ScottishPower Renewables

Hare Hill Windfarm Repowering and Extension

Technical Appendix 7.5: Bat Mitigation and Monitoring Plan

November 2025

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1. Introduction

1. The assessment of bat activity at the Hare Hill Windfarm Repowering and Extension (the Development) identified four genera of bats present on site (*Nyctalus*, *Pipistrelle, Myotis and Plecotus*).

2. This document describes the mitigation measures and monitoring programme which will be implemented during the operational phase of the Development. It also describes the process by which any changes to mitigation measures will be made as part of feedback from monitoring data where required.

2. Fatality Estimates

3. Although the relationship between recorded bat activity and fatalities at windfarm sites in the UK remains unclear[1], ScottishPower Renewables (SPR) are able to infer this relationship to some extent by comparing activity data recorded at the Development to that collected from operational projects in the same or relatively close by region (i.e. central and south-west Scotland) which have a known rate of bat fatalities sampled by SPR.

4. SPR have conducted detailed acoustic and fatality monitoring of bats at 11 operational wind farms and acoustic monitoring aligned to the NatureScot *et al*. (2021) guidance[2] at 17 development phase projects. This combined dataset comprises data collected at 390 unique locations providing a total sample size of 31,964 detector nights of bat activity and 653,146 bat passes.

5. Carcass surveys have been undertaken at all 11 of the operational wind farms using methods consistent with the DEFRA study[2]. Of these, five were found to have zero bat fatalities, two had an "incidental" rate of fatality (considered to be equal or less than 2 bat fatalities / turbine / year) and four had fatality rates greater than 2 bat fatalities / turbine / year.

6. The data collected at the 11 operational wind farms indicates a relationship between bat activity and the rate of fatalities. Figure 1a (for Pipistrelle species) and Figure 1b (for *Nyctalus* species) below shows the 11 operational sites ranked by bat activity and colour coded by the category of fatality rate. Locations with higher activity generally tended to have higher rates of fatality, although the relationship is not directly proportional and there are several exceptions.

[1] 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. DEFRA, UK.
[2] NatureScot, Natural England, Natural Resources Wales, RenewableUK, ScottishPower Renewables, Ecotricity Ltd, the University of Exeter and the Bat Conservation Trust (2021). Bats and Onshore Wind Turbines: survey, assessment and mitigation.

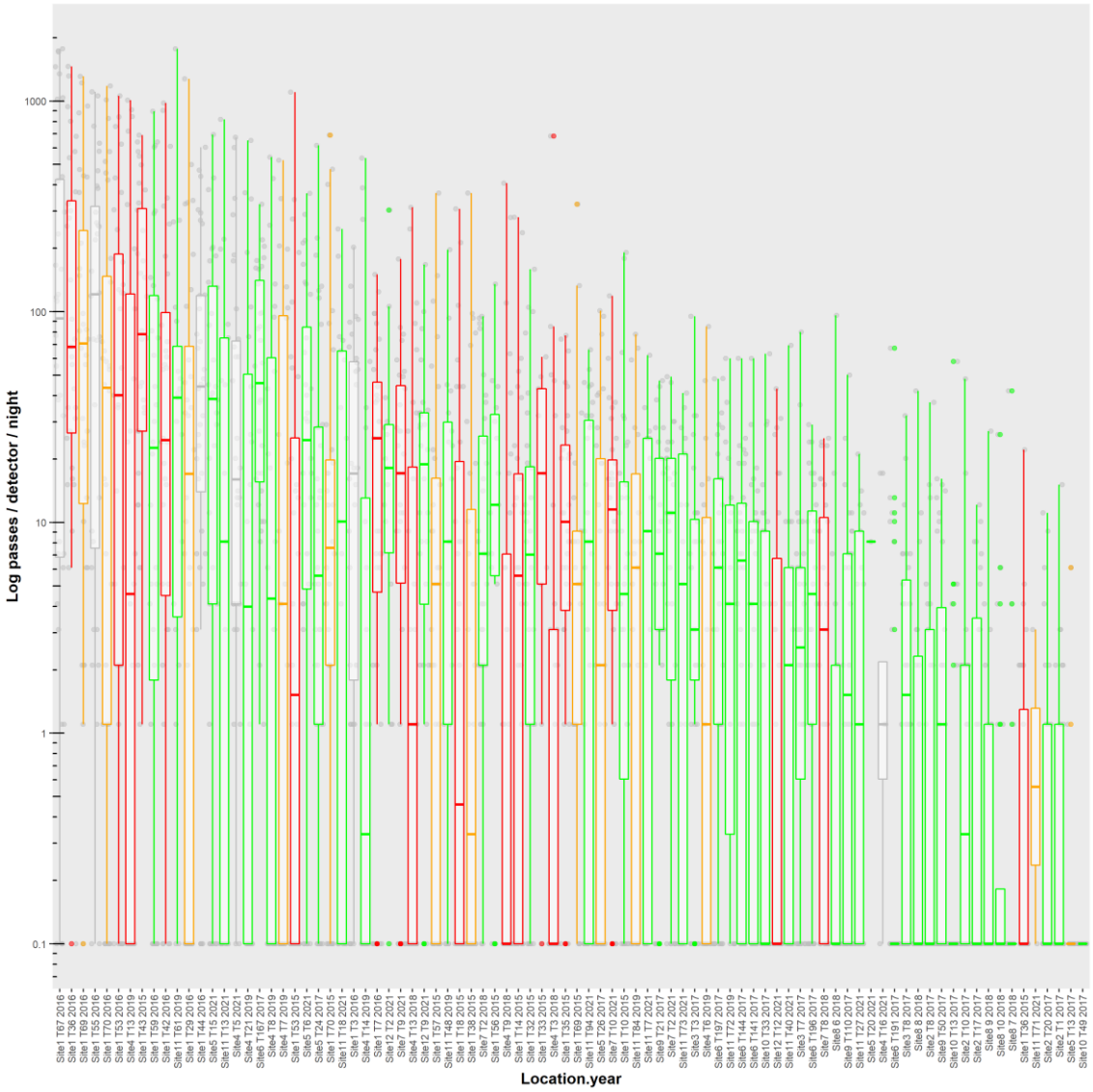

Figure 1a: Operational wind farm monitoring locations ranked left to right in descending order of Pipistrelle species activity (recorded 15th August – 15th September), shown both as box plots of the overall dataset and individual samples as grey points. Red locations had >2 fatalities / turbine / year; amber locations had <=2 fatalities / turbine / year; green locations had zero fatalities detected.

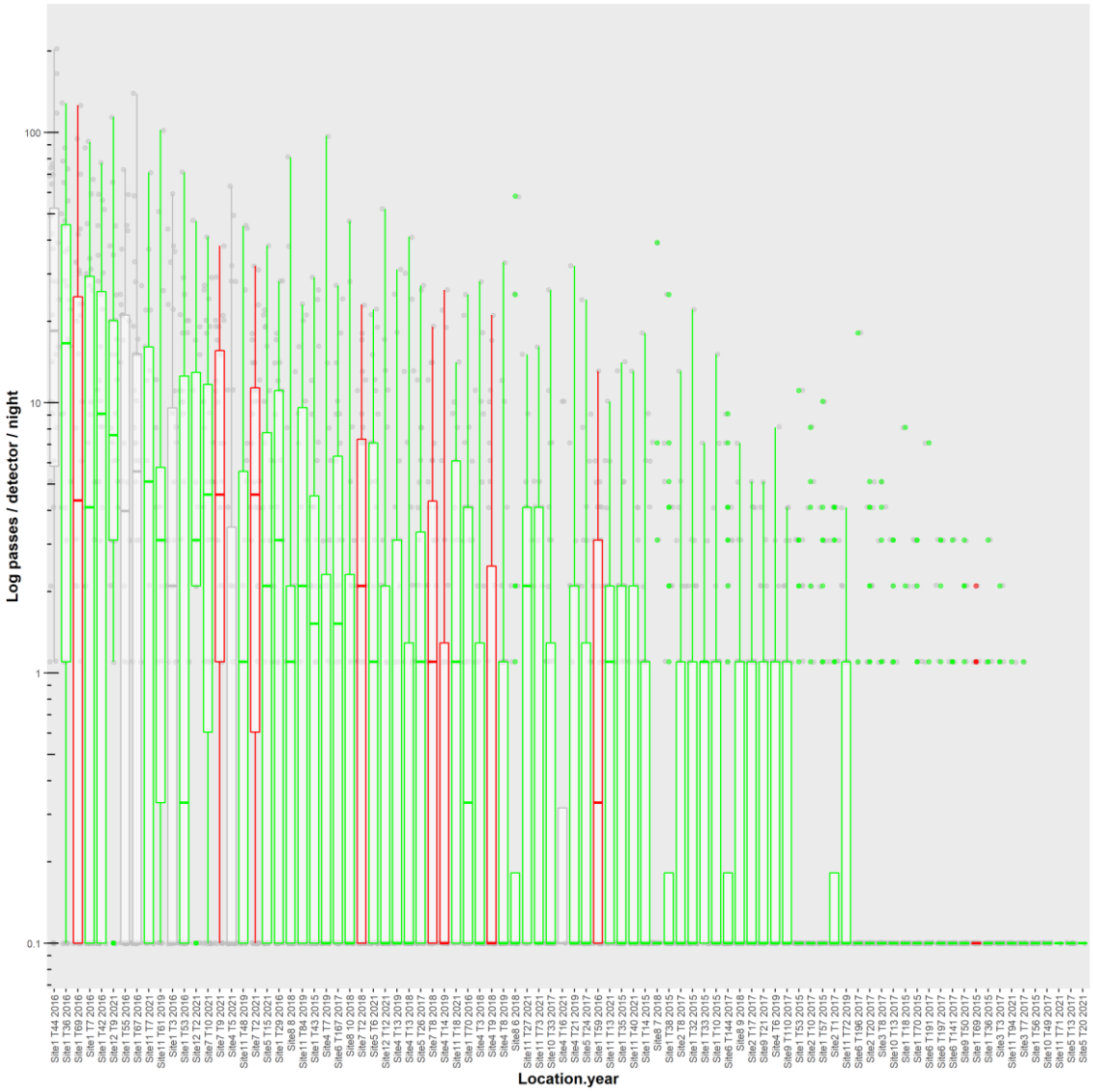

Figure 1b: Operational wind farm monitoring locations ranked left to right in descending order of *Nyctalus* species activity (recorded 15th August – 15th September), shown both as box plots of the overall dataset and individual samples as grey points. Red locations had >0 fatalities / turbine / year; green locations had zero fatalities detected.

7. This dataset can be used as a reference for new projects with unknown bat fatality rates by providing a comparison of bat activity within a region in a similar manner to EcoBat[3], but in addition it can benchmark activity rates for new projects against activity rates of sites with a known rate of bat fatalities.

2.1. Acoustic Surveys

8. Acoustic detectors were deployed at 17 locations across the Development between April-October 2023 (Map 1). The detectors were left to record continuously for 30 nights for each of the three survey blocks within this period (spring, summer and autumn). The resulting activity was analysed

[3] *http://www.ecobat.org.uk/*

alongside SPR reference data. This analysis focused on *Pipistrellus* and *Nyctalus* activity levels as they make up 94% of all call activity over the survey period.

9. Figures 2 and 3 show the number of *Pipistrellus* and *Nyctalus* bat passes respectively per location per night at different percentiles, and overall means 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 the Development would generate fatality rates classified as per Table 1.

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

Detector location	Pipistrelle fatality rate	*Nyctalus* fatality rate
Loc1	> Incidental	None
Loc2	> Incidental	> Incidental
Loc3	None - > Incidental	> Incidental
Loc4	> Incidental	> Incidental
Loc5	None	None
Loc6	None	None
Loc7	None - > Incidental	None
Loc8	None	> Incidental
Loc9	None	None
Loc10	None - > Incidental	None
Loc11	None	None
Loc12	None - > Incidental	None
Loc13	None	None
Loc14	None	None
Loc15	None	None
Loc16	None	None
Loc17	None	None

The predicted fatality rate for *Pipistrellus* bats is greater than incidental at three of the monitoring locations when compared to reference data. Additionally, the predicted bat fatality rates for *Nyctalus* bats were found to be greater than incidental at four monitoring locations.

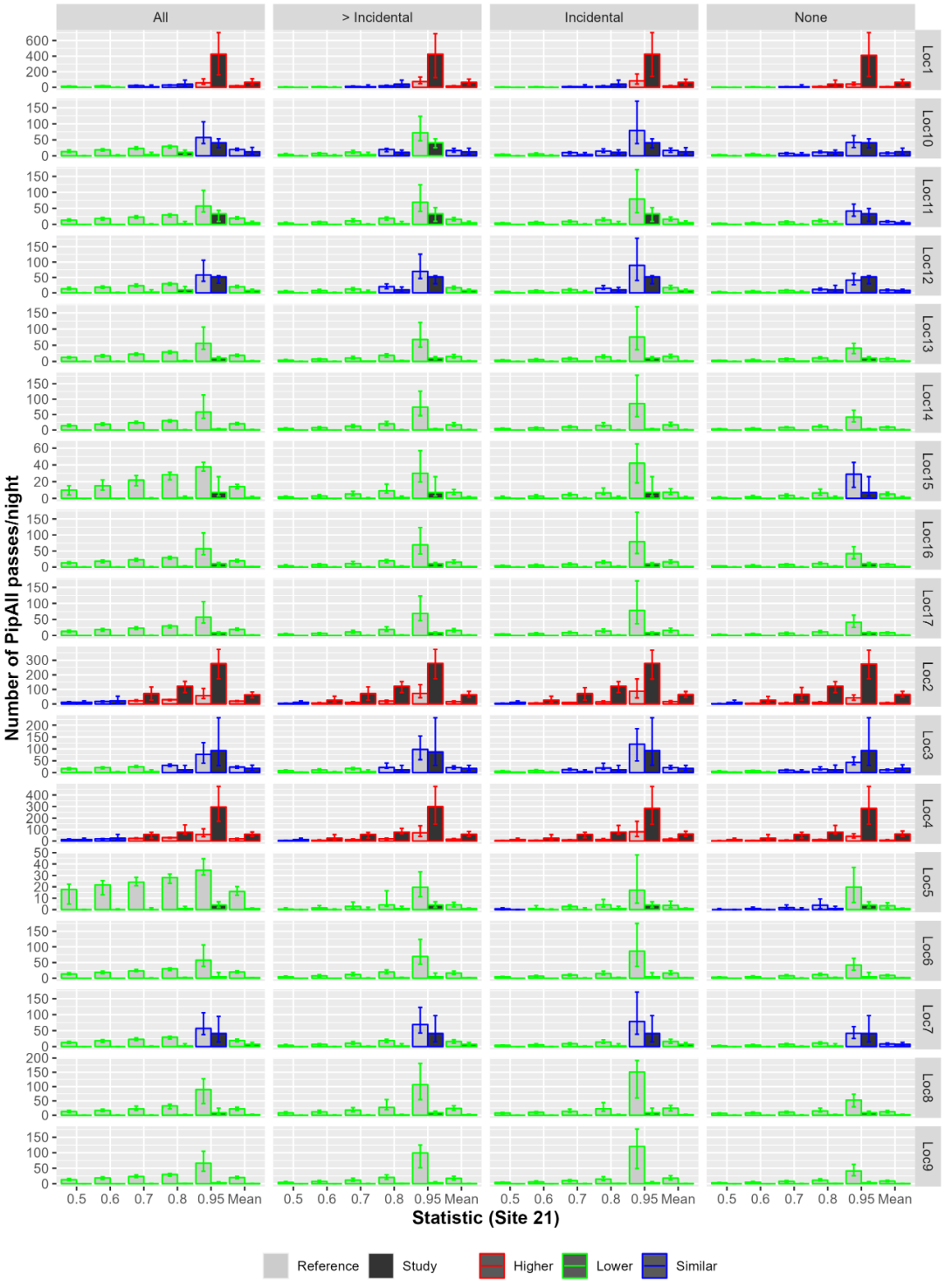

Figure 2: Number of *Pipistrellus* bat passes per night per location at different percentiles compared to operational projects with a known category of bat fatality. Error bars are 95% CIs derived using bootstrap methods due to non-normal distribution of the datasets.

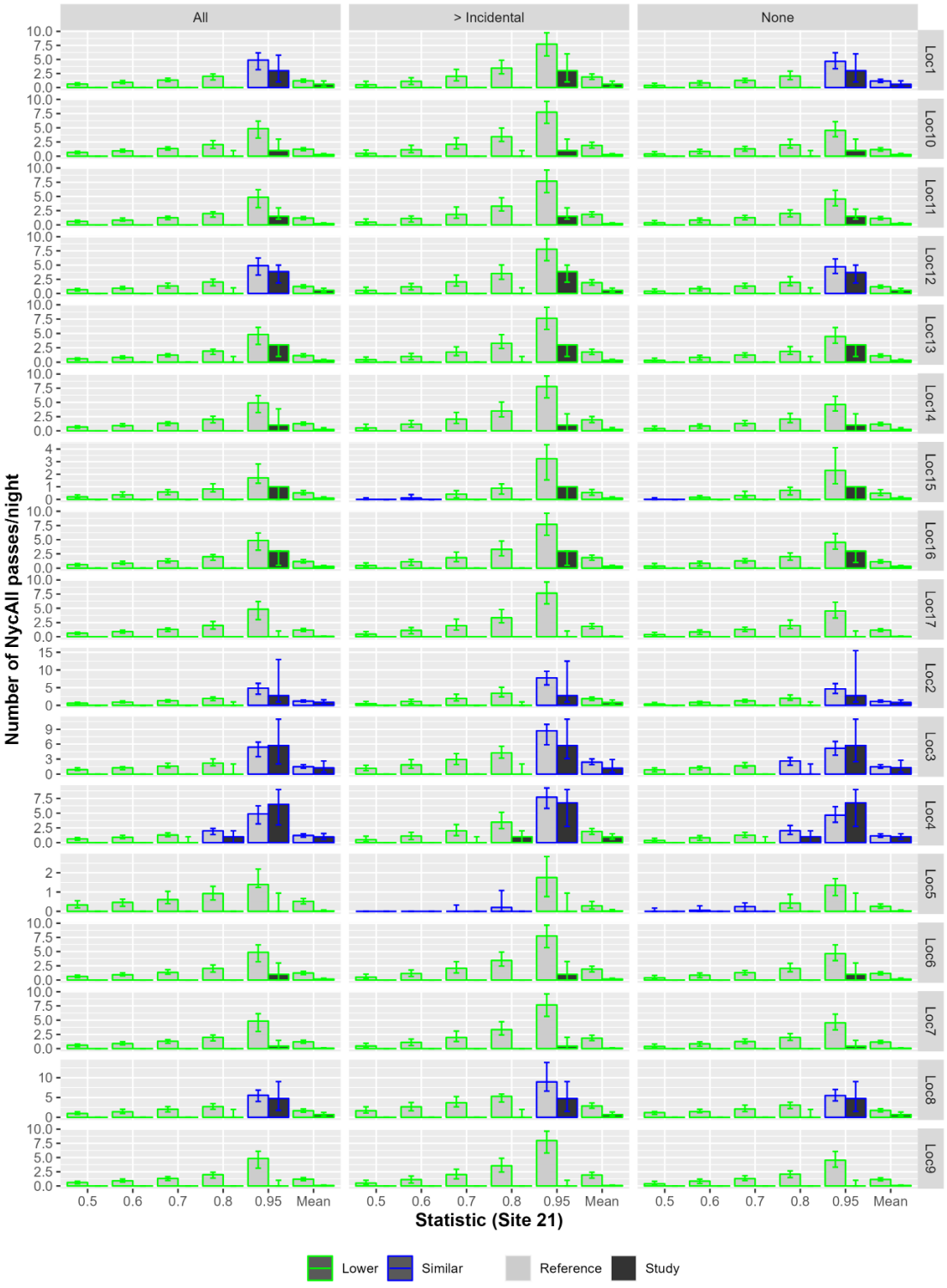

Figure 3: Number of *Nyctalus* bat passes per night per location at different percentiles compared to operational projects with a known category of bat fatality. Error bars are 95% CIs derived using bootstrap methods due to non-normal distribution of the datasets.

2.2. Carcass searches

10. The existing turbines at the operational Hare Hill windfarm were searched for carcasses as this is considered to be the best way to assess the current fatality levels at this site as well as predicting likely fatality levels at the Development.

11. Carcass searches were completed in line with NatureScot *et al.* (2021)[2] guidance at 24 randomly selected turbines at Hare Hill windfarm between July and September 2024. A dog team was utilised to identify any bat carcasses on the hardstanding of the surveyed turbines.

12. A total of 3 bat carcasses were found during the search period, two *Pipistrellus* sp. and one *Nyctalus*. Using the number of turbines searched during this period, this equates to 0.13 bats per turbine.

13. The results of the carcass searches were run through GenEst to estimate the number of bat fatalities per turbine across the whole operational site, which has 55 turbines, during the survey period. This produced a median fatality estimate of 12.48, with a 95% confidence interval between 4 and 23.3[4] (Figure 4).

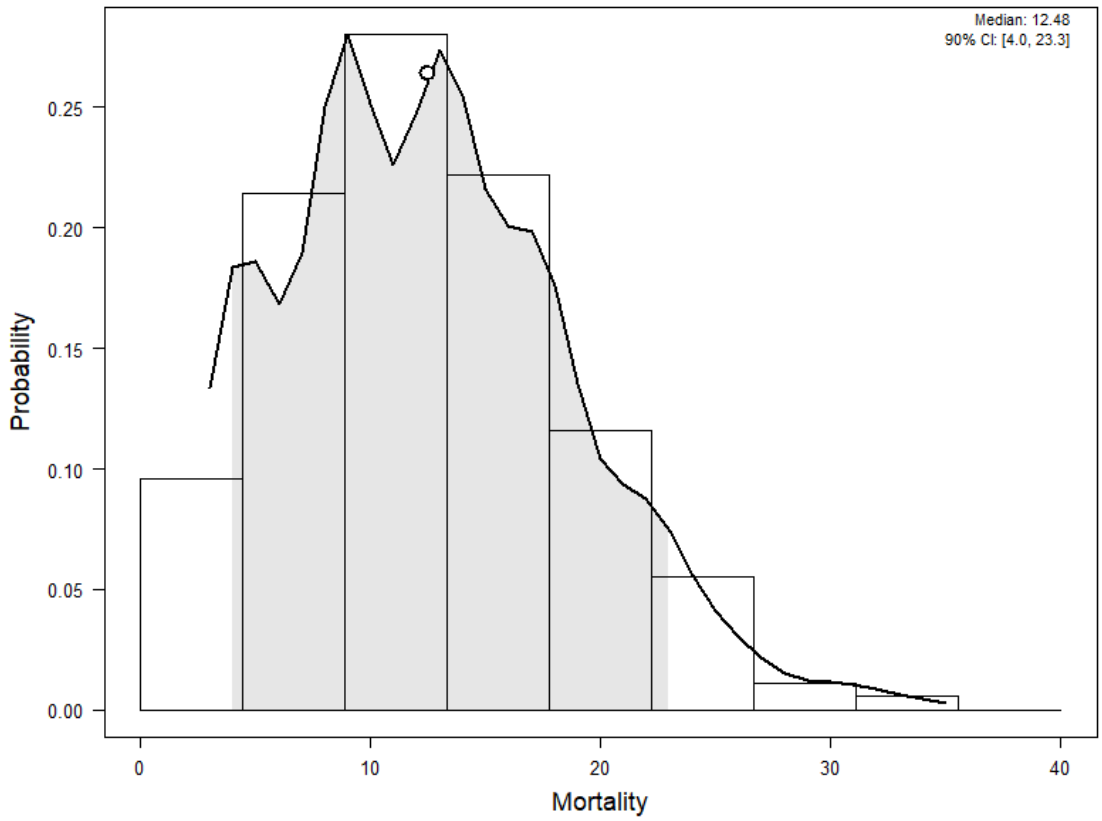

Figure 4. Probability distribution of estimates of true fatality rate across the operational Hare Hill windfarm based on the three carcasses found during the carcass searches.

[4] *Calculated using GenEst "Mortality Estimation" package*

14. Based on this estimate, 0.23 bat fatalities per turbine occurred at the operational Hare Hill windfarm over this survey period. This is less than the recommended 2 bats per turbine threshold, suggesting the operational site poses an acceptable low risk to bats.

2.3. Analysis

15. The acoustic monitoring suggests higher levels of activity for both *Pipistrellus* sp. and *Nyctalus* bats at several locations throughout the site, but the fatality monitoring implies a low risk to bats during the survey period. However, there are several limitations which lead to difficulty in drawing conclusions from these two datasets.

16. The acoustic and carcass surveys were completed in different years. Bat activity can vary between years, and as such NatureScot *et al*. (2021)[2] guidance suggests both acoustic and fatality surveys should be completed within the same year. Therefore, the results from the acoustic and fatality survey cannot be confidently compared with each other.

17. Moreover, the turbines at the operational Hare Hill Windfarm are smaller than the turbines proposed for the Development, and in greater number. The guidance from NatureScot *et al*. (2021) states that relevant surveys from the operational site should be used to assess whether the proposed changes from a repower are likely increase the risk of bat mortality[2]. However, there is little research on the relationship between carcass numbers at an operational windfarm and the subsequent repowered windfarm. As such, it is difficult to conclude that the above fatality estimates would be reflective of the those at the Development.

3. Mitigation and Monitoring

18. As a standard mitigation measure by design, no turbines will be located where any part of their structure or blade will fall within 50m of features of value to bats (unless agree by the Planning Authority).

19. Due to the mixed conclusions from the analysis detailed in Section 2.3, no further mitigation is recommended at this time. Nonetheless, it is proposed that the Development is assessed again upon windfarm commissioning, using both acoustic surveys and carcass searches. Analysis of this monitoring data will indicate if any further mitigation is required and this plan will updated accordingly.

4. Monitoring

4.1. Rationale and Objective

20. Monitoring will comprise measurement of bat activity and fatality rates and would be undertaken annually for a period of two years following the commissioning of the windfarm.

21. 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 two bat fatalities per turbine per year, which would be an annual total of 46 bat fatalities at the proposed Development.

22. This is based on fatality thresholds applied at German windfarm sites (irrespective of species present) and is usually achievable without excessive losses in power production (yield)[5][6]. Due to the limited data available on bat populations and bat ecology in Scotland it is not possible to predict exact impacts on bat populations, therefore applying a fatality value from within a European context is the best currently available method of establishing a threshold.

23. 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.

24. The objective of the monitoring is to provide a robust estimate of the total number of bat fatalities at the Development, which will be used to determine whether the mitigation is effective. The proposed sampling approach is in line with current NatureScot guidance[2].

4.2. Overview

4.2.1. Acoustic monitoring

25. The survey methodology will comprise static bat detectors (full spectrum) at 12 randomly selected wind turbines through two survey periods (summer and autumn)[7], and will ensure mid-August to mid-September is included, which is the period when most fatalities are found to occur. During each survey period the loggers will continuously record for a period of 30 nights. All data collected during the survey periods will be analysed. Using 12 turbines provides a representative sample size of the proposed Development (~50% of turbines).

26. This represents a precautionary approach in that if bat fatality rates are sufficiently low during this period they are unlikely to be greater at other times of the year.

27. Microphones will be mounted at least 2m high above ground level and positioned horizontally facing away from turbine towers.

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[5] 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.
[6] 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.
[7] *Spring is not included as carcass monitoring is only undertaken in two seasons according to NatureScot et al. (2021) guidance Appendix 4.*

28. Wind speed and temperature data averaged over 10 minute periods will be obtained from anometry located in the nacelle of the operational turbines.

4.2.2. Carcass searches

29. Carcass searching will be undertaken using sniffer dogs trained to locate bat carcasses within accessible areas within a 50m radius at the same 12 turbines across seasonal survey blocks. Seasons will be split into three survey blocks of 12 days. Within each 12 day block, searches will occur every four days (i.e. three visits per turbine per block). Searcher efficiency trials will be included throughout the carcass search survey blocks and in order to be appointed to do this work, search dog teams must be able to demonstrate a minimum searcher efficiency rate of 80%. 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.

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

Table 2: Example search schedule indicating number of search days

Season	Search Date	T1 - T12											
Summer	Block 1	3											
	Block 2	3											
	Block 3	3											
Autumn	Block 4	3											
	Block 5	3											
	Block 6	3											

4.3. Estimates and Precision

31. 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.

32. The median carcass persistence rate for bat carcasses at other SPR sites from n=111 trials has been estimated at 15.41 days[8]. This may vary at the Development and as such will be estimated across the monitoring period by placing n=3 bat carcasses (or suitable proxy such as dark coloured mice) distributed randomly below the n=12 turbines to be searched during the survey period (i.e. n=36 bat carcasses trials in total). Each carcass will also be paired with a motion activated camera-trap or checked manually, to provide the timing as to when a carcass is removed. Carcasses will be left in-situ if remains are still visible for a maximum of 4 weeks before being retrieved.

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

33. 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=36 carcasses. Previous work at SPR sites using trained dog teams (and for the DEFRA study) has demonstrated that an observer efficiency rate of >0.89 is achievable; recent observer efficiency trials using dog searches have achieved 100% efficiency rates. It is assumed that 95% of the area under the turbines will be searched since there are no ground conditions at the Development which would restrict access, although this will be checked during surveys.

34. Based on the above parameters, if n=22 carcasses were found the adjusted median total fatality estimate would be 45.8, with a 95% confidence interval between 34.4 and 59 (Figure 5).

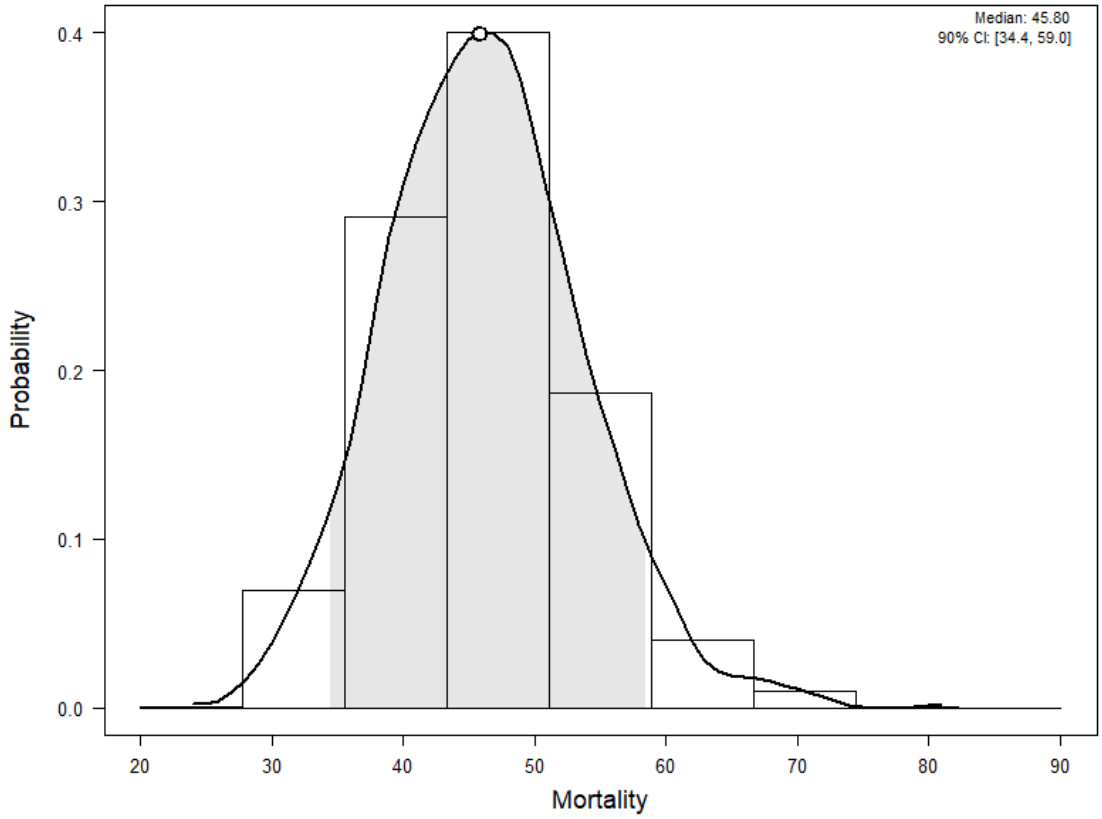

Figure 5: Probability distribution of estimates of true fatality rate based on the monitoring design described and a scenario where 22 carcasses are found.

35. Therefore, in order to be 95% confident that the true fatality rate is equal or less than 2 bats per turbine per year (i.e. n=46 fatalities), 22 or fewer bat carcasses must be detected within the total search area using the survey methodology outlined above.

4.4. Analysis

36. Detailed analysis of the carcass search results will be undertaken using the USGS developed Generalised Mortality Estimator software[9], which combines different accepted methods of calculating fatalities into a single tool and allows different models to be fitted to datasets depending

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

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.

4.5. Change Management

37. Following each annual monitoring period, if the number of adjusted bat fatalities is greater than 2 bats per turbine per year, the operator shall propose amendments to the mitigation to reduce the number of fatalities to equal or less than 2 bats per turbine per year. An assessment of bat activity in relation to weather conditions will be made in order to determine weather parameters suitable for the site location. Analysis of data on other SPR windfarms has found that 90% of bat activity takes place below wind speeds of 5m/s and temperatures above 11.5°C.

38. Any changes proposed will be implemented the following year and monitored for two subsequent seasons using the methods described above unless otherwise varied.

39. Annual reports will be submitted to NatureScot for each year monitoring has been undertaken.

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.

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