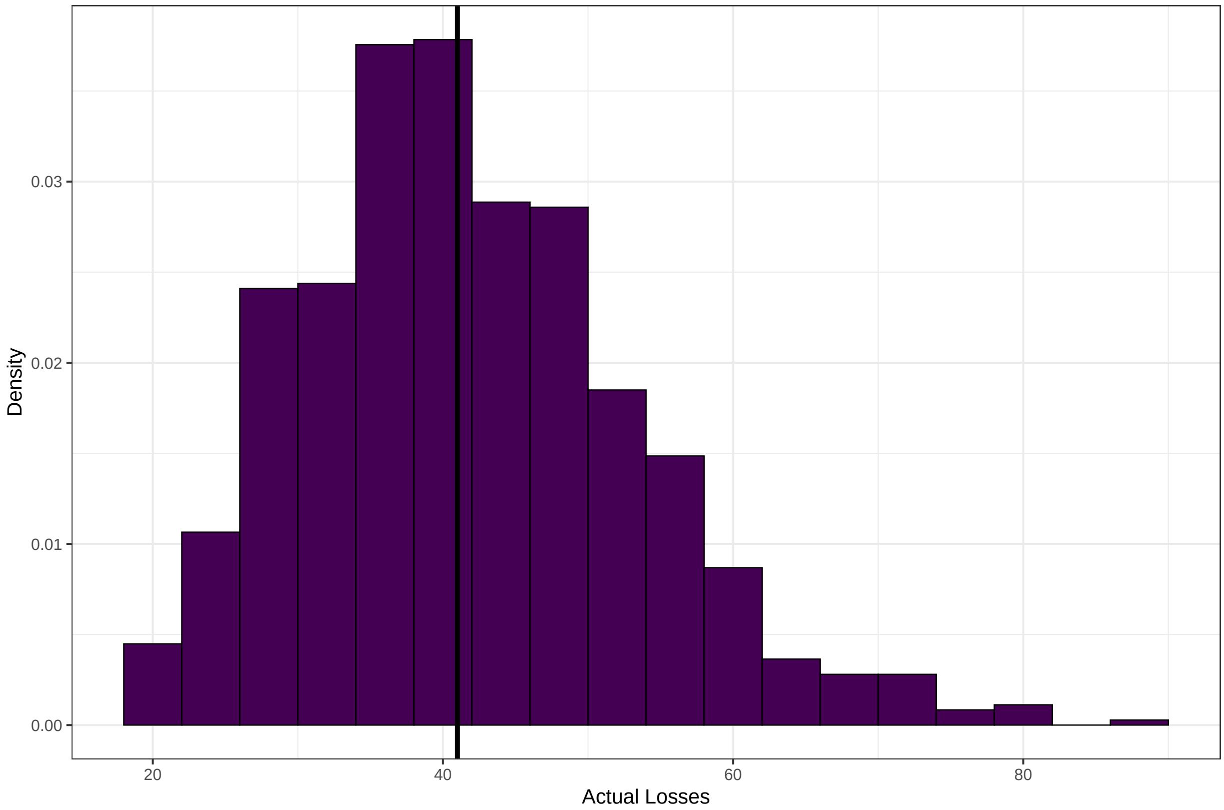

Figure 2: Histogram of the total losses distribution (birds - Wedge-tailed Eagles excluded), given 11 were detected on-site. The black solid line shows the median.

Table 6: Percentiles of estimated total eagle losses over year two of the surveying.

0%	50% (median)	90%	95%	99%	99.9%
2	2	4	4	5	7

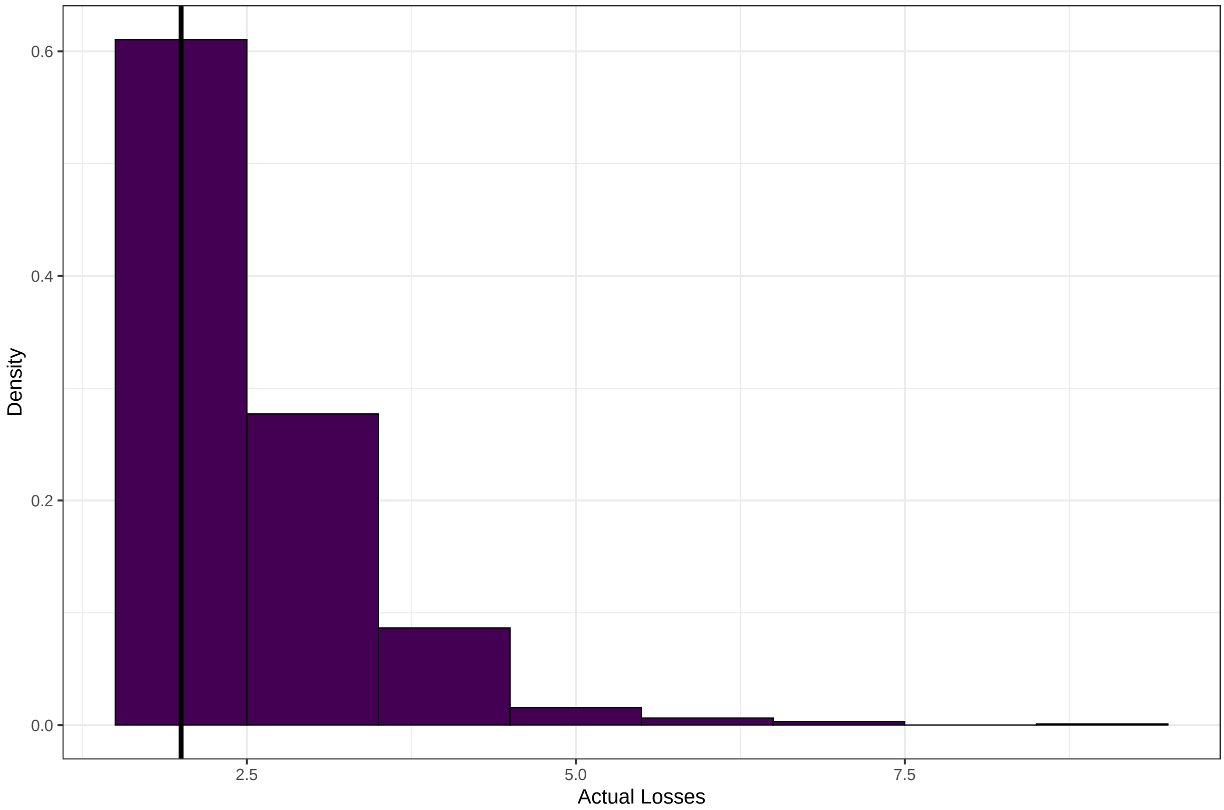

Figure 3: Histogram of the total losses distribution for Wedge-tailed Eagles, given 2 were detected on-site. The black solid line shows the median.

Bat results

During second year of surveys a total of 35 bats were found during formal surveys (Table 3). The resulting estimate of total mortality, accounting for searcher efficiency, scavenge rate, search area and timing of surveys is an expectation (mean) of 171 and a median of 167 bats lost on site over the twelve months.

Table 7 and Figure 4 and display the percentiles of the distributions to show the confidence interval in these averages.

Based on the detected carcasses and measured detectability and scavenge rate, we expect that there was a total site loss of around 171 bats, and are 95% confident that fewer than 233 bats were lost.

Table 7: Percentiles of estimated total bat losses over year two of the survey period.

0%	50% (median)	90%	95%	99%	99.9%
94	167	219	233	264	292

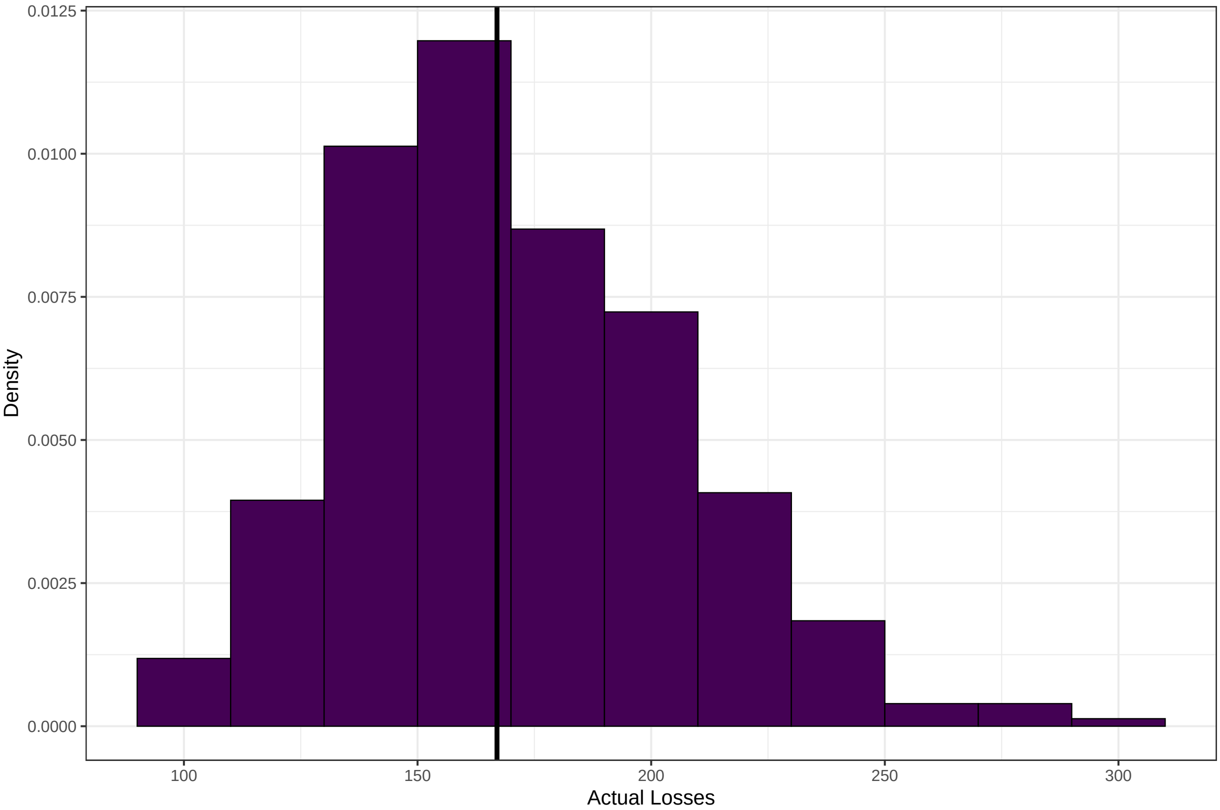

Figure 4: Histogram of the total losses distribution (bats), given 35 were detected on-site. The black solid line shows the median.

Comparison of year one and two

Bat results

During the first year of surveys (2018-06-02 to 2019-05-21) a total of 73 bats were found during formal surveys[2]. The resulting estimate of total mortality is an expectation (mean) of around 187 bats over the survey period, and we are 95% confident that fewer than 239 individuals were lost.

In comparison, in the second year of surveys a total of 35 bats were found during formal surveys. The resulting estimate of total mortality is an expectation of 171 bats over the survey period, and we are 95% confident that fewer than 233 individuals were lost.

Statistical testing (using the Kolmogorov-Smirnov test) was used to determine if there was a significant difference between the modelled distribution of mortalities in year one and year two. There was no significant difference between the first and second years ($K = 0.242$ is less than the critical value, $K_{0.05} = 0.351$).

[2]Note: there are slight differences in the reported Year 1 bat and bird mortality estimates in this report, compared with in Symbolix (2019b). This is due to a minor update in the simulation methodology.

Bird results

During the first year of surveys a total of seven birds were found during formal surveys. No Wedge-tailed Eagles were found in the first year. The resulting estimate of total mortality is an expectation of around 16 birds (excluding Wedge-tailed Eagles) over the survey period, and we are 95% confident that fewer than 25 individuals were lost.

In comparison, in the second year of surveys a total of 11 birds (excluding Wedge-tailed Eagles) were found during formal surveys. two Wedge-tailed eagles were found. The resulting estimate of total mortality for birds (excluding Wedge-tailed Eagles) is an expectation of 42 birds over the survey period, and we are 95% confident that fewer than 62 individuals were lost.

When considering all non-eagle bird mortalities, we find the distribution of the first year to be shifted left, compared to the distribution of year two mortalities ($K = 0.915$ is greater than the critical value, $K_{0.05} = 0.351$).

We did not compare modelled distribution of mortalities in year one and year two for Wedge-tailed Eagles since none were found in the first year of surveys.

Assuming all model assumptions hold, this would imply that the true total number of bird losses (excluding Wedge-tailed Eagles) in year one was significantly lower than the number of losses in year two.

Concluding remarks

In evaluating the potential impact, it is important to remember that all mortality estimators have an inherent assumption that there is an unlimited supply of carcasses to be found. In particular, we did not apply an upper limit on the number of bats or birds that could be onsite, and we assumed that bats and birds were present all year round. The ecological feasibility of this assumption should be accounted for if using these results to comment on overall ecological impact.

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Korner-Nievergelt, Fränzi, Pius Korner-Nievergelt, Oliver Behr, Ivo Niermann, Robert Brinkmann, and Barbara Hellriegel. 2011. "A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches." *Wildlife Biology* 17 (4): 350–63.

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APPENDIX 2

Eagle Scavenger Trial Analysis

Prepared for Elmoby Ecology, 12 September 2019, Ver. 1.0

1 Background

The purpose of this study is to quantify the removal rates of a range of carcass sizes at Yaloak Wind Farm in Western Victoria. We are testing the hypothesis that there is no difference in the removal rate of eagles, passerines, small birds and bats by scavengers.

1.1 Data

Scavenger trials at Yaloak Wind Farm were held starting on the following dates: 2018 Sep, 2019 Jan, 2019 Apr, 2019 Jul. The aim was to place 24 carcasses per trial - 4 eagles, 4 birds of prey, 4 medium passerines, 4 small passerines, 4 bats, and 4 mice.

The final data set was comprised of the species summarised in Table 1. In total, we had a final set of 84 observations. We note that an additional five were placed, but data was not available due to corrupted files.

Table 1: Summary of carcass types placed over the trial.

Species Type	2018 Sep	2019 Jan	2019 Apr	2019 Jul
bat	4	4	4	4
bird of prey	4	2	0	4
eagle	5	4	4	3
medium bird	2	4	4	6
mouse	4	3	4	4
small bird	4	4	3	0

Eagles placed are summarised in Table 2.

Table 2: Number of eagles placed.

Species	Date	Carcasses
wedge-tailed eagle	2018 Sep	5
wedge-tailed eagle	2019 Jan	3
little eagle	2019 Jan	1
wedge-tailed eagle	2019 Apr	4
wedge-tailed eagle	2019 Jul	3

Of all the carcasses placed, 14 were still remaining at the end of the trial. Of these, 12 were eagles.

For more information on how the data was prepared leading up to the survival analysis, see Symbolix (2019).

2 Survival analysis

Survival analysis (Kaplan and Meier (1958)) was used to determine the average time until complete loss from scavenge. Survival analysis was required to account for the fact that we do not know the exact time of scavenge loss, only an interval in which the scavenge event happened. By performing survival analysis we can estimate the average survival percentage after a given length of time, despite these unknowns.

2.1 Modelling

The model was fit on the set of 84 carcasses. We have used the exponential distribution to model survival rate. This model assumes a constant hazard throughout the "lifetime" of the carcass.

We started with a model of the form:

$$\text{Survival time} = \alpha + \beta \times \text{Species type} + \gamma \times \text{Month}$$

where species type is as set out in Table 1. Using an AIC selection method, we determined that:

- Month of year was a necessary factor
- Species type could be combined into the aggregated categories of: "bat + mouse", "eagle", "small bird + medium bird + bird of prey"

The final model coefficients, for the different categories, are displayed in Table 3.

Table 3: Final modelling coefficients for the mean scavenge rate (in days), plus their 95% confidence intervals.

Species type (aggregate)	Month	Mean	Lower	Upper
Eagle	Jan	465	160	1360
Eagle	Apr	292	98.8	865
Eagle	Jul	139	48.5	397
Eagle	Sep	844	290	2460
Small bird + medium bird + bird of prey	Jan	8.34	5.02	13.8
Small bird + medium bird + bird of prey	Apr	5.24	2.91	9.42
Small bird + medium bird + bird of prey	Jul	2.49	1.42	4.36
Small bird + medium bird + bird of prey	Sep	15.1	9.08	25.2
Bat + mouse	Jan	3.45	1.91	6.24
Bat + mouse	Apr	2.17	1.25	3.77
Bat + mouse	Jul	1.03	0.576	1.84
Bat + mouse	Sep	6.26	3.74	10.5

2.2 Species type differences

Figure 1 provides a comparison of the scavenger rates of different species types used in the trials. For clarity, we just plot the rates for species types for the January trials. The other months' trials have mean scavenger rates proportional to that of January.

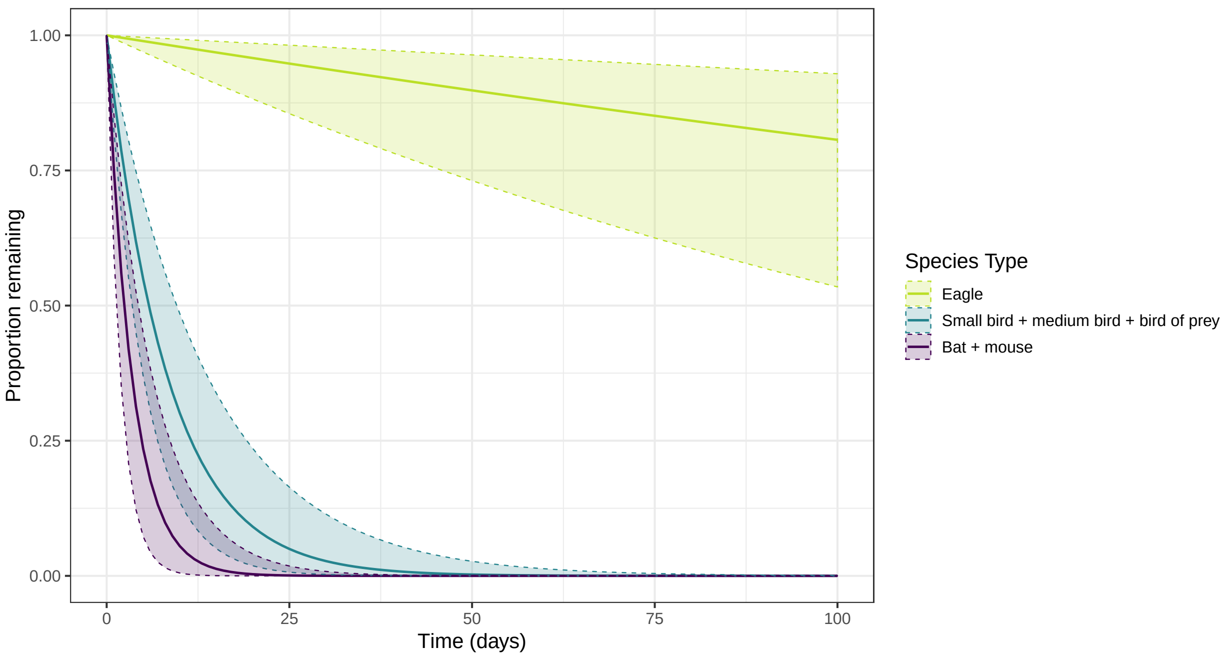

Figure 1: Comparative plot of scavenger rates of different species types (January only) with associated confidence intervals (shaded region).

During analysis, we found that:

- Separating bats and mice does not result in an improved model, via AIC selection. Therefore, we chose a model which aggregates them into a single category,
- Additionally, AIC selection favours combining small birds, medium birds and birds of prey.

We can see that bats and mice are scavenged the fastest, and eagles are scavenged the slowest. Other birds are scavenged somewhat faster than bats, but a lot slower than eagles.

For overall rates, aggregating over months, see Symbolix (2019).

2.3 Temporal differences

Via AIC selection, we found that incorporating month of year (of the trial start) resulted in a model with a better fit, compared to leaving the term out. Taking January as a baseline month, Table 4 describes the difference in scavenger rates between months, for eagles. September had relatively slower scavenger rate, while July had a relatively faster rate.

The values in Table 4 can be interpreted directly as multiplicative factors onto January's rate, for eagles.

Table 4: Multiplicative factors to scavenger rates, for different months.

Month	Factor	p-value
Apr	0.63	= 0.2
Jul	0.30	< 0.001
Sep	1.81	= 0.08

2.4 Probability of eagle carcasses remaining on the ground.

Table 5 shows the probability that an eagle carcass remains in-field (and observable) after 30 and 60 days, given the starting month of the trial.

Table 5: Probability of an eagle carcass remaining after 30 or 60 days.

statistic	Jan	Apr	Jul	Sep
Prob(carcass remains after 30 days)	0.94	0.90	0.81	0.97
Prob(carcass remains after 60 days)	0.88	0.81	0.65	0.93

3 Comparison with other sites

We are interested to see if scavenger behaviour is the same at Yaloak compared to other sites. We have available data from Portland Wind Farm. While we don't have wedge-tailed eagle scavenger data from Portland, we do have medium-sized bird and bat data.

We test the hypothesis that scavenger behaviour is similar at Portland compared to Yaloak, for medium sized birds and bats. Medium birds at Portland included the Ringnecked Parrot and Magpie, and medium birds at Yaloak included Crow, Magpie, and Quail. Bats were mostly White-striped Freetails.

The best fit model by AIC selection was one which differentiated between the two sites (and by species type). Therefore we cannot conclude that the scavenger behaviour is similar between sites. The Portland scavenger rate is not as fast as Yaloak's, by a factor of approximately 0.48.

References

Kaplan, Edward L, and Paul Meier. 1958. "Nonparametric Estimation from Incomplete Observations." *Journal of the American Statistical Association* 53 (282). Taylor & Francis: 457–81.

Symbolix. 2019. "Yaloak Wind Farm Mortality Estimate - Year 1." Symbolix.

APPENDIX 3

Complete list of finds for both year 1 and 2 at Yaloak South Wind Farm

Date	Carcass ID	Turbine	Species	Species Type	Distance From Turbine
16/07/2018	1	9	cockatoo	FS	78
13/08/2018	2	13	Wedge Tail Eagle	Bird	110
10/09/2018	3	3	Gould's wattled bat	bat	24
24/09/2018	4	13	unknown	fs	54
24/09/2018	5	12	Wedge Tail Eagle	fs	150
24/09/2018	6	12	Wedge Tail Eagle	bird	90
8/10/2018	7	10	Gould's wattled bat	Bat	24
8/10/2018	8	10	southern forest bat	Bat	21
8/10/2018	9	8	southern forest bat	Bat	8
8/10/2018	10	4	unknown	FS	46
22/10/2018	11	13	Eastern falsistrelle	Bat	16
22/10/2018	12	13	Little forest bat	Bat	18
22/10/2018	13	11	Gould's wattled bat	Bat	38
29/10/2018	14	7	lesser long eared bat	bat	20
5/11/2018	15	7	silvereye	bird	28
5/11/2018	16	12	Little forest bat	Bat	17
12/11/2018	17	13	southern forest bat	Bat	12
6/12/2018	18	11	lesser long eared bat	Bat	31
10/12/2018	19	12	Eastern falsistrelle	Bat	63
17/12/2018	20	8	European goldfinch	Bird	5
31/12/2018	21	6	Gould's wattled bat	Bat	32
31/12/2018	22	6	Gould's wattled bat	Bat	14
7/01/2019	23	12	Gould's wattled bat	bat	41
7/01/2019	24	12	Eastern falsistrelle	bat	22
7/01/2019	25	11	white striped freetail	Bat	46
10/01/2019	26	13	Eastern falsistrelle	Bat	26
14/01/2019	27	8	unknown	bat	36
14/01/2019	28	7	white striped freetail	bat	11
28/01/2019	29	14	Gould's wattled bat	bat	17
28/01/2019	30	14	unknown	Bat	36
28/01/2019	31	3	lesser long eared bat	bat	24
28/01/2019	32	10	Gould's wattled bat	bat	16

28/01/2019	33	10	white striped freetail	bat	13
28/01/2019	34	2	Gould’s wattled bat	bat	26
4/02/2019	35	10	white striped freetail	Bat	10
4/02/2019	36	14	white striped freetail	bat	50
4/02/2019	37	11	white striped freetail	bat	10
7/02/2019	38	4	white striped freetail	bat	21
7/02/2019	39	5	crested pigeon	bird	6
7/02/2019	40	7	white striped freetail	bat	40
7/02/2019	41	11	white striped freetail	bat	35
7/02/2019	42	13	white striped freetail	bat	29
7/02/2019	43	13	white striped freetail	bat	15
7/02/2019	44	13	white striped freetail	bat	29
7/02/2019	45	14	Gould’s wattled bat	bat	14
11/02/2019	46	14	Gould’s wattled bat	bat	4
11/02/2019	47	3	magpie	FS	50
11/02/2019	48	6	Eastern falsistrelle	bat	15
19/02/2019	49	3	white striped freetail	Bat	39
25/02/2019	50	13	Gould’s wattled bat	Bat	2
25/02/2019	51	12	large forest bat	Bat	2
4/03/2019	52	7	white striped freetail	Bat	5
4/03/2019	53	7	lesser long eared bat	Bat	11
7/03/2019	54	6	unidentifiable	bat	22
7/03/2019	55	5	white striped freetail	bat	46
7/03/2019	56	10	lesser long eared bat	bat	23
7/03/2019	57	10	Gould’s wattled bat	bat	8
7/03/2019	58	11	Eastern falsistrelle	bat	27
7/03/2019	59	14	lesser long eared bat	bat	46
7/03/2019	60	13	lesser long eared bat	bat	2
7/03/2019	61	13	lesser long eared bat	bat	12
11/03/2019	62	3	white striped freetail	bat	6

11/03/2019	63	11	lesser long eared bat	bat	21
11/03/2019	64	11	white striped freetail	bat	45
19/03/2019	65	4	white striped freetail	bat	34
19/03/2019	66	3	white striped freetail	Bat	25
19/03/2019	67	5	welcome swallow	Bird	19
19/03/2019	68	5	white striped freetail	Bat	27
25/03/2019	69	6	Gould's wattled bat	bat	8
25/03/2019	70	13	lesser long eared bat	bat	15
25/03/2019	71	13	Eastern falsistrelle	bat	7
25/03/2019	72	13	white striped freetail	bat	29
25/03/2019	73	14	white striped freetail	bat	11
25/03/2019	74	2	white striped freetail	bat	31
25/03/2019	75	2	white striped freetail	bat	19
25/03/2019	76	2	white striped freetail	bat	40
25/03/2019	77	11	WTE (male, juvenile)	bird	137
4/04/2019	78	4	Eastern falsistrelle	bat	34
16/04/2019	79	13	lesser long eared bat	bat	9
16/04/2019	80	13	large forest bat	bat	15
16/04/2019	81	13	lesser long eared bat	bat	16
16/04/2019	82	3	Eastern falsistrelle	bat	14
16/04/2019	83	7	chocolate wattled bat	bat	35
16/04/2019	84	4	white striped freetail	bat	15
16/04/2019	85	4	lesser long eared bat	bat	7
13/08/2019	86	7	bronze wing pigeon	bird	4
27/08/2019	87	7	bronze wing pigeon	bird	4
10/09/2019	88	4	Magpie	FS	60
24/09/2019	89	10	Wedge Tail Eagle	bird	53
8/10/2019	90	11	Magpie	bird	23
8/10/2019	91	5	Eastern falsistrelle	bat	22
23/10/2019	92	11	lesser long eared bat	bat	38
23/10/2019	93	12	Magpie	fs	55

5/11/2019	94	14	unknown	fs	33
5/11/2019	95	9	southern forest bat	bat	32
19/11/2019	96	13	southern forest bat	bat	10
19/11/2019	97	13	Wedge Tail Eagle	bird	24
19/11/2019	98	13	Wedge Tail Eagle	bird	68
19/11/2019	99	14	lesser long eared bat	bat	48
19/11/2019	100	1	Gould's wattled bat	bat	54
3/12/2019	101	14	southern forest bat	bat	30
3/12/2019	102	14	Gould's wattled bat	bat	42
3/12/2019	103	1	unknown	bird	9
6/12/2019	104	12	white striped freetail	bat	57
6/12/2019	105	10	sparrow	bird	35
6/12/2019	106	6	unknown	fs	5
10/01/2020	107	14	Gould's wattled bat	bat	29
10/01/2020	108	14	white striped freetail	bat	20
10/01/2020	109	5	white striped freetail	bat	17
7/02/2020	110	9	small forest bat	bat	35
7/02/2020	111	12	white striped freetail	bat	5
3/03/2020	112	1	unknown	bat	35
3/03/2020	113	9	white striped freetail	bat	43
3/03/2020	114	9	unknown	fs	37
3/03/2020	115	11	lesser long eared bat	bat	13
3/03/2020	116	13	Eastern falsistrelle	bat	70
6/03/2020	117	1	starling	bird	71
6/03/2020	118	1	cockatoo	fs	47
6/03/2020	119	1	white striped freetail	bat	11
6/03/2020	120	5	unknown	bat	33
6/03/2020	121	12	lesser long eared bat	bat	53
6/03/2020	122	13	unknown	bat	11
6/03/2020	123	13	lesser long eared bat	bat	23
7/04/2020	124	4	Eastern falsistrelle	bat	34
7/04/2020	125	4	white striped freetail	bat	67
7/04/2020	126	6	Gould's wattled bat	bat	11
7/04/2020	127	5	white striped freetail	bat	37
7/04/2020	128	9	Eastern falsistrelle	bat	26

7/04/2020	129	10	Unknown forest bat	bat	79
7/04/2020	130	13	white striped freetail	bat	8
10/04/2020	131	2	Gould’s wattled bat	bat	13
10/04/2020	132	5	Unknown forest bat	bat	31
10/04/2020	133	9	Gould’s wattled bat	bat	37
8/05/2020	134	7	white striped freetail	bat	45
8/05/2020	135	6	Gould’s wattled bat	bat	50
8/05/2020	136	13	southern forest bat	bat	29
2/06/2020	137	3	white striped freetail	bat	0
2/06/2020	138	6	white striped freetail	bat	0