Appendix 7.1: Bat Survey Report

Appendix 7.2: REDACTED- Confidential Badger and Otter report

Bat Survey Report for Mullaghclogher Windfarm, Co. Tyrone

For: res power for good

September 2023

Document history

Author	Michelle Duggan	24/04/2023
Checked	Cormac Loughran	19/09/2023
Approved	Cormac Loughran	19/09/2023

Client Details	
Contact	Ellen Cross
Client Name	Res UK & Ireland. Ltd
Address	Willowbank Business Park, Millbrook, Larne, County Antrim, BT40 2SF

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Registered Office:
Blackstaff Ecology Ltd
First Floor
19 Arthur Street
Belfast
BT1 4GA

Reg No: NI 616090
VAT No: 152 5823 15

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Executive Summary

This is a brief summary of survey results. For full details please read the report in its entirety.

- No bat roosts were recorded during surveys. As a result, the proposed development was assessed as having a negligible potential to impact upon roosting bats.

- Activity levels were **low** across 69% of the automated static monitoring period.

- Significant levels of bat activity (i.e., a BAI of >5) were recorded at all turbines (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 12) , on 60 of the 308 survey nights (by individual species) with negligible or low activity on all other nights.

- Therefore, all turbines may potentially present a risk to foraging/commuting bats, particularly Pipistrelles and Leisler's bats. The collision risk of the proposed development on foraging and/or commuting bats was assessed as **high**.

- A detailed BMMP (Bat Monitoring & Mitigation Plan), including carcass searches/curtailment has been recommended.

- With this mitigation, the development will not have a significant impact on local bat populations.

Introduction

1. Blackstaff Ecology Ltd. was commissioned by RES UK & Ireland Ltd. to assess bat activity at a proposed windfarm (of 13 turbines) situated between the townlands of Donemana and Plumbridge Co. Tyrone.

2. The site was initially identified as being of low risk (see Table 4.4, Chapter 10 BCT Good Practice Guidelines (2012) due to the presence of largely low-quality foraging habitat for bats (blanket bog, upland heath and improved grassland) across the majority of site, with small areas of potential foraging habitat for bats (river, and lines of trees) that mosaic through the site. Outside of the site, there are larger areas of woodland to the south and west. The site and surrounding area are a mix of plantation woodland, improved fields with areas of raised bog.

3. The Scottish Natural Heritage (SNH) 2021 guidance *"Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation."* This guidance draws on the findings of the DEFRA-led research *Understanding the "Risk to European Protected Species (bats) at Onshore Wind Turbine Sites to inform Risk Management (Mathews et al. (2016))"* hereafter referred to as the National Bats & Wind Turbines Project.

4. The NIEA Natural Environment Division (2022) - Guidance on Bat Surveys, Assessment and Mitigation for Onshore Wind Turbine Developments in Northern Ireland; applies to both proposed single wind turbine developments and wind farms.

5. Therefore, the methodology undertaken as part of the current study has taken due cognisance of these guidelines by monitoring eleven of the proposed turbine locations for ten consecutive nights during each season (spring, summer and autumn), as recommended by the SNH 2019 guidance. This equates to a total of 30 nights of static monitoring at eleven turbines.

6. The automated monitoring involves the placement of detectors at ten potential turbine locations plus a third of additional potential turbine sites. Bat activity levels between the various locations can then be compared in order to build up a picture of the levels of activity within the site.

7. All detectors used/methods of recording allow for the identification of all species of bat and store the information for later analysis (as required by the NIEA guidance[1]).

8. The aim of the current survey was to collect a robust dataset on the level and distribution of bat activity at the site, allowing for the assessment of any potential impacts of the proposed development on the local bat population.

Statement of Authority

9. The survey was designed by Cormac Loughran (CEnv MCIEEM MSc), Director of Blackstaff Ecology Ltd. Static detector deployment was undertaken by Philip Leathem (Senior Environmental Technician). This report was prepared by Michelle Duggan (Assistant Ecologist) and updated and reviewed by Cormac Loughran.

10. Cormac is a Chartered Environmentalist (CEnv), and a full member of the Chartered Institute of Ecology

[1] https://www.daera-ni.gov.uk/sites/default/files/publications/daera/bat-survey-specifications.pdf

and Environmental Management (MCIEEM). He holds an MSc (Distinction) in Environmental Management from the University of Ulster, and has extensive experience in bat surveys; having undertaken and coordinated full bat surveys and associated impact assessments for more than 20 major wind farm developments, and 25 single turbines. He is also a licenced bat surveyor and regularly undertakes activities under licence from NIEA. Cormac has previously held a Natural England Disturbance Licence (20121610) for Bats (all species, (all counties of England)). He regularly attends lectures, courses and conferences, specifically relating to bats, for the purposes of CPD (Continuing Professional Development).

11. Michelle has a BSc (Hons) in Field Biology and wildlife tourism (1st class) from the Institute of Technology Tralee and an MSc in Ecological Management and Conservation Biology from Queen's University, Belfast. Michelle is also a Qualifying member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and holds a BTO ringing T- permit. She has gained professional and voluntary experience within the ecology and nature conservation sector working with organisations such as, The National Trust, Mourne Heritage Trust, RSPB NI and the Belfast Hills Partnership. Michelle also undertook an environmental internship within Astellas Pharma Co Ltd, Co. Kerry, completing a Preliminary Ecological Appraisal to facilitate future management of a site. Since joining Blackstaff in May 2021, Michelle has been involved in projects in Northern Ireland and ROI. She has completed various types of bat surveys including; bat carcass searches for over twelve single turbines each season (approx. 75 searches per annum), conducted over thirty emergence/ re-entry surveys, ten bat roost potential surveys and three PRF (Potential roosting feature) inspection surveys using an endoscope to search for evidence of bats within features on trees; experience utilising both static and handheld detectors and completed the associated reports.

12. Philip has worked as a Senior Environmental Technician with Blackstaff Ecology Ltd for over 8-years. He is responsible (among other things) for the upkeep and deployment of a suite of >50 static detectors (used on a wide variety of sites in any given year). To date he has deployed and gathered data on over 30 windfarms as well as 100 individual turbine installations. He is also currently working towards a degree in Environmental Science.

Legislation

13. All bat species found in Northern Ireland are listed under Appendix III of the Bern Convention and Annex IV of the EC Habitats Directive. In addition, bats and their habitats are listed under Appendix II of the Bonn Convention; therefore, there is an obligation to protect the habitat of bats, including links to important feeding areas. Bats also receive protection under Schedule 2 of the Conservation (Natural Habitats) Regulations (NI) 1995, as amended.

14. In relation to the above European Protected Species, it is an offence if:

- *They are deliberately captured, injured or killed*
- *These animals are disturbed in such a way as to significantly affect their ability to survive, breed, or rear / nurture their young, or in a way that affects the local distribution or abundance of that species*
- *A breeding site or resting place of these species is damaged or destroyed, even if this is unintentional and / or when the animal is not present*
- *Access to a structure or place used by these species for protection or shelter is intentionally or recklessly obstructed*
- *This legislation applies to all life stages of these species*

15. Also note that a licence may be required from the Northern Ireland Environment Agency for development work which is likely to affect a bat roost.

16. In addition to the above legislation, local planning authorities are also required to take into consideration natural heritage (including protected species and habitats) when a proposed planning application is being considered; the criteria used for this purpose are detailed in the guidance document 'Planning Policy Statement 2 (PPS2) – Natural Heritage'. The local planning authority should also consult with the Northern Ireland Environment Agency regarding protected species and / or habitats which may be present within the application area.

Bats & Wind Turbines

17. There is evidence from the USA and mainland Europe to suggest that wind turbines can impact upon bats with carcasses having been found beneath some turbines. Such deaths may have been caused either by direct collision with the turbine blades, or caused by damage to the bat's lungs as they pass close to the rotating turbine blades.

18. Such damage is called 'pulmonary barotrauma' and is thought to occur as bats fly into areas of low air pressure which are created as the turbine blades are rotating; the resulting sudden change in air pressure is thought to cause the bat's lungs to expand at a rate which causes soft tissues within the lungs to rupture.

19. A European Union Advisory Committee called EUROBATs (which was initiated in 1994 and is concerned with the conservation of European bat populations) has produced guidance on how any potential impacts of wind turbines on bats can be assessed.

20. The guidance, 'EUROBATS Publication Series No. 3: Guidelines for consideration of bats in windfarm projects (2008)' identifies a need to conduct pre-construction bat activity surveys as well as assessing any habitat feature(s) which may be used by bats within the local landscape. Such a survey should particularly aim to identify situations which would pose a high level of risk to bats e.g., active bat roost, commuting corridor or foraging habitat in close proximity to a proposed turbine location.

21. Various bat species are at varying degrees of risk from wind turbines as each species has a different flight style, foraging method and echolocation call. Using these parameters, it has been determined that two Irish bat species are at a high level of risk from turbines (at a population level)[2] Leisler's bat and Nathusius' Pipistrelle; the remaining six Irish bat species were all regarded as being at a low level of risk from turbines (at a population level).

Bat Call Analysis

22. Kaleidoscope Pro was used to undertake analysis of data collected during automated passive monitoring, although noise files were also manually checked using AnalookW in order to double check the bat classifiers were accurate. Bat activity was measured using the number of files containing a bat call or bat call sequence irrespective of length, for a complete night of recording. This method of passive monitoring enables determination of species composition, temporal activity patterns (between different times of year and different times of night) at a fixed location.

23. All detectors used during surveys are broadband detectors however, the frequencies of ultrasonic calls

[2] Natural England Technical Information Note TIN051 Bats and onshore wind turbines Interim guidance. Third edition 11 March 2014.

(from the static detectors) were divided by a factor of 8 and the data produced were then viewed as ZC (zero-crossed) files.

24. All the various software programmes used represent the recorded calls as sonograms (graphs of call frequency along the Y axis against time (duration) of the call along the X axis). All sonograms were then analysed to determine bat species. Echolocation calls are reliably distinguishable from other sounds (e.g., wind, mechanical sounds, birds or insects), but the ability to distinguish species of bats varies with taxon, location, type of equipment & quality of recording, and can be difficult. Some bats are relatively easy to speciate from viewing sonograms and very little additional analysis of the sonograms may be required. Some species, such as those within the genus Myotis, can be extremely difficult, if not impossible to separate into species.

25. Bat echolocation calls consist of repetitive patterns commonly referred to as pulses or calls. Here, a singularly produced sound is defined as a pulse and the consecutive repetition (sequence) of pulses is defined as a call. Calls which were difficult to identify from viewing the sonogram alone were analysed in more detail by determining the mathematical parameters of the pulses that could be defined. Any noise distorting the clear definition of a pulse was excluded from analysis. The mathematical parameters measured included:
    - Time between each pulse known as Inter Pulse Interval (IPI);
    - Duration of call (Dur);
    - Maximum frequency of call (Fmax);
    - Minimum frequency of call (Fmin); and,
    - Peak frequency of the call (Fpeak).

26. There are inherent limitations when surveying bats using ultrasonic detectors. Ultrasound, unlike audible sound, is attenuated rapidly in air. Many echolocation calls are in the 40KHz to 60KHz region, where air attenuation is over 1dB per metre. Sound absorption increases exponentially with frequency and a bat echolocating at 30kHz is unlikely to have a range exceeding 30m, with the range decreasing to 10m at 100KHz. Some bats call louder than others, notably Leisler's bat, which calls at the lowest frequency of any Irish at <25KHz where excess attenuation is around 0.5 dB per metre. It is frequently audible at around 80m (Altringham, 2003).

27. In practice this means that bat detectors do not detect most bats calling from 30kHZ and upwards at distances over 30m[3]. Some species, such as brown long-eared bat, make very directional and quiet calls and can only easily be detected when the detector is facing the source of call (i.e., the bat) and at close range.

28. Therefore, there may be some bias in the recording of bat species, caused by variations in the detectability of different species. The potential for some species of bats to be overlooked has been reduced as much as possible by the use of a variety of broadband (full-spectrum & frequency division) bat detectors (and with the use of headphones to cut down on background noise experienced by the surveyors), static recording, subsequent analysis of recordings and by the use of point counts (listening stops) during transects, where the surveyors are standing still, which reduces background noise on the detectors caused by surveyor movement. The manual surveys also used a combination of electronic detectors and observing bat behaviour where possible; the behaviour and size of bats can be used in combination with the calls to indicate species.

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[3] John D. Altrincham (2003) British Bats

29. Table 1 indicates the maximum distances of ultrasonic detection for bat species occurring in the UK. The data has been taken from Eurobats and was collated based on a literature review and on the experience of Eurobat Intercessional Working Group members. It should be noted that this data is from surveys carried out on the continent and using a Pettersson Elektronik D980 bat detector.

Table 1 - Distances of ultrasonic detection for bats occurring in Northern Ireland[4]

Species	Forages close to habitat structure	High Flight (>40 m high)	Low Flight (i.e. almost ground level)	Maximum distance of ultrasonic detection (m)
Common pipistrelle	Yes	Yes	Yes	30
Soprano pipistrelle	Yes	Yes	Yes	30
Nathusius' pipistrelle	Yes	Yes	Yes	30-40
Brown long-eared	Yes	Yes	Yes	30
Daubenton's bat	Yes	Yes	Yes	30
Natterers' bat	Yes		Yes	20
Whiskered bat	Yes		Yes	15
Leisler's bat		Yes		60-80

30. Data from automated/static systems is limited because there is no observational context. Fifty bat passes could represent one bat passing 50 times (i.e. while foraging along a riparian corridor) or 50 bats each passing once (i.e. when commuting between a roost and a favoured foraging location. Reality is likely to be somewhere between these two extremes.

31. Therefore, the ability to estimate abundance of bats by carrying out detector surveys is limited as it requires differentiation between multiple passes of a single bat and multiple bats making single passes, and is not usually possible through echolocation monitoring. However, the results can be used to indicate relative activity of bats in different habitats based on number of bat passes over time.

32. There are also some limitations on identification of some bats to species level, particularly those of the genera Myotis. This is due to similarities in calls of the different species and they can be difficult to identify to species level in cases where the bat pass was; brief, distant, faint or if the bat was not seen. Due to the similarities in call parameters, species of the genera Myotis can often not be identified to species level using analysis of recorded bat calls.

33. The methods used have referred to best practice guidance available at the time of the surveys and used a range of survey methods on a number of visits to increase the chances of encountering bats. Bat activity surveys and static recording has been carried out within the active season (May – September), including within the periods of key bat activity at upland windfarm sites (late-summer/early–autumn), and have covered all of the proposed turbine locations. The data collected is therefore suitable for evaluation and impact assessment in relation to the proposed development.

Evaluation

34. Although the CIEEM (2018) Guidelines on Ecological Impact Assessment in the UK provide general guidance for evaluating the nature conservation value of habitats, it is extremely difficult to evaluate

[4] Information taken from Rodrigues, L., L. Bach, M.J. Dubourg-Savage, J. Goodwin & C. Harbusch (2008): *Guidelines for consideration of bats in wind farm projects.* EUROBATS Publication Series No. 3 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany, 51 pp. (Table 2, pp 48-49)

the value of species; species and the habitats that support them are generally considered together.

35. For the purpose of this project the guidance Valuing Bats in Ecological Impact Assessment (Wray et al, 2010)[5] has been considered. This guidance is based upon the rarity of bat species (see Table 2). The limitations involved in this evaluation method are largely related to the limited data available on bat populations in Britain and Ireland.

Table 2 - Categories of bat rarity in Northern Ireland (adapted from CIEEM, 2010)

Rarity within Range	Northern Ireland
Rarest (population under 10,000)	whiskered
Rarer (population 10,000 to 100,000)	Daubenton's Natterer's Leisler's Nathusius' pipistrelle brown long-eared
Common (population over 100,000)	common pipistrelle soprano pipistrelle

Species Present and Conservation Status

36. Bat species recorded during the surveys (in order of abundance from most abundantly recorded to least recorded) together with details of the species' conservation status are given in Tables 3 and 4.

37. The potential presence of a number of species of the genera Myotis was identified but could not be identified with certainty to species level. However, analysis of the recordings suggested that Daubenton's and Natterer's bats were present. Table 3 below includes the Myotis species that could be within the geographic area.

38. Along with the information received from the data search, the following references were used for information on the national and local status of bat populations:

- Bat Conservation Trust, 2000: Distribution Atlas of Bats in Britain and Ireland;
- The National Bat Monitoring Programme. Annual Report 2010. Bat Conservation Trust, London. (http://www.bats.org.uk/pages/national_bat_monitoring_programme_annual_report_2010.html);
- UK Biodiversity Action Plan (http://jncc.defra.gov.uk/default.aspx?page=5155);
- Harris S., Morris, P., Wray, S. & Yalden, D. (1995) A review of British mammals: population estimates and conservation status of British mammals other than cetaceans. JNCC, Peterborough; and
- Harris, S. and Yalden, D. (2008) Mammals of the British Isles Handbook, 4th Edition. The Mammal Society.

39. All UK bats are listed under the following European Community Directives, Conventions or UK legislation:

[5] Wray S, Wells D, Long E, Mitchell-Jones T (December 2010) Valuing Bats in Ecological Impact Assessment, IEEM In-Practice p 23-25

- Appendix II of the Bern Convention. An agreement on the Conservation of Bats in Europe (EUROBATS) under the auspices of the Bonn Convention, also known as the Convention on Migratory Species (CMS) is in force, and all European bats are listed under Appendix II of the CMS;
- Appendix II of the Bonn Convention (and Recommendation 36 on the Conservation of Underground Habitats),
- Annexes II and IV of the EC Habitats Directive; and
- The Conservation (Natural Habitats etc.) Regulations (Northern Ireland) 1995 (as amended).

40. All of the bat species listed in Table 3 below have been recorded commuting and/or foraging within habitats in the application site. The population of each of the bat species listed in Table 3 within NI are unknown; however, estimates of the NI population trends have been derived from the Car-based Bat Monitoring Scheme undertaken (since 2003) by BCI (Bat Conservation Ireland) and part-funded by NIEA.

Table 3 - Bat species recorded within the survey area and their conservation status

Bat Species	Species Action Plan (SAP) Status	NI Population Trend	Estimated Population size, rarity and distribution
Leisler's	All Ireland SAP LBAP	Increasing	Leisler's bat is monitored by the Car-based Bat Monitoring Scheme and its annual trend has shown significant increases since 2003. The reasons for the increase are poorly understood but it may be recovering from past declines, or responding to increased woodland cover and/or climate change.
Common pipistrelle	All Ireland SAP LBAP	Increasing	Results from this scheme indicate that since 2003 the soprano pipistrelle has increased significantly while the common pipistrelle has also increased, albeit more slowly. The reasons for these increases are poorly understood but both species may be recovering from past declines, or responding to increased woodland cover and/or climate change.
Soprano pipistrelle	All Ireland SAP UK SAP LBAP	Increasing	Results from this scheme indicate that since 2003 the soprano pipistrelle has increased significantly while the common pipistrelle has also increased, albeit more slowly. The reasons for these increases are poorly understood but both species may be recovering from past declines, or responding to increased woodland cover and/or climate change.
Nathusius' pipistrelle	All Ireland SAP LBAP	No trend data available	This species is recorded by the Car-based Bat Monitoring Scheme, although in such low numbers that its annual population trend is difficult to establish with certainty.
Daubenton's bat	All Ireland SAP LBAP	No trend data available	The Daubenton's bat annual trend is monitored using a volunteer-based programme – the All Ireland Daubenton's Bat Waterways Survey. This scheme has been ongoing since 2006 and the Daubenton's bat trend has been reasonably stable since this time.

Table 4 - Nature conservation importance of individual bat species present within the survey area

Species	Relative population size and status[6]	Background
Leisler's	Scarce	This is a rarer bat species in Britain but is more common in NI. Present bat population in the county unknown.
Common pipistrelle	Common	This species is common and widely distributed across NI and uses a range of habitats including urban and industrial areas.
Soprano pipistrelle	Common	This species is common and widely distributed across NI.
Nathusius' pipistrelle	Rare	This species is uncommon and localised within NI. Anecdotally it is mostly found near large water bodies such as Lough Neagh and Upper Lough Erne.
Myotis	Common/fairly common/locally distributed (depending on species)	These rarer species are widespread across the UK but in low numbers (the low numbers of these species could be due to a lack of recording effort rather than them not being present).

Methodology

41. Survey methodology followed guidance in NIEA 2022[7] and SNH 2021[8]. Due consideration was also given to Table 10.2 of the 2012 BCT Guidelines for 'Low-risk' sites, and also of the Bat Conservation Trust Bat Surveys: Good Practice Guidelines' (Collins, 2016); the Northern Ireland Environment Agency also recommends consultation with this publication with reference to any bat surveys carried out within Northern Ireland.

Desk Study

42. Bat surveys (including; pre-survey site visit and automated passive monitoring) were conducted during 2022.

Bat Records

43. Consultation with the NIBG (Northern Ireland Bat Group) was undertaken in order to obtain records for roosts within 10 km of the site. Records were also obtained from the Biodiversity Maps website as this contains some All-Ireland records (i.e., Daubenton's Bat Waterway Survey (which is managed by Bat Conservation Ireland), as well as the Northern Ireland National Biodiversity Network Atlas (NBN Atlas) and the Centre for Environmental Data and Recording (CEDaR).

Pre-Survey Site Visit/Potential Roost Assessment

44. A daytime inspection of trees and structures within 200m (plus rotor radius) was undertaken for evidence of roosting bats and to make a general assessment of potential roosting features within the

[6] Based on Battersby, J (Ed) & Tracking Mammals Partnership (2005).

[7] Guidance on Bat Surveys, Assessment & Mitigation for Onshore Wind Turbine Developments – Version 1.1 NIEA, Natural Environment Division, May 2022

[8] BATS AND ONSHORE WIND TURBINES: SURVEY, ASSESSMENT AND MITIGATION Version: August 2021 (updated with minor revisions)

survey area to identify structures or trees which could potentially be used by bats. Ordinance Survey mapping and aerial photographs were also used to aid in the identification of potential features prior to the site visit.

45. Both direct and indirect methods were employed in order to search for evidence of bats. Direct methods involve surveying for observations of bats or the remains of dead bats. Indirect methods involve identification of faecal pellets, urine, oil stains and feeding remains, which indicate evidence of bat activity. It should be noted however that bats often leave little evidence of their presence.

Automated monitoring

46. Automated passive monitoring was undertaken between the 6th June to the 22nd September 2022. Each proposed turbine location (T1-T10 and T12) was monitored for 30 nights in total over spring, summer and autumn. It should also be noted; during the summer monitoring period the static detector at T4 stopped recording after three nights due to a battery failure, during the autumn monitoring period the static detector at T3 stopped recording after three nights, and at T7 after two nights due to a battery failure.

47. Calibrated ultrasonic detectors with omnidirectional microphones (SM2Bat+/SMZC/SM4ZC SM mini/ Anabat Express or Anabat Chorus) were used. Detectors were programmed to record from 30 minutes prior to sunset until 30 minutes after sunrise each night. The results of the static monitoring are provided in Appendix 1 (Bat Activity Indices), photographs of deployed equipment are contained in Appendix 2, and the locations of the static monitoring equipment can be found in Appendix 3 (Figures 1).

Results

Desk Study

48. Records were obtained from the Northern Ireland Bat Group (NIBG), with further records sourced through the Biodiversity Maps website (https://maps.biodiversityireland.ie) from the National Bat Database of Ireland and the Northern Ireland Mammal Database. A total of 16 records within 10 km of the site were provided. As is typical for such records they are dominated by pipistrellus species and are clustered in proximity to human habitation, the majority of the records were near to Dunamanagh. Two records were located within 2 km NE of the Site and there were records of pipistrelle, unidentified species and brown long-eared bat.

49. The NBA Atlas NI holds 25 records of Daubenton's Bat within 10km of the site

Pre-Survey Site Visit

50. The daytime inspection revealed there were no trees or buildings present within 200m (plus rotor radius) of any of the proposed turbines

Static Detector Results

51. Overall, there were approximately 302.5 hours of recording (across 30 nights) throughout the combined 2022 automated monitoring sessions at Mullaghclogher.

52. There was significant variation in night length throughout the survey period, so the number of bat passes recorded during different months of the year are not directly comparable. In order to standardise bat activity between survey periods, results are displayed as a 'Bat Activity Index' (BAI), which is the total number of bat passes divided by the number of hours per night (Hundt, 2012). This was calculated from sunset to sunrise, using publicly available data from www.timeanddate.com.

53. At present there is not a standard system in the UK to categorise bat activity as low, moderate or high, because activity levels vary depending on the species involved and the location of the site. For the purposes of this report, we use a bespoke system to discuss and compare levels of bat activity at the site, as outlined in the table below. This approach uses standardised terms (e.g., occasional, frequent) to categorise bat activity indices within certain ranges; the average time interval between passes is also provided to give a more- intuitive interpretation of the terms. For the purposes of this assessment, we consider activity levels of occasional or higher (i.e., a BAI of >5) to be significant. This is similar to the threshold of 50 bat passes used in Mathews et al (2016) to define 'high bat activity', because 50 bat passes in a 10-hour night gives a BAI of 5.

54. It should be noted that activity levels should only be compared within a species and not between species, due to differences in the detection distances for each species and their flight characteristics. For example, if there are infrequent passes by brown long-eared bats (a species with short-range echolocation pulses) and occasional passes by Leisler's bats (which has longer-range echolocation pulses), it does not necessarily mean that Leisler's bats are more abundant than brown long-eared bats at that location.

Table 7 – Description of levels of bat activity (adopted from Matthews et al. 2016)

Description	Bat Activity Index	Interval between passes
Negligible	<1	>60 minutes
Low	1 – 5	12 – 60 minutes
Moderate	5 – 12	5 – 12 minutes
High	12 – 60	1 – 5 minutes
Near-constant	>60	<1 minute

55. The abbreviations for each species are as follows; NYLE – *Nyctalus leisleri* (Leisler's bat); PIPI – *Pipistrellus pipistrellus* (common pipistrelle); PIPY – *Pipistrellus pygmaeus* (soprano pipistrelle); PINA – *Pipistrellus nathusii* (Nathusius' pipistrelle). Myotis spp – *Myotis species* (collectively refers to Daubenton's bat *Myotis daubentonii,* whiskered bat *Myotis mystacinus* and Natterer's bat *Myotis nattereri*).

56. The following sections provide an overview of results for each proposed turbine location. See Appendix 1 – (Bat Activity Indices) for a full detailed breakdown across all sessions.

Turbine 1

57. The monitoring period at T1 ran for a total of 10 nights across three separate periods; (6th to 15th June; 9th to 18th August; 13th to 22nd September). The night length averaged at 7.75, 10 and 12.5 hours during the spring, summer and autumn. This equates to 302.5 hours of recording across 30 nights.

58. There was a total of 791 bat passes recorded over the 30 nights. Bat passes were recorded on 24 of these nights, and 7 species of bat were recorded. The peak number of bat passes (by individual species) in a single night (13/08/22) was 280 (BAI; 28) indicating **high** activity.

59. Activity levels were negligible during the spring (BAI; 0.46), moderate during the summer (BAI; 6.79) and negligible during the autumn (BAI; 0.61) (see BAI tables in Appendix 1).

60. Overall activity levels at T1 were assessed to be **low** (BAI; 2.61)

Turbine 2

61. The monitoring period at T2 was the same as T1.

62. There was a total of 308 bat passes recorded over the 30 nights. Bat passes were recorded 24 of these nights, and 7 species of bat were recorded. The peak number of bat passes (by individual species) in a single night (12/08/22) was 64 (BAI; 6.40) , indicating **moderate** activity.

63. Activity levels were negligible during the spring (BAI; 0.15), low during the summer (BAI; 1.89) and negligible during the autumn (BAI; 0.86)

64. Overall activity levels at T2 were assessed to be **low** (BAI; 1.02)

Turbine 3

65. The monitoring period at T3 was the same as T1.

66. During the autumn monitoring period the static detector stopped recording after three nights due a battery failure. There was a total of 525 bat passes recorded over the 23 nights. Bat passes were recorded 11 of these nights (6th June, 9th -14th, 16th and 17th August, 13th and 15th September). All 7 species of bat were recorded in the summer. The peak number of bat passes (by individual species) in a single night (10/08/22) was 133 (BAI; 13.30) , indicating **high** activity.

67. Activity levels were negligible during the spring (BAI; 0.10), moderate during the summer (BAI; 5.06) and negligible during the autumn (BAI; 0.29)

68. Overall activity levels at T3 were assessed to be **low** (BAI; 1.74)

Turbine 4

69. The monitoring period at T4 was the same as T1.

70. During the summer monitoring period the static detector stopped recording after three nights due a battery failure. There was a total of 359 bat passes recorded over the 23 nights. Bat passes were recorded 19 of these nights (6^{th}, 8^{th}, 12^{th}-15^{th} June, 9^{th} -11^{th} August, 13^{th} -22^{nd} September). All 7 species of bat were recorded in the spring. The peak number of bat passes (by individual species) in a single night (11/08/22) was 86 (BAI; 8.60) , indicating **moderate** activity.

71. Activity levels were low during the spring (BAI; 1.12), low during the summer (BAI; 4.53) and low during the autumn (BAI; 1.16)

72. Overall activity levels at T4 were assessed to be **low** (BAI; 1.19)

Turbine 5

73. The monitoring period at T5 was the same as T1.

74. There was a total of 481 bat passes recorded over the 30 nights. Bat passes were recorded 23 of these nights (8^{th}-11^{th}, 13^{th}-15^{th} June, 9^{th} -14^{th}, 16^{th}- 18^{th} August, 13^{th}, 16^{th} -20^{th}, 22^{nd} September). Six species of bat were recorded in the summer and autumn (Daubenton's, Natterer's, Leisler', common and soprano pipistrelle and Brown long-eared bat). The peak number of bat passes (by individual species) in a single night (10/08/22) was 149 (BAI; 14.90) , indicating **high** activity.

75. Activity levels were negligible during the spring (BAI; 0.36), low during the summer (BAI; 4.13) and negligible during the autumn (BAI; 0.32)

76. Overall activity levels at T5 were assessed to be **low** (BAI; 1.59)

Turbine 6

77. The monitoring period at T6 was the same as T1.

78. There was a total of 1570 bat passes recorded over the 30 nights. Bat passes were recorded 24 of these nights (6^{th}, 13^{th}-15^{th} June, 9^{th}-18^{th} August, 13^{th}-22^{nd} September). Six species of bat were recorded in the summer and autumn (Daubenton's, Natterer's, Leisler', common and soprano pipistrelle and Brown long-eared bat). The peak number of bat passes (by individual species) in a single night (10/08/22) was 298 (BAI; 29.80), indicating **high** activity.

79. Activity levels were negligible during the spring (BAI; 0.45), high during the summer (BAI; 13.02) and low during the autumn (BAI; 1.86)

80. Overall activity levels at T6 were assessed to be **moderate** (BAI; 5.19)

Turbine 7

81. The monitoring period at T7 was the same as T1.

82. During the autumn monitoring period the static detector stopped recording after two nights due a battery failure. There was a total of 2619 bat passes recorded over the 22 nights. Bat passes were recorded 18 of these nights (6^{th},11^{th}- 15^{th} June, 9^{th}-18^{th} August, 13^{th} and 14^{th} September). All 7 species of bat were recorded. The peak number of bat passes (by individual species) in a single night (13/09/22) was 622 (BAI; 49.76), indicating **high** activity.

83. Activity levels were low during the spring (BAI; 1.01), high during the summer (BAI; 17.79) and high during the autumn (BAI; 30.48)

84. Overall activity levels at T7 were assessed to be **moderate** (BAI; 8.66)

Turbine 8

85. The monitoring period at T8 was the same as T1

86. There was a total of 887 bat passes recorded over the 30 nights. Bat passes were recorded 25 of these nights (6^{th},9^{th},12^{th},14^{th} and 15^{th} June, 9^{th}-18^{th} August, 13^{th} – 22^{nd} September). Six species of bat were recorded in the summer and autumn (Daubenton's, Natterer's, Leisler', common and soprano pipistrelle and Brown long-eared bat). The peak number of bat passes (by individual species) in a single night (10/08/22) was 153 (BAI; 15.30), indicating **high** activity.

87. Activity levels were negligible during the spring (BAI; 0.30), moderate during the summer (BAI; 6.11) and low during the autumn (BAI; 2.02)

88. Overall activity levels at T8 were assessed to be **low** (BAI; 2.93)

Turbine 9

89. The monitoring period at T9 was the same as T1

90. There was a total of 1068 bat passes recorded over the 30 nights. Bat passes were recorded 22 of these nights (6th,7th and 15th June, 9th-18th August, 13th – 20th and 22nd September). All 7 species of bat were recorded. The peak number of bat passes (by individual species) in a single night (13/08/22) was 371 (BAI; 37.10), indicating **high** activity.

91. Activity levels were negligible during the spring (BAI; 0.19), moderate during the summer (BAI; 9.63) and negligible during the autumn (BAI; 0.72)

92. Overall activity levels at T9 were assessed to be **low** (BAI; 3.53)

Turbine 10

93. The monitoring period at T10 was the same as T1

94. There was a total of 1205 bat passes recorded over the 30 nights. Bat passes were recorded 26 of these nights (6th,11th- 15th June, 9th-18th August, 13th –22nd September). Six species of bat were recorded (Daubenton's, Natterer's, Leisler', common and soprano pipistrelle and Brown long-eared bat). The peak number of bat passes (by individual species) in a single night (12/08/22) was 236 (BAI; 23.60), indicating **high** activity.

95. Activity levels were negligible during the spring (BAI; 0.61), moderate during the summer (BAI; 9.49) and low during the autumn (BAI; 1.67)

96. Overall activity levels at T10 were assessed to be **low** (BAI; 3.98)

Turbine 12

97. The monitoring period at T12 was the same as T1.

98. There was a total of 2323 bat passes recorded over the 30 nights. Bat passes were recorded 27 of these nights (6th- 9th, 13th- 15th June, 9th-18th August, 13th –22nd September). All 7 species of bat were recorded. The peak number of bat passes (by individual species) in a single night (11/08/22) was 456 (BAI; 45.60), indicating **high** activity.

99. Activity levels were low during the spring (BAI; 1.01), high during the summer (BAI; 17.51) and low during the autumn (BAI; 3.95)

100. Overall activity levels at T12 were assessed to be **moderate** (BAI; 7.68)

Assessment

Survey Constraints

101. There were no significant constraints to survey noted during the automated monitoring sessions. Meteorological conditions were reasonably favourable for bat activity and access to the site was unimpeded. Battery failure was experienced during the summer monitoring period at T4 after three nights and during the autumn monitoring period at T3 after three nights and at T7 after two nights. The data provided is considered to be sound and sufficient to allow an assessment to be completed.

Discussion

102. Recent University of Exeter / DEFRA research (Matthews et al.,2016) has led NED to adopting a more precautionary approach when assessing the likely impact of wind turbines on bat populations. NED also considers that any proposed mitigation must consider the results of the recent research.

103. Therefore, a review of the DEFRA report was undertaken with specific reference to the site in question.

104. The DEFRA (2016) report concluded that: -

- Bat casualty rates at British wind farms are similar to those recorded elsewhere in Europe. At a third of sites studied no casualties were found. From the DEFRA project it is not possible to conclude whether or not there is an impact on local or national bat populations;
- The species most at risk from collisions are common pipistrelle, soprano pipistrelle and noctule bats;
- Casualty rates are highly variable. Most of this variability appears to be due to site-specific factors, and is not simply explained by differences in bat activity levels; collision risk is generally lowest at locations with low bat activity;
- The size of the wind turbine installation had no link with the per turbine casualty rate;
- Turbines with larger blade lengths pose an increased risk to bats, and this is stronger predictor than the height of the nacelle;
- Most fatalities occur on nights of relatively low mean wind speed (<5m/s at ground level). All casualties occurred on nights with mean wind speed <10m/s;
- The presence of woodland within a 1500m radius of the centre of wind farms appears to reduce the risk to pipistrelles but increase the risk to noctule bats;
- Trained search dogs are the most effective way of identifying dead bats at turbines;
- Bat activity shows extremely high variability. Much longer monitoring periods than are currently used as standard practice are therefore required for robust estimation of bat activity.

105. This relates to Mullaghclogher in that;

a. Activity levels were negligible across 52.6% (162 out of 308 nights total) of the monitoring period

b. There were 86 nights of **low** bat activity during spring, summer and autumn.

c. There were 28 nights of **moderate** activity at turbines T1-8, 10, 12, recorded during spring, summer and autumn

d. There were 32 nights of **high** activity recorded at turbines T1, 3, 5-10, 12 recorded during the summer and autumn monitoring period.

e. All species most at risk from collision were recorded.

f. Therefore, a Bat Monitoring & Mitigation Plan has been recommended (which includes the used of trained search dogs).

Potential Impacts

Construction phase

106. Site clearance works will involve significant removal of vegetation. However, there are similar habitats throughout the site and surrounding area, so the removal of these vegetation features will not have a significant impact on any bat species.

Operation phase

107. Although bat fatalities have been reported from operational windfarms in North America and parts of Europe for almost twenty years, evidence from Britain and Ireland has only begun to emerge in recent years. The publication in 2016 of a large-scale study by researchers at Exeter University (Mathews et al.), which was based on observations of bat activity and carcass searches at 46 operational wind farms throughout Britain (but excluding NI).

108. Bat carcasses were found at two-thirds of these sites, of which 48% of fatalities were common pipistrelles, 40% were soprano pipistrelles and 10% were noctule bats (which are closely related to Leisler's bats, and in fact this species is commonly referred to as the lesser noctule across much of the rest of Europe).

109. The estimated casualty rates, which were corrected for predator removals and the efficiency of the searchers, ranged from 0 - 5.25 bats per turbine per month, and from 0 - 77 bats per site per month, during the period of the study. As with previous studies on bats & windfarms, there was a relationship between weather conditions and recorded bat fatalities: most nights where casualties occurred (81.5%) had low mean wind speeds (less than or equal to 5m/s measured at the ground} and maximum night-time temperatures of >10ºC. However, it was also estimated that 95.3% of nights with mean wind speeds >5m/s would have no casualties.

110. The study revealed no clear relationship between recorded bat activity levels and the number of fatalities recorded at a site, as follows: "*Activity at the control locations (a proxy for pre-construction surveys) was not a useful predictor of the number of bat casualties, although it was a predictor of whether or not any casualties occurred (i.e., a binary yes/no categorisation*)".

111. The nights of highest pipistrelle activity were considered to have the highest likelihood of casualties, although bat fatalities were only recorded in one third of locations. In the Mathews et al. (2016) study, 'high activity' was defined as a night with more than 50 bat passes, which is similar to the BAI of 5 used in this assessment (i.e., 50 bat passes over a 10-hour night gives a BAI of 5).

112. Fatality research studies elsewhere in Europe have shown that, due to their different behaviour and flight style, bat species are affected differently by wind turbines (Rodrigues et al., 2008; Natural England, 2014). On this basis, the risk of impacts for this species are assessed below.

113. There were significant levels of bat activity (i.e., a BAI of >5) recorded at all turbines (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 12) , on 60 of the 308 survey nights (by individual species) with negligible or low activity on all other nights.

114. Therefore, all turbines may present a risk to foraging/commuting bats, particularly Pipistrelles and Leisler's bats. It is not possible to make a prediction about the number of bats that may be affected, but in a worst-case scenario it is possible that there could be a significant impact on local populations of this species.

115. All bat species receive strict protection under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (S.I. 1995/380, as amended), under which it is an offence to kill, injure or disturb any bat species. In accordance with policy NH 2 of the Planning Policy Statement 2: Natural Heritage (DOENI, 2013), planning permission will only be granted for a development that is not likely to harm any protected species (subject to suitable mitigation measures).

Decommissioning phase

116. All decommissioning work will be carried out from internal access tracks and hardstanding areas, so it will not be necessary to clear any trees, hedgerows or other vegetation. As a result, there will be no impact on feeding areas or commuting routes.

Mitigation

117. Due to the presence of bat species known for open-air foraging (i.e., considered to be at risk from turbine associated mortality (i.e., Leisler's bats and pipistrelle sp.), and the **moderate – high** levels of bat activity recorded across the monitoring period, a Bat Mitigation & Monitoring Plan (BMMP) has been recommended. This will be implemented at all turbines and in a surrounding 150m buffer area.

118. Monitoring, (in the form of bat mortality surveys), will be undertaken for the first 5 years (post-consent (if approved)) and will be reviewed annually to determine whether remedial action is required to mitigate the effects of the Development on bats. In the event that a bat carcass if found, NIEA NED will be immediately contacted in order to discuss/agree the implementation of mitigation measures.

119. At the end of year 5, the data will be reviewed to determine whether monitoring should continue.

Frequency of searches

120. It is recommended that systematic searches should be conducted within a 150m x 150m grid centred on each turbine. A minimum of 20 searches (for medium risk sites) per turbine should be conducted during spring, summer and autumn.

121. Searches will be conducted at 2 to 4-day intervals (based on National Bats and Wind Turbines study recommendations). Data must be obtained from the turbine operators on whether or not the target turbine was operational on the night preceding the search, with the surveying protocol being adjusted as necessary if the turbines were either non-operational or were not rotating because of a lack of wind.

122. To maximise the duration of monitoring during each season, whilst maintaining low carcass removal rates, it is recommended that surveying should be split into blocks as illustrated in Table 10 below. This schedule will be repeated for each season and across each of the five years of the programme.

Table 10 - Summary of proposed schedule for carcass searches

Days 1-10	Days 11-20	Days 21-30	Days 31-40	Days 41-50	Days 51-60
Initial 'sweep' then survey alternate days (d2, d4, d6, d8, d10)	*No Survey*	*Initial 'sweep' then survey alternate days*	*No survey*	*Initial 'sweep' then survey alternate days*	*No survey*

Bat Carcass (Mortality) Searches

123. Bat carcass searches will be undertaken using a specialist ECoW. Searches will be undertaken across 50 days over the monitoring period (with at least 10 consecutive nights in each season and an additional 20 nights in summer or other high-risk period) the exact timing/spacing will be at the discretion of the ECoW. However, searches will only take place the morning after optimal conditions for bats have occurred. These are defined as;

- <5m/s ground wind speed,
- >10°C of temperature (1 hour after dusk),
- no rain, and
- after a warm day of similar settled conditions (i.e. the dusk should have a peak in bat activity in the area).

124. Carcass searches will commence one hour after dawn to minimise the potential for carcass removal by predators.

125. This approach has been selected to maximise the likelihood of finding bat carcasses, which is essential in enabling predicted bat mortality to be accurately estimated. Bat carcasses will be collected (if found) to enable accurate species identification, using DNA where required.

Meteorological Data

126. Simultaneous daily collection of meteorological data including wind speed, temperature, and precipitation will be undertaken at the turbine location, alongside bat carcass searches to identify the effect on levels of bat activity at the turbine.

Operational curtailment

127. In the event that a dead bat is found during carcass searches, curtailment of the particular turbine will be immediately implemented on a precautionary basis. This will involve increasing the cut-in speed to 5 m/s, which is recommended by Mathews et al (2016). As bats are nocturnal, the increased cut-in speed will only apply at night, measured from 30 minutes before sunset to 30 minutes after sunrise. The increased cut-in speed will only apply between the 01 May and the 30 Sep each year (i.e. the generally accepted bat activity season in NI). For the remainder of the year (i.e. 01 Oct to 30 Apr), the turbine manufacturer's cut-in speed will be used.

128. In addition, the turbine will be feathered when winds are below cut-in speed, which will involve pitching the blades to 90° and/or rotating the blades parallel to the wind. This will prevent the turbines from freewheeling or idling, and reduce the rotation rate to the minimum level required, ideally to below one revolution per minute. This will substantially reduce the risk of bats being struck by idling blades, and

will reduce the spatial extent of low-pressure vortices in the wake of the blades (i.e. will substantially reduce the potential for barotrauma to occur).

129. Also, the recording of a bat carcass will escalate the searches to involve the use of trained scent dogs (although the search protocol and programme will remain unchanged).

Search efficiency trials

130. In addition to the proposed operational curtailment, the efficiency of the search dogs will be assessed based on integrated efficiency trials (Mathews et al., 2016). Use of this method will allow a correction factor for search efficiency to be factored into statistical modelling of numbers of bats which may be found dead beneath any turbines.

131. Carcasses will be dropped from waist height at randomly selected points within the search area under turbines, on days when the dog teams are conducting searches and prior to searches taking place. The person placing the bats will not be involved in the search and will not reveal the exact number and location of bats that have been deployed to the dog teams until the trial is concluded.

132. When conducting observer efficiency trials for dog search teams, care will be taken to avoid transferring human scent to the specimen, for example by using tongs or disposable gloves. To allow human scent from footprints to dissipate, an interval of at least an hour will be left between placing the bats and conducting the searcher efficiency trial.

Scavenger removal rates

133. In order to determine the rate at which carcasses are removed (and therefore not be available for dogs to find), scavenger removal trials will be completed.

134. A carcass (of similar size and colour to a bat) will be left under two different turbines in the wind farm each season. The carcasses will be placed out around dusk, and transference of human smell will be avoided. Carcasses will not be left under turbines if and when searches are being carried out at these turbines.

135. The carcasses will be monitored through the use of a motion-activated remotely operated camera for up to 10 days (battery life is affected by weather and the number of times the camera is triggered and is not entirely predictable). A second visit will be made to the site to check the cameras and change the batteries to ensure we can assess the scavenging rates over a three-week period. Assessing rates over a shorter timeframe would not enable a true test of scavenging removal rates to be made (Mathews et al., 2016). Different habitat types will be selected for the trials to ensure a robust evaluation of scavenging rates can be made.

136. The methods used in the Matthews (2016) study involved daily visits, rather than camera traps, to check corpses for the first seven days, but the use of camera traps will be more resource efficient and should also indicate the time at which the corpse was taken as well as the species of scavenger in most cases.

137. Different locations will be selected for the carcasses during each visit so that scavengers do not become familiar with feeding locations, and the cameras will be repositioned accordingly.

Estimating actual mortality rates

138. The number of observed bat carcasses recorded during the study will be corrected taking into account the area searched, scavenger rates and searcher efficiency results. Various researchers have proposed different approaches to data correction including Korner-Nievergelt et al. (2011), Korner-Nievergelt, et al. (2011), Bispo et al. (2012), and Lintott et al. (2016).

139. The most up to date formula for estimating the total number of carcasses present per turbine per season will be applied to the data collected at the end of the survey season

Remedial Measures

140. The trigger threshold for remedial measures will be linked to 'significance' in line with the CIEEM guidelines for EcIA. Remedial measures will be triggered by an impact predicted to be of significance to bats at the local level or greater.

141. For geographic context, the local level is considered to represent the site boundary plus a 15km radius (for Leisler's bats). A significant effect would be triggered where the level of bat mortality is considered to reduce the ability of the bat population at the local scale to sustain a viable and stable population, as informed by monitoring.

142. The requirement for and design of additional remedial measures will depend upon the findings and conclusions of monitoring and specific measures will be developed as appropriate to mitigate and significant impact predicted (those considered significant to bat populations at the local scale or above). Where significant impacts are predicted, potential remedial options may include, but are not limited to, the feathering of the turbine (as per the protocol described in case study presented in the 2019 SNH Guidelines) see Appendix 4.

Conclusions

143. The implementation of the BMMP should substantially reduce the risk of fatalities at the proposed turbine locations. There is a high degree of confidence in the effectiveness of the measures described (as it has been demonstrated to reduce bat fatalities in peer-reviewed studies (e.g., Arnett et al. 2013), and is widely implemented elsewhere in Europe and North America.

144. Overall, the potential impacts to the local bat population (and in particular to Pipistrelle and Leisler's bats) should be reduced to not significant with the implementation of the mitigation measures (as outlined above).

References

Altrincham. J. D, (2003) British Bats.

Bispo R., Bernardino J., Marques T., Pestana, D. (2012) Modeling carcass removal time for avian mortality assessment in wind farms using parametric survival analysis. Environmental and Ecological Statistics, 20, 147 – 165.

Collins, J. (ed.) (2016) *Bat Surveys for Professional Ecologists – Good Practice Guidelines.* 3rd edition. Bat Conservation Trust, London.

Hundt, L. (2012) *Bat Surveys: Good Practice Guidelines, 2nd edition*. Bat Conservation Trust, London.

Korner-Nievergelt, F., Brinkmann, R., Niermann, I. & Behr, O. (2011a) Estimating bat and bird mortality occurring at wind energy turbines from covariates and carcass searches using mixture models. *Plos One*, 8 (7).

Korner-Nievergelt, F., Korner-Nievergelt, P., Behr, O., Niermann, I., Brinkmann, R., & Hellriegel, B. (2011b) A new method to determine bird and bat fatality at wind energy turbines from carcass searches. *Wildlife Biology*, 17, 350 – 363.

Lintott, P.R., Richardson, S.M., Hosken, D.J., Fensome, S.A. & Mathews, F. (2016) Ecological impact assessments fail to reduce risk of bat casualties at wind farms. *Current Biology*, 26, 1135 – 1136.

Mathews, F., Richardson, S., Lintott, P. & Hosken, D. (2016) Understanding the Risk of European Protected Species (Bats) at Onshore Wind Turbine Sites to Inform Risk Management. Report by University of Exeter. pp 127.

Natural England (2014) *Bats and onshore wind turbines Interim guidance*. Technical Information Note TIN051, Third edition.

NIEA, Natural Environment Division (May 2022) *Guidance on Bat Surveys, Assessment & Mitigation for Onshore Wind Turbine Developments – Version 1.1*

Rodrigues, L., L. Bach, M.J. Dubourg-Savage, J. Goodwin & C. Harbusch (2008): Guidelines for consideration of bats in wind farm projects. EUROBATS Publication Series No. 3 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany.

Scottish Natural Heritage (2021) *Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation*.

Wray S, Wells D, Long E, Mitchell-Jones T (December 2010) Valuing Bats in Ecological Impact Assessment, IEEM In-Practice p 23-25.

Appendix 1 – 2022 Bat Activity Indices (BAI)

T1

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	0	1	8	0	8	3	0	**20**	**2.58**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	1	0	0	0	1	0	0	**2**	**0.26**
20220613	1	1	2	0	2	0	0	**6**	**0.77**
20220614	2	0	2	0	1	1	0	**6**	**0.77**
20220615	0	0	1	0	0	1	0	**2**	**0.26**
Species Total	**4**	**2**	**13**	**0**	**12**	**5**	**0**	**36**	
Passes per hour	**0.05**	**0.03**	**0.17**	**0.00**	**0.15**	**0.06**	**0.00**	**0.46**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	8	4	12	0	13	5	4	**46**	**4.60**
20220810	4	4	12	0	16	20	3	**59**	**5.90**
20220811	8	9	17	0	18	28	6	**86**	**8.60**
20220812	4	2	54	1	28	24	5	**118**	**11.80**
20220813	8	4	72	0	87	97	12	**280**	**28.00**
20220814	0	1	14	0	24	11	1	**51**	**5.10**
20220815	0	0	0	0	0	0	0	**0**	**0.00**
20220816	0	1	19	0	1	0	2	**23**	**2.30**
20220817	0	2	1	0	3	0	1	**7**	**0.70**
20220818	4	1	3	0	1	0	0	**9**	**0.90**
Species Total	**36**	**28**	**204**	**1**	**191**	**185**	**34**	**679**	
Passes per hour	**0.36**	**0.28**	**2.04**	**0.01**	**1.91**	**1.85**	**0.34**	**6.79**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	0	1	1	2	12	2	0	**18**	**1.44**
20220914	1	1	0	1	6	2	1	**12**	**0.96**
20220915	0	0	1	0	3	0	1	**5**	**0.40**
20220916	0	0	0	0	1	0	0	**1**	**0.08**
20220917	0	0	0	0	1	1	0	**2**	**0.16**
20220918	1	0	0	0	22	6	2	**31**	**2.48**
20220919	0	0	1	0	1	0	0	**2**	**0.16**
20220920	0	1	0	0	0	0	0	**1**	**0.08**
20220921	1	0	0	0	2	0	0	**3**	**0.24**
20220922	0	0	0	0	0	1	0	**1**	**0.08**
Species Total	**3**	**3**	**3**	**3**	**48**	**12**	**4**	**76**	
Passes per hour	**0.02**	**0.02**	**0.02**	**0.02**	**0.38**	**0.10**	**0.03**	**0.61**	

T2

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	0	1	3	0	5	0	0	**9**	**1.16**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	1	0	0	0	0	**1**	**0.13**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	1	0	0	0	0	0	0	**1**	**0.13**
20220614	0	0	0	0	0	0	0	**0**	**0.00**
20220615	0	0	1	0	0	0	0	**1**	**0.13**
Species Total	**1**	**1**	**5**	**0**	**5**	**0**	**0**	**12**	
Passes per hour	**0.01**	**0.01**	**0.06**	**0.00**	**0.06**	**0.00**	**0.00**	**0.15**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	0	2	2	0	10	5	1	**20**	**2.00**
20220810	5	1	2	0	18	8	2	**36**	**3.60**
20220811	2	2	0	0	5	2	2	**13**	**1.30**
20220812	7	1	7	3	35	10	1	**64**	**6.40**
20220813	7	1	2	1	10	4	2	**27**	**2.70**
20220814	1	2	11	0	3	1	0	**18**	**1.80**
20220815	1	0	5	0	0	0	0	**6**	**0.60**
20220816	1	0	0	0	0	0	0	**1**	**0.10**
20220817	0	1	0	0	0	0	1	**2**	**0.20**
20220818	1	0	1	0	0	0	0	**2**	**0.20**
Species Total	**25**	**10**	**30**	**4**	**81**	**30**	**9**	**189**	
Passes per hour	**0.25**	**0.10**	**0.30**	**0.04**	**0.81**	**0.30**	**0.09**	**1.89**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	3	3	0	0	16	1	2	**25**	**2.00**
20220914	2	0	1	0	8	1	1	**13**	**1.04**
20220915	1	0	0	0	14	1	0	**16**	**1.28**
20220916	1	0	0	0	2	1	1	**5**	**0.40**
20220917	1	0	0	0	0	1	0	**2**	**0.16**
20220918	2	0	0	0	18	7	0	**27**	**2.16**
20220919	0	0	1	0	2	1	0	**4**	**0.32**
20220920	1	0	0	0	0	0	0	**1**	**0.08**
20220921	0	0	1	0	9	1	0	**11**	**0.88**
20220922	0	0	0	0	3	0	0	**3**	**0.24**
Species Total	**11**	**3**	**3**	**0**	**72**	**14**	**4**	**107**	
Passes per hour	**0.09**	**0.02**	**0.02**	**0.00**	**0.58**	**0.11**	**0.03**	**0.86**	

T3

Spring									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220606	0	0	6	0	2	0	0	**8**	**1.03**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	0	0	0	0	0	0	0	**0**	**0.00**
20220614	0	0	0	0	0	0	0	**0**	**0.00**
20220615	0	0	0	0	0	0	0	**0**	**0.00**
Species Total	**0**	**0**	**6**	**0**	**2**	**0**	**0**	**8**	
Passes per hour	**0.00**	**0.00**	**0.08**	**0.00**	**0.03**	**0.00**	**0.00**	**0.10**	

Summer									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220809	1	2	1	0	5	6	2	**17**	**1.70**
20220810	4	0	16	0	68	43	2	**133**	**13.30**
20220811	2	1	18	1	80	20	1	**123**	**12.30**
20220812	3	1	36	0	46	27	1	**114**	**11.40**
20220813	3	0	13	2	32	16	1	**67**	**6.70**
20220814	0	0	16	0	10	11	0	**37**	**3.70**
20220815	0	0	0	0	0	0	0	**0**	**0.00**
20220816	0	0	8	0	1	0	0	**9**	**0.90**
20220817	0	0	1	0	5	0	0	**6**	**0.60**
20220818	0	0	0	0	0	0	0	**0**	**0.00**
Species Total	**13**	**4**	**109**	**3**	**247**	**123**	**7**	**506**	
Passes per hour	**0.13**	**0.04**	**1.09**	**0.03**	**2.47**	**1.23**	**0.07**	**5.06**	

Autumn									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220913	2	1	1	0	4	0	1	**9**	**0.72**
20220914	0	0	0	0	0	0	0	**0**	**0.00**
20220915	0	1	0	0	0	0	1	**2**	**0.16**
20220916								**0**	**0.00**
20220917								**0**	**0.00**
20220918								**0**	**0.00**
20220919				Battery Failure				**0**	**0.00**
20220920								**0**	**0.00**
20220921								**0**	**0.00**
20220922								**0**	**0.00**
Species Total	**2**	**2**	**1**	**0**	**4**	**0**	**2**	**11**	
Passes per hour	**0.05**	**0.05**	**0.03**	**0.00**	**0.11**	**0.00**	**0.05**	**0.29**	

T4

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	1	1	17	0	20	2	1	**42**	**5.42**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	1	0	0	0	0	0	0	**1**	**0.13**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	10	0	0	0	0	**10**	**1.29**
20220613	3	0	3	0	0	1	1	**8**	**1.03**
20220614	1	0	4	10	6	4	0	**25**	**3.23**
20220615	0	0	1	0	0	0	0	**1**	**0.13**
Species Total	**6**	**1**	**35**	**10**	**26**	**7**	**2**	**87**	
Passes per hour	**0.08**	**0.01**	**0.45**	**0.13**	**0.34**	**0.09**	**0.03**	**1.12**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	1	0	4	0	4	7	1	**17**	**1.70**
20220810	1	0	6	0	16	9	1	**33**	**3.30**
20220811	4	1	12	0	45	24	0	**86**	**8.60**
20220812								**0**	**0.00**
20220813								**0**	**0.00**
20220814		Battery Failure						**0**	**0.00**
20220815								**0**	**0.00**
20220816								**0**	**0.00**
20220817								**0**	**0.00**
20220818								**0**	**0.00**
Species Total	**6**	**1**	**22**	**0**	**65**	**40**	**2**	**136**	
Passes per hour	**0.20**	**0.03**	**0.73**	**0.00**	**2.17**	**1.33**	**0.07**	**4.53**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	1	2	6	0	18	7	2	**36**	**2.88**
20220914	0	0	1	0	4	6	1	**12**	**0.96**
20220915	1	4	0	0	5	0	2	**12**	**0.96**
20220916	1	0	0	0	2	2	2	**7**	**0.56**
20220917	5	1	0	0	0	0	0	**6**	**0.48**
20220918	3	0	2	0	37	13	1	**56**	**4.48**
20220919	1	0	1	0	3	1	2	**8**	**0.64**
20220920	0	0	0	0	0	1	0	**1**	**0.08**
20220921	0	0	0	0	0	0	1	**1**	**0.08**
20220922	1	2	0	0	1	2	0	**6**	**0.48**
Species Total	**13**	**9**	**10**	**0**	**70**	**32**	**11**	**145**	
Passes per hour	**0.10**	**0.07**	**0.08**	**0.00**	**0.56**	**0.26**	**0.09**	**1.16**	

T5

Spring									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220606	0	0	0	0	0	0	0	**0**	**0.00**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	1	0	0	0	0	0	0	**1**	**0.13**
20220609	0	1	1	0	0	0	0	**2**	**0.26**
20220610	1	0	3	0	0	0	0	**4**	**0.52**
20220611	1	0	0	0	0	0	1	**2**	**0.26**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	4	1	4	0	0	1	0	**10**	**1.29**
20220614	3	1	2	0	0	0	0	**6**	**0.77**
20220615	0	1	2	0	0	0	0	**3**	**0.39**
Species Total	**10**	**4**	**12**	**0**	**0**	**1**	**1**	**28**	
Passes per hour	**0.13**	**0.05**	**0.15**	**0.00**	**0.00**	**0.01**	**0.01**	**0.36**	

Summer									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220809	1	2	12	0	2	9	1	**27**	**2.70**
20220810	3	0	36	0	74	34	2	**149**	**14.90**
20220811	1	0	10	0	43	15	1	**70**	**7.00**
20220812	2	0	31	0	22	16	1	**72**	**7.20**
20220813	1	0	33	0	34	10	1	**79**	**7.90**
20220814	0	0	3	0	0	0	0	**3**	**0.30**
20220815	0	0	0	0	0	0	0	**0**	**0.00**
20220816	1	1	5	0	0	0	1	**8**	**0.80**
20220817	0	0	2	0	1	1	0	**4**	**0.40**
20220818	1	0	0	0	0	0	0	**1**	**0.10**
Species Total	**10**	**3**	**132**	**0**	**176**	**85**	**7**	**413**	
Passes per hour	**0.10**	**0.03**	**1.32**	**0.00**	**1.76**	**0.85**	**0.07**	**4.13**	

Autumn									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220913	0	2	0	0	1	1	1	**5**	**0.40**
20220914	0	0	0	0	0	0	0	**0**	**0.00**
20220915	0	0	0	0	0	0	0	**0**	**0.00**
20220916	1	2	0	0	2	0	0	**5**	**0.40**
20220917	1	0	0	0	0	0	0	**1**	**0.08**
20220918	1	4	0	0	6	4	0	**15**	**1.20**
20220919	1	2	1	0	0	1	0	**5**	**0.40**
20220920	0	0	0	0	0	0	1	**1**	**0.08**
20220921	0	0	0	0	0	0	0	**0**	**0.00**
20220922	1	1	1	0	3	0	2	**8**	**0.64**
Species Total	**5**	**11**	**2**	**0**	**12**	**6**	**4**	**40**	
Passes per hour	**0.04**	**0.09**	**0.02**	**0.00**	**0.10**	**0.05**	**0.03**	**0.32**	

T6

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	2	0	24	0	1	0	0	**27**	**3.48**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	0	0	0	0	0	1	0	**1**	**0.13**
20220614	0	0	3	0	0	0	0	**3**	**0.39**
20220615	0	0	4	0	0	0	0	**4**	**0.52**
Species Total	**2**	**0**	**31**	**0**	**1**	**1**	**0**	**35**	
Passes per hour	**0.03**	**0.00**	**0.40**	**0.00**	**0.01**	**0.01**	**0.00**	**0.45**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	5	0	37	0	12	1	7	**62**	**6.20**
20220810	4	0	128	0	91	73	2	**298**	**29.80**
20220811	8	1	130	0	80	38	3	**260**	**26.00**
20220812	3	0	176	0	65	33	3	**280**	**28.00**
20220813	7	1	194	0	51	14	0	**267**	**26.70**
20220814	2	0	34	0	4	5	1	**46**	**4.60**
20220815	0	0	49	0	1	0	0	**50**	**5.00**
20220816	1	0	28	0	1	0	2	**32**	**3.20**
20220817	0	0	4	0	1	0	0	**5**	**0.50**
20220818	0	0	2	0	0	0	0	**2**	**0.20**
Species Total	**30**	**2**	**782**	**0**	**306**	**164**	**18**	**1302**	
Passes per hour	**0.30**	**0.02**	**7.82**	**0.00**	**3.06**	**1.64**	**0.18**	**13.02**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	4	1	1	0	5	1	4	**16**	**1.28**
20220914	8	0	8	0	7	0	4	**27**	**2.16**
20220915	2	2	3	0	3	1	4	**15**	**1.20**
20220916	11	4	2	0	3	0	7	**27**	**2.16**
20220917	11	5	0	0	2	2	15	**35**	**2.80**
20220918	14	2	18	0	8	1	8	**51**	**4.08**
20220919	8	2	0	0	0	0	1	**11**	**0.88**
20220920	2	2	0	0	0	0	1	**5**	**0.40**
20220921	0	0	20	0	0	0	0	**20**	**1.60**
20220922	16	1	0	0	3	0	6	**26**	**2.08**
Species Total	**76**	**19**	**52**	**0**	**31**	**5**	**50**	**233**	
Passes per hour	**0.61**	**0.15**	**0.42**	**0.00**	**0.25**	**0.04**	**0.40**	**1.86**	

T7

Spring									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220606	4	0	7	4	6	0	0	**21**	**2.71**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	1	8	0	0	0	0	**9**	**1.16**
20220612	1	1	20	0	1	3	0	**26**	**3.35**
20220613	4	0	8	0	0	0	0	**12**	**1.55**
20220614	0	0	5	0	0	0	0	**5**	**0.65**
20220615	2	1	2	0	0	0	0	**5**	**0.65**
Species Total	**11**	**3**	**50**	**4**	**7**	**3**	**0**	**78**	
Passes per hour	**0.14**	**0.04**	**0.65**	**0.05**	**0.09**	**0.04**	**0.00**	**1.01**	

Summer									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220809	5	1	73	0	19	15	12	**125**	**12.50**
20220810	5	0	89	0	194	131	13	**432**	**43.20**
20220811	10	1	50	0	75	17	10	**163**	**16.30**
20220812	4	1	203	0	118	35	9	**370**	**37.00**
20220813	6	1	71	0	120	13	5	**216**	**21.60**
20220814	2	1	106	0	8	4	10	**131**	**13.10**
20220815	0	0	145	0	23	1	3	**172**	**17.20**
20220816	2	0	83	0	24	1	4	**114**	**11.40**
20220817	1	0	20	0	0	1	2	**24**	**2.40**
20220818	4	0	25	0	0	0	3	**32**	**3.20**
Species Total	**39**	**5**	**865**	**0**	**581**	**218**	**71**	**1779**	
Passes per hour	**0.39**	**0.05**	**8.65**	**0.00**	**5.81**	**2.18**	**0.71**	**17.79**	

Autumn									
DATE	**MYODAU**	**MYONAT**	**NYCLEI**	**PIPNAT**	**PIPPIP**	**PIPPYG**	**PLEAUR**	**TOTALS**	**BAI**
20220913	3	2	82	2	381	142	10	**622**	**49.76**
20220914	0	0	37	0	75	28	0	**140**	**11.20**
20220915								**0**	**0.00**
20220916								**0**	**0.00**
20220917								**0**	**0.00**
20220918		Battery Failure						**0**	**0.00**
20220919								**0**	**0.00**
20220920								**0**	**0.00**
20220921								**0**	**0.00**
20220922								**0**	**0.00**
Species Total	**3**	**2**	**119**	**2**	**456**	**170**	**10**	**762**	
Passes per hour	**0.12**	**0.08**	**4.76**	**0.08**	**18.24**	**6.80**	**0.40**	**30.48**	

T8

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	0	0	7	0	5	0	0	**12**	**1.55**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	1	0	0	0	0	**1**	**0.13**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	1	0	0	0	0	**1**	**0.13**
20220613	0	0	0	0	0	0	0	**0**	**0.00**
20220614	0	0	2	0	0	0	0	**2**	**0.26**
20220615	0	0	7	0	0	0	0	**7**	**0.90**
Species Total	**0**	**0**	**18**	**0**	**5**	**0**	**0**	**23**	
Passes per hour	**0.00**	**0.00**	**0.23**	**0.00**	**0.06**	**0.00**	**0.00**	**0.30**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	0	0	10	0	29	20	1	**60**	**6.00**
20220810	5	1	30	0	87	29	1	**153**	**15.30**
20220811	1	0	4	0	46	21	3	**75**	**7.50**
20220812	1	1	40	0	68	40	1	**151**	**15.10**
20220813	2	0	10	0	29	10	0	**51**	**5.10**
20220814	0	0	11	0	7	4	1	**23**	**2.30**
20220815	1	0	51	0	7	2	0	**61**	**6.10**
20220816	2	0	10	0	7	1	0	**20**	**2.00**
20220817	1	0	9	0	4	1	0	**15**	**1.50**
20220818	0	0	2	0	0	0	0	**2**	**0.20**
Species Total	**13**	**2**	**177**	**0**	**284**	**128**	**7**	**611**	
Passes per hour	**0.13**	**0.02**	**1.77**	**0.00**	**2.84**	**1.28**	**0.07**	**6.11**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	3	0	7	0	11	2	13	**36**	**2.88**
20220914	0	1	1	0	21	8	5	**36**	**2.88**
20220915	1	0	0	0	6	2	6	**15**	**1.20**
20220916	1	1	0	0	4	0	8	**14**	**1.12**
20220917	2	0	3	0	1	0	8	**14**	**1.12**
20220918	2	1	7	0	49	3	9	**71**	**5.68**
20220919	1	0	1	0	1	1	5	**9**	**0.72**
20220920	1	2	0	0	0	0	2	**5**	**0.40**
20220921	0	0	1	0	0	0	0	**1**	**0.08**
20220922	0	1	1	0	30	10	10	**52**	**4.16**
Species Total	**11**	**6**	**21**	**0**	**123**	**26**	**66**	**253**	
Passes per hour	**0.09**	**0.05**	**0.17**	**0.00**	**0.98**	**0.21**	**0.53**	**2.02**	

T9

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	0	1	10	0	1	0	0	**12**	**1.55**
20220607	0	0	1	0	0	0	0	**1**	**0.13**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	0	0	0	0	0	0	0	**0**	**0.00**
20220614	0	0	0	0	0	0	0	**0**	**0.00**
20220615	0	0	2	0	0	0	0	**2**	**0.26**
Species Total	**0**	**1**	**13**	**0**	**1**	**0**	**0**	**15**	
Passes per hour	**0.00**	**0.01**	**0.17**	**0.00**	**0.01**	**0.00**	**0.00**	**0.19**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	5	1	19	0	8	7	9	**49**	**4.90**
20220810	2	1	66	0	39	30	2	**140**	**14.00**
20220811	5	0	128	0	32	22	6	**193**	**19.30**
20220812	9	0	105	0	8	4	4	**130**	**13.00**
20220813	4	0	280	0	58	26	3	**371**	**37.10**
20220814	1	1	32	0	4	1	0	**39**	**3.90**
20220815	0	0	4	0	0	0	0	**4**	**0.40**
20220816	0	0	27	0	1	0	3	**31**	**3.10**
20220817	0	0	3	0	0	0	0	**3**	**0.30**
20220818	0	0	3	0	0	0	0	**3**	**0.30**
Species Total	**26**	**3**	**667**	**0**	**150**	**90**	**27**	**963**	
Passes per hour	**0.26**	**0.03**	**6.67**	**0.00**	**1.50**	**0.90**	**0.27**	**9.63**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	1	2	0	1	3	0	2	**9**	**0.72**
20220914	4	1	0	1	2	0	1	**9**	**0.72**
20220915	0	3	1	2	2	0	2	**10**	**0.80**
20220916	3	1	1	0	1	1	1	**8**	**0.64**
20220917	7	0	0	0	0	0	3	**10**	**0.80**
20220918	14	4	0	0	6	0	3	**27**	**2.16**
20220919	3	2	0	0	0	1	0	**6**	**0.48**
20220920	1	1	0	0	0	0	2	**4**	**0.32**
20220921	0	0	0	0	0	0	0	**0**	**0.00**
20220922	3	2	0	0	0	1	1	**7**	**0.56**
Species Total	**36**	**16**	**2**	**4**	**14**	**3**	**15**	**90**	
Passes per hour	**0.29**	**0.13**	**0.02**	**0.03**	**0.11**	**0.02**	**0.12**	**0.72**	

T10

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	1	0	5	0	2	0	0	**8**	**1.03**
20220607	0	0	0	0	0	0	0	**0**	**0.00**
20220608	0	0	0	0	0	0	0	**0**	**0.00**
20220609	0	0	0	0	0	0	0	**0**	**0.00**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	1	1	7	0	0	0	0	**9**	**1.16**
20220612	1	1	7	0	0	0	0	**9**	**1.16**
20220613	0	0	4	0	0	0	0	**4**	**0.52**
20220614	0	0	2	0	0	0	0	**2**	**0.26**
20220615	0	0	15	0	0	0	0	**15**	**1.94**
Species Total	**3**	**2**	**40**	**0**	**2**	**0**	**0**	**47**	
Passes per hour	**0.04**	**0.03**	**0.52**	**0.00**	**0.03**	**0.00**	**0.00**	**0.61**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	5	1	34	0	8	10	3	**61**	**6.10**
20220810	4	0	61	0	51	32	6	**154**	**15.40**
20220811	3	0	92	0	40	12	7	**154**	**15.40**
20220812	5	0	200	0	12	11	8	**236**	**23.60**
20220813	6	0	93	0	43	9	9	**160**	**16.00**
20220814	1	0	43	0	8	0	1	**53**	**5.30**
20220815	0	0	50	0	1	0	1	**52**	**5.20**
20220816	2	0	37	0	9	1	1	**50**	**5.00**
20220817	0	0	13	0	0	0	0	**13**	**1.30**
20220818	0	0	15	0	0	0	1	**16**	**1.60**
Species Total	**26**	**1**	**638**	**0**	**172**	**75**	**37**	**949**	
Passes per hour	**0.26**	**0.01**	**6.38**	**0.00**	**1.72**	**0.75**	**0.37**	**9.49**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	3	0	0	0	25	20	4	**52**	**4.16**
20220914	5	1	2	0	8	1	8	**25**	**2.00**
20220915	1	1	0	0	11	1	4	**18**	**1.44**
20220916	4	1	0	0	5	0	6	**16**	**1.28**
20220917	4	2	0	0	3	0	5	**14**	**1.12**
20220918	6	4	1	0	20	1	6	**38**	**3.04**
20220919	2	2	0	0	2	2	8	**16**	**1.28**
20220920	3	1	1	0	1	0	5	**11**	**0.88**
20220921	1	0	0	0	0	0	2	**3**	**0.24**
20220922	3	2	0	0	4	1	6	**16**	**1.28**
Species Total	**32**	**14**	**4**	**0**	**79**	**26**	**54**	**209**	
Passes per hour	**0.26**	**0.11**	**0.03**	**0.00**	**0.63**	**0.21**	**0.43**	**1.67**	

T12

Spring									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220606	0	0	40	0	0	0	0	**40**	**5.16**
20220607	0	0	3	0	0	0	0	**3**	**0.39**
20220608	1	0	0	0	0	0	0	**1**	**0.13**
20220609	0	0	5	0	0	0	0	**5**	**0.65**
20220610	0	0	0	0	0	0	0	**0**	**0.00**
20220611	0	0	0	0	0	0	0	**0**	**0.00**
20220612	0	0	0	0	0	0	0	**0**	**0.00**
20220613	1	0	2	0	0	0	0	**3**	**0.39**
20220614	0	0	16	0	0	0	0	**16**	**2.06**
20220615	1	1	8	0	0	0	0	**10**	**1.29**
Species Total	**3**	**1**	**74**	**0**	**0**	**0**	**0**	**78**	
Passes per hour	**0.04**	**0.01**	**0.95**	**0.00**	**0.00**	**0.00**	**0.00**	**1.01**	

Summer									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220809	21	5	23	0	6	5	14	**74**	**7.40**
20220810	19	2	95	0	99	64	20	**299**	**29.90**
20220811	28	4	145	0	163	105	11	**456**	**45.60**
20220812	14	2	255	0	28	5	19	**323**	**32.30**
20220813	31	4	208	1	30	9	12	**295**	**29.50**
20220814	14	0	108	0	3	0	1	**126**	**12.60**
20220815	0	0	35	0	0	0	0	**35**	**3.50**
20220816	2	0	24	0	75	7	6	**114**	**11.40**
20220817	0	0	14	0	0	1	1	**16**	**1.60**
20220818	5	1	6	0	0	0	1	**13**	**1.30**
Species Total	**134**	**18**	**913**	**1**	**404**	**196**	**85**	**1751**	
Passes per hour	**1.34**	**0.18**	**9.13**	**0.01**	**4.04**	**1.96**	**0.85**	**17.51**	

Autumn									
DATE	MYODAU	MYONAT	NYCLEI	PIPNAT	PIPPIP	PIPPYG	PLEAUR	TOTALS	BAI
20220913	7	3	15	0	167	19	12	**223**	**17.84**
20220914	11	4	2	0	18	8	10	**53**	**4.24**
20220915	1	4	0	0	20	1	9	**35**	**2.80**
20220916	10	9	0	0	26	1	4	**50**	**4.00**
20220917	8	4	0	0	3	0	9	**24**	**1.92**
20220918	12	3	1	0	21	2	7	**46**	**3.68**
20220919	10	3	0	0	0	0	6	**19**	**1.52**
20220920	2	3	1	0	0	1	5	**12**	**0.96**
20220921	0	0	0	0	0	1	0	**1**	**0.08**
20220922	11	3	1	0	1	0	15	**31**	**2.48**
Species Total	**72**	**36**	**20**	**0**	**256**	**33**	**77**	**494**	
Passes per hour	**0.58**	**0.29**	**0.16**	**0.00**	**2.05**	**0.26**	**0.62**	**3.95**	

Appendix 2 – Photographs

Photo 1- SM mini bat deployed in the spring at T1

Photo 2- Anabat chorus deployed in the summer at T1

Photo 3- SM mini bat deployed in the Autumn at T1

Photo 4- Anabat express v3 mic deployed in the spring at T2

Photo 5- Anabat chorus deployed in the summer at T2

Photo 6- SM mini bat deployed in the Autumn at T2

Photo 7- Anabat express v3 mic deployed in the spring at T3

Photo 8- Anabat chorus deployed in the summer at T3

Photo 9- SM mini bat deployed in the Autumn at T3

Photo 10- SM mini bat deployed in the spring at T4

Photo 11- Anabat chorus deployed in the summer at T4

Photo 12- Anabat chorus deployed in the Autumn at T4

Photo 13- Anabat Chorus deployed in the spring at T5

Photo 14- Anabat chorus deployed in the summer at T5

Photo 15- Anabat chorus deployed in the Autumn at T5

Photo 16- SM mini bat deployed in the spring at T6

Photo 17- deployed in the summer at T6

Photo 18- SM mini bat deployed in the Autumn at T6

Photo 19- SM mini bat deployed in the spring at T7

Photo 20- deployed in the summer at T7

Photo 21- SM mini bat deployed in the Autumn at T7

Photo 22- SM mini bat deployed in the spring at T8

Photo 23- deployed in the summer at T8

Photo 24- SM mini bat deployed in the Autumn at T8

Photo 25- Anabat express v3 mic deployed in the spring at T9

Photo 26- deployed in the summer at T9

Photo 27- Anabat Chorus deployed in the Autumn at T9

Photo 28- SM mini bat deployed in the spring at T10

Photo 29- deployed in the summer at T10

Photo 30- SM mini bat deployed in the Autumn at T10

Photo 31- SM mini bat deployed in the spring at T12

Photo 32- deployed in the summer at T12

Photo 33- SM mini bat deployed in the Autumn at T12

Appendix 3 – Figures

res

MULLAGHCLOGHER WIND FARM

FIGURE 1

AUTOMATED STATIC BAT DETECTOR LOCATIONS

KEY

- STATIC BAT DETECTOR LOCATION
- SITE ENTRANCE LOCATION
- SITE BOUNDARY
- TURBINE LOCATION
- WATERCOURSE CROSSING
- ACCESS TRACK
- CRANE HARDSTANDING (TEMPORARY)
- CRANE HARDSTANDING (PERMANENT)
- SUBSTATION COMPOUND
- TEMPORARY ENABLING WORKS COMPOUND
- TEMPORARY CONSTRUCTION COMPOUND
- BATTERY STORAGE COMPOUND

LAYOUT DWG	T-LAYOUT NO.
DRAWING NUMBER	

SCALE - 1: 9,750 @ A3

BAT SURVEY REPORT

Blackstaff Ecology

Appendix 4 – Weather data (2022)

Static monitoring

	Date	Weather Conditions (@21:00pm)			
		Temperature (°C)	Wind Speed (m/s)	Wind Direction	Rainfall (mm)
Spring	06/06/2022	12	1	SW	0
	07/06/2022	12	4	SW	0.6
	08/06/2022	10	4	NW	1.6
	09/06/2022	14	4	WSW	0.1
	10/06/2022	12	6	WNW	0.9
	11/06/2022	11	5	NNW	0.3
	12/06/2022	10	4	N	0
	13/06/2022	11	3	NW	0.2
	14/06/2022	12	2	WNW	0.1
	15/06/2022	14	2	WNW	0.2
Summer	09/08/2022	16	1	NW	0
	10/08/2022	15	1	E	0
	11/08/2022	15	2	E	0
	12/08/2022	17	2	E	0
	13/08/2022	17	2	ESE	0
	14/08/2022	16	2	SSE	1.1
	15/08/2022	14	6	ENE	0.2
	16/08/2022	13	5	E	0
	17/08/2022	13	2	WSW	0.1
	18/08/2022	13	5	NNW	0.5
Autumn	13/09/2022	10	1	NE	0
	14/09/2022	11	3	NNE	0.1
	15/09/2022	9	2	NE	0
	16/09/2022	8	1	NNE	0
	17/09/2022	8	2	NNW	0
	18/09/2022	10	1	NNE	0
	19/09/2022	12	0	NW	0
	20/09/2022	13	2	ESE	0
	21/09/2022	15	5	WNW	3.1
	22/09/2022	10	1	ENE	0.1

Appendix 5 – Curtailment Case-study (SNH 2019)

Appendix 5: Case study of operational curtailment implementation

Introduction

Curtailment mitigation has been implemented at a large (>100MW) windfarm in response to new evidence on the frequency of bat fatalities which emerged during site operation. The site occupies the upland zone above 200m altitude and comprises a mixture of forestry plantation, felled plantation and existing moorland habitats.

Methodology

In order to determine whether curtailment would be effective at reducing bat fatalities, and if so what parameters should be used, a study was designed to investigate the pattern of bat activity at the site temporally, spatially and in response to weather conditions. Bat activity was measured at n=18 turbines continuously between July and September in Year 1 in combination with carcass surveys. In addition, wind speed and temperature data were continuously recorded at nacelle height.

In Year 2, curtailment was activated at the site using parameters determined from Year 1 data, with bat activity data collected from n=12 locations continuously between April and mid-October in combination at carcass surveys at n=24 locations.

Results

Over 95% of recorded passes on the site comprised 3 species: soprano pipistrelle (56.6%); common pipistrelle (35.5%); and noctule (3.8%).

There was a strong pattern of seasonal temporal variability in bat passes, with most activity occurring between the mid-August to mid-September period (Figure 1).

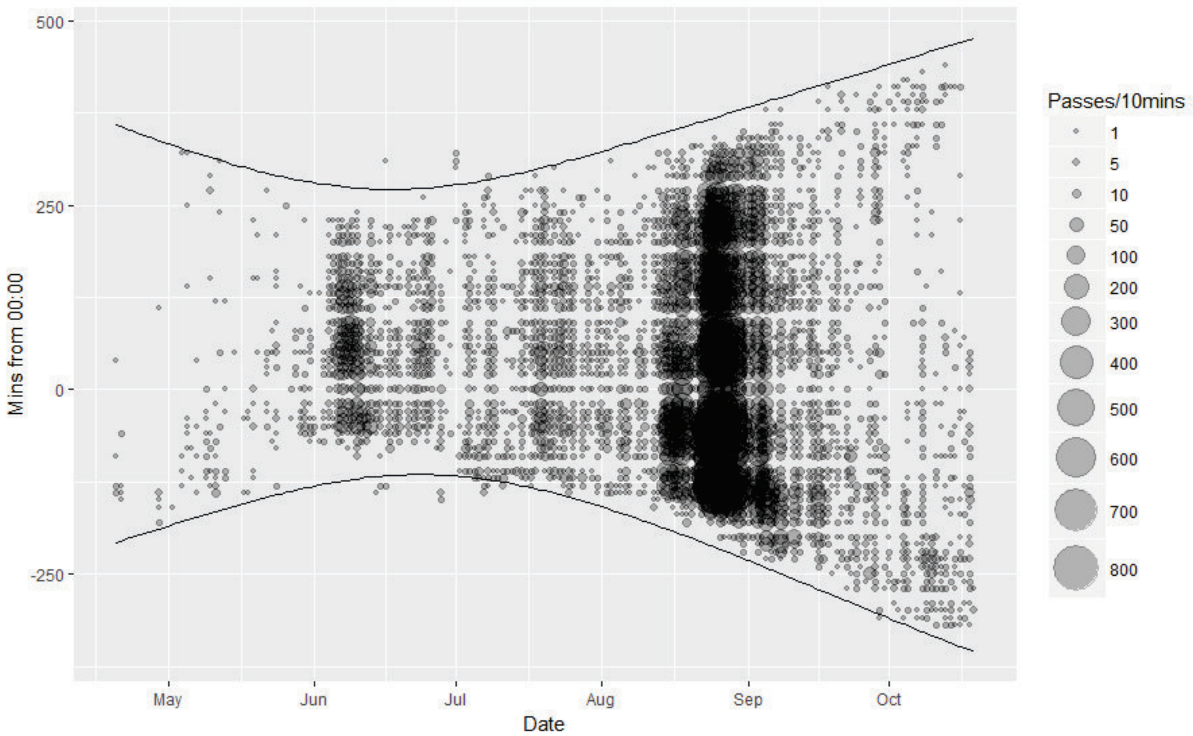

Figure 1: Total number of all bat passes recorded in Year 2 in each 10 minute period at n=12 locations. The upper and lower solid lines represent sunrise and sunset respectively. A similar pattern was recorded in Year 1.

There were no discernible spatial patterns in recorded bat activity or fatalities within the site. Temperature and wind speed were significant factors (both $p<0.001$) associated with recorded bat passes (adjusted R-squared 0.5). A plot of the raw activity data with corresponding nightly temperature and wind speeds is shown in Figure 2.

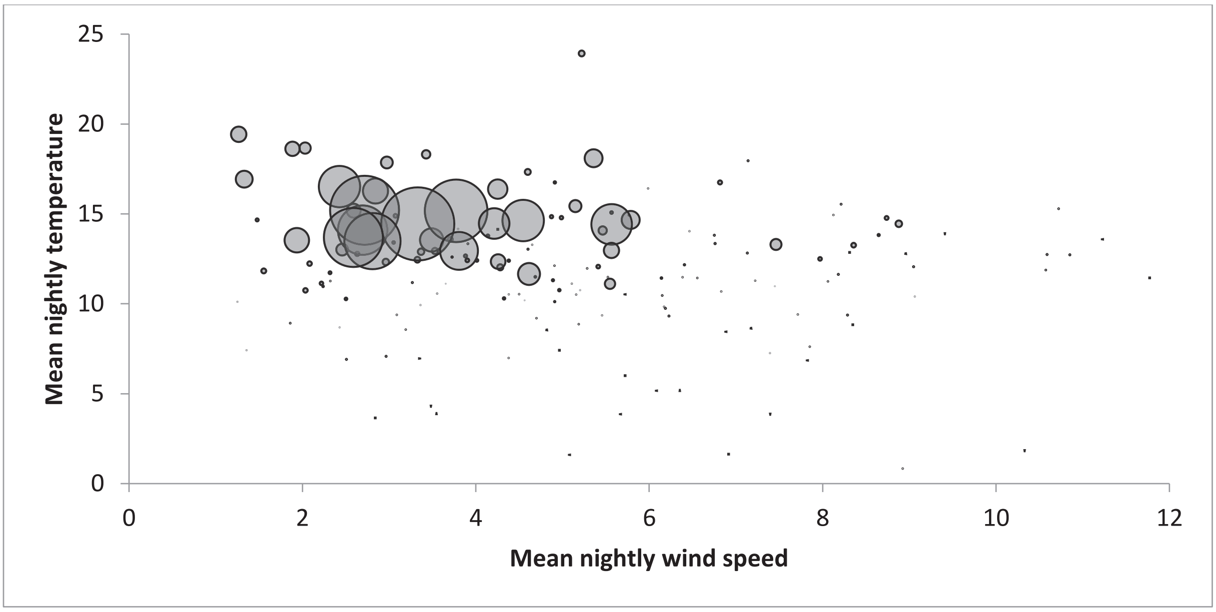

Figure 2: Relative abundance of recorded bat passes plotted against corresponding mean nightly wind speed and temperature.

Curtailment strategy

After Year 1 it was calculated that 90% of all bat activity occurred on the site when temperature exceeded 11.5°C and windspeed was below 5m/s. In addition, the first bat passes were recorded 30min after sunset and the last bat passes were recorded 40min prior to sunrise. As such a software module was programmed into the SCADA system controlling the turbines to curtail turbines when all of these criteria were met. Curtailment is achieved by opening the blade pitch into the fully-feathered position, which reduces blade rotation speed to <1rpm.

Following activation of this system, no bat carcasses were detected at any of the curtailed turbines during Year 2. Given the high probability of carcass detection using trained dog teams it can be concluded with high confidence that the total number of bat fatalities is either zero or so close to zero to be undetectable.

The performance of the system in terms of its ability to respond to the changes in bat abundance based on temperature and wind speed was analysed to confirm it was neither significantly over- nor under- curtailing during different periods of bat activity. Since individual turbines are subject to variation in ambient temperature and wind speed at any given time the whole site will be curtailed for a variable percentage of the available operational time during the night depending on the weather. The percentage of the available operating time within a night the site was curtailed and the corresponding level of bat activity in is shown below in Figure 3. The linear regression has an R-squared value of 0.57, which suggests the curtailment parameters are a good predictor of bat activity, with no points in the extreme bottom-right or top-left areas which would give concern as they would represent significant over- or under-curtailment respectively.

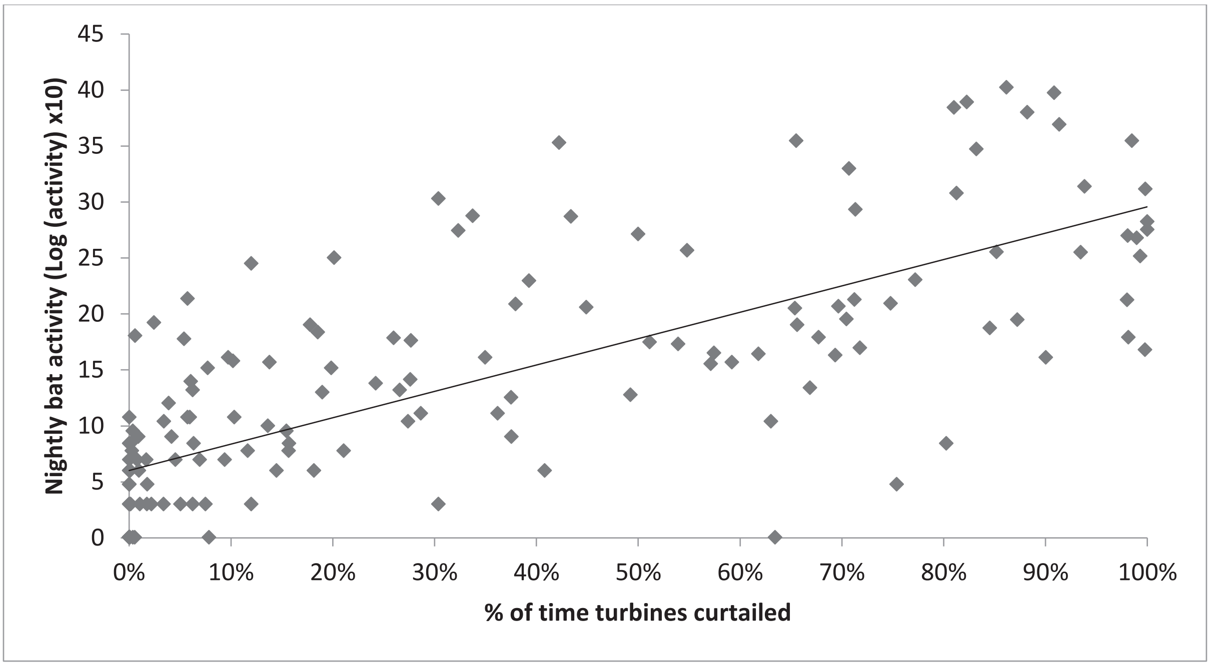

Figure 3: Scatterplot % time all turbines were curtailed on a single night against the recorded number of bat passes during the same period. The solid line is a simple linear regression.

Operationally the system has been working without causing consequences for the windfarm. The “restart” wind speed was increased to 5.5m/s to avoid short-term cycling on/off of the curtailment, so the behaviour of the system is to curtail below 5m/s (when nightly temperatures >11.5°C) but will not restart until the wind speed is >5.5m/s.

Given the performance of the system in minimising fatalities the curtailment system is deemed to be adequate and will continue to be in place for the duration of the project life, with no further bat monitoring proposed.