Technical Appendix 7.6: Bat Mitigation and Monitoring Plan

1 Introduction

The assessment of bat activity at Harestanes South Renewable Energy Development concluded that pipistrelle bats (both common pipistrelle Pipistrellus pipistrellus and soprano pipistrelle Pipistrellus pygmaeus, hereafter referred to as "pipistrelle bats") are present in sufficient abundance that the development is considered to pose a High risk to these bat populations (see EIA Report Appendix 7.5 Bat Survey Report).

As such mitigation measures are required to reduce the risk to bats during operation of the proposed Development. This document describes the mitigation measures, method of implementation, auditing and monitoring programme which will be implemented during the operational phase of the proposed Development. It also describes the process by which any changes to mitigation measures will be made as part of feedback from monitoring data.

2 Mitigation Measures

SPR have conducted detailed acoustic and fatality monitoring of bats at 10 operational windfarms and acoustic monitoring aligned to the 2019 Scottish Natural Heritage (SNH / NatureScot) guidance[1] at 3 development phase projects. This combined dataset comprises data collected at 71 unique locations with static bat detectors deployed for a total of 1710 nights, providing a total sample size of 9367 detector nights of bat activity (sample unit = 1 detector / night) after some samples were removed due to equipment failure. Of these, 7269 samples are from 9 projects in south-west Scotland and were used for the analysis.

Carcass surveys have been undertaken at all 10 of the operational windfarms using methods consistent with the DEFRA study. Of these, 6 were found to have zero bat fatalities, 2 had an "incidental" rate of fatality (considered to be <2 bat fatalities / turbine / year) and 2 had fatality rates greater than 2 bat fatalities / turbine / year.

The data collected at the 10 operational windfarms indicates a relationship between bat activity and the rate of fatality. Figure 1 shows the 10 operational sites ranked by bat activity and colour coded by the category of fatality rate. Sites with higher activity tended to have higher rates of fatality.

[1] SNH (2019). Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation.

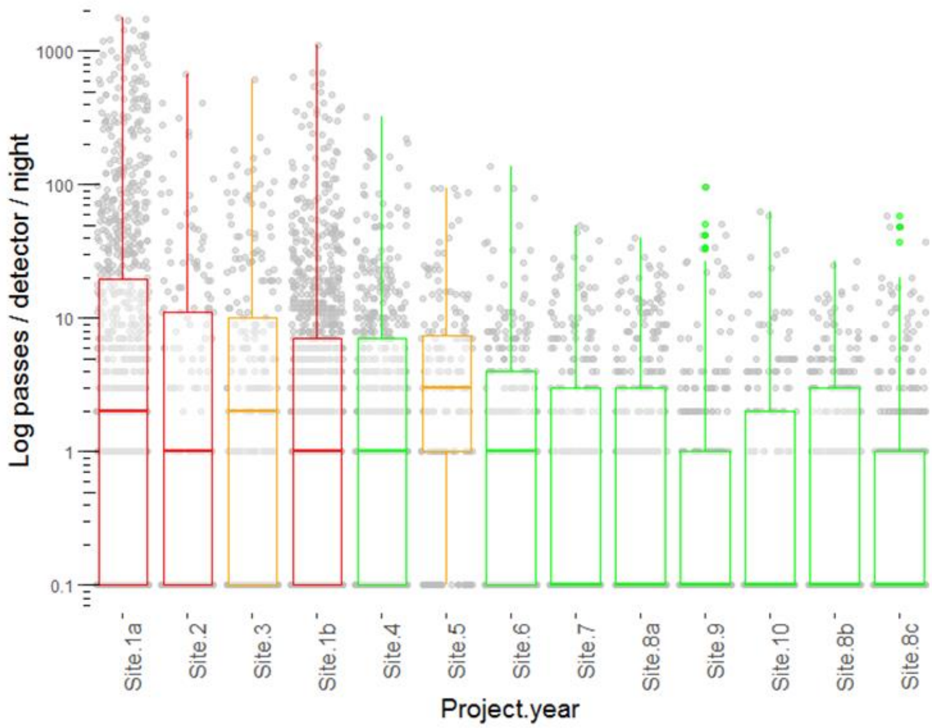

Figure 1: Operational windfarm sites ranked left to right in descending order of bat activity (recorded July – September), shown both as box plots of the overall dataset and individual samples as grey points. Red sites had >2 fatalities / turbine / year; amber sites had <2 fatalities / turbine / year; green sites had zero fatalities detected. The data only includes Pipistrelle and Nyctalus species.

This dataset can be used as a reference for new projects by providing a comparison of bat activity within a region in a similar manner to EcoBat, but in addition it can benchmark activity rates for new projects against activity rates of sites with a known rate of bat fatality.

Figures 2 and 3 show the number of pipistrelle and Nyctalus bat passes respectively per location per night at different percentiles compared to the same values derived from operational projects with different categories of bat fatality. From these data it is predicted that without mitigation, the bat activity at Harestanes South Renewable Energy Development would generate fatality rates classified as per Table 1.

Detector location	Pipistrelle fatality rate	Nyctallus fatality rate
SM01	High	None-high
SM02	High	None-high
SM03	High	High
SM04	High	None-high
SM05	None-high	None-high
SM06	None-high	None-high
SM07	None-high	None-high

Detector location	Pipistrelle fatality rate	Nyctallus fatality rate
SM08	High	High
SM09	High	High
SM10	High	High
SM11	High	High
SM12	None-high	None

Table 1: Predicted bat fatality rates for each detector location in the absence of mitigation

Since the predicted bat fatality rate at most locations has the potential to be high for either one or both key bat genus, the mitigation measures will comprise curtailment of the operation of all wind turbines during certain weather conditions.

Based on work done at other operational windfarms in upland forested sites in south-west Scotland, 90% of Pipistrelle bat activity occurs when wind speeds are below 5.5 m/s and temperatures are above 11 degrees Celsius at nacelle height (Figure 4). The curtailment would apply between 30 mins post-sunset and 40 mins pre-sunrise. As such they will be used as the starting parameters for curtailing turbines at Harestanes South Renewable Energy Development. The mitigation measures will be implemented at each turbine between 1st April – 31st October each year for the lifetime of the Development unless monitoring results necessitate a change.

This approach has been implemented successfully at the adjacent Harestanes Windfarm, and post-mitigation monitoring in 2016 showed that bat fatalities were close to zero using these parameters.

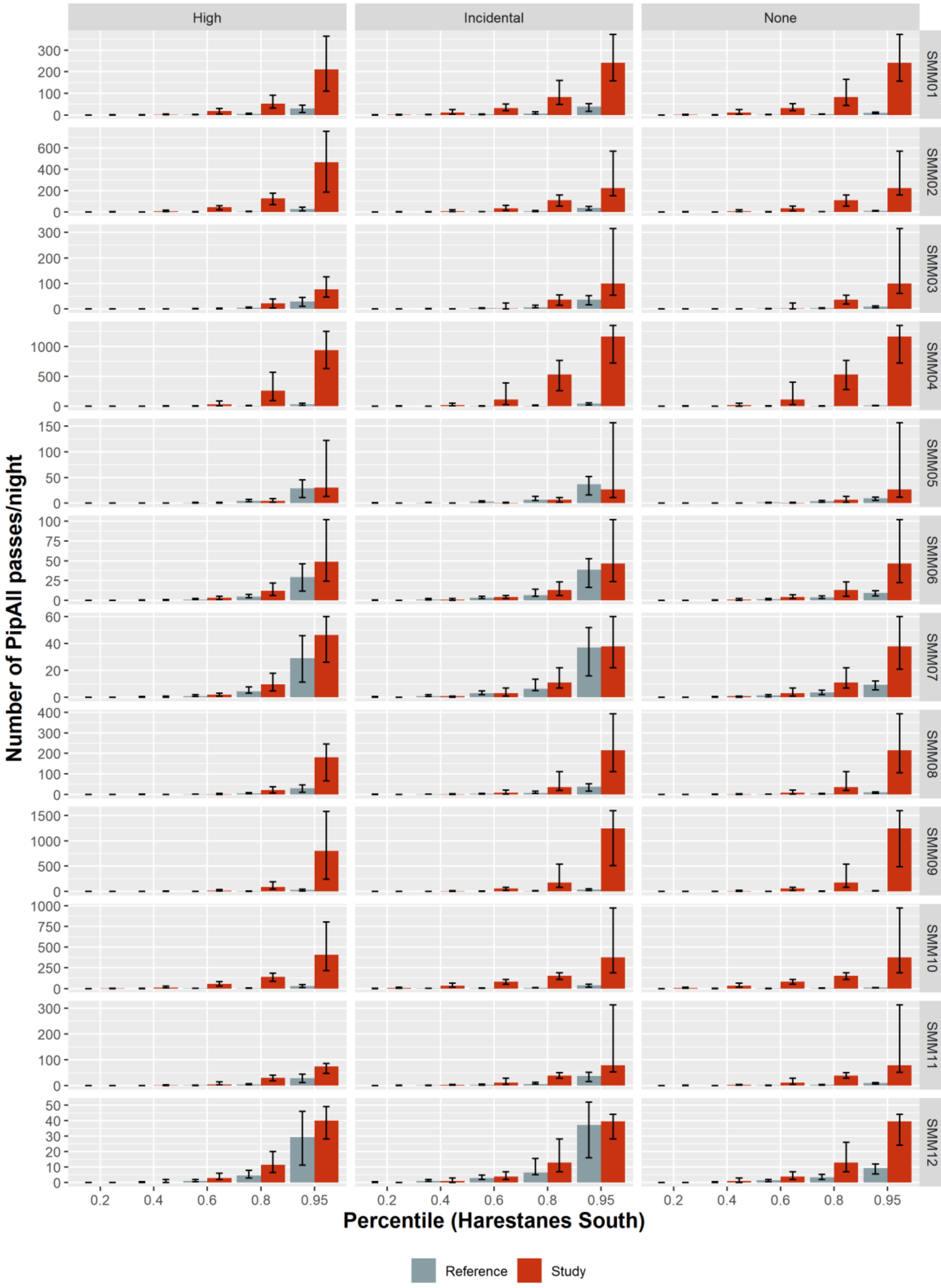

Figure 2: Number of pipistrelle bat passes per night per location at different percentiles compared to operational projects with a known category of bat fatality. Error bars are 95% CIs derived using bootstrap methods due to non-normal distribution of the datasets.

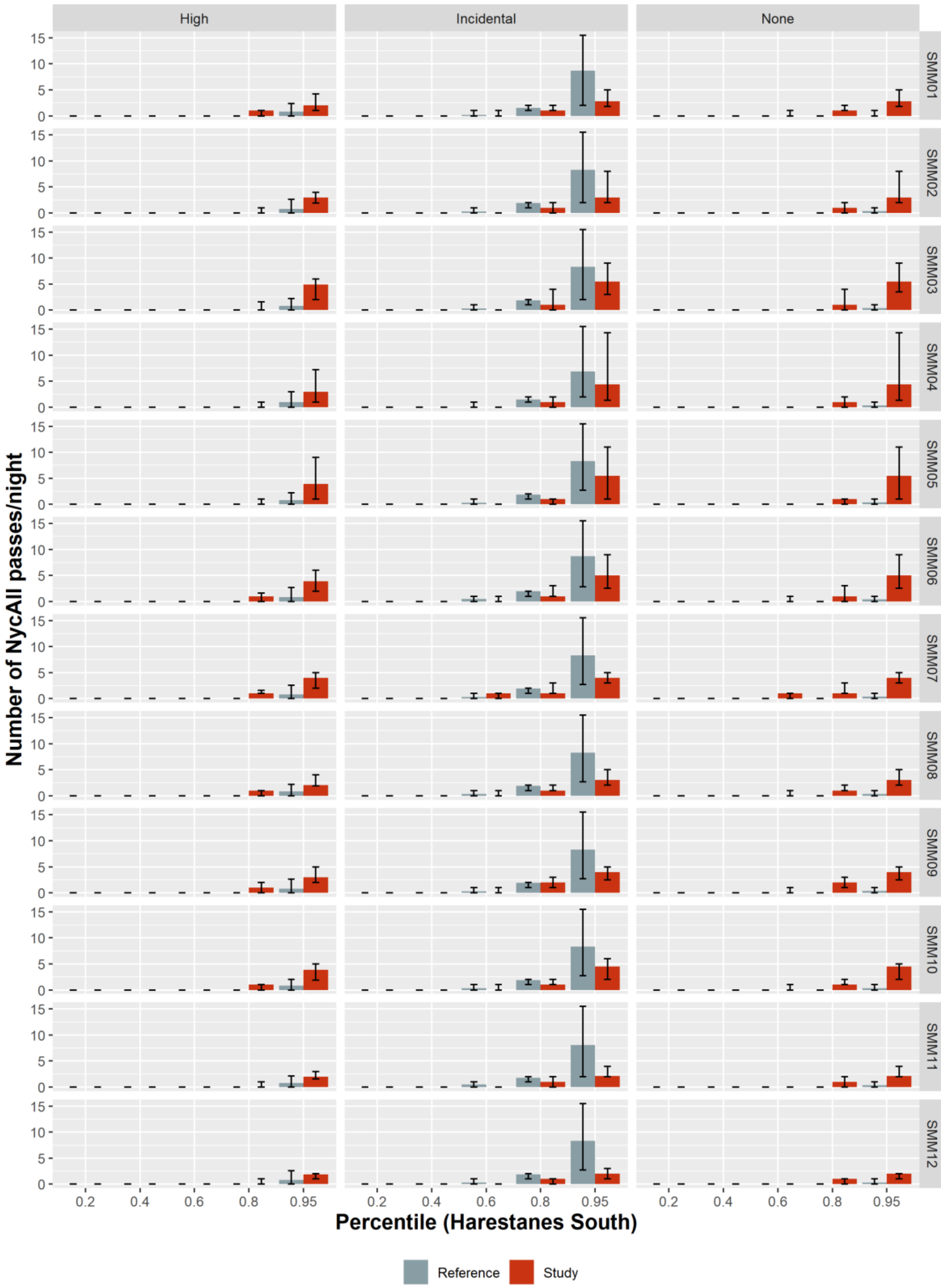

Figure 3: Number of Nyctallus bat passes per night per location at different percentiles compared to operational projects with a known category of bat fatality. Error bars are 95% CIs derived using bootstrap methods due to non-normal distribution of the datasets

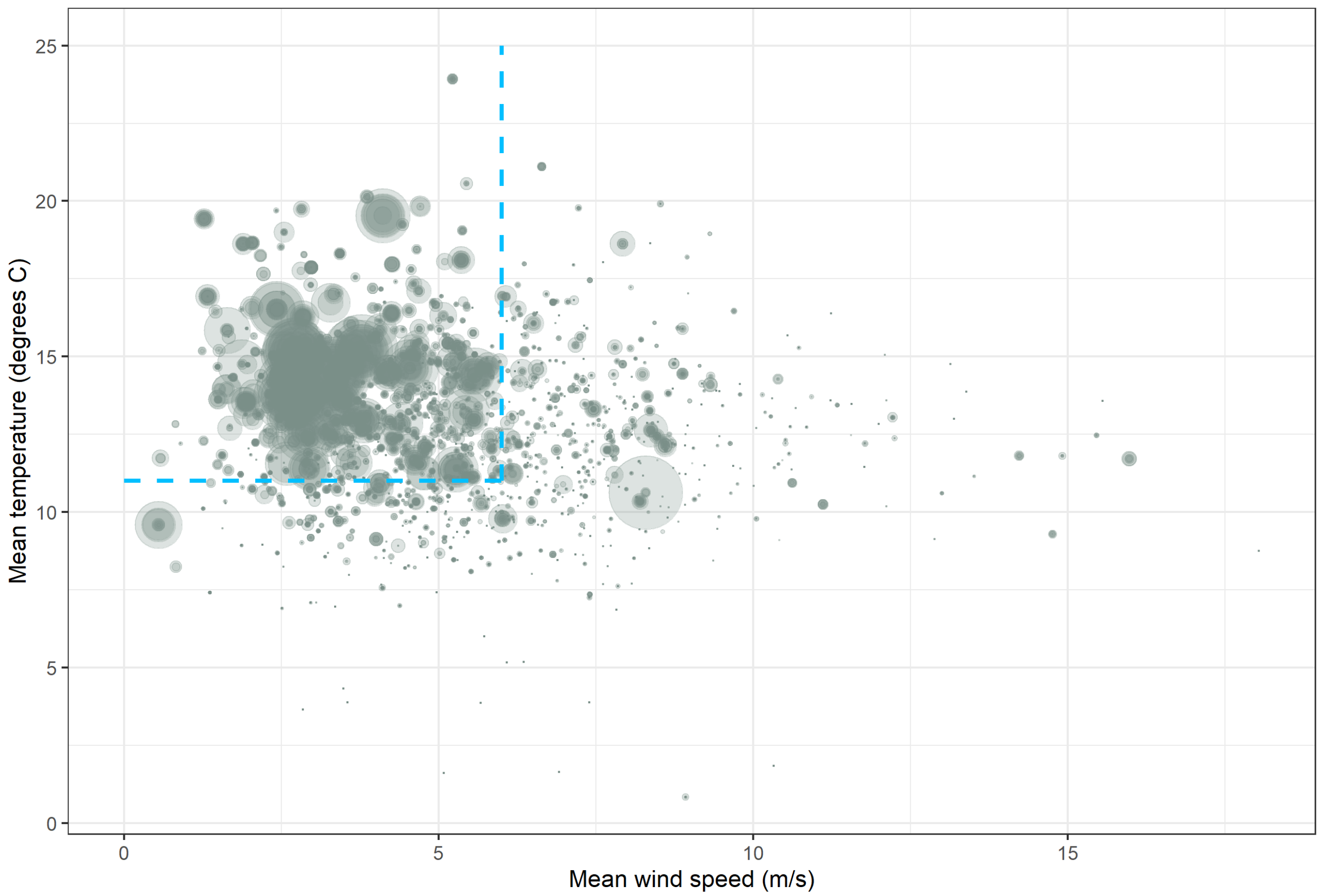

Figure 4: Typical pattern of bat Pipistrelle activity compared to wind speed and temperature parameters measured at upland operational windfarms in south-west Scotland. The dashed lines indicate the 5.5m/s windspeed and 11 degrees C thresholds which correspond with circa. 90% of all activity.

3 Implementation

The implementation of the mitigation will be via software which will automatically send a "pause" command to the relevant turbine when the parameters are met, initiating a feathering of the blades to the fully open position using the pitch controls and disengagement of the generator. This will slow the rotation speed of the blades to below 1 RPM (i.e. slower than the second hand of a clock). The emergency braking system shall not be used.

The wind speed will be obtained from each turbine anemometry apparatus (on the nacelle) via the Supervisory Control and Data Acquisition (SCADA) interface. The control software will run within the proprietary SPR Centre of Operation of Renewable Energy (CORE) system.

This method of control has already been established and is used for another SPR windfarm, Figure 5 is a screenshot of the parameter input window for this project within CORE. Note that the example includes a parameter for temperature which can be used if curtailment is required, as well as offsets for sunset and sunrise if required.

Note that in the example of Figure 5 there is a "Speed Lo limit" of 5.5 m/s, below which the turbine would enter a "pause" state, and a "Speed Hi Limit" of 5.6 m/s above which the turbine would "run". The reason for this is to stop the turbine rapid cycling between "pause" and "run" when the wind speed is averaging 5.5 m/s.

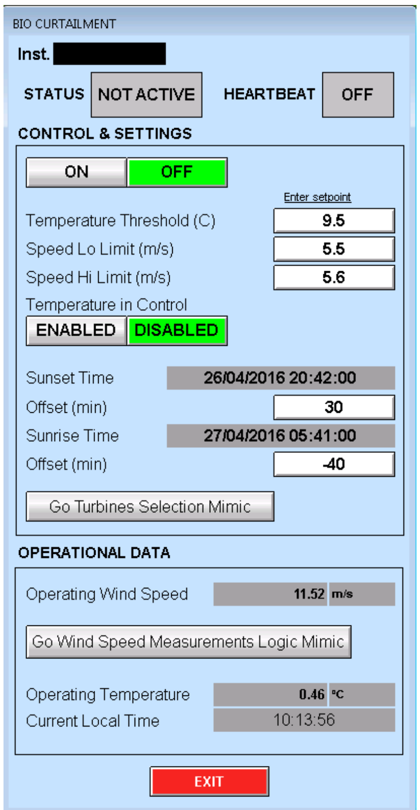

Figure 5: Screenshot of the curtailment parameter input window within CORE in use for another SPR windfarm.

4 Auditing

All turbine sensor data reported via SCADA is logged in a PI database[2]. This includes the wind speed and temperature data recorded at each turbine anemometry, as well as a TRUE/FALSE flag as to whether the mitigation system was in operation. As such it is a simple process to download the data over any period to validate that the system was operating according to the chosen parameters. An example of this output for another SPR windfarm is displayed in a graphical format in Figure 6. A similar output would be included in the annual report of the system operation for the proposed Development.

[2] PI is a commercial product of OSISoft: https://www.osisoft.com/pi-system/

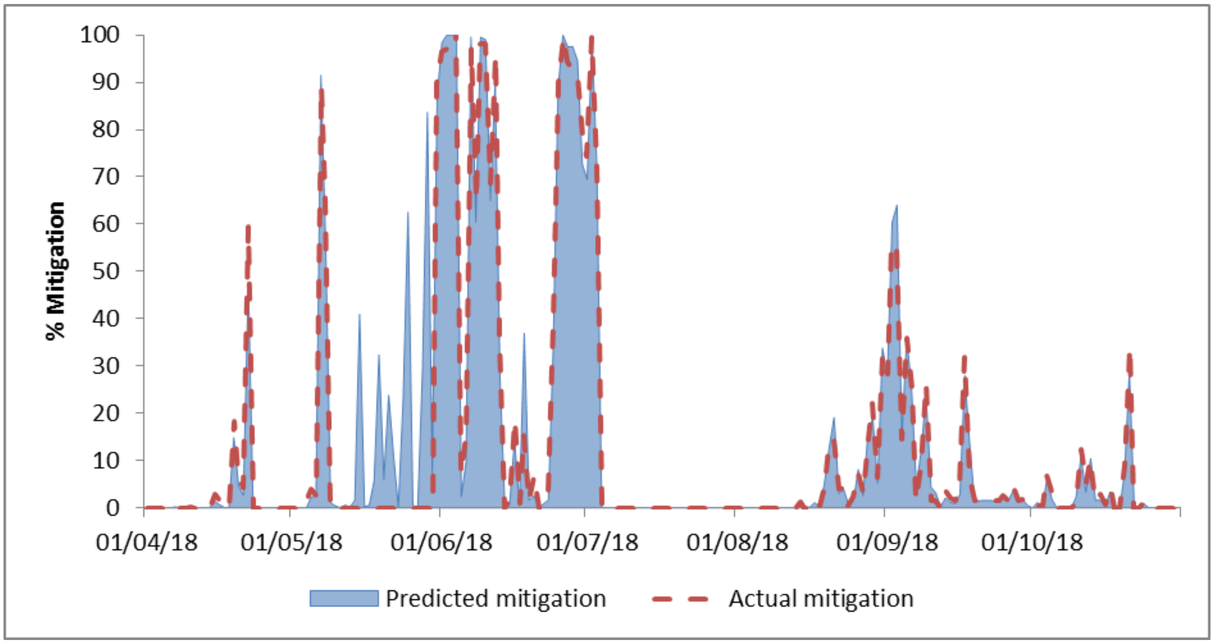

Figure 6: Example output of the auditing available from turbine SCADA data for another SPR windfarm in 2018. The blue shaded areas show the predicted mitigation (based on weather data) and the red dashed line shows the actual mitigation implemented during each night automatically by the CORE software. Data not available during two periods of site outage 9-29th May and 5th July – 12th August, when turbines were non-operational.

5 Monitoring

5.1 Rationale and Objective

Monitoring would comprise measurement of bat activity and fatality rates and would be undertaken annually until validation of the initial parameters and any amendments are established in consultation with SNH.

The maximum increase to natural mortality due to bat fatalities which is considered unlikely to have a significant impact on bat populations, and therefore deemed 'incidental', is considered to be 2 bat fatalities per turbine per year. This is based on fatality thresholds applied at German windfarm sites (irrespective of species present) and is achievable without excessive losses in power production (yield)[34].

The basis of "incidental" levels of bat mortality arising from windfarm operation being criminal was considered in RWE vs Eaton 2012 in England, which ruled that a threshold of bat fatalities must exist to enable legitimate activities to take place.

[3] Behr, O. (2015). 'Bat-friendly' operation of wind turbines – the current status of knowledge and planning procedures in Germany. Presentation at Wind Power and Wildlife Symposium, Stirling University.

[4] http://www.windbat.techfak.fau.de/tools/index_en.shtml ProBat tool used in Germany to help select curtailment parameters to achieve <2 fatalities / turbine / year

The objective of the monitoring is to provide a robust estimate of the total number of bat fatalities, which will be used to determine whether the mitigation is effective. There is no specific objective to determine the specific weather conditions under which a fatality may have occurred, since the hypothesis at Year 1 is that the mitigation would be effective. As such the proposed sampling approach varies from that suggested in Appendix 4 of the guidance[2].

5.2 Overview

The survey methodology will comprise static bat detectors at 6 randomly selected wind turbines during July – September inclusive which is when most fatalities are found to occur. This represents a precautionary approach in that if bat fatality rates are sufficiently low during this period, they are highly unlikely to be greater at other times of year. Therefore if the mitigation is effective during this period, it will be effective during periods of lower levels of activity. The use of 6 turbines is considered to provide a representative sample (75% of turbines sampled) and is coincident with the number of turbines which can reliably be searched by a dog team in a single day.

Microphones will be mounted 2 m height above ground level and positioned horizontally facing away from turbine towers.

Carcass searching will be undertaken within a 50 m radius at the same 6 turbines every 2 weeks from 1st July until end of September i.e. 7 searches in total. An example search schedule, which was used for the worked example below, is shown in Table 2. The search schedule will be adapted, should turbines be non-operational or not revolving during the night prior to the scheduled search.

A worked example of the expected parameter estimation and resulting precision of estimates is described below.

Search Date	T1	T2	T3	T4	T5	T6
1st July	1	1	1	1	1	1
15th July	1	1	1	1	1	1
29th July	1	1	1	1	1	1
13th August	1	1	1	1	1	1
27th August	1	1	1	1	1	1
10th September	1	1	1	1	1	1
24th September	1	1	1	1	1	1

Table 2: Example search schedule using 14 day search interval

5.3 Estimates and Precision

All sampling methods are a pragmatic compromise, and an acceptable threshold for the precision of the estimates must be made. The precision of fatality estimates is based on four key factors: carcass persistence rate; observer efficiency rate; search interval and proportion of area searched.

The median carcass persistence rate for bat carcasses at other SPR sites from n=111 trials has been estimated at 15.41 days[5]. This may vary at Harestanes South, and as such will be estimated across the monitoring period by placing n=5 bat carcasses distributed randomly below the n=6 turbines to be searched during each survey (i.e. n=30 bat carcasses trials in total). Each carcass will also be paired with a motion activated camera-trap, which will provide the exact timing as to when a carcass is removed. The carcasses will then be checked manually on the following survey and left in-situ if remains are still visible for a maximum of 4 weeks (i.e. 2 survey periods) then retrieved.

The search methodology will aim to achieve an observer efficiency rate of >80% (i.e. 80% of carcasses which are present are detected) and will calculate this using integrated trials of the n=30 carcasses placed to determine carcass persistence. Previous work at SPR sites using trained dog teams (and for the DEFRA study) has demonstrated that an observer efficiency rate of >0.81 is achievable. It is assumed that 95% of the area under the turbines will be searched since there are no ground conditions at Harestanes South which would restrict access, although this will be checked during surveys. Based on these parameters and a 14 day search interval (i.e. every 2 weeks), a median estimate of 62.9% (95% CI 56.7-69.5%)[6] of carcasses which exist will be detected.

Based on the above parameters, if n=4 carcasses were found the adjusted median total fatality estimate would be 8.85, with a 90% confidence interval between 4 and 14.42[7] (Figure 7).

[5] Calculated using GenEst "Carcass persistence" package, lognormal model

[6] Calculated using GenEst "Detection Probability" package

[7] Calculated using GenEst "Mortality Estimation" package

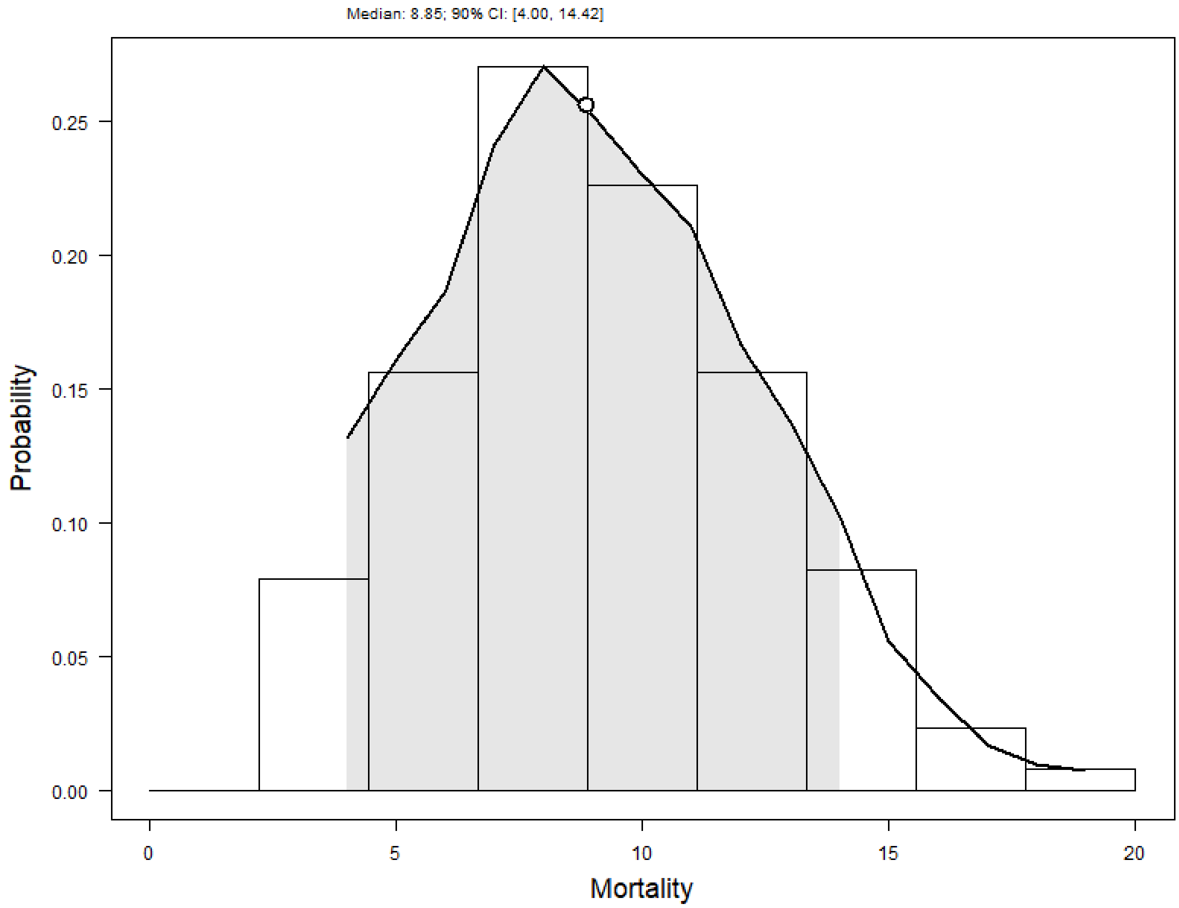

Figure 7: Probability distribution of estimates of true fatality rate based on the monitoring design described and a scenario where 4 carcasses are found.

Therefore, in order to be 95% confident that the true fatality rate is less than 2 bats per turbine per year (i.e. n=16 fatalities), 4 or fewer bat carcasses must be detected within the total search area using the survey methodology outlined above.

5.4 Analysis

Detailed analysis of the results will be undertaken using the USGS developed Generalised Mortality Estimator software[8], which combines different accepted methods of calculating fatalities into a single tool and allows different models to be fitted to datasets depending on their distribution. It also combines the calculation of different sources of error around each parameter into an estimate of uncertainty around the final estimate.

5.5 Change Management

Following each annual monitoring period, if the number of bat fatalities is less than 2 bats per turbine per year, the operator shall be entitled to propose amendments to the curtailment parameters. If the number of bat fatalities is greater than 2 bats per turbine per year, the operator shall be obligated to

[8] https://www.usgs.gov/software/genest-a-generalized-estimator-mortality

propose amendments to the mitigation. Any changes proposed will be consulted on with SNH and implemented the following year with repeated monitoring using the methods described above unless otherwise varied (e.g. to investigate condition in which fatalities are occurring).

6 References

Behr, O. (2015) 'Bat-friendly' operation of wind turbines – the current status of knowledge and planning procedures in Germany. Presentation at Wind Power and Wildlife Symposium, Stirling University

Dalthorp, D.H., Simonis, J., Madsen, L., Huso, M.M., Rabie, P., Mintz, J.M., Wolpert, R., Studyvin, J., Korner-Nievergelt, F (2018) Generalized Mortality Estimator (GenEst) - R code & GUI. U.S. Geological Survey Software Release

Mathews, F., S. Richardson, P. Lintott and D. Hosken (2016) Understanding the Risk to European Protected Species (bats) at Onshore Wind Turbine Sites to inform Risk Management. Final Report. University of Exeter

SNH, Natural England, Natural Resources Wales, Renewable UK, ScottishPower Renewables, Ecotricity Ltd, the University of Exeter & Bat Conservation Trust (BCT) (2019) Bats and Onshore Wind Turbines: Survey Assessment and Mitigation.

Windbat 2016, Federal Ministry for Economic Affairs and Energy Germany, accessed 8th May 2019, <www.windbat.techfak.fau.de/tools/index_en.shtml>