Ferguson Wind Farm Year 2 Post Construction Monitoring Report

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Contents Page number

Executive Summary

The Ferguson Wind Farm is located approximately 6.5 kilometres west of Kennedys Creek) and consists of three turbines, each with a maximum tip height of 200 metres and a minimum Rotor Swept Area (RSA) height of 64 metres (E&HP, 2019). Operational commissioning of Turbine 1 occurred in November 2020, with Turbines 2 and 3 becoming operational in April 2021.

The project area is on the northwest side of Princetown Rd between Turrong Rd (refer to Figure 1), and Boorook Rd. Land management consists of grazed pasture for beef production and areas used to grow silage (feed). The project area is slightly sloping with scattered farm dams and gully lines of mature remnant vegetation.

Ferguson Wind Farm Pty Ltd was required to implement an endorsed BAM Plan to meet the planning requirements of the minister for Planning. The scope of works focusses on a; "*mortality monitoring program to answer the following key questions through the completion of carcass searches, scavenger trials and detectability trials":*

1. *What is the estimated annual mortality rate?*
2. *What species are being impacted?*
3. *Is there seasonal variation in the number of microbat mortalities?*

(E&HP 2019)

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 60 metres of each turbine.

Four bats were found within the RSA and considered to have died because of turbine strike (refer to Figure 3). The collisions of four White-striped Freetail Bats (*Austronomous australis*) occurred in February 2022 triggering a non-conservation species incident report as per the BAM Plan requirements, Section 6.2.

The median bat mortality rates for the 2022 monitoring period were estimated to be 64 bats over the 12-month monitoring period, average of 21.3 mortalities per turbine.

Seven bat detectors were deployed to cover the peak roost movement period of Southern Bent-wing Bats in spring/early summer and late summer/early autumn. No Southern Bent-wing Bat calls were recorded over the two monitoring periods in 2022 or the two years of monitoring.

Bat activity varied depending on the proximity to suitable bat habitat i.e., water and native vegetation. Location 3 located on the edge of a large patch of native vegetation had the highest average of bat call activity per / night, autumn 78 calls per / night and spring 202 calls per / night.

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

1 Introduction

1.1 *Project Background*

The Ferguson Wind Farm was approved by the Victorian Minister for Planning on 12 April 2017. The wind energy facility is located approximately 6.5 kilometres west of Kennedys Creek) and consists of three turbines, each with a maximum tip height of 200 metres and a minimum Rotor Swept Area (RSA) height of 64 metres (E&HP, 2019). Operational commissioning of Turbine 1 occurred in November 2020, with Turbines 2 and 3 becoming operational in April 2021.

Ferguson Wind Farm Pty Ltd is required to implement an endorsed BAMP to meet the planning requirements of the minister for Planning.

1.2 *Bird and Bat Management Plan Objectives*

The key objectives as outlined in the BAM Plan (E&HP 2019) were to focus on a; "*mortality monitoring program to answer the following key questions through the completion of carcass searches, scavenger trials and detectability trials":*

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

Are Southern Bent-wing Bats using the wind farm area during peak migration periods, and if so,

- Are they flying at RSA height?
- How frequent is bat activity?
- Are all habitat types being utilised?

(E&HP 2019)

1.3 *Project Area*

The project area is on the northwest side of Princetown Rd between Turrong Rd and Boorook Rd, (refer to Figure 1). Land management of the project area consists of grazed pasture for beef production and areas used to grow silage. The project area is slightly sloping with scattered farm dams and gully lines of mature remnant vegetation.

1.4 *Acronyms*

Acronym	Description
BAM Plan	Bird and Avifauna Management Plan
CoA	Conditions of Approval
DEECA	Department of Energy, Environment and Climate Action
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

Figure 1: Ferguson Wind Farm

Drawn By; R. Gration
Date: 7/03/2022
Drawing No: 000410.Ver 1.2

2 Methods

2.1 Methodology

2.1.1 Field Assessment

The post construction monitoring commenced in December 2020 when Turbine 1 was commissioned for operation. Post construction monitoring commenced at Turbines 2 and 3 in April 2021 when they were commissioned for operation. This report covers the first 12-months of operation, December 2020 – November 2021

2.1.2 Carcass Searches

Monthly carcass searches were undertaken at each turbine site mid-month starting in December 2020. Carcass searches were completed for the 1st year of monitoring in November 2021. Carcass searches were undertaken for a total of 12 months. To reduce error and refine mortality estimates, a pulse search method was deployed 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 60 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 animals are found, DEWLP are notified within two days.

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

2.1.3 Scavenger Trials

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 (refer to Section 2.1.5) over the two monitoring periods. One element of the original method was replaced, the use of cameras.

The use of cameras on a working farm has inherent risks of failure due to disturbance / damage by stock and vehicles. Cameras also introduce a bias in the results due to scavengers associating a camera with a food source.

In place of cameras, the carcasses were checked by an ecologist. The changes to the method are shown below. The method used was developed after consultation with Symbolix, the company responsible for undertaking the mortality modelling.

The carcasses were checked twice a day for the first 3-days and then once every 2nd day up to day 11, once on day 14 then, once a day every 4-days thereafter until all carcasses were removed by scavengers or, the 30-day period was completed.

Two one-month scavenger trials were undertaken in the first year, one in spring (October 2021), and one in autumn (April 2021). A summary of the procedure is provided below:

- Three bat carcasses and surrogates (e.g., mice) were placed randomly within the 60-metre search area of each turbine for the Spring trials (14/4/2021-20/4/2021). Two surrogates and 1 bat were placed at each turbine. Surrogates were used for the Autumn trials (16/10/2021-16/11/2021) due to a lack of bat carcasses.
- Carcasses were checked as described above until they were removed by scavengers or at 30-days after placement.

2.1.4 Searcher Detectability Trials

Searcher detectability trials were undertaken in conjunction with the scavenger trials in the 1st year (refer to Attachment B). The efficiency trials, in conjunction with scavenger trials, were used to correlate mortality estimates. 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 and did not know the location of the carcasses. The searcher applied the same search method as intended for normal carcass searches.

2.1.5 Data Analysis

All results from carcass searches, detectability trials and scavenger trials and Southern Bent-wing Bat monitoring 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 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).

2.1.6 Southern Bent-Wing Bat Monitoring

The objective of the Southern Bent-wing Bat (SBwB) monitoring was to assess if Southern Bent-wing Bats are using the study site and if so, are they at RSA height and the extent of activity.

Bat detectors were deployed during the assumed peak movement between roosts, i.e., spring/ early summer (Mid-October ~ mid-December) and late summer/early autumn (Mid-February ~ Mid-April) for up to 8-weeks in 2021 and 2022. The monitoring data has been incorporated into this report. A decision tree (45-55kHz) was used to extract calls that can be attributed to Southern Bent-wing Bat. The decision tree includes species within the SBwB call complex i.e., Little Forest Bat (*Vespadelus vulturnus*) and Chocolate Wattled Bat (*Chalinolobus morio*). Bat call analysis was undertaken by EcoAerials Principal Ecologist, Rob Gration, using Anabat Insight (Ver 2.0.6-3-g73846db) software. The presence of all species that can be identified by their characteristic call shape / frequency has been included in the report.

Seven bat detectors, (1 x Song Meter 4ZC & 6 x Song Meter Mini Bat, Wildlife Acoustics™), were deployed across the project area. In the absence of a pulley system on the meteorological tower, two detectors were placed at height on the guy wires of the meteorological tower (50m AGL and 25m AGL). A third detector was placed at the base of the meteorological tower (4m AGL). The other 4 detectors were located near dams and remnant vegetation. Two detectors were attached to fence posts near dams to minimise damage by stock, and two fixed to canopy trees.

Table 1 provides photographs of the bat detector deployments. Figure 2 provides details of detector locations. The deployment of bat detectors replicated monitoring in Year 1, (2021).

Table 1: Bat detector deployment

ID	Site Photographs	Comments
IMG_20210216_094957		Location 1 A patch of native vegetation approx.90m from Turbine 1 tower.

ID	Site Photographs	Comments
IMG_20210216_100637		Location 2 The dam is located approx. 160m from Turbine 2 tower. **Note:** A Song Meter Mini Bat was deployed at this location for the 2nd year of monitoring.
IMG_20210216_102106		Location 3 The patch of native vegetation is approx.300m from Turbine 2 tower and 180m from Turbine 3 tower. **Note:** A Song Meter Mini Bat was deployed at this location for the 2nd year of monitoring.
IMG_20210216_103756		Location 4 Dam located approx. 270m from Turbine 3 tower. **Note:** A Song Meter Mini Bat was deployed at this location for the 2nd year of monitoring.

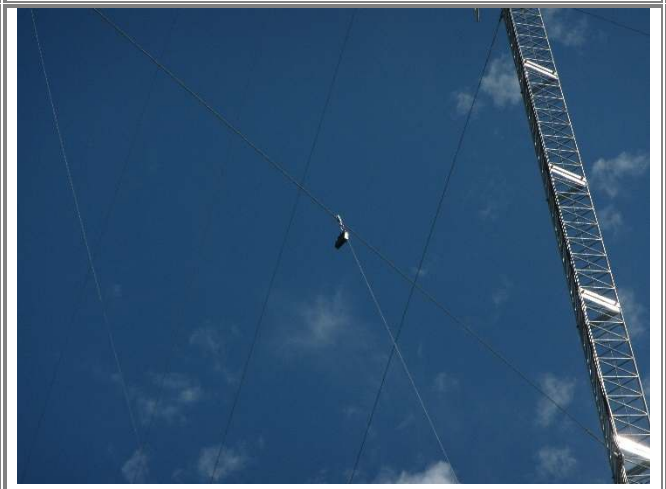
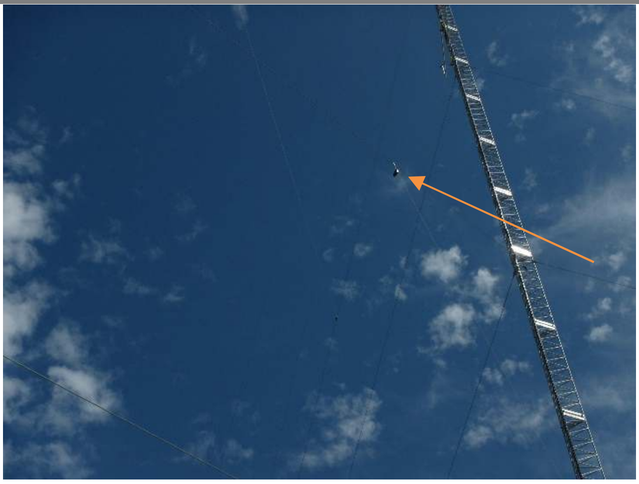
ID	Site Photographs	Comments
IMG_1598		Location 5 Meteorological Tower 4m AGL
IMG_1595		Location Meteorological Tower 25m AGL 6
IMG_1597		Location 7 Meteorological Tower 50m AGL

Figure 2: Bat Detector Locations

0 100 200 m

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Date: 7/03/2022
Drawing No: 000410.Ver 2.2

2.1.7 Reporting

This report is the second and final report providing details of the outcomes of monitoring activities from December 2021 to November 2022. A monthly email summary report was provided to DELWP, at the completion of the monthly carcass search. An incident report was also forwarded to DELWP because of a non-conservation species trigger, refer to Section 6.2 of BAMP (Ecology and Heritage Partners 2019). A copy of this report is provided in Appendix C.

3 Results

No threatened species were found during the carcass or during the bat detector monitoring, 754 bat detector nights in 2021 and 676 detector night in 2022. The focal species, Southern Bent-wing Bat was not recorded at the site. Details of the results of the carcass search, scavenger /searcher detectability trials and bat detector results are provided below.

3.1 Carcass Search

Four bats were found within the RSA and considered to have died because of turbine strike (refer to Figure 3). The collisions of four White-striped Freetail Bats (*Austronomous australis*) occurred in February 2022 triggering a non-conservation species incident report as per the BAM Plan requirements, Section 6.2 (Ecology and Heritage Partners 2019). Table 1 below details the turbines where carcasses were found.

The wind speed and temperature conditions leading up to the collision events, 11-16 February 2022, 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 in a 10-minute interval during the night (average across the three turbines). Columns 3 and 4 provide the mean overnight windspeed and temperature for the three turbines from 8pm to 7am.

The lowest wind speed on 13/02/2022 – 14/02/2022 (1.1 m/s) occurred for a brief period between 2.10am and 2.20am. Wind speed was below the cut in threshold from 12.50am-2.30am. The mean windspeed was 5.20 m/s between 8.00pm and 7.00am.

The lowest windspeed on 15/02/2022 – 16/02/2022 (0.6 m/s) also occurred for a brief period between 2.00am and 2.10am. Wind speed was below the cut in threshold from 12.50am-5.40am. The mean windspeed was 3.20 m/s between 8.00pm and 7.00am.

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

Table 1: Turbine Strike Incidents

Incident No	Carcass Id	Survey Type	Turbine	Species	Sex / age	Distance from Tower (m)	Date
1	WsFB1	Formal	1	White-striped Freetail bat (WsFB)	Male / Adult	16	14/02/2022
2	WsFB2	Formal	2	White-striped Freetail bat (WsFB)	Male / Adult	13	14/02/2022
3	WsFB3	Formal	2	White-striped Freetail bat (WsFB)	Female / Adult	42	16/02/2022
4	WsFB4	Formal	2	White-striped Freetail bat (WsFB)	Male / Adult	45	16/02/2022

Table 2: Nightly Weather Conditions Leading up to Incidents.

Date	Wind Speed minimum m/s @ 110m	Overnight Wind Speed Mean m/s @ 110m	Overnight Temp C Mean @ 110m
11/02/2022- 12/02/2022	5.3	7.8	13
12/02/2022-13/02/2022	9.3	13.75	18
13/02/2022-14/02/2022	1.1	5.20	16.5
14/02/2022-15/02/2022	6.0	8.0	14.5
15/02/2022- 16/02/2022	0.6	3.20	15.5

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Figure 3: Carcass finds Febraury 2022

0 75 150 m

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Date: 20/01/2023
Drawing No: 00410 Ver 1.0

3.2 Scavenger Trials

The scavenger trials were conducted over two seasons, (Autumn, April 2021 & Spring, October 2021), to account for any variances in site conditions, (e.g., grazed pasture, silage prior and post baling) and seasonal behaviour of scavengers.

The results of the scavenger trials varied between seasons, with carcasses taken quicker during the Autumn trials. This is considered an artefact that there was very little ground cover (refer to Photograph 1 below), and fox control had not yet been undertaken. Carcass offtake for Autumn was 1 day to 6 days.

Unsurprisingly carcasses remained for between 1 day and 30 days due to presence of silage and pasture and fox control undertaken post Autumn trials. Figure 4 details where the carcasses were randomly placed for both the scavenger and searcher detectability trials.

The results of the 2021 scavenger and searcher efficiency trials were used for the collision modelling for the 2022 monitoring period as per the endorsed BAM Plan, (refer sections 3.2 & 3.3, Ecology and Heritage Partners 2019).

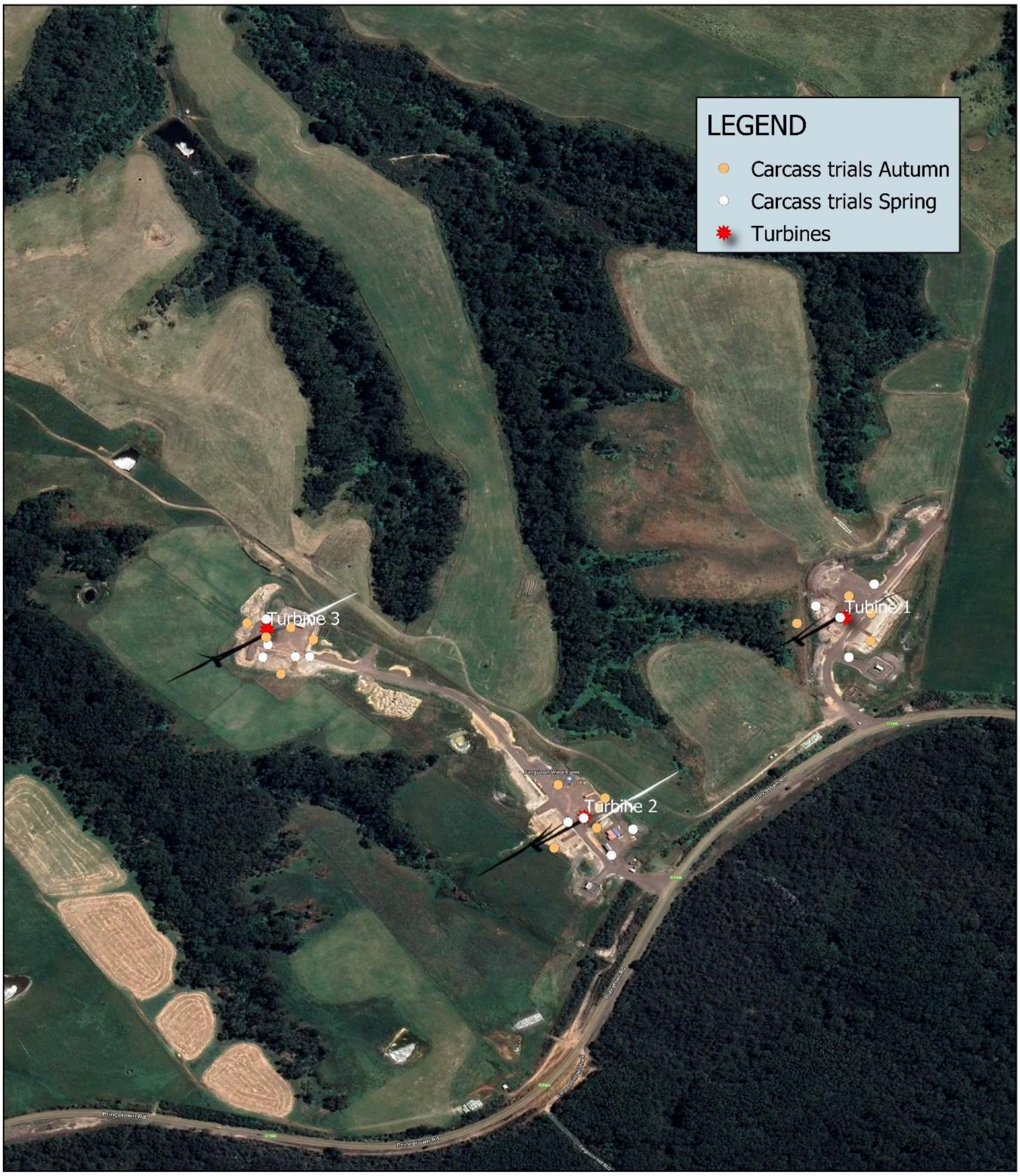

Figure 4: Scavenger and Searcher Effeciency Trials

0 100 200 m

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3.2.1 Autumn 2021

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

Table 6: Carcass removal during Autumn.

TURBINE	SCAVENGER TYPE	GROUND TYPE	DAY REMOVED	SCAVENGER DATE
1	WsFB	Pasture	1	15/04/2021
1	Mouse	Pasture	1	15/04/2021
1	Mouse	Hardstand	1	15/04/2021
1	Mouse	Weed	4	18/04/2021
2	SBwB	Weeds	1	15/04/2021
2	Mouse	Paddock	1	15/04/2021
2	Mouse	Paddock	6	20/04/2021
2	Mouse	Paddock	3	17/04/2021
3	LaFB	Pasture	1	15/04/2021
3	Mouse	Pasture	2	16/04/2021
3	Mouse	Hardstand	2	16/04/2021
3	Mouse	Hardstand	1	15/04/2021
3	Mouse	Pasture	2	16/04/2021

Legend: WsFB = White-striped Freetail Bat; SBwB = Southern Bent-winged Bat; CWB = Chocolate Wattled Bat
LaFB; Large Forest Bat

3.2.2 Spring 2021

All but one carcass was removed over a period of 12-days. One carcass lasted the full 30-days. Refer to Table 7.

Table 7: Carcass removal during spring.

TURBINE	SCAVENGER TYPE	GROUND TYPE	DAY REMOVED	SCAVENGER DATE
1	Mouse	Hardstand	6	20/10/2021
1	Mouse	Paddock	6	20/10/2021
1	Mouse	Paddock	3	17/10/2021
1	Mouse	Hardstand	4	18/10/2021
2	Mouse	Hardstand	30	-
2	Mouse	Paddock	4	18/10/2021
2	Mouse	Paddock	12	26/10/2021
2	Mouse	Hardstand	4	18/10/2021
3	Mouse	Paddock	8	22/10/2021
3	Mouse	Paddock	6	20/10/2021
3	Mouse	Hardstand	8	22/10/2021
3	Mouse	Paddock	3	17/10/2021

3.3 Searcher Detectability Trials 2021

The searcher detectability trials were conducted over two seasons in 2021 to account for any variances in site conditions, (e.g., grazed pasture, silage prior and post) and seasonal behaviour of scavengers. Fourteen of the 25 carcasses (56%) were found.

3.3.1 Autumn

The ground conditions during the autumn trials were considerably different compared to the spring trials, 10 of 13 carcasses were found during the Autumn trials. There was very little vegetation present during autumn compared to the spring trials (refer to photograph 1).

Photograph 1: Typical of ground conditions during autumn detectability trials. Turbine 1

3.3.2 Spring

Pasture and silage had established since the spring trials making carcasses harder to find (refer to photograph 2). Ground conditions were also extremely wet during the spring trials making the carcasses harder to see on the hardstands and in the paddocks (refer to photograph 3).

Photograph 2: Typical of groundcover present during spring detectability trials. Turbine 1

Photograph 3: Mouse carcass placed for detectability trial on water saturated hardstand.

3.4 Bat detector Surveys

The focus of the bat detector surveys was Southern Bent-wing Bat (SBwB) but also included Yellow-bellied Sheathtail Bat. An inventory of non-threatened species was undertaken in Year 1. Seven species were identified at the site and two call complex:

1. White-striped Freetail Bat
2. Southern Freetail Bat
3. Gould's Wattled Bat
4. Eastern Falsistrelle
5. Large Forest Bat
6. Little Forest Bat
7. Chocolate Wattled Bat.

Call Complex:

1. *Vespadelus sp*
2. *Nyctophilus sp.*

The two species associated with the SBwB call complex were identified from their characteristic call features:

1. Chocolate Wattled Bat - *Chalinolobus morio*
2. Little Forest Bat - *Vespadelus vulturnus*

Refer to Attachment D for call images indicative of species identified by their characteristic call features.

3.4.1 Autumn 2022

A total of 19,712 files (Table 8) with bat call files within a frequency range of 10-55 kHz were recorded. The frequency range covers all bats likely to be present in the region.

Average calls per night were relatively consistent across Location 1, 2, 3 and 4. Location 1 and 3 were located on the edge of relatively large tracts of native vegetation. Locations 2 and 4 were located adjacent to farm dams. The levels of activity were not unexpected at these four locations. Bat activity was greater near native vegetation and waterbodies. Waterbodies attract insects as does native vegetation. Location 5, 6 and 7 were at 4m, 25m, 50m AGL respectively on the meteorological tower. Unsurprisingly the average bat call activity at height was considerably less than Location's 1, 2, 3 and 4. This is consistent with the findings of Pennay and Mills (2017) and other windfarms where the author has analysed bat activity (e.g., Timboon West Wind Farm, Willatook Wind Farm and Woolsthorpe Wind Farm).

The number of bat call files (Table 9) extracted by the Anabat Insight software as Southern Bent-wing Bat call complex (SBwB) was 138. All files were visually analysed and identified as either Chocolate Wattled Bat or Little Forest Bat. Location 2 recorded the greatest average number of SBwB call complex files per night (1.45p/n). There were no calls identified as Southern Bent-wing Bat.

Table 8: Results for bat call files between 10-55kHz- Autumn 2022

Location No	Proximity Water (m)	Proximity Vegetation (m)	Detector Nights	No of Files	Ave / night
1	390	0	58	4,293	74
2	10	50	57	4,226	74
3	160	0	58	4,562	78
4	15	120	58	3,854	66
5	160	180	58	892	15
6	160	180	57	859	15
7	160	180	58	1,026	17
TOTAL			**399**	**19,712**	**49.40**

Table 9: Results for SBwB call complex files before analysis- Autumn 2022.

Location No	Proximity Water (m)	Proximity Vegetation (m)	Detector Nights	No of Files	Ave / night
1	390	0	58	5	0.08
2	10	50	57	83	1.45
3	160	0	58	4	0.07
4	15	120	58	24	0.41
5	160	180	58	7	0.12
6	160	180	57	5	0.08
7	160	180	58	10	0.17
TOTAL			**357**	**138**	**0.39**

Refer to Figure 2 for detector locations.

3.4.2 Spring 2022

A total of 28,151 files with pulses attributed to bat calls within the frequency range of 10-55 kHz were recorded (Table 10).

Location 3 recorded the highest average number of bat calls per night (212.25p/n). A SD Card error occurred due to O-ring failure on the case of the Wildlife Acoustics Mini-bat recorder at Location 6 (refer to table 10). O-ring failure also occurred at Location 7 reducing the detector nights to 37. As was the case during the Autumn surveys, the detectors placed at height had the lowest average number of nightly calls.

The number of bat call files (Table 11) extracted by the software as Southern Bent-wing Bat call complex (SBwB) was 354. All 354 files were visually analysed and were identified as either Chocolate Wattled Bat or Little Forest Bat. Location 3 recorded the greatest average number of call complex files per night (2.84p/n). There were no calls identified as Southern Bent-wing Bat.

Table 10: Results for bat call files between 10-55kHz – Spring 2022.

Location No	Proximity Water (m)	Proximity Vegetation (m)	Detector Nights	No of Files	Ave / night
1	390	0	55	11,097	202
2	10	50	57	3,003	52.70
3	160	0	57	12,125	212.25
4	15	120	57	856	15.02
5	160	180	56	201	3.60
6*	160	180	0	0	0
7#	160	180	37	59	1.60
TOTAL			**319**	**28,151**	**88.24**

Table 11: Results for SBwB call complex files before visual analysis- Spring 2022

Location No	Proximity Water (m)	Proximity Vegetation (m)	Detector Nights	No of Files	Ave / night
1	390	0	55	33	1.66
2	10	50	57	132	2.31
3	160	0	57	162	2.84
4	15	120	57	11	0.19
5	160	180	56	5	0.09
6*	160	180	0	0	0.00
7#	160	180	37	11	0.30
TOTAL			**319**	**354**	**1.10**

* = SD Card corrupted due to water ingress in unit.

= Unit stopped functioning at day 37 due to water ingress in unit.

4 Discussion

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

4.1 Southern Bent-wing Bat Monitoring

Bat detector surveys were undertaken for a period of 676 detector nights in 2022 during the Autumn and Spring Southern Bent-wing Bat roost movement periods. Over the two years of monitoring, bat detectors were deployed for a total of 1,430 detector nights.

A total of 47,863 files in the 2022 monitoring periods (Autumn 19,712 and Spring 28,151), contained recordings consistent with bat call pulses of species likely to be present in the wider project area.

Bat activity varied depending on the proximity to suitable bat habitat i.e., water and native vegetation. Location 3 within an extensive area of native vegetation recorded the highest average nightly calls in both Autumn and Spring.

The number of files targeting Southern Bent-wing Bat was 492 (Autumn 138 & Spring 354). The calls of two species associated with the call complex; Chocolate Wattled Bat and Little Forest Bat were identified by their characteristic call features (refer to Attachment D). Both are relatively common in the south-west region.

Autumn Southern Bent-wing Bat Results

There were no calls attributed to Southern Bent-wing Bat. SBwB call complex were visually identified as either Chocolate Wattled Bat or forest bats.

Spring Southern Bent-wing Bat *Results*

There were no calls attributed to Southern Bent-wing Bat. SBwB call complex were visually identified as either Chocolate Wattled Bat or forest bats.

4.2 Species Significance of Turbine Collision

Four microbats, all White-striped Freetail Bat (WsFB) were considered to have been killed because of turbine collision. This species is not a listed threatened species.

The four incidents were recorded whilst undertaking the formal carcass searches. Three WsFB were found at Turbine 2 and one WsFB at Turbine 1, refer to Figure 3. There were periods of wind speeds below the flight speed of White-striped Freetail Bat (approx. 8.3 m/s) leading up to an incident, refer to Table 2.

Dr Greg Richards (2008) refers to the increased collision risk on nights of low wind speed in the Ryan's Corner Wind Farm Environment Effect Statement Panel Hearing report. Low wind speed nights are likely to contribute to bat collisions at Ferguson Wind Farm.

The collision of four WsFB triggered the reporting requirement to DELWP i.e., a total of four (4) or more carcasses of the same species in two (2) consecutive months of Year 1 or Year 2 (E&HP 2019). A copy of the report submitted to DELWP is provided in Attachment C.

4.3 Collision Risk Modelling

The collision risk modelling was undertaken by Symbolix Pty Ltd. The estimated median mortality rate for Year 2 was calculated to be 64 bats, 21.3 mortalities per turbine (Symbolix

2023). This is higher than the median of 47 bats, (15.6 mortalities per turbine), in 2021. The median increase was the result of a one-off incident occurring in February 2022 when four White-striped Freetail Bats collided with Turbine 1 and 2. There were no other observed incidents during Year 2. The incident report, provided in Attachment C details a period of low wind speed leading up to the incident.

A copy of the Collison Risk Modelling report is provided in Attachment E.

4.3.1 Collision Risk Compared to Other Wind Farms

The collision risk per turbine annually was not able to be calculated so the average was applied for the 3 turbines. This is an artefact of the low number of bat carcass found at turbines and it is not statistically justified to make comparisons (Symbolix 2020). There is no publicly available data for a comparable wind farm (i.e., 3 turbines). A review by Moloney et al (2019) and a detailed assessment undertaken recently by Symbolix (2020) have been used for comparison.

The Symbolix data is based on 5432 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 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 Ferguson Wind Farm is estimated to be 103 bats over the duration of the 2-year monitoring period i.e., 2021 & 2022. The average over the two-years was calculated as 17.1 deaths per turbine annually. This is slightly higher the Moloney et al (2019) turbine 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, Southern Freetail Bat and Gould's Wattled Bat (Gration unpublished). The February incident involved White-striped Freetail Bats, the species most prevalent colliding with wind turbines.

4.4 Mitigation Measures to Reduce Risk

4.4.1 Carrion Removal

The Ferguson property is primary agricultural with the main activity the production of beef cattle. The landowner has not been required to remove any carrion or 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.

European rabbits and or warrens are not present on the property and there has not been the need for a baiting or warren ripping program. Fox baiting was also regularly undertaken each year.

4.4.2 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 present at the turbines or 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. Domestic animals are confined when not working.

4.4.3 Supplementary Mitigation Measures

There have not been any impact triggers requiring the implementation of supplementary mitigation measures.

4.4.4 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 BayWa r.e. site representative. Any carcasses are to be handled with gloves, put into a bag, and placed in a freezer.

The BayWa r.e. representative would contact EcoAerials Director, Rob Gration, who will organise for the carcass to be collected by local ecologist Lauren Eddy (Plume Ecology), a Timboon resident. A report will be prepared for DEECA as per the BAM Plan requirements, outlining if any further mitigation measures will be implemented.

4.5 Conclusion

As expected, the levels of activity close to the Turbines (due to their location in paddocks), and at height were considerably lower than locations where native vegetation or a waterbody are close. The lower activity levels near the turbines are considered an artefact of the lack of suitable habitat for microbats. Average nightly bat activity was considerably lower at height (e.g., Locations 5-7), in both the first and second year of monitoring; 2021 and 2022.

The pattern of bat activity at height is consistent with the findings of Pennay and Mills (2017). Bat activity near vegetation is also consistent with research by Lumsden (2007), Pennay and Mills (2017) and the report author's experience undertaking bat call analysis at wind farms. Bat activity is concentrated where suitable habitat exists in the form of native vegetation and waterbodies.

Location 2 in the Autumn (1.45) and Location 3 in the Spring (2.84) had the highest calls per night within the frequency range analysed for SBwB and SBwB call complex.

There were no calls of SBwB, recorded over the 754 detector nights in 2021 and 676 detector nights in 2022. Two of the species associated with the call complex, Chocolate Wattled Bat and Little Forest Bat were positively identified by their characteristic call features.

The SBwB call complex recordings pre-visual analysis were a very small proportion of the calls per detector night in 2021; Autumn 0.18 per night / Spring 0.17 per night and 2022; Autumn 0.39 per night and Spring 1.1 calls per night.

The collision results indicate that bats are flying at Rotor Swept Area (RSA) height, albeit with low activity levels and the estimated collisions rate is slightly higher than other wind farms (Maloney et al, 2019). There was not any discernible difference with the number of bat collisions between seasons and, bat activity is concentrated where native vegetation, or a waterbody is present. Bat activity is many orders of magnitude lower in the RSA. The small sample size of recorded collisions, six bats over two-years, does not provide any conclusive answers why bats are at risk of collision.

New generation wind turbines generate power at lower wind speeds, the VESTAS V136 4Mw model at Ferguson WF cuts in at 3m/s. Power generation does not occur at wind speeds of less than 3m/s. This threshold is 2m/s lower than bat collision studies, (e.g., Whitby et al 2021; Arnett et al, 2012, 2011), where a 5m/s threshold for power generation occurs with older generation turbines. The freewheel pitch position, (feathering of blades), of the Ferguson Wind Farm turbines (when the wind speed is below the cut-in speed) is 20 degrees.

With current generation turbines, feathering blades is likely to not be an effective option and other mitigation strategies will require investigation e.g., altering magnetic field around turbines (Nicholls and Racey 2007) and acoustic deterrents (Ramono et al 2017).

4.6 Monitoring results in relation to the BAMP Objectives

The key objectives as outlined in the BAMP (E&HP 2019) were to establish an outcome-focussed and adaptive monitoring program aimed at answering the following key questions:

1. Is operation of the wind farm resulting in microbat mortality, and if so:
    - What is the estimated annual mortality rate?

The median mortality rate is estimated to be 47 bats in 2021 and 64 in 2022. The 2021 estimated median mortality is consistent with estimates at other wind farms across southwest Victoria (Maloney et al, 2019) and higher in 2022. The median annual collision per turbine over the two years is 17.16 bats per turbine.

- What species are being impacted?

A total of 6 bats were found during the carcass search of the 3 turbines over the two-years of monitoring, two in 2021 and four in 2022. Gould's Wattled Bat and Chocolate Wattled Bat were recorded in 2021 and four White-striped Freetail Bat in 2022.

There were no incidents with the EPBC Act and FFG Act listed Southern Bent-wing Bat.

Is there seasonal variation in the number of microbat mortalities?

Due to the low number of incidents (2), it was not statistically possible to access any seasonal variation of microbat mortalities.

2. Are Southern Bent-wing Bats using the wind farm area during peak migration periods, and if so:

- Are they flying at RSA height?

There was no incident with a Southern bent-wing Bat colliding with a turbine and bat detector monitoring did not record any Southern Bent-wing Bat calls at height.

- How frequent is bat activity?

Unsurprisingly bat activity is greatest near remnant patches of native vegetation and waterbodies. Bat activity at height was several orders of magnitude lower than activity at ground level.

3. 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.

The E&HP (2019) BAMP, Section 6.1.2. Figure 3., provides the decision-making framework for responding to impacts on bats and birds. This framework will continue to apply to the post 2-years on monitoring period should a carcass be found by the landowner.

- Detail procedures for the periodic reporting of findings to DEECA.

As per the E&HP BAMP (2019), Section 7, any incidental carcass finds post construction monitoring period will be reported to DEECA. The framework for reporting is as described in Section 6.1.2, Figure 3 of the BAMP. Further to this a monthly email report is submitted to DEECA outlining the carcass search results.

- Provide a clear summary of management actions required to address the subject Conditions of Approval (CoA).

All management actions have been implemented as required of the Conditions of Approval and the Summary of BAM Plan Measures Section 8 of the E&HP (2019) BAMP. There has not been any triggers for any further actions apart from the notifying DELWP of the White-striped Freetail Bat incident in February 2022.

The results of the first and second year of post construction monitoring indicates that the risk to non-threatened bat species by the Ferguson Wind Farm is consistent with other wind farms in south-west Victoria and a low risk to the EPBC Act and FFG Act listed Southern Bent-wing Bat.

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Attachment A- Scavenger Trials: Autumn and Spring 2021

TRIAL_START_DATE	TRIAL_START_TIME	TURBINE	SPECIES	SCAVENGE_SPECIES_TYPE	SCAVENGE_CARCASS_ID	GROUND_TYPE	DAYS	INTERVAL1	INTERVAL2
14/04/2021	9:46:00	1	BAT	WSFT	FE1	Paddock	1	14/04/2021 14:10	15/04/2022 9:44
14/04/2021	9:46:00	1	BAT PROXY	MOUSE	FE2	Paddock	1	14/04/2021 14:11	15/04/2022 9:45
14/04/2021	9:46:00	1	BAT PROXY	MOUSE	FE3	Hardstand	1	14/04/2021 14:12	15/04/2022 9:46
14/04/2021	9:46:00	1	BAT PROXY	MOUSE	FE4	weeds	4	16/04/2021 14:13	18/04/2021 8:15
14/04/2021	10:15:00	2	BAT	SBWB	FE5	weeds	1	14/04/2021 14:10	15/04/2021 16:46
14/04/2021	10:15:00	2	BAT PROXY	MOUSE	FE6	Paddock	1	14/04/2021 14:10	15/04/2021 16:48
14/04/2021	10:15:00	2	BAT PROXY	MOUSE	FE7	Paddock	6	15/04/2021 16:47	20/04/2021 10:15
14/04/2021	10:15:00	2	BAT PROXY	MOUSE	FE8	Paddock	3	15/04/2021 16:48	17/04/2021 14:24
14/04/2021	10:46:00	3	BAT	LaFB	FE9	Paddock	1	14/04/2021 17:10	15/04/2022 9:10
14/04/2021	10:46:00	3	BAT PROXY	MOUSE	FE10	Paddock	2	15/04/2021 16:52	16/04/2021 16:28
14/04/2021	10:46:00	3	BAT PROXY	MOUSE	FE11	Hardstand	2	15/04/2021 16:53	16/04/2021 16:26
14/04/2021	10:46:00	3	BAT PROXY	MOUSE	FE12	Hardstand	1	14/04/2021 17:12	15/04/2021 16:50
14/04/2021	10:46:00	3	BAT PROXY	MOUSE	FE13	Paddock	2	15/04/2021 16:48	16/04/2021 8:28
16/10/2021	9:10:00	1	BAT PROXY	MOUSE	FE1	Hardstand	6	18/10/2021 10:30	20/10/2021 10:15
16/10/2022	9:10:00	1	BAT PROXY	MOUSE	FE2	Paddock	6	18/10/2021 10:31	20/10/2021 10:16
16/10/2022	9:10:00	1	BAT PROXY	MOUSE	FE3	Paddock	3	16/10/2021 12:10	17/10/2021 10:40
16/10/2022	9:10:00	1	BAT PROXY	MOUSE	FE4	Hardstand	4	17/10/2021 16:20	18/10/2021 12:45
16/10/2022	9:40:00	2	BAT PROXY	MOUSE	FE5	Hardstand	30	14/11/2021 12:30	
16/10/2022	9:40:00	2	BAT PROXY	MOUSE	FE6	Paddock	4	17/10/2021 16:20	18/10/2021 12:50
16/10/2022	9:40:00	2	BAT PROXY	MOUSE	FE7	Paddock	12	24/10/2021 10:50	26/10/2021 11:15
16/10/2022	9:40:00	2	BAT PROXY	MOUSE	FE8	Hardstand	4	17/10/2021 16:21	18/10/2021 16:15
16/10/2022	10:12:00	3	BAT PROXY	MOUSE	FE9	Paddock	8	20/10/2021 11:30	22/10/2021 11:15
16/10/2022	10:12:00	3	BAT PROXY	MOUSE	FE10	Paddock	6	18/10/2021 14:05	20/10/2021 11:31
16/10/2022	10:12:00	3	BAT PROXY	MOUSE	FE11	Hardstand	8	20/10/2021 11:32	22/10/2021 11:16
16/10/2022	10:12:00	3	BAT PROXY	MOUSE	FE12	Paddock	3	16/10/2021 15:15	17/10/2021 14:10

Attachment B- Searcher Detectability Trials: Autumn and Spring 2021

DATE	TURBINE	OBSERVER	OBSERVER_TYPE	GROUND_TYPE	SPECIES	DETECT_SPECIES_TYPE	DETECT_CARCASS_ID	DISTANCE_M	FOUND	COMMENTS
14/04/2021	1	Lauren Eddy	Human	Pasture	WSFB	bat proxy	FE1	47	1	WSFB= white-striped freetail bat
14/04/2021	1	Lauren Eddy	Human	Pasture	Mouse	bat proxy	FE2	27	1	mouse
14/04/2021	1	Lauren Eddy	Human	hardstand	Mouse	bat proxy	FE3	25	1	mouse
14/04/2021	1	Lauren Eddy	Human	weeds	Mouse	bat proxy	FE4	58	1	mouse
14/04/2021	2	Lauren Eddy	Human	weeds	SBWB	bat proxy	FE5	32	0	Southern bent-winged bat
14/04/2021	2	Lauren Eddy	Human	pasture	Mouse	bat proxy	FE6	18.5	1	mouse
14/04/2021	2	Lauren Eddy	Human	Pasture	Mouse	bat proxy	FE7	56	1	mouse
14/04/2021	2	Lauren Eddy	Human	Pasture	Mouse	bat proxy	FE8	58	0	mouse
14/04/2021	3	Lauren Eddy	Human	Pasture	LaFB	bat proxy	FE9	60	0	large forest bat
14/04/2021	3	Lauren Eddy	Human	Pasture	Mouse	bat proxy	FE10	26.5	1	mouse
14/04/2021	3	Lauren Eddy	Human	hardstand	mouse	bat proxy	FE11	6	1	mouse
14/04/2021	3	Lauren Eddy	Human	hardstand	mouse	bat proxy	FE12	26.5	1	mouse
14/04/2021	3	Lauren Eddy	Human	Pasture	mouse	bat proxy	FE13	51.5	1	mouse
16/10/2021	1	Lauren Eddy	Human	Hardstand	Mouse	bat proxy	FE1	8	1	Very wet conditions, mouse blended in with background
16/10/2021	1	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE2	36	0	Very wet conditions, mouse blended in with background
16/10/2021	1	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE3	56	0	Very wet conditions, mouse blended in with background
16/10/2021	1	Lauren Eddy	Human	Hardstand	Mouse	bat proxy	FE4	57	0	Very wet conditions, mouse blended in with background
16/10/2021	2	Lauren Eddy	Human	Hardstand	Mouse	bat proxy	FE5	57	0	Very wet conditions, mouse blended in with background
16/10/2021	2	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE6	60	0	Very wet conditions, mouse blended in with background
16/10/2021	2	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE7	14	1	Very wet conditions, mouse blended in with background
16/10/2021	2	Lauren Eddy	Human	Hardstand	Mouse	bat proxy	FE8	6	1	Very wet conditions, mouse blended in with background
16/10/2021	3	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE9	46	1	Very wet conditions, mouse blended in with background
16/10/2021	3	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE10	28	0	Very wet conditions, mouse blended in with background
16/10/2021	3	Lauren Eddy	Human	Hardstand	Mouse	bat proxy	FE11	11	0	Very wet conditions, mouse blended in with background
16/10/2021	3	Lauren Eddy	Human	Paddock	Mouse	bat proxy	FE12	24	0	Very wet conditions, mouse blended in with background

Attachment C – Non-threatened Bat Incident Report

23 Rosie Place,
Altona 3018
Phone: 03 9315 2031
Mobile: 0414 689 853
Email: rob@ecoaerial.com.au

BayWa r.e. Pty Ltd
Level 2 79-81 Coppin Street,
Richmond VIC 3121
Attention:
Josh Shephard - Project Manager
Charlie Perry - Senior Project Manager
Breeana Sandley - Junior Asset Manager

12/05/2022

RE: Responses to further information required by BSW Planning (DELWP): *Investigation into White-striped Freetail Bat Turbine Strike at the Ferguson Wind Farm.*

Dear Breeana and Charlie,

As requested by BSW Planning (DELWP), I have addressed the request for further information to ensure compliance with the endorsed Bat and Avifauna Management Plan (Ecology and Heritage Partners 2019). An investigation is required when:

"*A significant impact for non-conservation listed species will occur if two or more bird or bat carcasses (or parts thereof) of a non-threatened species, other than ravens or magpies are found within the wind farm footprint in any two consecutive monthly carcass searches (i.e. a total of four (4) or more carcasses of the same species in two (2) consecutive months (Year 1 or Year 2)".*

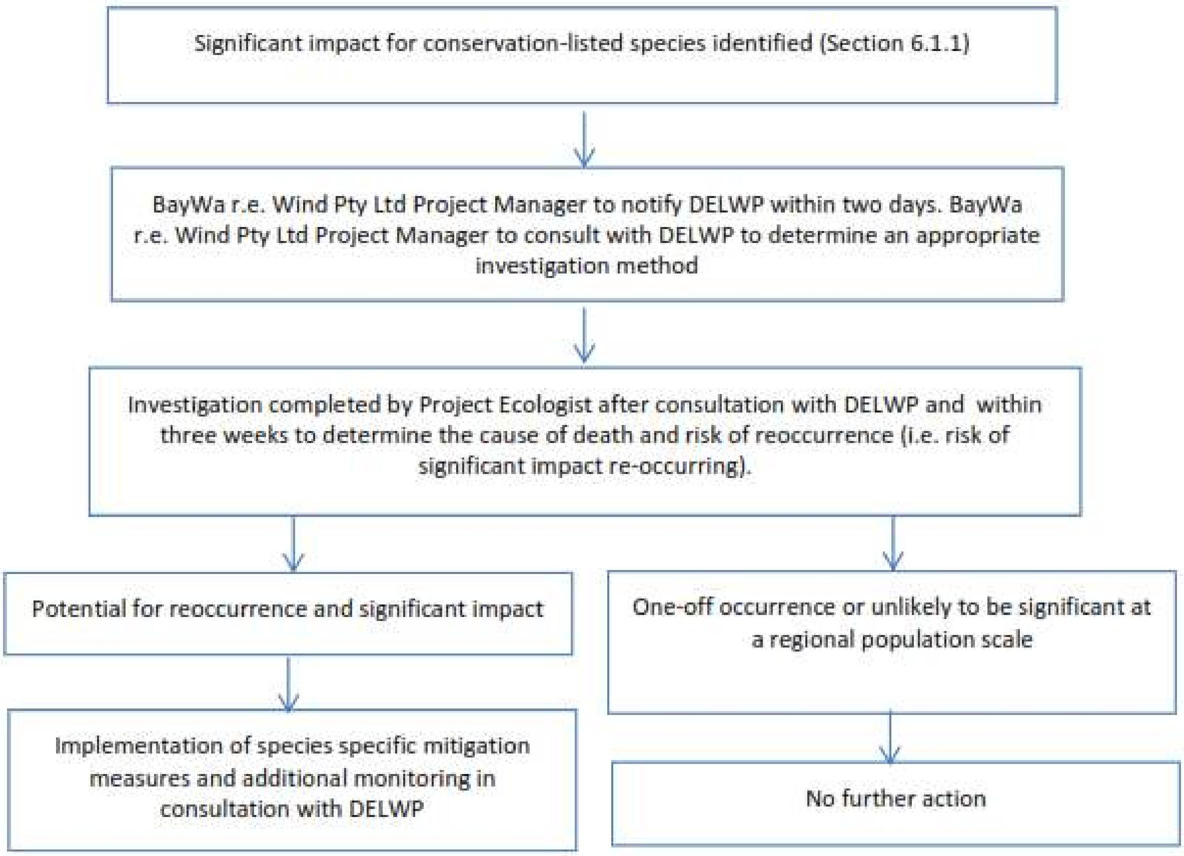
In this case four white-striped freetail bats were found during the carcass search undertaken in February 2022:

- 1 x White-striped Freetail bat (WsFB) at Turbine 1, 1 x WsFB at Turbine 2; 14/02/2022,
- 2 x WsFB during the pulse search at Turbine 2; 16/02/2022.

Whilst not in line with the triggers described above, it was interpreted that the four WsFB carcasses found in the one month constituted a trigger. DELWP were notified within the required 2-day period as per the requirements of the BAM Plan.

The purpose of the investigation is to determine the cause of death and risk of reoccurrence. A decision-making framework is provided in the BAMP for conservation listed species. This framework is also applied for non-threatened species, see below.

Figure 1: Decision making framework



It is estimated that the carcasses were approx., 12-24-hours old when found by field staff (Lauren Eddy), based on the condition of the carcasses.

There were no obvious signs of trauma but the proximity of the carcasses to the turbine tower and blade rotor swept area suggests the deaths were a result of turbine strike or collision with the tower.

Species Profile

Identification

The features used for identification as White-striped Freetail Bat were as follows:

- Large-bodied bat approximately the size of palm, weight range 30~47 grams
- Rounded ears not joining at the top of the head
- Distinctive white fur at the intersection of the underarm and wing
- Tail extending past the tail membrane.

Distribution

White-striped Freetail Bat, along with Gould's Wattled Bat are one of the most widely distributed microbats in Australia. They are found in all states of mainland Australia typically south of the Tropic of Capricorn (Churchill, 2008).

Habitat

White-striped Freetail Bat are tree hollow roosting species. They are known to roost alone or in groups of up to twenty-five individuals. Maternal roosts may have up to three hundred individuals. They are known from a wide range of environs; urban, woodland, forests, and agricultural landscapes (Churchill, 2008). It is believed they migrate to the southern limits of the distribution (e.g., Victoria) in mid-September, heading north in May (Lumsden, 1999).

Collision Investigation

Carcass searches have been undertaken twice a month since December 2020 (18-months). Prior to this incident, two bat carcasses were found; Gould's Wattled Bat and Chocolate Wattled Bat, both are non-threatened species.

The wind speed and temperature conditions leading up to the collision events, 11-16 February 2022, were sourced from the three turbine tower weather stations. Weather conditions are recorded every 10-minutes.

Column 2 in Table 1 (refer below) is the minimum wind speed recorded in a 10-min interval during the night (average across the three turbines). Columns 3 and 4 provide the mean overnight windspeed and temperature for the three turbines from 8pm to 7am.

The lowest wind speed on 13/02/2022 – 14/02/2022 (1.1 m/s) occurred for a brief period between 2.10am and 2.20am. Wind speed was below the cut in threshold from 12.50am-2.30am. The mean windspeed was 5.20 m/s between 8.00pm and 7.00am.

The lowest windspeed on 15/02/2022 – 16/02/2022 (0.6 m/s) also occurred for a brief period between 2.00am and 2.10am. Wind speed was below the cut in threshold from 12.50am-5.40am. The mean windspeed was 3.20 m/s between 8.00pm and 7.00am.

The weather conditions leading up to the turbine strike event follow a similar pattern to the Year 1 turbine strike results. There were periods of wind speeds below the flight speed of white-striped freetail bat (approx. 8.3 m/s) leading up to an incident.

Table 1: Nightly weather conditions leading up to incidents

Date	Wind Speed minimum m/s @ 110m	Overnight Wind Speed Mean m/s @ 110m	Overnight Temp C Mean @ 110m
11/02/2022-12/02/2022	5.3	7.8	13
12/02/2022-13/02/2022	9.3	13.75	18
13/02/2022-14/02/2022	1.1	5.20	16.5
14/02/2022-15/02/2022	6.0	8.0	14.5
15/02/2022-16/02/2022	0.6	3.20	15.5

Conclusions

Gration's (unpublished) analysis of 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 14ms, wavelength of between 9.5mm and 34mm, and inter-pulse duration of between 118ms and 715ms are at greater risk i.e., White-striped Freetail Bat; 12.05ms mean pulse duration, 28.05mm mean wavelength and 753ms mean inter-pulse duration.

Due to the small number of turbine strikes at Ferguson WF during the first year of monitoring (i.e., 2 incidents), statistical analysis was not possible to determine if there were any mitigating factors between the three turbines (Symbolix 2022). The first year's collision monitoring analysis at Ferguson Wind Farm has a similar median range of bat deaths when compared to other wind farms (Maloney et 2019). EcoAerials Ferguson Wind Farm annual report (2022) does note there were low wind speeds leading up to each of the turbine strike events in 2021, as was the case for these four incidents. Two of the bat carcasses were found within 10m of the turbine tower, it is also possible that these two collisions were with the tower.

Maloney et al (2019) and Symbolix (2020) document that white-striped freetail bat are the most common species documented in collisions at wind farms.

The following information has been used to assess whether the incidents are likely to be significant at a regional scale:

- *White-striped freetail bat are widely distributed across mainland Australia.*
- *White-striped Freetail Bat are migratory, moving north prior to the onset of winter in the southern states before returning in September (Churchill, 2009; Lumsden, 1999).*
- *White-striped freetail bat are fast flying and known to commute up to 11km (Rhodes, 2006).*
- *Bat detector monitoring has been competed (14 February 2022 – 13 April 2022) since the incident report was submitted to BAS Planning (DELWP). Bat detector monitoring details the continued occupation across the site with no reduction of call activity levels in February and March and no further incidents.*
- *The February incidents are the first collision records of white-striped freetail at Ferguson Wind Farm in 18-months of monitoring.*

Turbine curtailment

New generation wind turbines generate power at lower wind speeds, the VESTAS V136 4Mw model at Ferguson WF cuts in at 3m/s. Power generation does not occur at wind speeds of less than 3m/s. This threshold is 2m/s lower than bat collision studies, (e.g., Whitby et al 2021), where a 5m/s threshold for power generation occurs with older generation turbines. The freewheel pitch position, (feathering), of the Ferguson Wind Farm turbines (when the wind speed is below the cut-in speed) is 20 degrees.

Whilst there were periods of wind speed lower than the 3m/s threshold in the lead up to when the incidents were considered to have occurred, data from the turbines shows pitching the blades to 20 degrees slows the rotation of the blades to between 0 and 2 rotations/minute. This approach is consistent with Arnett's findings in relation to feathering blades and slowing rotor speed up to the turbine manufacturer's cut-in speed to substantially reduce the fatality of bats. Vestas has provided the following advice as to why the blades cannot be feathered to completely stop rotating:

1. the gearbox doesn't stand idle (this can cause standstill marks which may lead to failure); and
2. when the wind picks up the slowly rotating blades more efficiently catch the wind to allow the turbines to start generating.

White-striped freetail bat are one of the most widely distributed bats in Australia and there is movement between the southern regions of Victoria to the north in autumn, returning south in September (Lumsden, 1999). White-striped freetail bat are wide ranging across southwest Victoria based on bat call analysis I have undertaken in southwest Victoria.

Whilst bat detector monitoring cannot determine the number of individuals present, it provides an index of activity that has been used for comparison. There was no reduction in white-striped freetail activity from the period of the 2nd incident and for the remainder of February and March, similar weather conditions occurred post incident (BOM). There were no further recorded incidents. On this basis, the February incidents are considered unlikely to impact white-striped freetail bat at a regional scale and no further action is available to reduce the likelihood of any future collision of white-striped freetail bat. We will continue to monitor the correlation between low wind speed and bat turbine strike.

Should you have any queries in relation to this report please do not hesitate to contact me.

Regards,

Rob Gration

Director / Principal Ecologist

EcoAerial Pty Ltd

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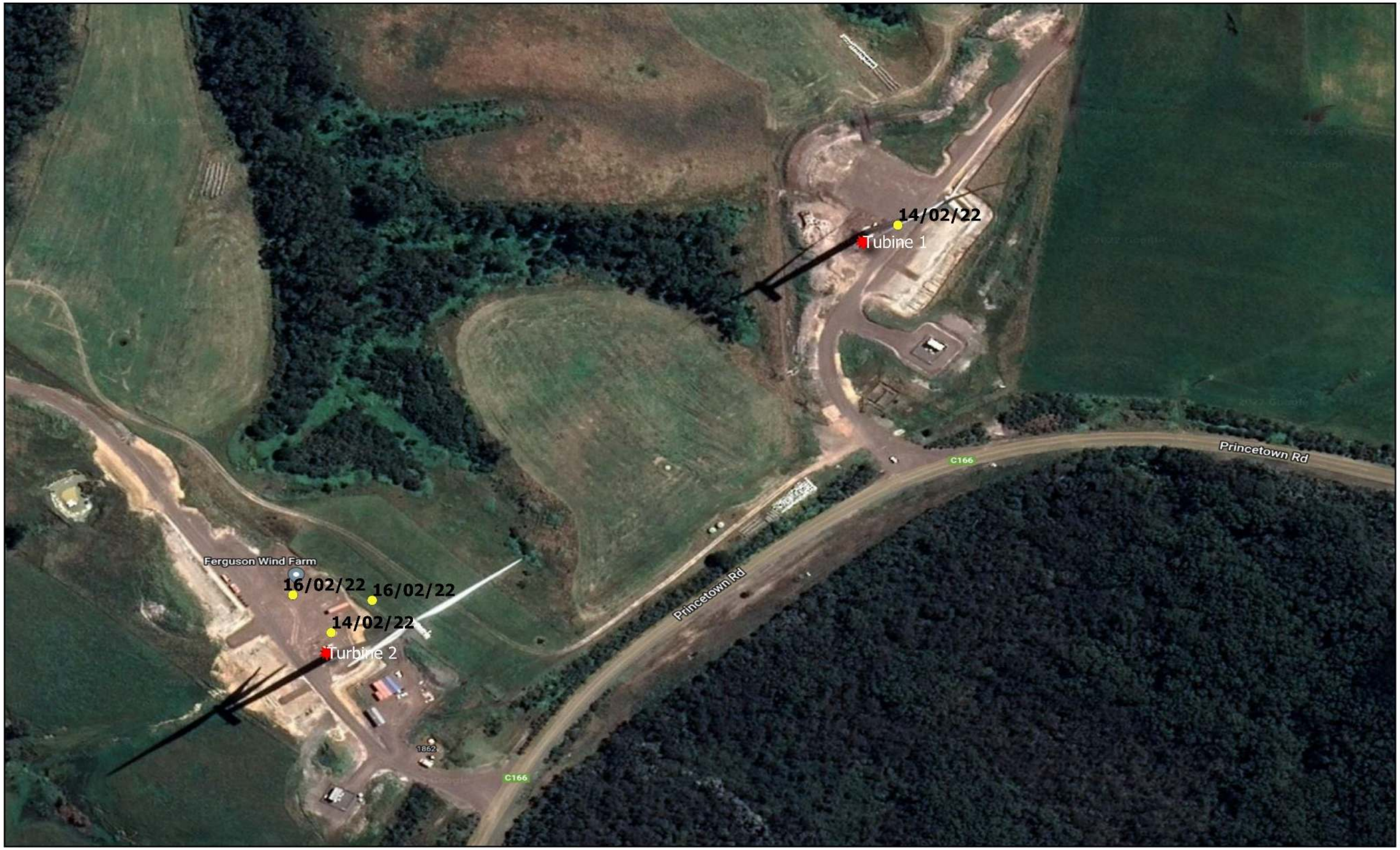
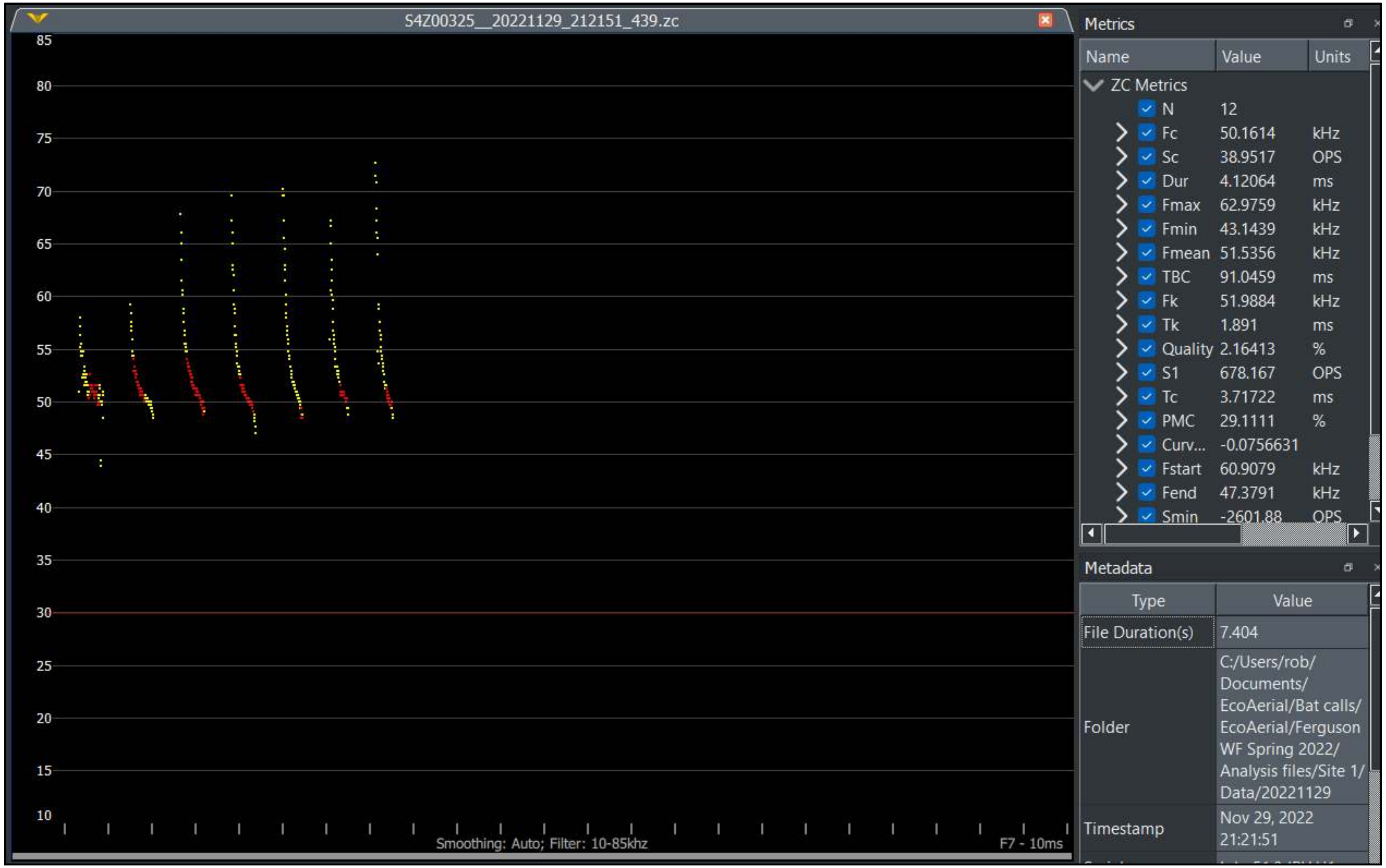


Figure 1: Carcass finds Febraury 2022

0 75 150 m

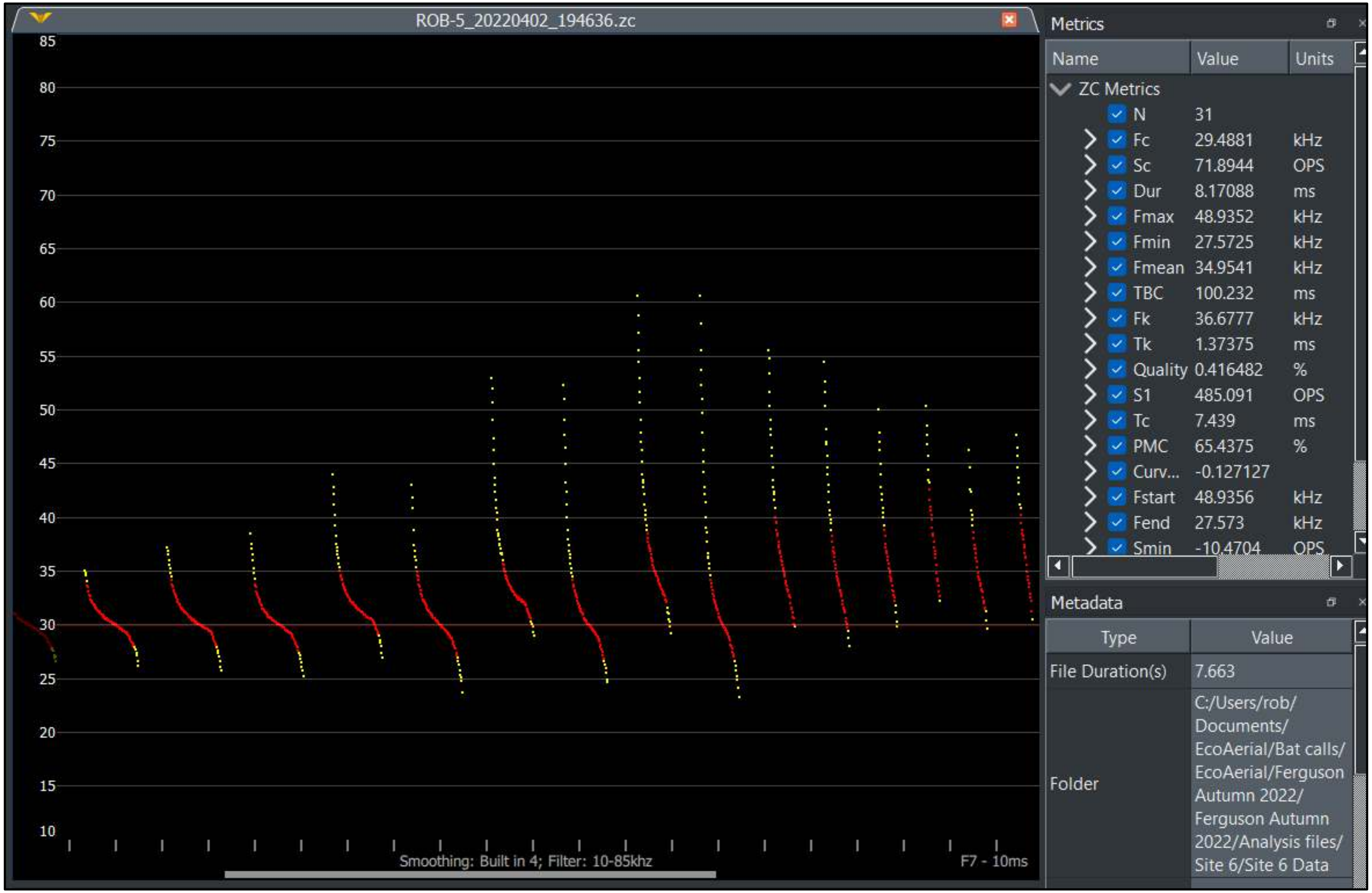
Drawn: R. Gration
Date: 10/03/2022
Drawing No: 00410 Ver 1.0

Attachment D – Bat call Images

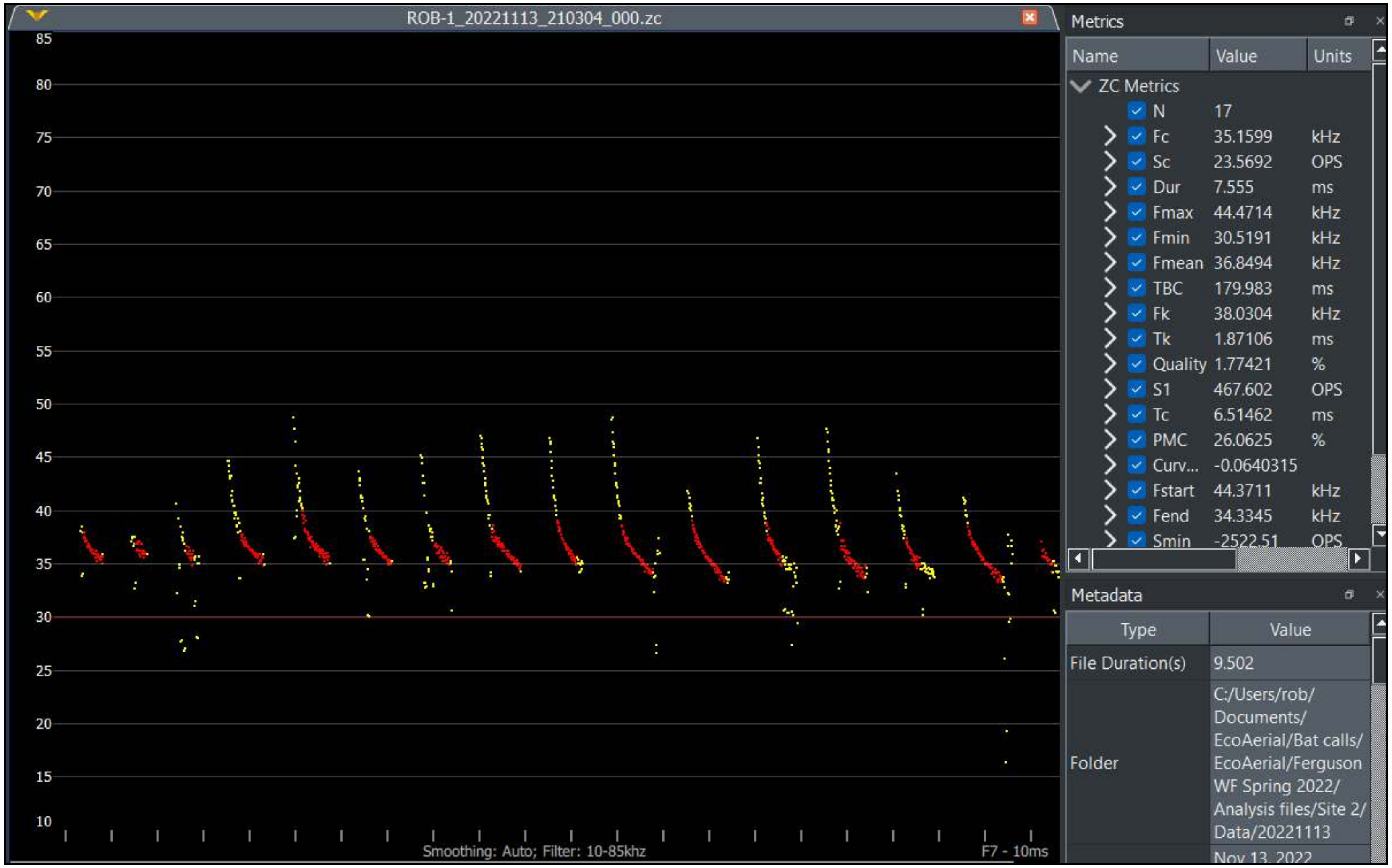


Chocolate Wattled Bat – one of the species associated with the Southern Bent-wing Bat call complex.

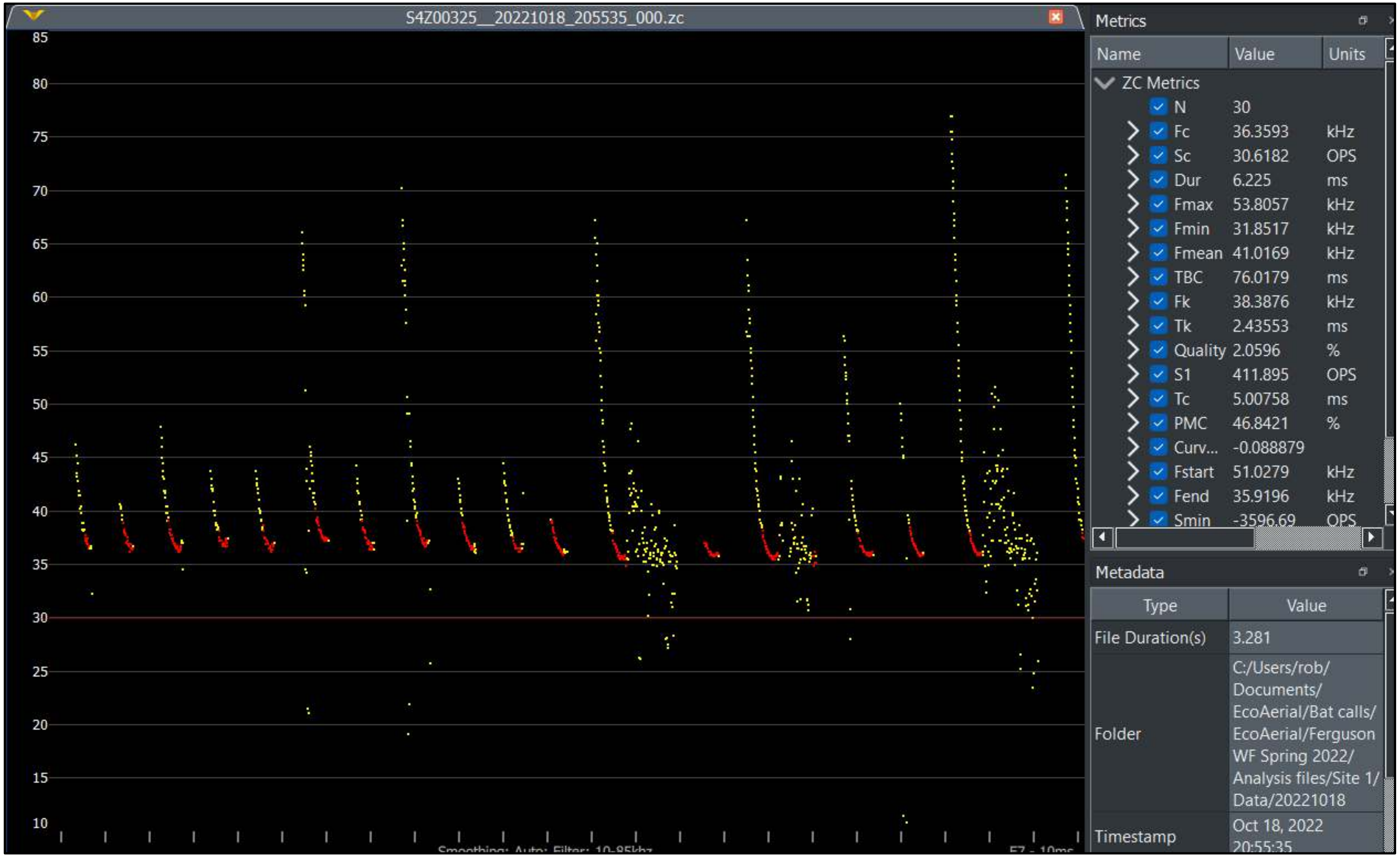
Little Forest Bat - one of the species associated with the Southern Bent-wing Bat call complex.



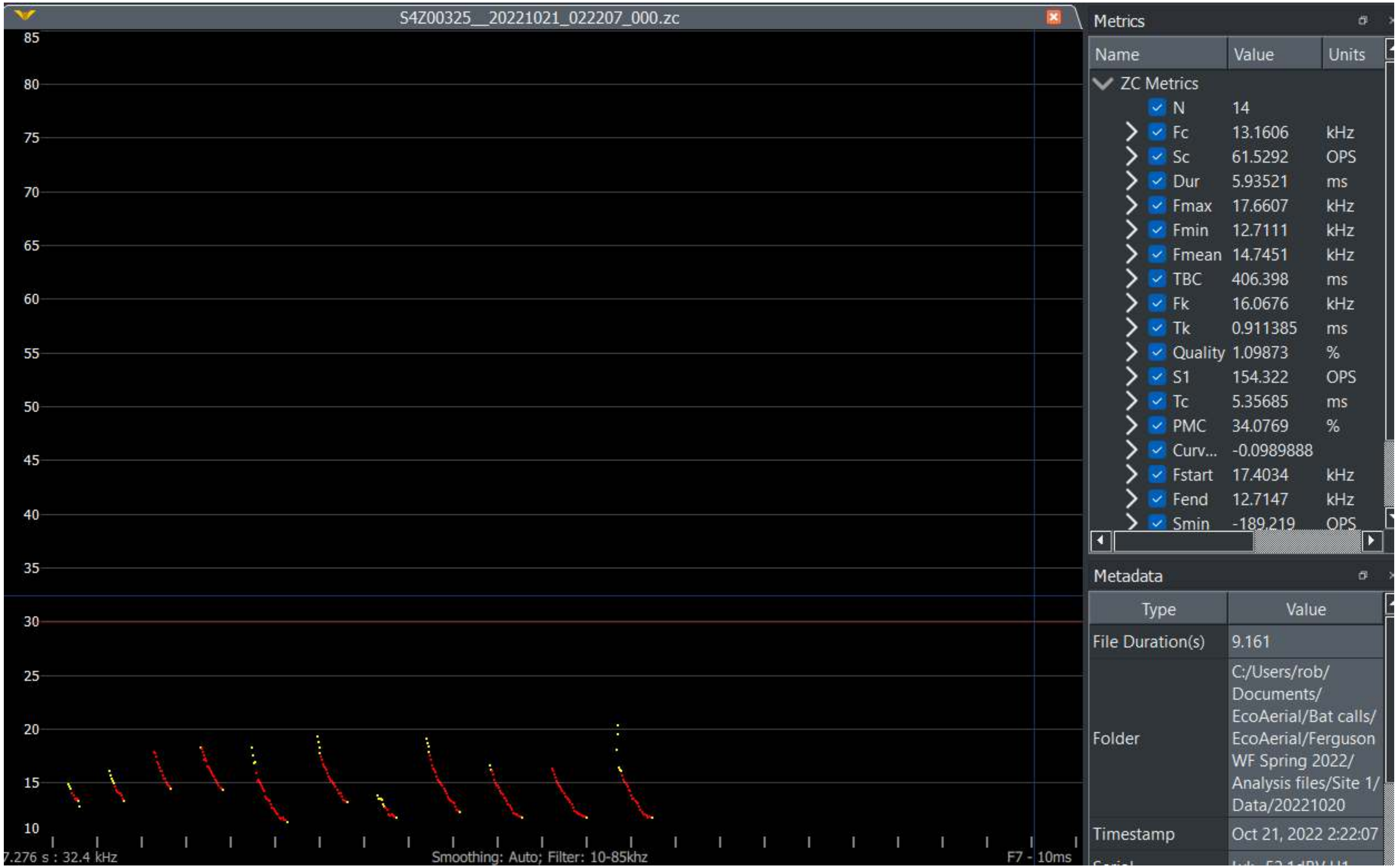
Gould's Wattled Bat



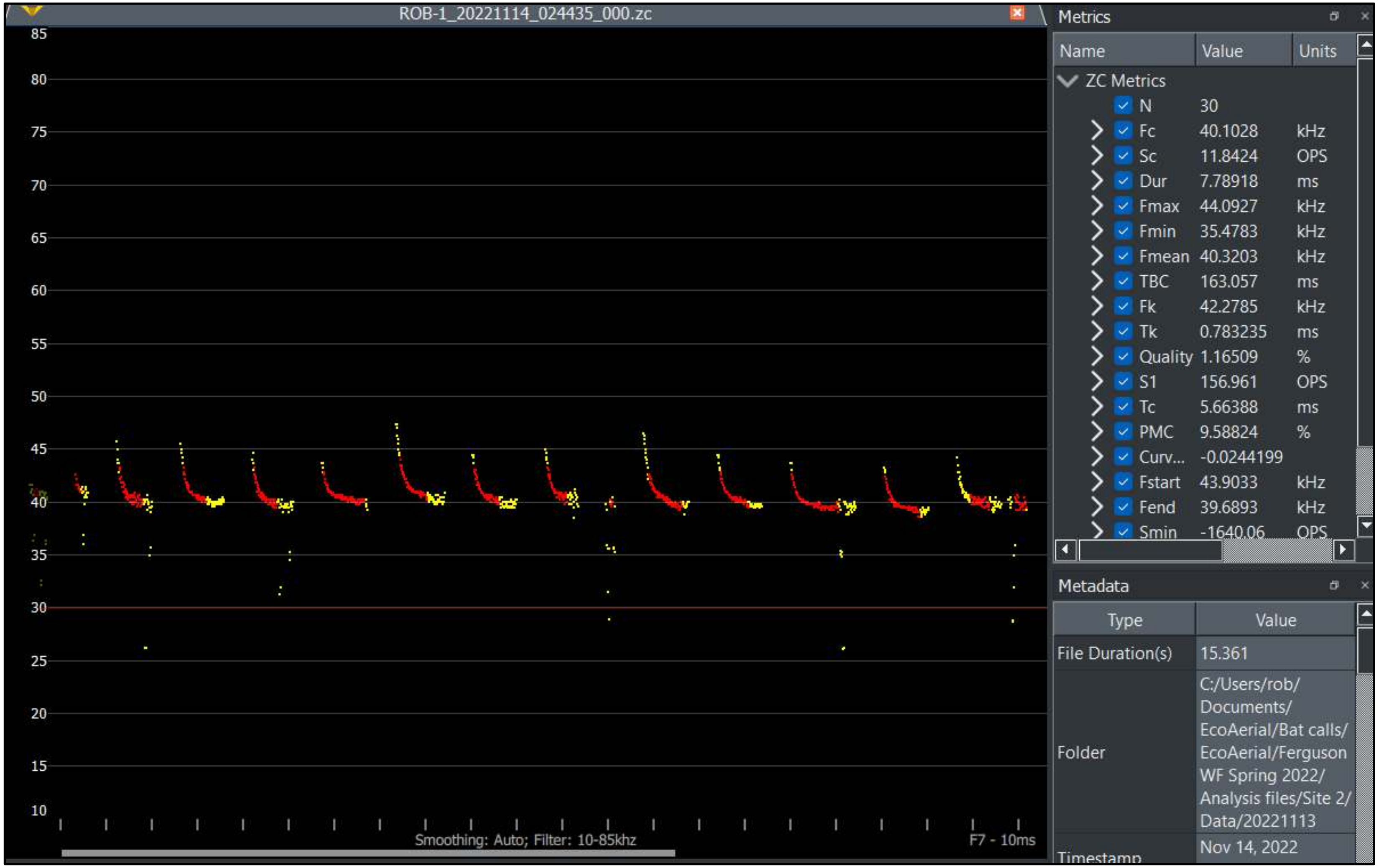
Eastern Falsistrelle



Inland Broad-nosed Bat-potentially. Outside of known distribution by approximately 20km. Call frequency is consistent with species.



White-striped Freetail Bat



Large Forest Bat

Attachment E – Collision Risk Report - Symbolix

Ferguson Wind Farm Mortality Estimate - Year 2

Prepared for EcoAerial Environmental Services, 16 February 2023, Ver. 1.0

This report outlines an analysis of the mortality data collected at Ferguson Wind Farm from 14/12/2020 to 24/11/2022. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in April 2021 and October 2021
- Scavenger loss rates – consisting of trials in April 2021 and October 2021
- Mortality estimates - based on monthly surveys at 3 turbines, from 14/12/2020 to 24/11/2022

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:

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \quad (1)$$

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 **â**, **r̂** and **p̂**. **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), F. 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).

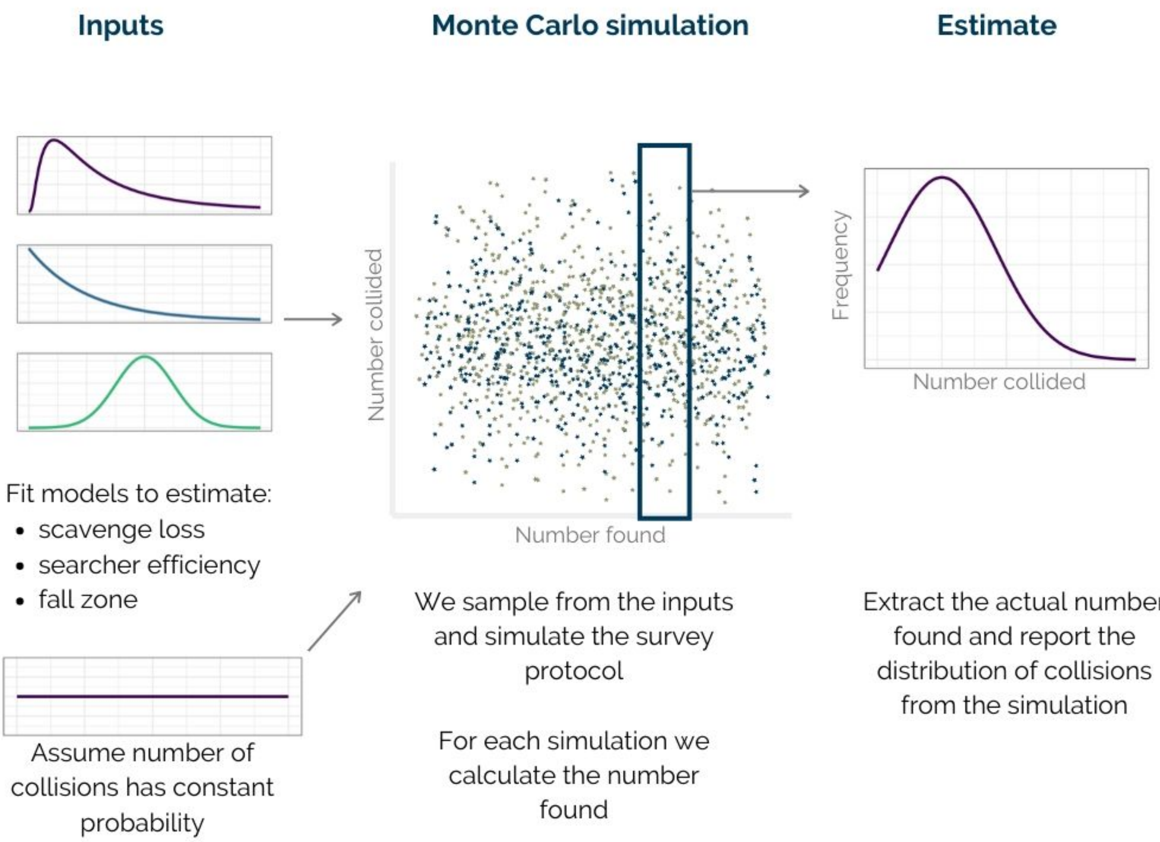


Figure 1: Overview of how the mortality estimation works.

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 60m radius from the turbine tower by an ecologist.

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. All three turbines were selected, and were generally surveyed twice each month out to 60 metres, with one standard and one pulse survey for each turbine.

Table 1: Number of surveys per month.

Date	Standard	Pulse
2020 Dec	3	3
2021 Jan	3	3
2021 Feb	3	3
2021 Mar	3	3
2021 Apr	3	3
2021 May	3	3
2021 Jun	3	3
2021 Jul	3	3
2021 Aug	3	3
2021 Sep	3	3
2021 Oct	3	3
2021 Nov	3	3
2021 Dec	3	3
2022 Jan	3	3
2022 Feb	3	3
2022 Mar	3	3
2022 Apr	3	3
2022 May	3	3
2022 Jun	3	3
2022 Jul	3	3
2022 Aug	3	3
2022 Sep	3	3
2022 Oct	3	3
2022 Nov	3	3

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 two years.

Species	Year 1	Year 2
Chocolate Wattled bat	1	
Gould's Wattled bat	1	
White-striped Freetail Bat		4

3.2 Searcher efficiency

The aim of searcher efficiency trials is the 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. Human observers 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 searcher 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 April 2021 and October 2021; Table 3).

The detectability trials used bat (three replicates) and bat proxy (22 replicates) carcasses (Table 4) .

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

Date	Number of trials
2021-04-14	13
2021-10-16	12

Table 4: Species used during the detection surveys.

Species	Number of records
Large Forest Bat	1
Mouse (bat proxy)	22
Southern Bent-wing bat	1
White-striped Freetail Bat	1

The top two competing searcher efficiency models were:

- the “intercept-only” model (i.e. all carcasses have the same expected searcher efficiency) and;
- using survey month as a predictor

Out of the top two, we selected the intercept-only model, as it is much simpler (in terms of model parameters), provides a similar level of fit, and can easily be incorporated into the mortality estimate.

For the first year of surveys, due to unique ground conditions at Ferguson Wind Farm (R. Gration, *pers. comms*) we have split the detection rate in the following way. At Turbine 1, in the first four months of operation, the ground under the turbine was cleared so had high detectability. Therefore, to estimate its detection rate, we use the four trials held at Turbine 1 in April. This yields a point estimate of 100% with a 95% confidence interval of [40%, 100%]. At Turbines 2 and 3 (all survey period), and for the rest of the survey period for Turbine 1, there was grass/pasture under the turbine. To estimate its detection rate, we have used the remaining 21 trials, which gives a point estimate of 48% with a 95% confidence interval of [26%, 70%].

For the second year of surveys, all sites were noted as having grass/pasture under the turbine, therefore the estimate of 48% with a 95% confidence interval of [26%, 70%] is used for all turbines for this year.

Table 5: Detection efficiency for bats.

Variable	T1 first four months (cleared)	T2 & 3, T1 last eight months (pasture)
Number found	4	10
Number placed	4	21
Mean detectability proportion	1	0.48
Lower bound (95% CI)	0.4	0.26
Upper bound (95% CI)	1	0.7

To summarise:

- **For the first year of surveys at Turbines 2 and 3 we use a searcher efficiency of 48%, with a 95% confidence interval of [26%, 70%]**

- **For the first year of surveys at Turbine 1, we use a searcher efficiency which is a weighted average of the T1 April trial (1/3 weight, corresponding to first 4 months), and the remaining grass/pasture trials (2/3 weight, corresponding to last 8 months). Overall, this gives an estimate of 65% with a 95% confidence interval of [44%, 82%].**
- **For the second year of surveys, detectability for bats is 48% with a 95% confidence interval of [26%, 70%].**

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).

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 April 2021 and October 2021 (Table 6). The trials ran over 30 days. In total three bat and 22 bat proxy carcasses were used (Table 7).

Table 6: Scavenger trial timing.

Month	Number of trials
2021 April	13
2021 October	12

Table 7: Species types for scavenger trials.

Species type	Number of records
Bat	3
Bat proxy	22

Using AICc selection, there was no evidence that the scavenger rate differed by ground type. Scavenger rates from both trials have been aggregated, though we note that there was evidence that scavenger rates differed between the two trials. As carcass searches were performed year-round, we expect the aggregated scavenger rate will account for possible seasonal differences across the survey year.

The log-normal distribution best described the scavenger distribution, for both models.

Figure 2 shows a survival curve fitted to the bat 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 1.7 days, with a 95% confidence window of [1.1, 2.6] days.

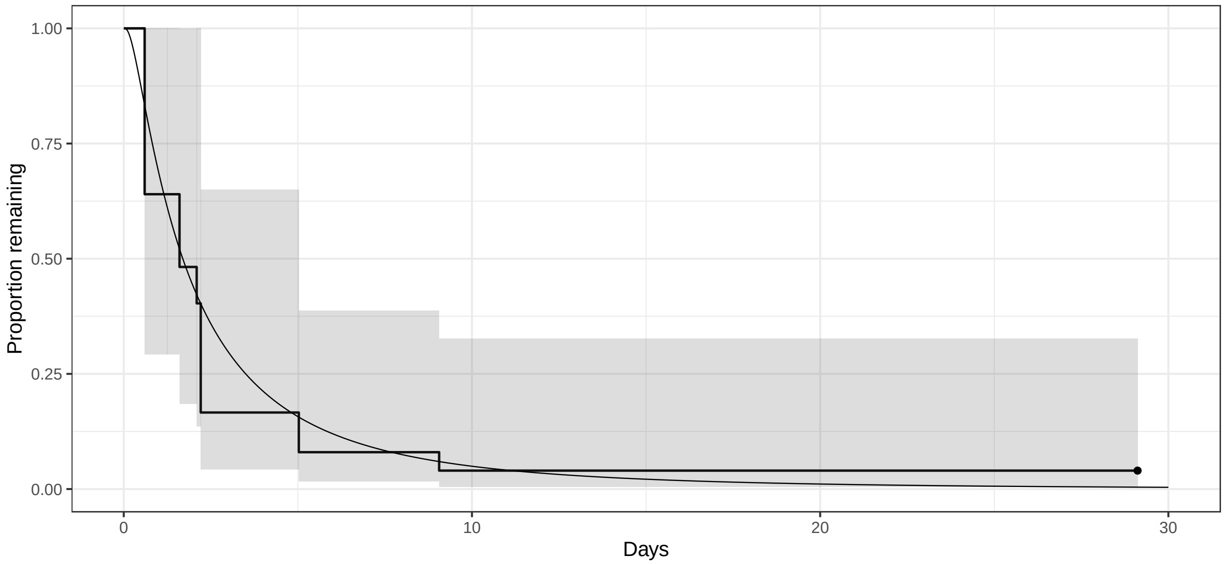


Figure 2: Empirical survival curves (the step function), with 95% confidence interval shaded. The smooth curves presents the fitted model.

3.4 Proportion of turbines searched

In the Monte Carlo algorithm, we explicitly simulate the survey design. The proportion of turbines sampled (which is 100%) 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 Ferguson Wind Farm, while Table 9 shows the bat 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
136	132	16.1

Table 9: Bat 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

Figure 3 displays the simulation results for 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 85% of Bat carcasses to fall within 60m of the turbine.

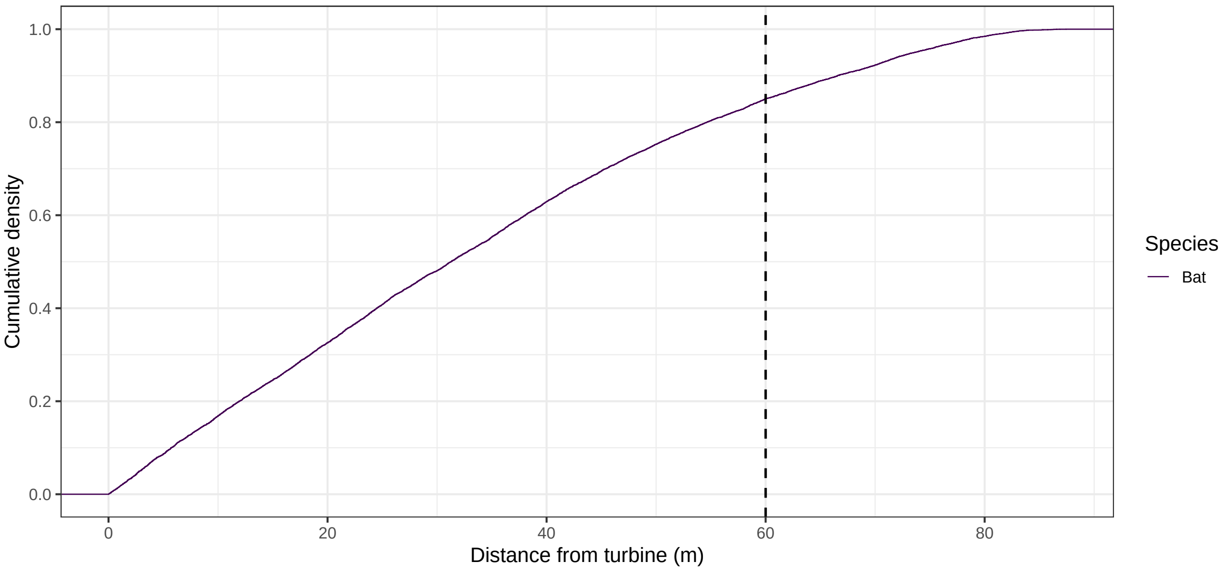


Figure 3: Cumulative distribution function of the fall zone simulation output for bats. Vertical lines indicate relevant survey radii.

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 85% of bat strikes 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 carcasses detected into an estimate of overall mortality at Ferguson Wind Farm from 14/11/2020 to 24/11/2022 (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, 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 3 turbines on site.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 1 for a summary).
- During the first year of surveys; for turbine 1, mortalities were allowed to occur up to a month before the initial survey (14/12/2020) and until the final surveyed date (18/11/2021). As turbines 2 and 3 were not operational for the whole survey period, for these turbines mortalities were allowed to occur from 24/03/2021 until the final surveyed date.
- During the second year of surveys, mortalities were allowed to occur up to a month before the initial survey (16/12/2021) and until the final surveyed date (24/11/2022).
- Bats are on-site at all times during this period.
- Bats 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.
- All three turbines were surveyed, and were searched out to a 60 metre radius, in accordance with the supplied survey data.
- The coverage factor was 85% for bats.

4.1 Combined years 1 and 2

During both years of surveys a total of 6 bats were found during formal surveys. The resulting (median) estimate of total mortality is 103 bats lost on site over the two years.

Table 10 and Figure 4 display the percentiles of the distributions, 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 103 bats over the survey period, and are 95% confident that fewer than 190 individuals were lost.

Table 10: Percentiles of estimated total bat losses over the two years of survey period.

0%	50% (median)	90%	95%	99%	99.9%
18	103	168	190	233	274

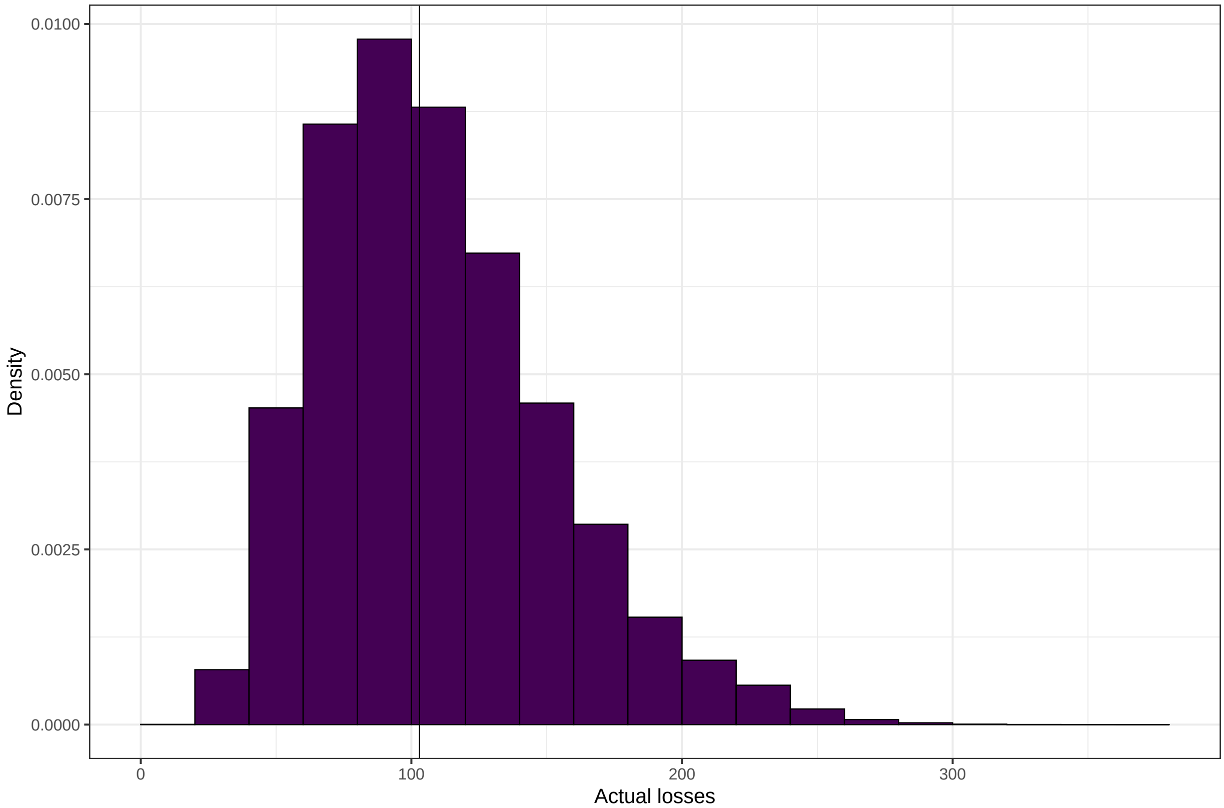


Figure 4: Histogram of the total losses distribution (bats), given 6 were detected on-site. The black solid line shows the median.

4.2 Year 1

During the first year of surveys a total of 2 bats were found during formal surveys. The resulting (median) estimate of total mortality is 47 bats lost on site over the first year.

Table 11 and Figure 5 display the percentiles of the distributions, 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 47 bats over the first year, and are 95% confident that fewer than 109 individuals were lost.

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

0%	50% (median)	90%	95%	99%	99.9%
5	47	91	109	149	180

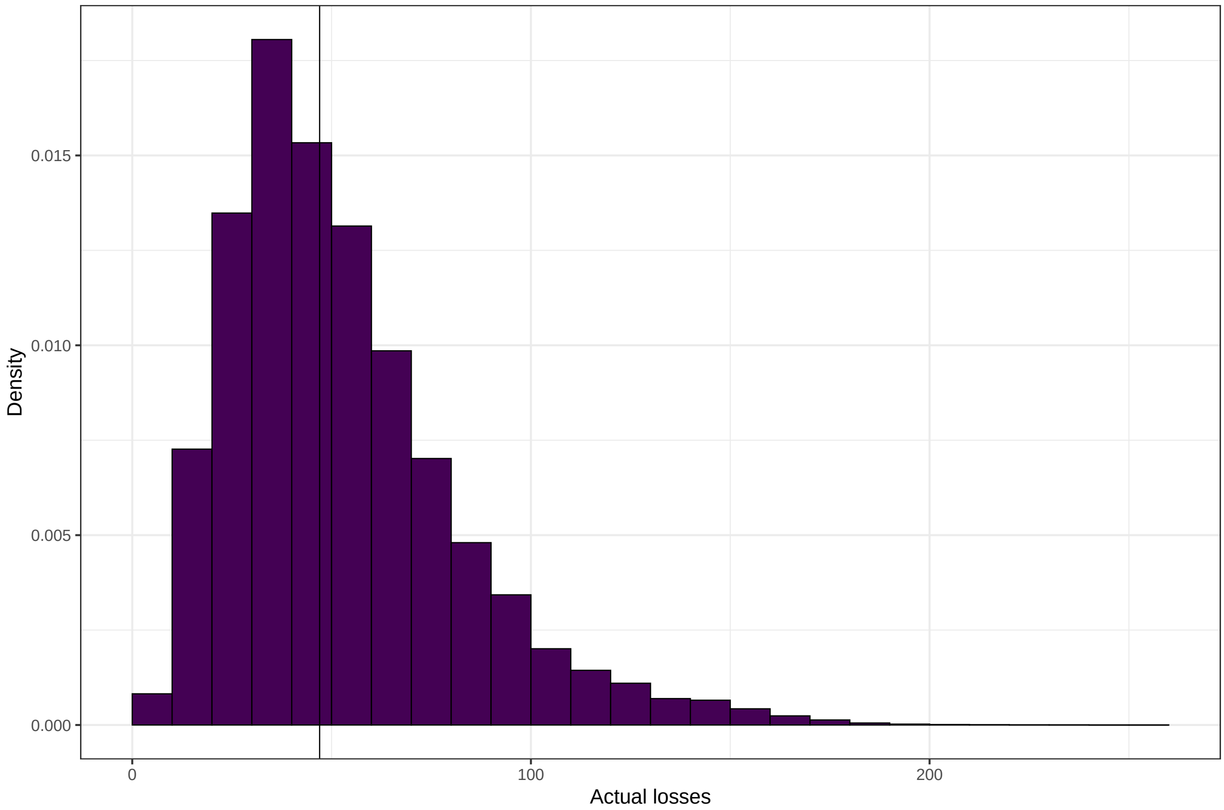


Figure 5: Histogram of the total losses distribution (bats) in the first year of surveys, given 2 were detected on-site. The black solid line shows the median.

4.3 Year 2

During the second year of surveys a total of 4 bats were found during formal surveys. The resulting (median) estimate of total mortality is 64 bats lost on site in the second year of monitoring.

Table 12 and Figure 6 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 64 bats over second year of surveys, and are 95% confident that fewer than 141 individuals were lost.

Table 12: Percentiles of estimated total bat losses over the second year.

0%	50% (median)	90%	95%	99%	99.9%
9	64	118	141	179	223

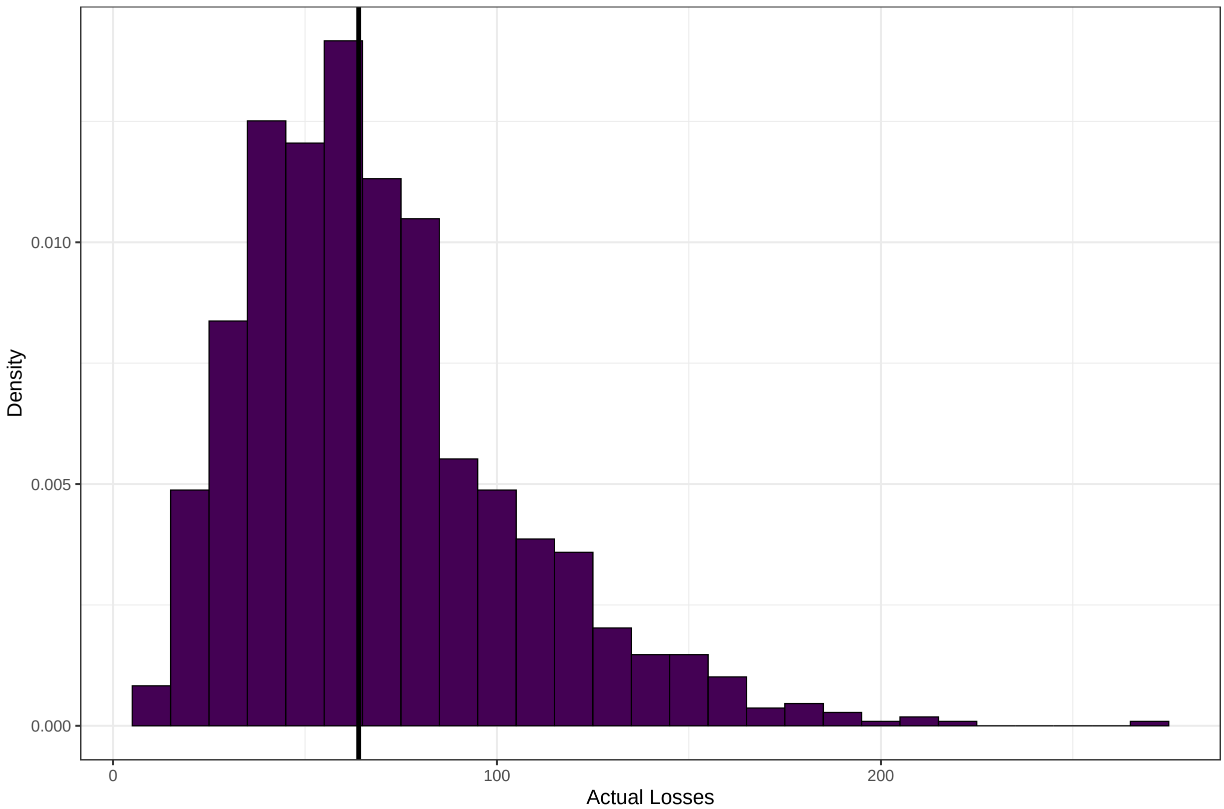


Figure 6: Histogram of the total losses distribution (bats) in the second year of surveys, given 4 were detected on-site. The black solid line shows the median.

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