Prime Super

Diapur Wind Farm Year 1 Post Construction Monitoring Report

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Landowner – Shirley and Dean Honeyman
BayWa r.e. – Bensil Paul; Charlie Perry
Diapur Wind Farm Pty Ltd – Jason Wang

Contents Page number

Executive Summary

The Diapur Wind Farm is located at Diapur approximately 20km west of Nhill Victoria (refer to Figure 1), 350 kilometres north-west of Melbourne. The Diapur Wind Farm occurs in the Wimmera bioregion in the Wimmera Catchment Management Authority area (CMA) within the jurisdiction of the Shire of Hindmarsh.

The Diapur Wind Farm consists of two wind turbines (refer to Figure 2), each with a maximum tip height of 200 metres and a minimum Rotor Swept Area (RSA) height of 50 metres Above Ground Level (AGL) and maximum blade length of 75m.

Diapur Wind Farm Pty Ltd was required to implement an endorsed Bat and Avian Management Plan (BAM Plan) to meet the planning requirements of the minister for Planning. Mortality analysis is based on completion of carcass searches, scavenger trials and detectability trials. The objective of the analysis of the combined attributes is to answer the following:

- Is operation of the wind farm resulting in significant bird and microbat mortality?
- What is the estimated annual mortality rate?
- What species are being impacted?
- Is there seasonal variation in the number of bird and bat mortalities?

The first year of monitoring commenced within 30-days of the two proposed turbines being commissioned for operation. All monitoring activities were undertaken by suitably qualified and experienced ecologist/s.

The ecologist walked concentric transects around each turbine tower at four metre intervals undertaking a pulse survey 2-days after the primary search. A range finder was directed at the turbine tower to maintain the correct transect spacing. Each primary and pulse event inspected an area up to 75 metres of each turbine.

Six bats and one bird were found within the RSA and considered to have died because of turbine strike (refer to Figure 3). The collisions of four southern freetail bats (*Ozimops planiceps*), two white-striped freetail bats (*Austronomous australis*) and one brown falcon (*Falco berigora*). The deaths of these species did not trigger a non-conservation species incident report as per the BAM Plan requirements, Section 4.2.

The median bat mortality rates for the 2022 monitoring period were estimated to be 11 bats and 2 birds over the 12-month monitoring period (Symbolix, 2023), an average of 6.5 mortalities per turbine.

The results of the relevant surveys and reviews indicates that the risk posed by the Diapur Wind Farm to microbats and birds is very low.

1 Introduction

1.1 Project Background

The Diapur Wind Farm is located at Diapur approximately 20km west of Nhill Victoria (refer to Figure 1), 350 kilometres north-west of Melbourne.

The Diapur Wind Farm consists of two wind turbines (refer to Figure 1), each with a maximum tip height of 200 metres and a minimum Rotor Swept Area (RSA) height of 50 metres Above Ground Level (AGL) and maximum blade length of 75m.

Diapur Wind Farm Pty Ltd sought an amendment to reduce the minimum Rotor Swept Area (RSA) to a height of 50m AGL from the original height of 60m AGL whilst still maintaining a maximum tip height of 200m. Ecology and Heritage Partners (E&HP 2017) assessed the study area based on a maximum tip height of 220m and minimum rotor swept area of 24m AGL.

The total construction impact area was estimated to be approximately 4.42 hectares including access tracks, cables, and turbine hardstands (E&HP 2017).

The Bat and Avifauna Management Plan (BAM Plan) for Diapur Wind Farm (EcoAerial 2019) was based on the findings of site assessments undertaken by Ecology and Heritage Partners (E&HP) on 13 and 14 October 2015 (EHP 2017) and, input from Belinda Cant, DELWP's representative.

1.2 Bird and Bat Management Plan Objectives

The objectives of the BAM Plan are to establish a monitoring framework aimed at answering the following:

- Is operation of the wind farm resulting in significant levels of bird and microbat mortality?
- What is the estimated annual mortality rate?
- What species are being impacted?
- Is there seasonal variation in the number of bird and bat mortalities?

Describe mitigation measures to reduce the risk of bat and bird mortality through turbine strike:

- Provide a framework for responding to detected impacts on bats and birds.
- Detail procedures for the periodic reporting to DEECA.
- Provide a clear summary of management actions required to address the Conditions of Approval (CoA).

Following endorsement of the BAM Plan, Diapur Wind Farm Pty Ltd was responsible for engaging suitably qualified ecologists to implement the BAM Plan.

1.3 Project Area

The E&HP (2017) site assessment identified approximately 37ha of native vegetation and 42 scattered trees within the wider study area. One community of state significance was present within the study area: Grey Box – Buloke Grassy Woodland (#434). No communities of national significance occur. Vegetation communities present within the project footprint include:

- Low Rises Woodland EVC_ 66 (Endangered)
- Sandstone Ridge Shrubland EVC _ 93 (Vulnerable)
- Lowan Sands Mallee EVC_882 (Vulnerable).

Twenty-nine native fauna species were recorded within the study area: 28 birds and one reptile. No significant fauna species were recorded during the field assessment (E&HP 2017).

Notwithstanding the lack of records of threatened fauna within 10km buffer the study area, E&HP (2017) noted that there is suitable habitat, albeit marginal, within the site for the nationally threatened Red-tailed Black-Cockatoo south-eastern subspecies (RTBC). They considered that: "*Given the very small extent of potential habitat proposed for removal and availability of similar and higher quality habitat in the broader landscape, the project is considered unlikely to significantly impact upon the RTBC"*.

There are two historical records (1978 & 1979) of the *Flora and Fauna Guarantee Act 1989* (FFG Act) listed Eastern Great Egret *Ardea modesta. "Eastern Great Egret is likely to occasionally forage within the study area, particularly within areas of pasture following rainfall events. Given the small size of the proposed wind farm and low likelihood of large numbers of Eastern Great Egret regularly using the study area, the potential operational impacts on the species are likely to be low (E&HP 2017)".*

Microbats are known to be susceptible to collision with wind turbines, in a particular white-striped freetail bats and Gould's wattled bat (E&HP 2017). A review of VBA contains no bat records within 10 kilometres of the study area. The lack of records was considered an artefact that surveys have not been undertaken in the region, rather than the surrounding landscape does not support bat populations (E&HP 2017).

The issued Planning Permit (PA1700251) states the requirement to prepare a Bird and Avifauna Management Plan (BAM) Plan, aimed at minimising bird and bat strike events because of the operation of the wind farm.   This report provides the results of the first years monitoring as outlined in the endorsed BAM Plan.

Figure 1: Diapur Wind Farm Location

0 1 2 km

LEGEND

Study Area

Turbines

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Date:4/04/23
Drawing No: 00206-1

250 0 250 500 750 1000 m

Map Projection: Simple Mercator
WGS 84

Legend

Turbines

Development Footprint

Figure 2: Diapur Wind Farm Site

Drawn by: Rob Gration
Date:2/11/18
Drawing No: 00206-2

1.4 Acronyms

Acronym	Description
BAM Plan	Bird and Avifauna Management Plan
CoA	Conditions of Approval
DEECA	Department of Energy, Environment and Climate Action, formerly DELWP
E&HP	Ecology and Heritage Partners
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FFG Act	*Flora and Fauna Guarantee Act 1988*
RSA	Rotor Swept Area
VBA	Victorian Biodiversity Database

2 Methods

2.1 Operational Monitoring Program

The mortality analysis is based on completion of carcass searches, scavenger trials and detectability trials. The objective of the analysis of these combined attributes is to answer the following:

- Is operation of the wind farm resulting in significant bird and microbat mortality?
- What is the estimated annual mortality rate?
- What species are being impacted?
- Is there seasonal variation in the number of bird and bat mortalities?

EcoAerial was engaged by Diapur Wind Farm Pty Ltd to develop a Bat and Avifauna Management Plan (BAM Plan) in consultation with DELWP, to address the following planning permit conditions:

Condition 34: *The Environmental Management Plan must include a Bat and Avifauna Management Plan (BAM Plan), which must:*

a) *include a statement of the objectives and overall strategy for minimising bird and bat strike arising from the operation of the facility.*

b) *include a mortality monitoring program of at least two years duration that commences when the first turbine is commissioned, or such other time approved by DELWP (Environment Portfolio). The monitoring program must include:*

   i. *procedures for reporting any bird and bat strikes to DELWP (Environment Portfolio);*

   ii. *information on the efficacy of searches for carcasses of birds and bats, and, where practicable, information on the rate of removal of carcases by scavengers, so that correction factors can be determined to enable calculations of the likely total number of mortalities; and*

   iii. *procedures for the regular removal of carcasses likely to attract raptors to areas near turbines.*

c) *Be prepared in consultation with DELWP Environment Portfolio prior to submission to the responsible authority.*

Condition 35: *When the monitoring program required under the BAM Plan is complete, the operator must submit a report to the responsible authority and DELWP Environment Portfolio setting out the findings of the program. The report must be:*

a) *To the satisfaction of the responsible authority and DELWP Environment portfolio*

b) *Made publicly available on the operator's website.*

Condition 36. *After considering the report submitted under Condition 34 and consulting with DELWP (Environment Portfolio) the responsible authority may direct the operator to conduct further investigation of impacts on birds and bats. The further investigation must be undertaken by the wind energy facility operator to the satisfaction of the responsible authority and DELWP Environment Portfolio.*

Notwithstanding that the CoA states monitoring for 2-years is required, the second year of monitoring may not be warranted. If the first year of monitoring provides sufficient information to not warrant another year of monitoring, or the risk to birds and bats is considered low, DEECA will be consulted to review the existing monitoring program. Options may be to cease monitoring or instigate alternative measures.

The first year of monitoring commenced within 30-days of the two proposed turbines being commissioned for operation. All monitoring activities were undertaken by suitably qualified and experienced ecologist/s.

2.2 Methodology

2.2.1 Field Assessment

The post construction monitoring commenced in December 2022 when Turbines 1 and 2 were commissioned for operation. This report covers the first 12-months of operation, December 2021 – November 2022. Completion of scavenger trials was not completed until January 2023.

2.2.2 Carcass Searches

Monthly carcass searches were undertaken at each turbine site mid-month starting in December 2021. Carcass searches were completed for the 1st year of monitoring in November 2022. Carcass searches were undertaken for a total of 12 months. To reduce error and refine mortality estimates, a pulse search method was deployed as prescribed by Symbolix, i.e., a second carcass search was undertaken two days following each primary search.

Searches commenced when suitable weather conditions prevailed. The ecologist walked concentric transects (refer to Diagram 1) around each turbine tower at four metre intervals. The pulse survey was conducted in the opposite direction to the primary survey 2-days later.

A range finder was directed at the turbine tower to maintain the correct transect spacing. Each primary and pulse event inspected an area within 75 metres of each turbine. The following steps were undertaken during each event:

- The searcher walked at a slow walking pace depending on ground layer conditions (i.e., height of pasture / silage) and searched thoroughly for carcasses.
- Carcasses found during the search were removed to avoid re-counting.
- Personnel wore gloves to remove carcasses. Carcasses were placed in a plastic bag and placed in a second plastic bag.
- Carcasses were labelled with the species name, turbine number, waypoint number and survey date.
- All bat carcasses were placed in a freezer for use with searcher efficiency and scavenger trials.
- The Carcass Search Data Sheet was completed.
- In event that any carcasses of conservation-listed species are found, DEECA are to be notified within two days.

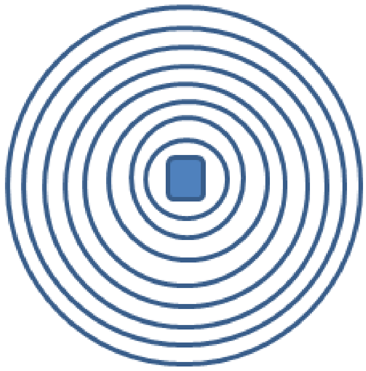

Diagram 1: Example of concentric transects at 4m intervals.

2.2.3 Scavenger Trials

Two one-month scavenger trials were undertaken in the first year, one in spring (September 2022), and one in summer (December 2022 / January 2023). A summary of the procedure is provided below:

- Two bat carcasses and three bird carcasses were placed randomly within the 75-metre search area of each turbine for the spring and summer trial.
- Carcasses were checked as described above until they were removed by scavengers or after 30-days after placement.

Scavenger trials were undertaken for the first year (refer to Attachment A). The results were used to estimate the length of time a bat carcass remains detectable before being scavenged. The scavenger trials in conjunction with detectability trials were used to correlate mortality estimates over the two monitoring periods. Whilst it was planned for scavenger trials to take place in Autumn and Spring, access to the turbine paddocks was not permitted by the landowners. Sheep were present in the turbine paddocks for lambing and scavenger trials would increase the likelihood of predation by foxes.

EcoAerial consulted with Symbolix, the company responsible for undertaking the mortality modelling, about conducting the scavenger trial in summer. They stated there were not any issues with the timing for the mortality modelling.

The scavenger trial carcasses were checked twice a day for days 1-3, once a day for days 4 & 5 and, once a day post day 5 on day 7 & 8; 14 & 15; 20 & 21 and day 30. Any carcasses remaining after day 30 were removed.

2.2.4 Searcher Detectability Trials

Searcher detectability trials were undertaken the month after the spring scavenger trial and in conjunction with the summer scavenger trial (refer to Attachment B). The efficiency trials, in conjunction with scavenger trials, were used to correlate mortality estimates by Symbolix, (refer to Attachment C). A summary of the procedure is provided below:

- Carcasses were placed by personnel not performing the searches and in a variety of exposures to simulate a range of conditions.

- The searcher was not present when the carcasses were placed or knew where they were placed. The searcher applied the same search method as intended for normal carcass searches.

2.2.5 Data Analysis

All results from carcass searches, detectability trials and scavenger trials are included in the report. The results of carcass monitoring, searcher detectability and scavenger trials were analysed by Symbolix, a specialist data analyst company with extensive experience modelling and analysing wind farm collision data.

The mortality estimate method used by Symbolix (e.g., Symbolix simulator, unpubl) accounts for survey imperfections in an unbiased manner and statistically estimates the annual bat strike. The model assumes bats are present throughout the year and whilst the collision risk weighting can be adjusted for the winter, it has minimal effects on the results (Stark, E. 2022 pers comm. 1 March).

2.2.6 Reporting

This report is the first annual report providing details of the outcomes of monitoring activities from December 2021 to November 2022. The report details the methods and results of monitoring, and focuses on providing recommendations for Year 2, specifically if ongoing monitoring is warranted or if alternative measures should be investigated.

The contents of the Year 1 report include:

- Detailed survey methods (including list of observers, dates and times of observations).
- Estimates of bat mortality rates based on carcass searches, detectability trials and scavenger trials.
- Detected mortality for all species recorded during the carcass searches.
- Any other wind turbine related bird and bat mortality recorded on site but not during designated carcass searches (i.e., incidental records by site personnel, etc.).
- Raw data sourced from carcass searches, detectability trials and scavenger trials.

A discussion of the results, include:

- Whether indirect impacts on bird and bat use of the site are significant at a regional, state or national level, or if listed species were affected indirectly.
- Whether the level of mortality was ecologically significant for birds and / or bat species.
- Whether continuation of the monitoring program is warranted and, if so, in what form.
- Any discernible differences in collision rates between lit and unlit turbines, where relevant.
- Any recommendations for reducing mortality, if necessary.

3 Results

No threatened species were found during the carcass searches and neither was there any incidental records. A total of seven individuals were found during the formal carcass searches, six microbats and one bird. Details of the results of the carcass search, scavenger /searcher detectability trials and bat detector results are provided below.

3.1 Carcass Search

Six bats, four southern freetail bats (*Ozimops planiceps*), two white-striped freetail bats (*Austronomus australis*) and one brown falcon (*Falco berigora*) were found within the RSA and considered to have died because of turbine strike (refer to Figure 3). Table 1 below details the carcasses records.

The wind speed and temperature leading up to the collision events, were sourced from the turbine tower weather stations. Weather conditions are recorded every 10 minutes.

Column 2 in Table 2 (refer below) is the minimum wind speed recorded leading up to an incident. Columns 3 and 4 provide the median overnight windspeed and temperature for the two turbines from 7.30pm to 7am. The feathering of the turbine blade threshold (i.e., less than 3m/s) occurred for short periods leading up to each of the incidents:

- 15/12/2021 (2.5m/s) between 5.10 and 5.20am
- 16/02/2022 (0.8 ~2.6m/s) between 4.10 and 7.00am
- 19/03/2022 (0.3 ~ 3m/s) between 7.30pm and 2.20am
- 15/07/2022 (1.3 ~2.5m/s) between 4.00am and 4.20am
- 21/10/2022 (2.1 ~2.7m/s) between 4.10 and 5.10am.

There were periods of wind speeds below the flight speed of White-striped Freetail Bat (approx. 8.3 m/s) and Ozimops sp (approx. 8.1m/s) leading up to each incident.

Table 1: Turbine Strike Incidents

Incident No	Carcass Id	Survey Type	Turbine	Species	Sex / age	Distance from Tower (m)	Date
1	OZISP1	Formal	2	*Ozimops planiceps*	Male / Adult	60	18/12/2021
2	BFALC1	Formal	2	Brown Falcon	Unknown	70	18/12/2021
3	OZISP2	Formal	1	*Ozimops planiceps*	Adult	11	19/02/2022
4	OZISP3	Formal	2	*Ozimops planiceps*	Adult	40	21/03/2022
5	OZISP4	Formal	2	*Ozimops planiceps*	Female / Adult	60	18/07/2022
6	WsFB	Formal	1	White-striped Freetail bat (WsFB)	Female / Adult	70	22/10/2022
7	WsFB	Formal	1	White-striped Freetail bat (WsFB)	Male / Adult	24	22/10/2022

Table 2: Nightly Weather Conditions Leading up to Incidents.

Date	**Turbine No**	**Wind Speed minimum m/s @ 110m**	**Overnight Wind Speed Median m/s @ 110m**	**Overnight Temp C Mean @ 110m**
15/12/2021- 18/12/2021	2	2.5	10.4	18
16/02/2022-19/02/2022	1	0.8	9.25	14
18/03/2022-21/03/2022	2	0.3	7.3	19
15/07/2022-18/07/2022	2	1.3	10.9	8
19/10/2022- 22/10/2022	1	2.1	7.85	16

Figure 3: Carcass finds

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Date: 20/03/2023
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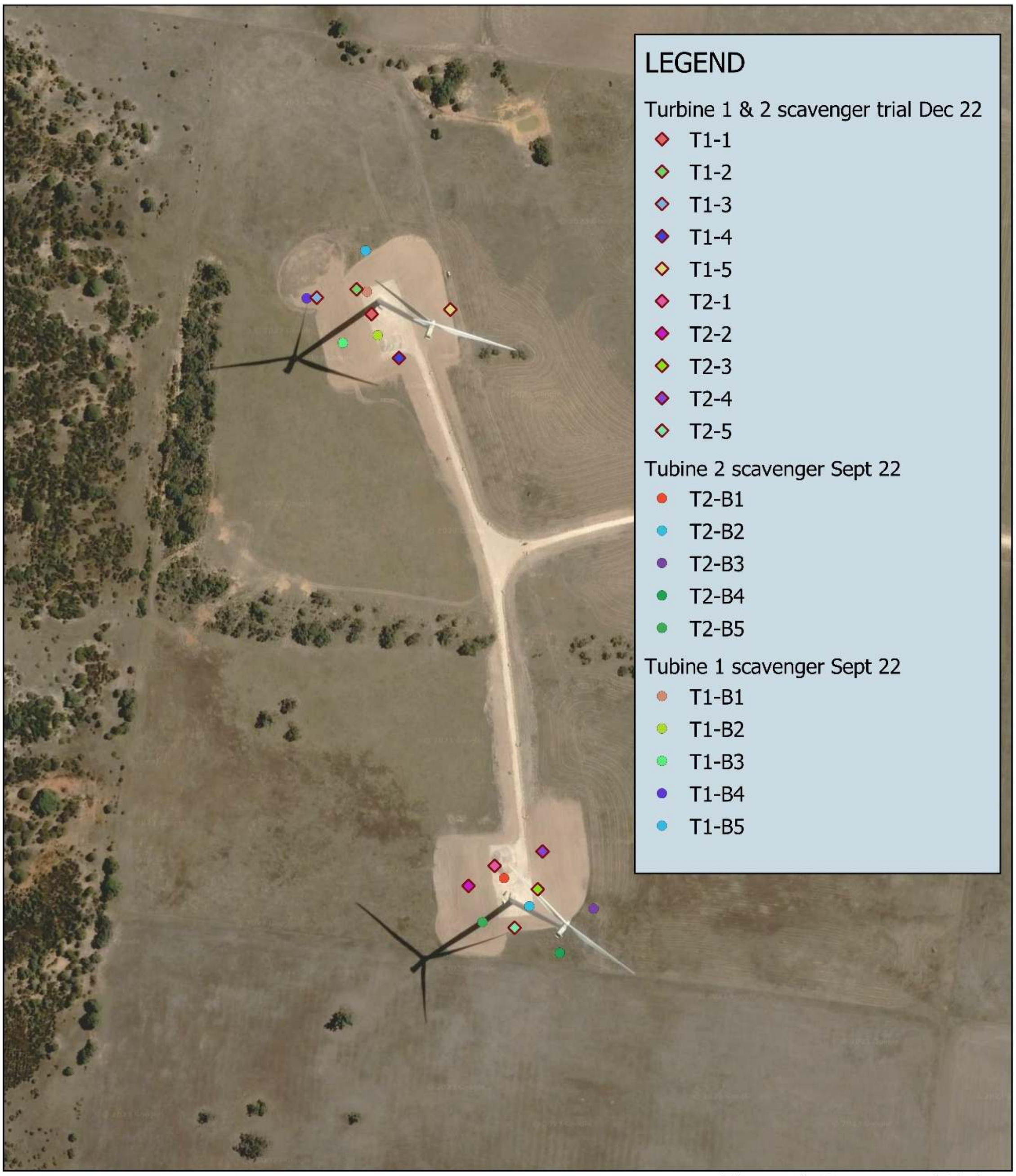
3.2 Scavenger Trials

The scavenger trials were conducted over two seasons, (Spring, October 2022 and, Summer, December 2022 /January 2023), to account for any variances in site conditions, (e.g., grazed and un-grazed pasture) and seasonal behaviour of scavengers.

The results of the scavenger trials varied between seasons, with carcasses taken quicker during the spring trials.

Carcasses remained for between 1 day and 13 days during spring. This is considered an artefact that predator activity was potentially greater post the lambing season. Figure 4 details where the carcasses were randomly placed for both the scavenger and searcher detectability trials.



0 100 200 m

Figure 4: Scavenger Trials

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3.2.1 Spring 2022

Carcass removal occurred over a period of 6-days. Refer to Table 6.

Table 6: Carcass removal during Spring.

TURBINE	SCAVENGER TYPE	GROUND TYPE	DAY REMOVED	SCAVENGER DATE
1	Southern Freetail Bat	Hardstand	2	19/09/2022
1	Galah	Hardstand	7	24/09/2022
1	Nankeen Kestrel	Paddock	1	18/09/2022
1	Lapwing	Paddock	7	24/09/2022
1	Southern Freetail Bat	Paddock	7	24/09/2022
2	Welcome Swallow	Hardstand	1	18/09/2022
2	Southern Freetail Bat	Hardstand	13	30/09/2022
2	Musk Lorikeet	Paddock	13	30/09/2022
2	White-striped Freetail bat	Paddock	1	18/09/2022
2	Nankeen Kestrel	Paddock	1	18/09/2022

3.2.2 Summer 2022 / 2023

All carcass remained for the duration of the 30-days. Refer to Table 7.

Table 7: Carcass removal during Summer.

TURBINE	SCAVENGER TYPE	GROUND TYPE	DAY REMOVED	SCAVENGER DATE
1	White-striped Freetail Bat	Hardstand	Removed at end of trial	Not applicable
1	Long-billed Corella	Paddock	Removed at end of trial	Not applicable
1	White-striped Freetail Bat	Paddock	Removed at end of trial	Not applicable
1	Magpie	Paddock	Removed at end of trial	Not applicable
1	Magpie	Paddock	Removed at end of trial	Not applicable
2	White-striped Freetail Bat	Hardstand	Removed at end of trial	Not applicable
2	White-striped Freetail Bat	Paddock	Removed at end of trial	Not applicable
2	Barn Owl	Paddock	Removed at end of trial	Not applicable
2	Magpie	Paddock	Removed at end of trial	Not applicable
2	Magpie	Paddock	Removed at end of trial	Not applicable

3.3 Searcher Detectability Trials 2022 / 2023

The searcher detectability trials were conducted over two seasons in 2022 to account for any variances in site conditions, (e.g., growing of pasture, grazed pasture, seasonal conditions) and seasonal behaviour of scavengers (refer to Figure 5). Seventeen of the 20 carcasses (85%) were found.

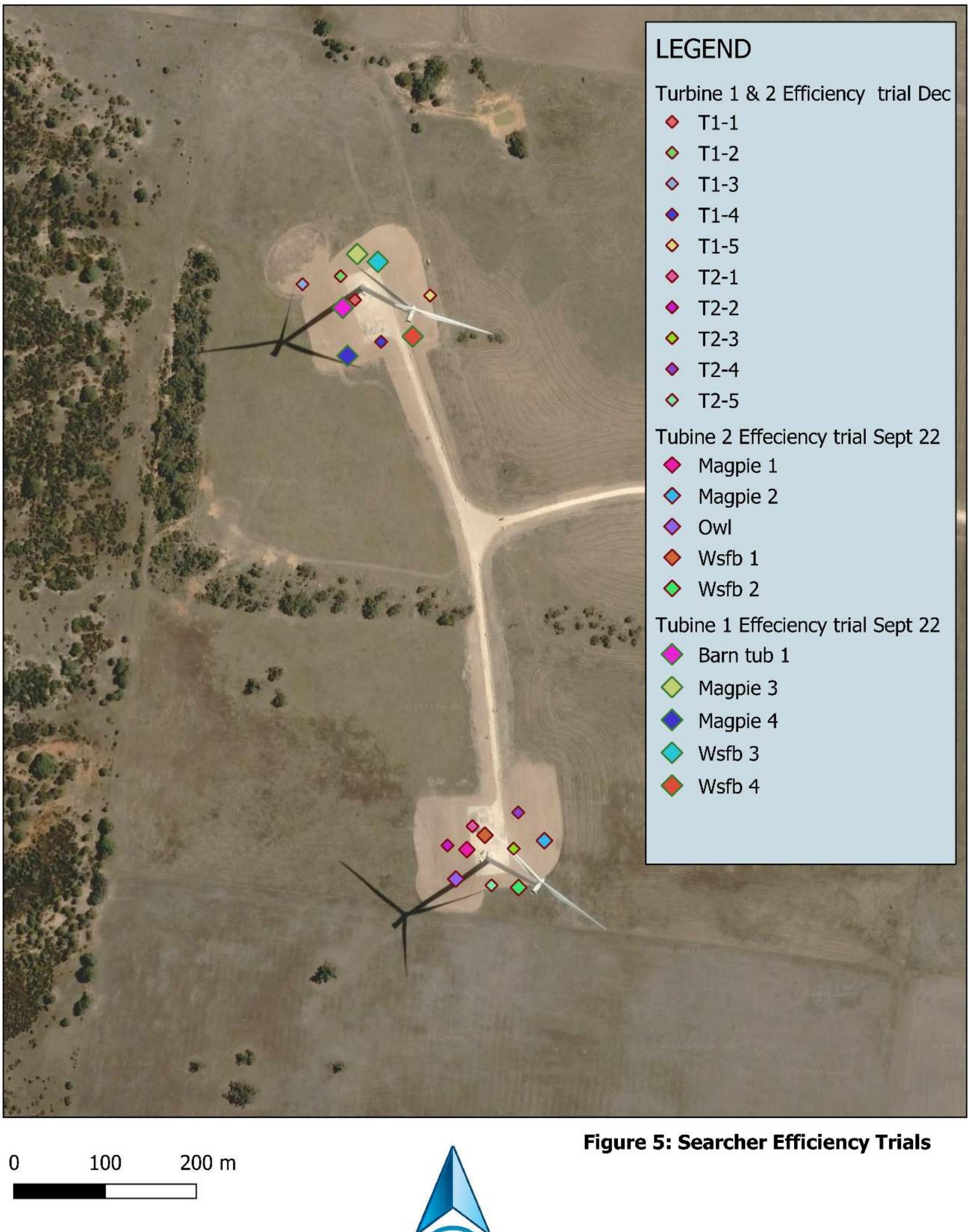

Figure 5: Searcher Efficiency Trials

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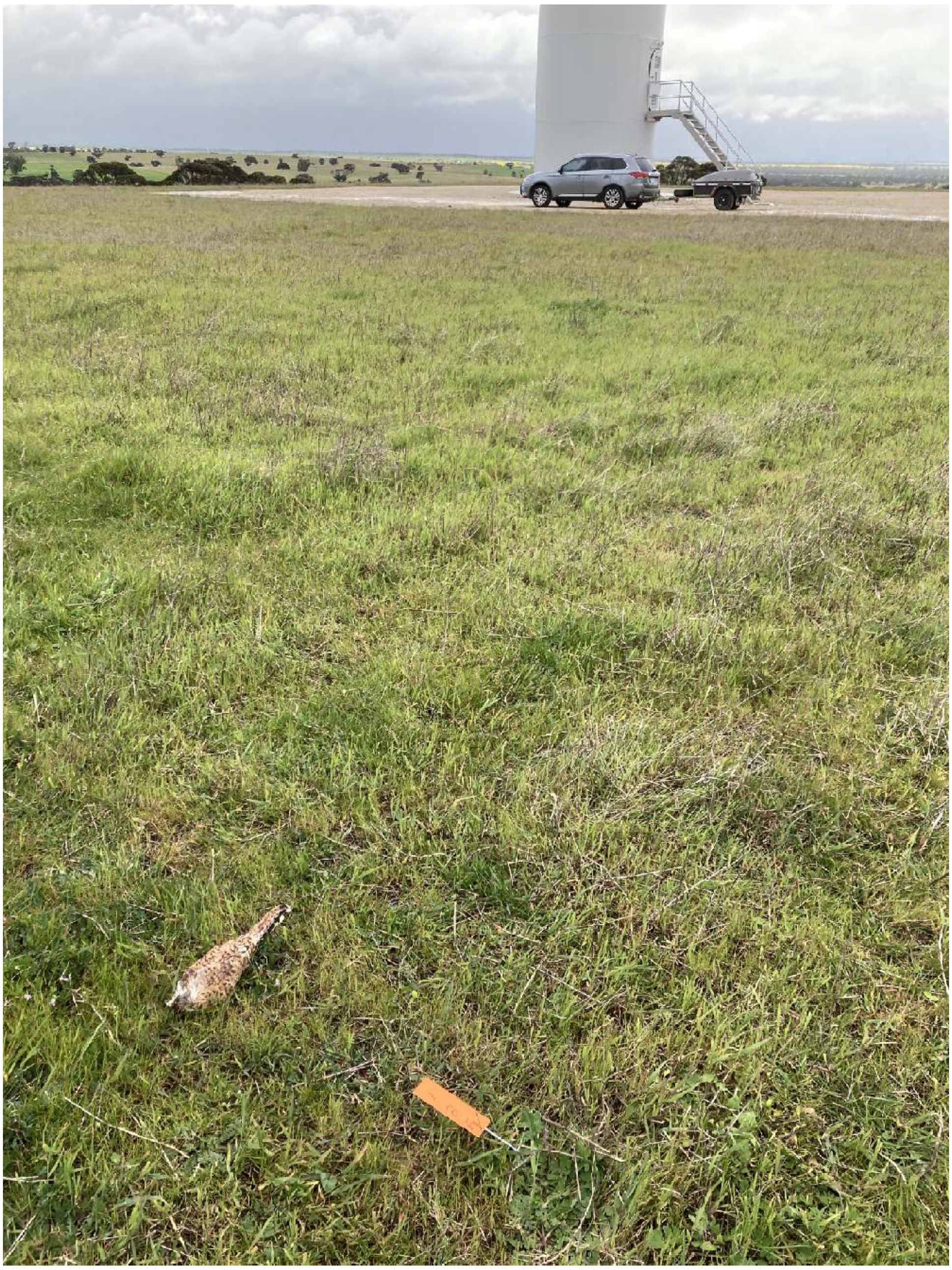
3.3.1 Spring

The ground conditions during the spring trials were different compared to the summer trials. The height of vegetation was approx., 10-15cm with new growth prominent. Carcasses contrasted with the vegetation (refer to photograph 1). The searcher found 9 of the 10 carcasses during the spring trials, one microbat was not found.



Photograph 1: Typical of ground conditions during spring scavenger and detectability trials.

3.3.2 Summer

Pasture and silage had established and was starting to dry off since the spring trials making carcasses slightly harder to find (refer to photograph 2). The searcher found 8 of the 10 carcasses during the summer trials, two microbats were not found.

Photograph 2: Typical of groundcover present during summer scavenger and detectability trials.

The results of the 2022 scavenger and searcher efficiency trials were used for the collision modelling as per the endorsed BAM Plan, (refer sections 2.2 & 2.3, EcoAerial 2019). The results of the scavenger and searcher efficiency trials are provided in Attachment A & B.

4 Discussion

The findings of the carcasses search, searcher detectability, scavenger trials and collision risk monitoring are discussed below.

4.1 Species Significance of Turbine Collision

Six microbats; four southern freetail bats, (3 males and 1 female), two white-striped freetail bats (2 male) and, one bird carcass; brown falcon was considered to have been killed because of turbine collision. None of these are listed threatened species.

The five incidents were recorded whilst undertaking the formal carcass searches. Three southern freetail bats were found at Turbine 2 and, one at Turbine 1. The two white-striped freetail bats were found at Turbine 1, the brown falcon was found at Turbine 2.

We note that in the days prior to a bat carcass being found, there were periods during the night of relatively low wind speed (refer to Table 2). A wind speed above the feathering of the blades, i.e., 3m/s and below 9m/s occurs is within the flight speed of southern freetail bat, approx. 8.1m/s, and white-striped freetail bat, approx. 8.3m/s, (Bullen and McKenzie 2016). There were few instances when the turbines were feathered to reduce the risk of collision.

4.2 Collision Risk Modelling

The collision risk modelling was undertaken by Symbolix Pty Ltd. The estimated median mortality rate was calculated to be 11 bats, 5.5 mortalities per turbine and 2 birds, 1 mortality per turbine, for the 12-month monitoring period. A copy of the Collison Risk Modelling report is provided in Attachment D.

4.2.1 Collision Risk Compared to Other Wind Farms

The annual collision risk per turbine was not able to be calculated so the average was applied for the two turbines. This is an artefact of the low number of carcass found at turbines and it is not statistically justified to make comparisons (Symbolix 2020). There is limited publicly available data for a comparable wind farm (i.e., two turbines in western Victoria).

A review by Moloney et al (2019) and a detailed assessment undertaken by Symbolix (2020) have been used for comparison. The authors acknowledge the limitation of both studies because of the potential lack of consistency with the carcass search method deployed.

The Symbolix data is based on 5,432 surveys covering an area of 147^2km comprising 428 bats and 355 bird carcasses. Symbolix estimated the median turbine collision for bats as 9.25 per turbine per year in south-western / western Victoria.

Moloney et al (2019) estimated a higher median collision per turbine rate of approx. 13 bats per turbine with the white-striped freetail bat alone constituting 6 deaths per turbine annually. The median number of mortalities at Diapur Wind Farm for the 2022 monitoring period is nearly half the Symbolix estimates and considerably lower than Moloney et al (2019) estimates. The median number of bird collisions is also below the Moloney et al (2019) and Symbolix (2020) estimates.

Gration's (unpublished) analysis of bat call characteristics of bats most prevalent in turbine collisions found that 91% of collisions are bats with a call frequency of 35kHz or less. This is consistent with studies undertaken overseas by Weller and Baldwin (2012).

Bats with a pulse duration of between 7.5ms and 12ms, wavelength between 9.5mm and 28.5mm and inter-pulse duration of between 118ms and 715ms are at greater risk e.g., white-striped freetail bat and southern freetail bat (Gration unpublished).

The collision results at DWF are below the median estimates of collision rates for both birds and bats as described in Maloney et al (2017) and Symbolix (2020).

4.3 Mitigation Measures to Reduce Risk

4.3.1 Carrion Removal

The Diapur property is mixed agricultural property with the main activities being the production of sheep and crops. The landowner has not been required to remove any carrion nor was there the need for carrion stockpiles or pits.

While there is no longer any site personal on the property, the landowner continues to keep an eye out for carrion whilst undertaking farming activities. Rabbit warrens are not present on the property and there has not been the need for a baiting or warren ripping program. Fox baiting is undertaking prior to lambing each year, early autumn.

4.3.2 Additional Mitigation Measures

None of the additional mitigation measures outlined in the BAM Plan has been required. Feeding of stock is confined to pasture and silage grown and bailed on-site. There are not any lights within proximity to the turbines. Only working animals are present within the operational area of the farm and they are locked up when not working.

Supplementary Mitigation Measures

To date, there have not been any impact triggers requiring the implementation of supplementary mitigation measures. It is acknowledged that should there be any evidence of any impact triggers, one or more of the supplementary mitigation measures may require implementation.

4.3.3 Further Reporting of Incidental Carcasses

The landowners are aware that should they find any incidental carcasses on their property that they are to contact the new owners, Diapur Wind Farm Pty Ltd representative, Jason Wang. Any carcasses are to be handled with gloves, put into a bag, and placed in a freezer.

The Diapur Wind Farm Pty Ltd representative will contact EcoAerials Director, Rob Gration, who will organise for the carcass to be collected. A report will be prepared for DEECA, as per the BAM Plan requirements, outlining if any further mitigation measures will be implemented.

4.4 Conclusion

The collision results indicate that bats and birds are flying at Rotor Swept Area (RSA) height, albeit what appears to be at low activity levels. The estimated collision rates for birds and bats at Diapur is lower than wind farm collision results analysed by Maloney et al, (2019) and Symbolix (2020).

4.5 Monitoring results in relation to the BAM Plan Objectives

The objective of the analysis of these combined attributes is to answer the following:

1. Is operation of the wind farm resulting in indirect impacts on bird and bat significant at a regional, state or national level, or if listed species where affected.
    - There were no incidents with any EPBC Act or FFG Act listed species. Whilst it cannot be confirmed there are no indirect impacts, the results of the collision risk modelling provide an indication of likely site use. Activity is likely to be confined to vegetation patches to the west and south of the turbines. Commuting between these patches takes birds and bats south of the turbines.
2. Is the level of mortality ecologically significant?
    - The median mortality rate is estimated to be 5.5 bats and 1 bird per turbine annually. This is considerably lower than estimates at other wind farms across Victoria (Maloney et al, 2019; Symbolix, 2020). Therefore, it is considered the mortality rates are not ecologically significant.
3. Is the continuation of the monitoring warranted and if so, in what form?
    - Whilst the collision modelling indicates the site is of low risk to birds and bats, the monitoring was undertaken during La Nina conditions. Whilst the Bureau of Meteorology modelling indicates we are currently in a neutral phase, they are predicting the likely return of El Nino later this year. On that basis the current monitoring regime should continue to see if there are changes in mortality rates as result of climatic changes.
4. Is there a change in collision rates between unlit and lit turbines, if applicable?
    - Due to the low number of incidents (7), and both turbines are lit, it was not statistically possible to access any variation of mortalities.
5. Describe any recommendations for reducing mortality through turbine strike.
    - Based on the low number of estimated turbine collisions, there are no supplementary mitigation measures likely to reduce mortality further.

The results of the first year of post construction monitoring indicates that the risk to bats and birds is considerably lower when compared than other wind farms in Victoria and therefore consider a low-risk site.

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Attachment A- Scavenger Trials - 2022

TRIAL_START_DATE	TRIAL_START_TIME	TURBINE	SPECIES	SCAVENGE_SPECIES_TYPE	SCAVENGE_CARCASS_ID	GROUND_TYPE	COMMENTS	INTERVAL1	INTERVAL2
17/09/2022	9:15:00	1	Ozimp sp	bat	T1-B1	Hardstand		18/09/2022 8:00	19/09/2022 8:00
17/09/2022	9:15:00	1	Galah	bird	T1-B2	Hardstand		23/09/2022 8:00	24/09/2022 8:15
17/09/2022	9:15:00	1	Kestral	bird	T1-B3	Paddock		17/09/2022 16:42	18/09/2022 8:00
17/09/2022	9:15:00	1	Lapwing	bird	T1-B4	Paddock		23/09/2022 16:42	24/09/2022 8:15
17/09/2022	9:15:00	1	Ozimp sp	bat	T1-B5	Paddock		23/09/2022 17:15	24/09/2022 8:15
17/09/2022	11:15:00	2	Swallow	bird	T2-B1	Hardstand		17/09/2022 16:42	18/09/2022 7:00
17/09/2022	11:15:00	2	Ozimp sp	bat	T2-B2	Hardstand		24/09/2022 16:15	30/09/2022 17:30
17/09/2022	11:15:00	2	Musk Lorikeet	bird	T2-B3	Paddock		20/09/2022 16:15	21/09/2022 7:30
17/09/2022	11:15:00	2	WsFB	bat	T2-B4	Paddock		24/09/2022 16:15	30/09/2022 17:30
17/09/2022	11:15:00	2	Kestral	bird	T2-B5	Paddock		24/09/2022 16:15	30/09/2022 17:30
19/12/2022	10:15:00	1	WsFB	bat	T1-B1	Hardstand		21/01/2023 17:00	
19/12/2022	10:15:00	1	LB Corella	bird	T1-B2	Paddock		21/01/2023 17:00	
19/12/2022	10:15:00	1	WsFB	bat	T1-B3	Paddock		21/01/2023 17:00	
19/12/2022	10:15:00	1	Magpie	bird	T1-B4	Paddock		21/01/2023 17:00	
19/12/2022	10:15:00	1	Magpie	bird	T1-B5	Paddock		21/01/2023 17:00	
19/12/2022	8:00:00	2	WsFB	bat	T2-B1	Hardstand		21/01/2023 17:00	
19/12/2022	8:00:00	2	WsFB	bat	T2-B2	Paddock		21/01/2023 17:00	
19/12/2022	8:00:00	2	Barn Owl	bird	T2-B3	Paddock		21/01/2023 17:00	
19/12/2022	8:00:00	2	Magpie	bird	T2-B4	Paddock		21/01/2023 17:00	
19/12/2022	8:00:00	2	Magpie	bird	T2-B5	Paddock		21/01/2023 17:00	

Attachment B- Searcher Detectability Trials - 2022

TURBINE	OBSERVER	OBSERVER_TYPE	GROUND_TYPE	SPECIES	DETECT_SPECIES_TYPE	DETECT_CARCASS_ID	DISTANCE_M	FOUND	COMMENTS
1	James Booth	Human	Pasture	Magpie	Bird	TD1	38	1	WsFB= white-striped freetail bat
1	James Booth	Human	Pasture	Magpie	Bird	TD2	74	1	
1	James Booth	Human	Pasture	Barn Owl	Bird	TD3	30	1	
1	James Booth	Human	Pasture	WsFB	Bat	TD4	34	1	WsFB= white-striped freetail bat
1	James Booth	Human	Pasture	GWB	Bat	TD5	77	0	GWB= Gould's Wattled bat
2	James Booth	Human	Pasture	Magpie	Bird	TD6	25	1	
2	James Booth	Human	Pasture	Magpie	Bird	TD7	65	1	
2	James Booth	Human	Pasture	Barn Owl	Bird	TD8	42	1	
2	James Booth	Human	Hardstand	WsFB	Bat	TD9	27	1	WsFB= white-striped freetail bat
2	James Booth	Human	Pasture	WsFB	Bat	TD10	46	1	WsFB= white-striped freetail bat
1	James Booth	Human	Hardstand	WsFB	bat	FE1	8	1	WsFB= white-striped freetail bat
1	James Booth	Human	Pasture	LB Corella	bird	FE2	36	1	
1	James Booth	Human	Pasture	WsFB	bat	FE3	56	0	WsFB= white-striped freetail bat
1	James Booth	Human	Pasture	Magpie	bird	FE4	57	1	
1	James Booth	Human	Pasture	Magpie	bird	FE5	57	1	
2	James Booth	Human	Hardstand	WsFB	bat	FE6	57	0	WsFB= white-striped freetail bat
2	James Booth	Human	Pasture	WsFB	bat	FE7	57	1	WsFB= white-striped freetail bat
2	James Booth	Human	Pasture	Barn Owl	bird	FE8	57	1	
2	James Booth	Human	Pasture	Magpie	bird	FE9	57	1	
2	James Booth	Human	Pasture	Magpie	bird	FE10	60	1	

Attachment C – Carcass Search Finds

SURVEY_ID	CARCASS_ID	FORMAL	TURBINE	SPECIES	SPECIES_TYPE	DISTANCE_M
2D	OZISP2	1	2	Ozimops sp	Bat	60
2D	BFALC1	1	2	Brown falcon	Bird	70
1F	OZISP3	1	1	Ozimops sp	Bat	11
3MA	OZISP4	1	2	Ozimops sp	Bat	40
4JUL	OZISP5	1	2	Ozimops sp	Bat	60
1O	WsFB1	1	1	White-striped Freetail Bat	Bat	70
1O	WsFB2	1	1	White-striped Freetail Bat	Bat	24

Attachment D – Collision Risk Report - Symbolix

Diapur Wind Farm Mortality Estimate - Year 1

Prepared for EcoAerial, 7 Feburary 2023, Ver. 1.1

This report outlines an analysis of the mortality data collected at Diapur Wind Farm from 18/12/2021 to 21/11/2022. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in October 2022 and December 2022
- Scavenger loss rates – consisting of trials in September 2022 and December 2022
- Mortality estimates - based on monthly surveys at 2 turbines, from 18/12/2021 to 21/11/2022

1 Available data

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

Turbine parameter data (rotor diameter and height) was provided by EcoAerial.

Species archetype data was taken from Hull and Muir (2010).

2 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 method to achieve this.

Best practice (M. M. Huso 2011) requires an estimator of the form:

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \tag{1}$$

where

- $\hat{M}_{ij}$ is the estimated mortalities at turbine i during search j

- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i r_{ij} p_{ij} \tag{2}$$

- a_i is the fraction of total carcasses within the searched area (note this is *not* the same as the fraction of area searched)
- r_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j
- p_{ij} is the probability that an existing carcass will be detected by the searcher

The following sections outline how we estimate $\hat{\mathbf{a}}$, $\hat{\mathbf{r}}$ and $\hat{\mathbf{p}}$. C is given by the field observation data.

Our final task is to estimate $\hat{M}$ for each group of turbines and species.

One limitation of analytical methods is estimating r_{ij} when the time between surveys is not constant. In Australia, it is common for the time between searches to vary due to seasonal changes in effort or the use of a pulsed design in which the turbine is searched monthly with a return visit a few days later.

To allow for survey protocols with non-standard intervals, we developed a Monte Carlo algorithm. We have used this method for annual estimates at over a dozen wind farms in Australia to date.

Monte Carlo methods (Sawilowsky (2003), Ripley (1987)) simulate a large set of possible survey results, by simulating the actual sampling protocol and sampling from the empirical distributions for scavenge loss and searcher efficiency. In this way, we can directly sample the probability a carcass was lost before the survey, negating the need to calculate r_{ij} analytically each time.

We can then estimate how many carcasses were truly in the field, given the range of searcher and scavenger efficiencies, 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 (M. M. 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).

Figure 1 provides an overview of the methodology. A detailed explanation can be found in Stark and Muir (2020).

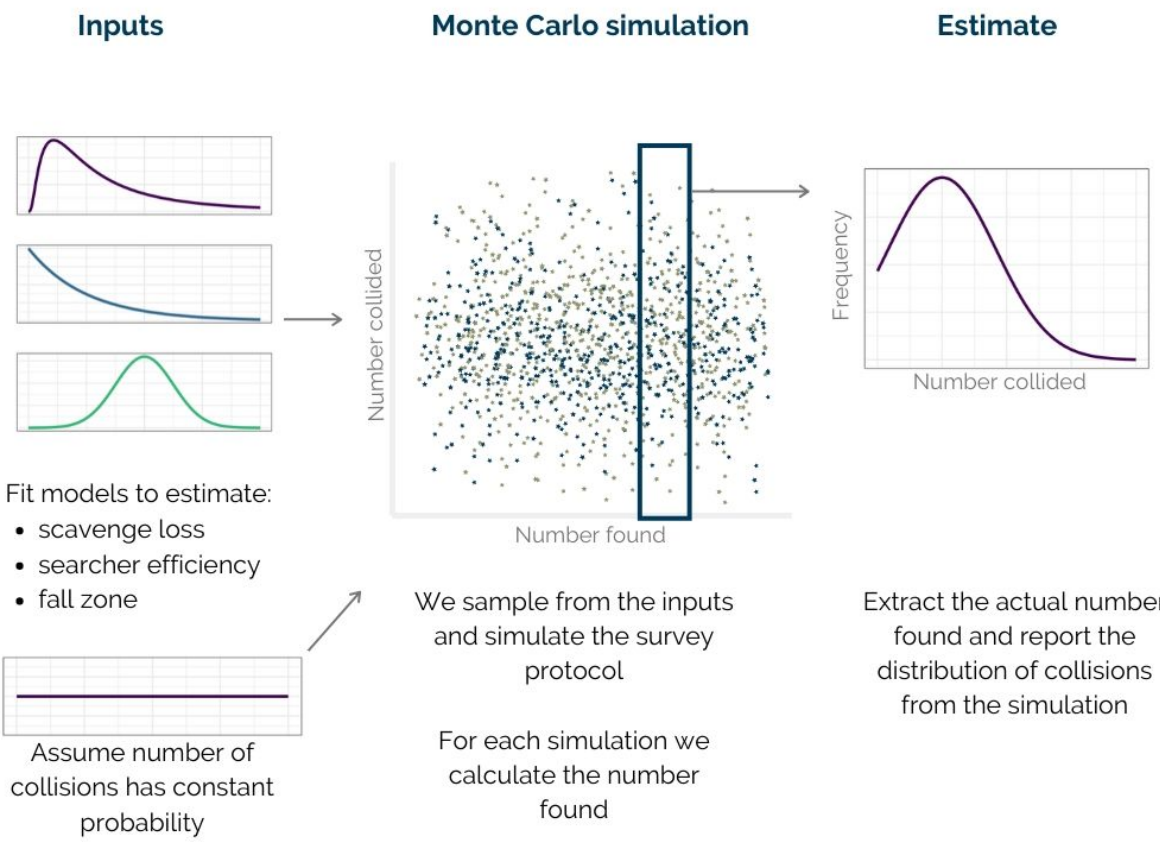

Figure 1: Overview of how the mortality estimation works.

3 Analysis and modelling

The survey program consisted of carcass searches, and adjunct scavenger and detection trials. We summarise the methods, field data and analysis results for each below.

3.1 Carcass search data

Carcass searches were undertaken monthly at each turbine site to a 75m radius from the turbine tower. An ecologist walked concentric transects around each turbine tower at four metre intervals.

A pulse search method was also employed, whereby a second carcass search was undertaken two days following each primary search.

The carcass searches provide the C term of Equation (1).

3.1.1 Survey effort

The mortality estimate was based on a dated list of turbine surveys. The survey frequency is summarised in Table 1. Both turbines were surveyed twice each month out to 75m, with one standard and one pulse survey being conducted.

Table 1: Number of surveys per month.

Date	Standard	Pulse
2021 Dec	2	2
2022 Jan	2	2
2022 Feb	2	2
2022 Mar	2	2
2022 May	2	2
2022 Jun	2	2
2022 Jul	2	2
2022 Aug	2	2
2022 Sep	2	2
2022 Oct	2	2
2022 Nov	2	2

3.1.2 Carcass finds

The breakdown of found carcasses per species are summarised in Table 2.

Table 2: Carcasses found during formal surveys over one year.

Species	Bat	Bird
Brown falcon		1
Ozimops sp	4	
White-striped Freetail Bat	2	

3.2 Searcher efficiency

The aim of searcher efficiency trials is to quantify the effectiveness of observers, at finding carcasses. They provide the p term in Equation (2).

3.2.1 Methods

The searcher efficiency data is sourced from trials conducted through the survey period. Carcasses were laid out, and an ecologist searched for the carcasses using the same protocol as the main mortality survey.

If the carcass was found, “success” was recorded, else “failure” was the ecologist missing the carcass.

We estimated searcher efficiency by fitting binomial generalised linear models (GLMs). The optimal model was determined, guided by the small-sample Akaike Information Criterion (Anderson and Burnham 2004), otherwise known as the AICc.

3.2.1.1 AIC model selection The theory of AIC is deep and complex, and beyond the scope of this report. However, to summarise, AIC is a method for choosing the best approximating model of the “truth”. For each model we fit to the data, we calculate the AIC. We compare the differences in AIC between models, which in turn informs us of the weight of evidence for that particular model.

AIC is not the same as significance testing. We do not aim to state anything is significant at the 5% level, instead we aim to find a good model fit for the data. Additionally, we also consider two other principles guiding model selection. They are parsimony (a simpler model is preferable to a more complex model), and application (for example, it’s all well and good to find that cloud cover affects detection rates, but it’s not feasible to incorporate cloud cover into a mortality estimate).

AICc is a modification of AIC, which is appropriate for smaller sample sizes.

3.2.2 Results

Searcher efficiency trials were conducted in October 2022 and December 2022 (Table 3).

The detectability trials used both bird (12 replicates) and bat (8 replicates) carcasses (Table 4).

Table 3: Number of trials conducted on each detection survey date.

Date	Number of trials
22/10/2022	10
19/12/2022	10

Table 4: Species used during the detection surveys.

Species	Number of records
Magpie	8
Barn Owl	3
White-striped Freetail Bat	7
Gould's Wattled bat	1
LB Corella	1

The top model according to AICc selection was the one which split by species type (bat/bird).

Table 5: Detection efficiencies for birds and bats.

Variable	Birds	Bats
Number found	12	5
Number placed	12	8
Mean detectability proportion	1	0.62
Detectability lower bound (95% confidence interval)	0.74	0.24
Detectability upper bound (95% confidence interval)	1	0.91

Detectability for birds is 100%, with a 95% confidence interval of [74%, 100%]. For bats, it's 62%, with a 95% confidence interval of [24%, 91%].

3.3 Scavenger efficiency

In order to accurately estimate mortality, we must account for carcass loss to scavengers. Scavenger trials are performed to quantify the time until a carcass is completely lost as a result of scavenger activity, which is the r term in (2).

Trials used human checks at regular intervals in order to determine approximate timing of scavenger events.

We note that, due to hot weather in the summer trial and the resulting desiccation of carcasses, that all 10 carcasses in the December 2022 trial remained unscavenged after 30 days (the trial end).

3.3.1 Methods

Survival analysis (Kaplan and Meier (1958), Kalbfleisch and Prentice (2011)) was used to determine the distribution of time until complete loss from scavenge. Survival analysis was required to account for the fact that we do not necessarily know the exact time of scavenge loss, only an interval in which the scavenge event happened. For example, any carcass which is unscavenged at the end of the trial, has its scavenge event in the interval $[x, \infty]$ (where x is the length of the trial).

By performing survival analysis we can estimate the time until carcass loss after a given length of time, despite these unknowns.

We fit parameterised models to analyse significant factors influencing time to scavenge (carcass species type etc), and to find the most appropriate distribution to fit the time-to-loss curve (e.g. log-normal, exponential).

Time to carcass loss is influenced by the parameters discussed above and the distribution of the loss curve we fit to the data (M. M. P. Huso, Dalthorp, and Korner-Nievergelt 2015). The choice of loss function is important because it should capture the behaviours and relative time dependence of the various scavengers. Generally, the best distribution is the log-normal distribution (Stark and Muir 2020).

3.3.2 Results

Scavenger efficiency trials were conducted in September 2022 and December 2022 (Table 6). The trials ran over 30 days. In total, 12 bird carcasses, and 8 bat carcasses, were used (Table 7).

Table 6: Scavenger trial timing.

Month	Number of trials
2022 September	10
2022 December	10

Table 7: Species types for scavenger trials.

Species type	Number of records
bat	8
bird	12

AICc selection suggested the model which best describes the data is the one that combines birds and bats.

In this case, the exponential and log-normal distribution gave similar results. We picked the log-normal model due to the evidence for this distribution in Stark and Muir (2020).

Figure 2 shows a survival curve fitted to the bat/bird combined cohort. The survival curve (smooth solid line for fitted, step function for empirical) shows the estimated proportion of the set remaining at any given time. The shaded portions are the 95% confidence intervals on the estimate.

Under these assumptions, the median time to total loss via scavenge is 27.6 days, with a 95% confidence window of [7.5, 100.7] days for bats/birds combined.

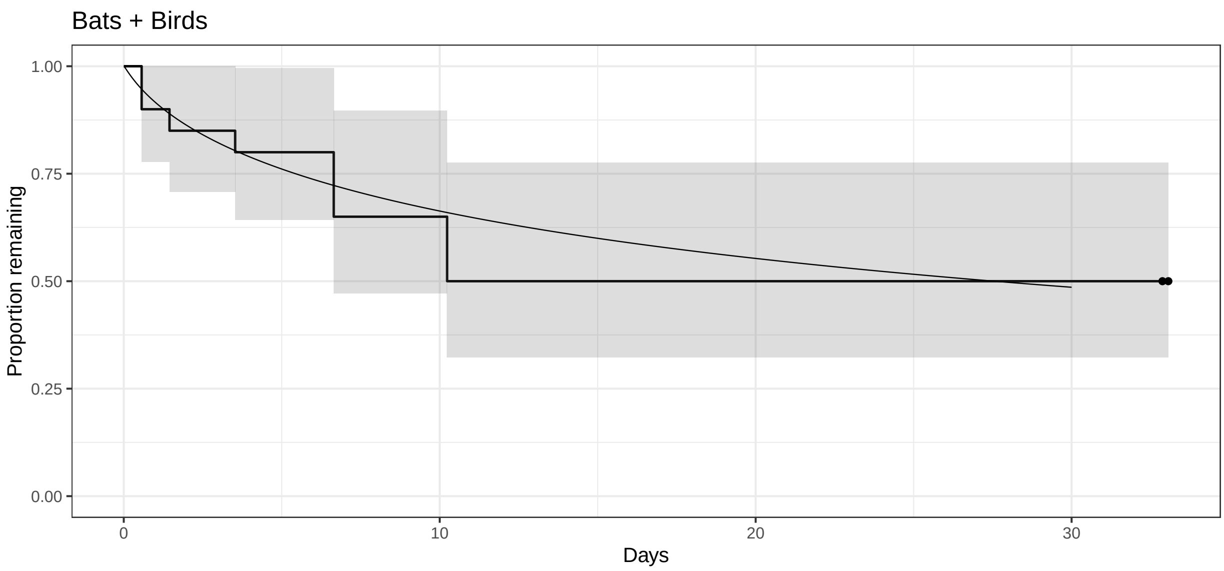

Figure 2: Empirical survival curves (the step function), with 95% confidence interval shaded. The smooth curves presents the fitted model.

3.4 Proportion of turbines searched

100% (of two total) turbines were searched at Diapur. In the Monte Carlo algorithm, we explicitly simulate the survey design. The proportion of turbines sampled is therefore explicitly accounted for in the simulation.

3.5 Coverage factor

The coverage factor estimates the probability that, given a carcass falls at a searched turbine, that the carcass falls within the searched area. This contributes to the a term in Equation (2)

3.5.1 Methods

We generated a carcass fall-zone distribution for each species class, given the turbine size at the wind farm. The percentage of the fall zone not covered by the survey area, provides a correction factor in the mortality estimate. Because carcasses that fall outside the searched area have a zero probability of being detected by a survey, the likelihood of landing in this region is essential to understanding the relationship between detections and actual losses.

The fall-zone estimate is the end result of the calculation detailed in Hull and Muir (2010).

3.5.2 Results

Table 8 displays the dimensions and RPM of the turbines at Diapur Wind Farm, while Table 9 shows the bird physical parameters used. These are input into the fall zone simulation.

Table 8: Turbine specifications for the wind farm.

Rotor Diameter (m)	Tower Height (m)	RPM
150	125	12

Table 9: Bird archetype parameters.

Species type	Archetype	Mass (kg)	Min. area (sq m)	Max. area (sq m)
Bat	Gould's Wattled Bat	0.014	0.0028	0.014
Bird	Raven	0.680	0.0450	0.100

Figure 3 displays the simulation results for birds and bats, given the factors specified above. We display the cumulative density function (CDF) on the y axis versus the distance from turbine (x axis). for each species type. The CDF describes the expected proportion of carcass which fall less than or equal to a certain distance from the turbine. For example, we see that we expect about 93% of Bat carcasses to fall within 75m of the turbine.

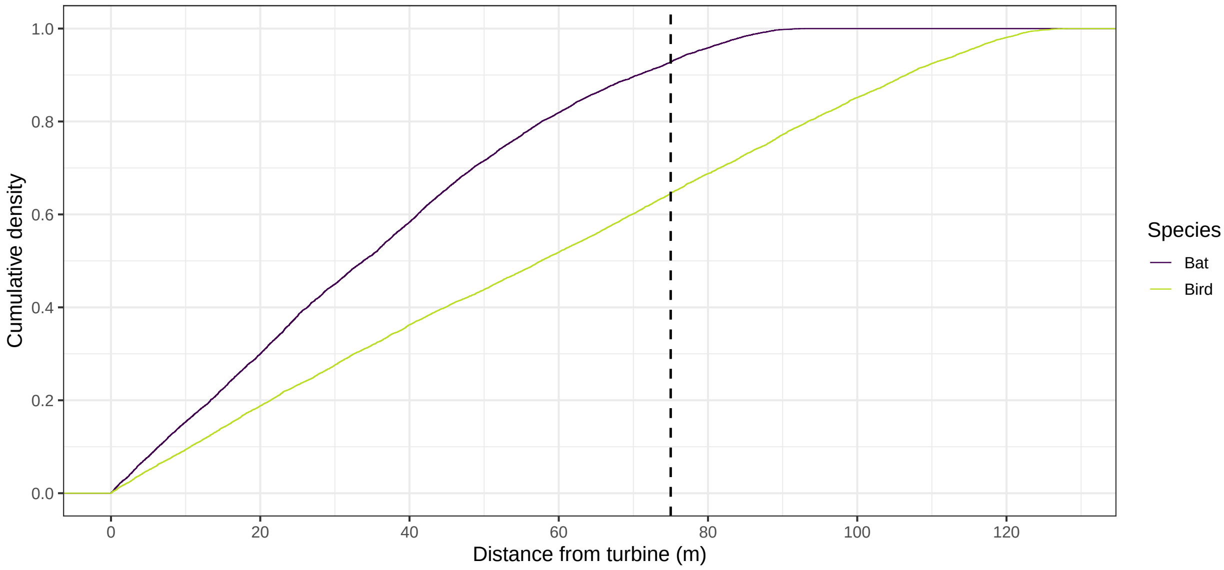

Figure 3: Cumulative distribution function of the fall zone simulation output for birds and bats. Vertical lines indicate relevant survey radii.

Once the fall zone distribution is calculated, we generate a “coverage factor” for each species type. The coverage factor represents the proportion of carcasses which fall within the searched area.

On average, we assume that 64% of bird strikes and 93% of bat strikes to land within the searched area.

4 Mortality estimate

With estimates for scavenge loss, searcher efficiency, and survey coverage, we then converted the number of bat and bird carcasses detected into an estimate of overall mortality at Diapur Wind Farm from 18/11/2021 to 21/11/2022 (we allow for collisions to occur up to a month prior to the first survey).

The mortality estimation is done via a Monte Carlo algorithm. We used 25000 simulations for bats, and 25000 for birds, 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 model assumptions are listed below:

- There were 2 turbines on site.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 1 for a summary).
- Mortalities were allowed to occur up to a month before the initial survey (18/12/2021) and until the final surveyed date (21/11/2022).
- Birds are on-site at all times during this period.
- Bats are on-site at all times during this period.
- Bats and birds that are struck are immediately replaced (i.e. strikes one day do not affect the chance of strikes the next).
- 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.
- 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 took scavenge loss and search efficiency rates as outlined above.
- We assumed a log-normal scavenge shape.
- 2 turbines were surveyed, and were searched out to a 75 metre radius, in accordance with the supplied survey data.
- The coverage factor was 93% for bats and 64'% for birds.

4.1 Bats

During the first year of surveys a total of 6 bats were found during formal surveys. The resulting (median) estimate of total mortality is 11 bats lost on site over the first year of monitoring.

Table 10 and Figure 4 display the percentiles of the distribution, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 11 bats over the survey period, and are 95% confident that fewer than 20 individuals were lost.

Table 10: Percentiles of estimated total bat losses over the first year.

0%	50% (median)	90%	95%	99%	99.9%
6	11	17	20	28	37

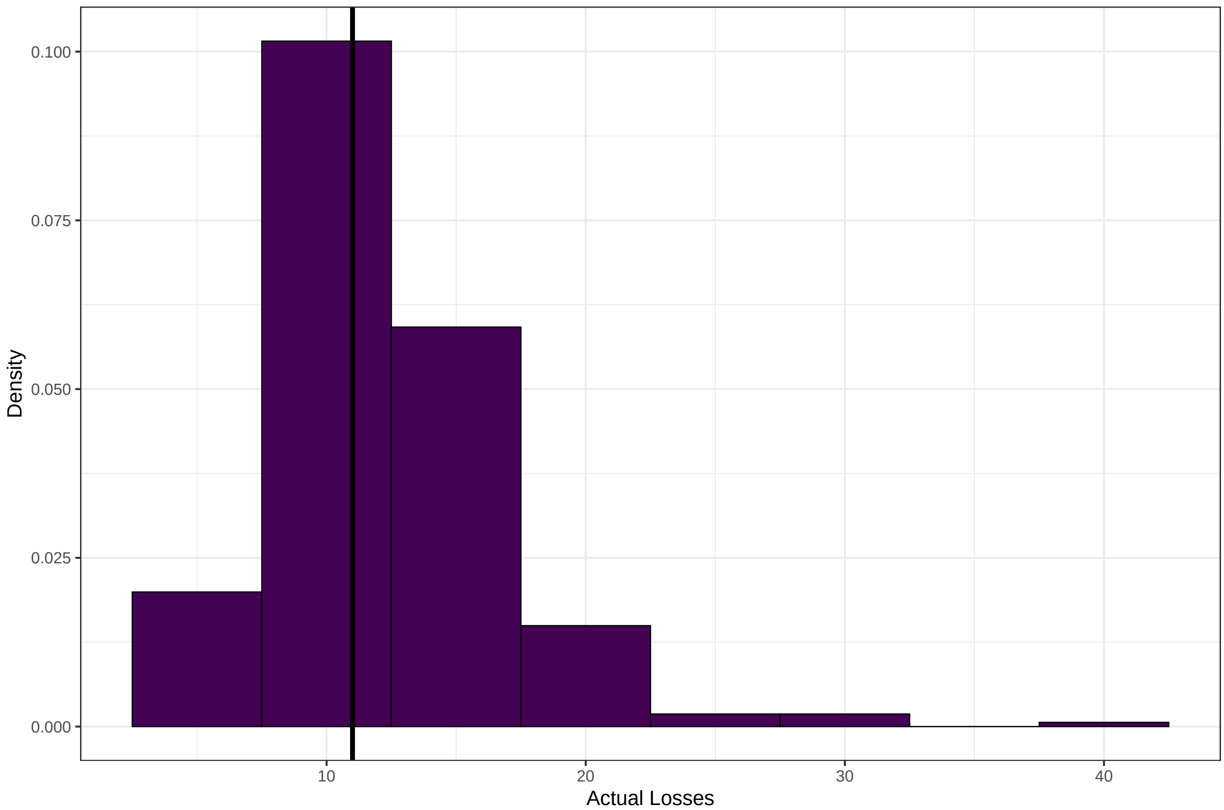

Figure 4: Histogram of the total losses distribution (bats), given 6 were detected on-site. The black solid line shows the median.

4.2 Birds

During the first year of surveys a total of 1 bird were found during formal surveys. The resulting (median) estimate of total mortality is 2 birds lost on site over the first year of monitoring.

Table 11 and Figure 5 display the percentiles of the distribution, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 2 birds over the survey

period, and are 95% confident that fewer than 6 individuals were lost.

Table 11: Percentiles of estimated total bird losses over the first year.

0%	50% (median)	90%	95%	99%	99.9%
1	2	5	6	10	12

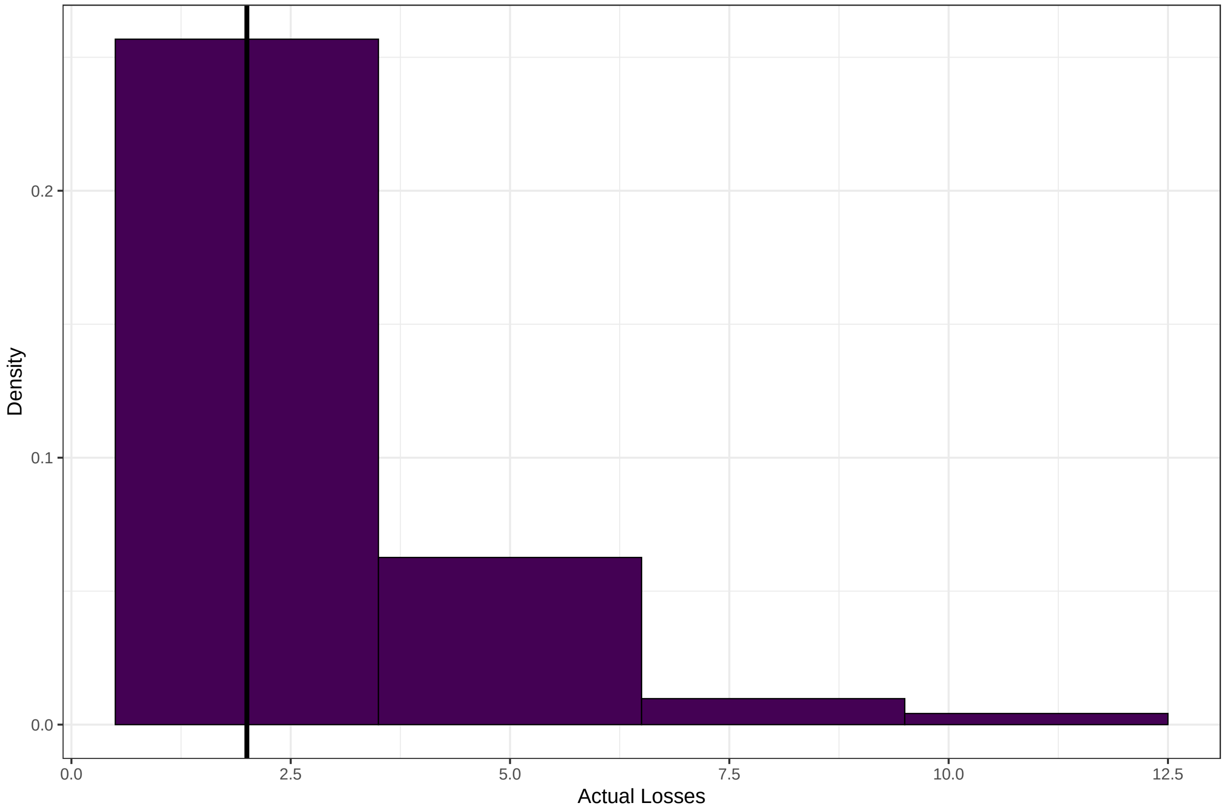

Figure 5: Histogram of the total losses distribution (birds), given 1 was detected on-site. The black solid line shows the median.

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