Appendix 7.2 Bat Survey Report

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MacArthur Green

Douglas West Wind Farm Extension

Bat Survey Report

Technical Appendix 7.2

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CONTENTS

EXECUTIVE SUMMARY

MacArthur Green was commissioned by Douglas West Extension Ltd (‘the Applicant’), to undertake bat surveys for the proposed Douglas West Wind Farm Extension (hereafter referred to as the ‘Proposed Development’).

These surveys were undertaken to inform the Proposed Development design process and the ecological assessment for the Proposed Development Environmental Impact Assessment Report (EIAR).

This report presents the results of the bat survey work undertaken between May and September 2018 at the site and within the bat study area.

Four bat species were recorded within the study area during the temporal (static detector) surveys: common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), Daubenton’s (*Myotis daubentonii*) and brown long-eared bat (*Plecotus auritus*). Two genus groups were also recorded within the study area; *Myotis* species (spp.) and *Nyctalus* spp. A total registration count of 2,688 and a mean Bat Activity Index (BAI) of 5.37 brpn (bat registrations per night) was recorded for the study area.

Nyctalus spp. (a high population vulnerability and high collision risk species) were recorded across the study area through the survey period. An average registration of >1 brpn during any particular survey month was recorded at the following locations; location 1; location 9 and location 10.

Common pipistrelle and soprano pipistrelle (medium population vulnerability and high collision risk species) recorded moderate BAI levels within the study area in June at location 10 and location 7. All other locations recorded a low BAI for common pipistrelle and soprano pipistrelle species on each survey visit.

Low to medium population vulnerability species and low collision risk species (Daubenton’s, brown long-eared bat and *Myotis* spp.) recorded a low BAI during every survey visit across the study area.

No bat roosts or potential bat roosts were located within 200 m plus radius diameter of a turbine, or within 30 m of the proposed access tracks.

1 INTRODUCTION

MacArthur Green was commissioned by the Douglas West Extension Ltd ('the Applicant') to carry out bat surveys at the proposed Douglas West Wind Farm Extension, by Douglas, South Lanarkshire (hereafter referred to as the 'Proposed Development'). The extents of the Proposed Development and associated bat study area are presented in Figures 7.7 to 7.11.

A survey plan for bats was conducted during the period of May to September 2018 (inclusive). The survey plan included:

- A preliminary bat roost assessment as part of the protected species surveys; and
- Temporal (static) bat detector surveys.

The aim of the surveys was to identify roosting potential, quantify study area usage and seasonal variation of bat activity within the study area. Surveys were carried out during the main bat activity period from May to September.

These surveys were undertaken to inform the ecological assessment for the Proposed Development Environmental Impact Assessment Report (EIAR).

2 THE PROPOSED DEVELOPMENT AND STUDY AREA

The Proposed Development will comprise 13 wind turbines up to 200 m blade tip height, each being around 6 megawatt (MW) in power rating. The Proposed Development generation capacity will be approximately 78 MW, plus around 20 MW of storage capacity. The associated infrastructure will include: site access, access tracks, crane hardstanding, underground cabling, on-site substation and maintenance building, energy storage compound, temporary construction compound, laydown area, concrete batching plant, potential excavations/borrow workings and a permanent meteorological mast.

The bat study area is dominated by coniferous forestry plantation within Cumberhead Forest. There are several watercourses present within the study area, including the upper reaches of the Hagshaw Burn and the Shiel Burn. The watercourses within the study area drain into the Poniel Water to the north.

The study area is also surrounded by a number of operating wind farms: Hagshaw Hill and Extension Wind Farm, Galawhistle Wind Farm and Nutberry Wind Farm, as well as former opencast mining areas.

The study area in which temporal (static) and preliminary roost surveys were completed, and the associated Anabat locations are shown in Figures 7.7 to 7.11.

4 BATS AND WIND FARMS

4.1 Policy and Guidance

All bats species are protected under the following legislation:

- The Habitats Directive 92/43/EEC (as amended);
- The Wildlife and Countryside Act 1981 (as amended); and
- The Nature Conservation (Scotland) Act 2004 (as amended).

Details pertaining to the legal status of bats are included within Annex 1.

In the UK, guidelines have been produced with regards to assessing the ecological impact upon bats from wind farm developments. These guidelines also provide aid for producing mitigation and compensation strategies to minimise any negative impact upon local bat populations. The following guidance documents have been used in the preparation of the baseline surveys and this report:

- Natural England (2014). *Bats and onshore wind turbines: interim guidance*. TIN051. Third Edition;
- Hundt, L. (2012). *Bat Surveys: Good Practice Guidelines, 2nd Edition*. Bat Conservation Trust, London;
- Collins, J. (ed.) (2016). *Bat Surveys for Professional Ecologists: Good Practice Guidelines* (3rd Edition). Bat Conservation Trust, London; and
- Rodrigues L., *et al*. (2014). *Guidelines for consideration of bats in wind farm projects*, revision 2014. EUROBATS Publication Series No. 6.

After the completion of field surveys in 2018, SNH *et al*. (2019) published new survey guidelines for bats and onshore wind farms. This new guidance was considered and used in preparation of this report as far as was practicable in advance of EIAR submission:

- SNH, Natural England, Natural Resources Wales, RenewableUK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter & Bat Conservation Trust (BCT) (2019). *Bats and Onshore Wind Turbines: Survey Assessment and Mitigation*.

SNH *et al*. (2019) now replaces the interim Natural England guidance (Natural England, 2014) and bat survey guidelines (Hundt, 2012). Surveys were conducted prior to the release of the 2019 guidance and as such were based on the preceding Natural England (2014) and Hundt (2012) guidance. Due to ongoing consultation between MacArthur Green and SNH in the preceding two years, a number of survey requirements that would form part of the 2019 guidance were already known prior to commencement of baseline surveys in 2018. Therefore, much of the survey effort detailed within this report also follows and is in line with the 2019 guidance, for instance with respect to the number of bat detectors deployed and the number of nights deployed. It is acknowledged there will be some information gaps in this report if solely assessed against the 2019 guidance, for instance the absence of accompanying weather data. However, the surveys and assessment here are in line with the applicable guidance in use at the time of survey (Natural England (2014) and Hundt (2012)). The subsequent analysis of bat data and assessments of bat activity has been revised and updated to consider the 2019 guidance as far as practicable (see Section 3.5 – Method of Analysis).

4.2 Potential Impacts

SNH *et al.* (2019) guidance includes an updated collision risk assessment for British bat species. This is divided into bat species likely to be threatened due to susceptibility to wind turbine collisions, and populations likely to be threatened due to impacts from wind turbines. Table 3-1 shows the relevant risk assessment for Scotland. Different bat species are considered at different levels of risk, depending on their habitat preferences, flight behaviour and population status.

The most notable change in the guidance compared to previous sources, is that certain common species, i.e. common and soprano pipistrelle bats, have been revised from medium collision risk species (Natural England, 2014) to now be considered as high collision risk species (SNH *et al.,* 2019). The population risk has also been revised for common and soprano pipistrelle bats with these bats reclassified from a low population risk (Natural England, 2014) to a medium population vulnerability species (SNH *et al.,* 2019).

This change in collision risk and population vulnerability is mainly due to research work at UK onshore wind farms which has found the relative percentage of fatalities at wind farms to be soprano pipistrelle (40.6%), common pipistrelle (48.6%), noctule bats (10.7%) with single carcasses of brown long-eared bat, Nathusius' pipistrelle bat and Natterer's bat also recorded (DEFRA, 2016).

Table 4-1 Bats in Scotland Likely to be at Collision Risk from Wind Turbines (taken from SNH *et al.* 2019)

Relative abundance	Scotland	Collison Risk		
		Low Collison Risk	**Medium Collison Risk**	**High Collision Risk**
	Common Species			Common pipistrelle Soprano pipistrelle
	Rarer Species	Brown long eared bat Daubenton's bat Natterer's bat		
	Rarest Species	Whiskered bat Brandt's bat		Nathusius' pipistrelle Noctule bat Leisler's bat

(Yellow = low population vulnerability; orange = medium population vulnerability; red = high population vulnerability)

The National Bats & Wind Turbines Project (DEFRA, 2016) found casualty rates at wind farms in the UK to be variable, ranging from 0.00 to 5.25 bats per turbine per standard month, and from 0 to 77 bats per site per standard month. The study found that while many fatalities occur at sites with high bat activity, there was also a degree of variability with some sites with low bat activity recording fatalities while other sites with high bat activity recording few or no fatalities. Due to this variability, it is important to not just rely on activity rates when making an assessment, but to also incorporate factors into the assessment such as: species, flight preferences, geographical location, habitat suitability, flight corridors, roost suitability and nearby roost locations.

A synthesis of European and American data by the Swedish Vindval research programme (Rydell *et al*., 2012) concluded the following habitats to be high risk locations for wind farms; coasts, wetlands, forested hills and ridges with linear landscapes such as lake shores, rivers, treelines, hedgerows, etc. also considered to increase the likelihood of collision. This study found that peak mortality usually

(90%) occurred on nights with low wind speeds in late June to early October and to a lesser extent (10%) also in April-June. The National Bats & Wind Turbines Project (DEFRA, 2016) found that most nights on which bat casualties occurred had low mean wind speeds (≤5 m/s at ground level; c.a. <10 m/s at nacelle level) and maximum night-time temperature of >10°C, although casualties were only found in 3.6% of nights with low wind speeds during the study.

A study on the response of bats to clear fell harvesting in the UK showed bat activity increased in areas of clear fell (Kirkpatrick *et al*., 2017). Activity of *Nyctalus* and pipistrelle species was significantly higher following felling according to the study. *Myotis* spp. activity was similar before and after felling at control and treated sites. The increase in activity was attributed to an increase in invertebrates and manoeuvrability to hunt, as well as edge habitat affording bats protection from environmental conditions and predators. The size of the felled area also influenced activity (for bats overall), with 90% higher activity in smaller felled stands (less than 5 ha) compared to larger felled stands (greater than 30 ha). For common pipistrelle, activity in felled areas decreased with the duration since harvesting. The greatest activity occurred in stands felled within two months compared to those harvested more than 16 months previously (Kirkpatrick *et al*., 2017). The small-scale felling (‘key-holing’) required for the installation of wind turbines could put foraging bats at risk of collision with turbines.

A study that radio tracked female soprano pipistrelle bats over two seasons in an area of the Galloway Forest Park in Scotland found that most individuals selected coniferous habitats over other habitat (Kirkpatrick, 2018), covering large distances to access plantation areas (mean 9.6 ± 3.12 km^2). At a local scale, bats used forest tracks to access water, felled stands or patches of broadleaved tree cover within the plantation. Sitka spruce plantations support a high abundance of the highland midge (*Culicoides impuctatus*) with it likely that female bats were availing of this plentiful food resource in the summer months during lactation which is an energetically expensive period.

There are often species-specific differences in the risks linked with habitat types: e.g. for noctule bats the presence of woodland is associated with increased risk, whereas for pipistrelles, there is some evidence of lowered risk (DEFRA, 2016).

4.3 Study Area Assessment

The appropriate level of effort for a bat survey at a proposed wind farm development depends on the scale of its likely impact, which in turn depends on the size of the development and the quality of the habitat.

Bat Conservation Trust (BCT) guidance (Hundt, 2012) provides recommendations of minimum standards of survey effort in instances where sampling is required. To determine the survey effort, the study area must be assigned as a high, medium or low risk site. Annex 2 contains the BCT assessment table “*Factors to consider when determining the survey effort and site risk*”, which was used to determine the survey effort of the study area.

Based on the table in Annex 2 from Hundt (2012) guidance, prior to surveys, the study area was assigned a medium value due to the following factors:

- Geographical location which is located within the known or core range of a high collision risk species (*Nyctalus* spp.);
- Negligible roosting suitability within the 200 m plus rotor radius of turbines with the study area dominated by closed conifer planation which is considered suboptimal for a bat roost;
- Low foraging and commuting suitability within 200 m plus rotor radius of turbines; and
- Study area only connected to the wider landscape by linear features of moderate suitability.

The BCT assessment table (Hundt, 2012) which was used to determine the site risk level for bats (see Annex 2), is comparable to the SNH *et al*. (2019) new survey guidelines (see Annex 4), with both assessment tables using similar factors such as roost sites, value of habitats and connectivity of the study area to determine the risk of the site to bats. The new guidance does however, also consider the size of the wind farm and the proximity of the study area to other wind farms. When using the new assessment table (Annex 4), the study area is also assessed to be a medium risk site.

4.4 Desk-based Study

A desk-based study was undertaken in order to inform the survey effort assessment and effects assessment of the EIAR. The following information was collected:

- Aerial photographs and OS mapping to identify features of potential value to bats;
- The proximity of statutory or non-statutory designated sites for bats;
- The location of the study area in relation to bat species distribution as shown in the 2013 UK Habitats Directive Article 17 Report; and
- Leisler's and noctule bat records from the Scottish Leisler's Bat Project within 20 km of the location of the proposed turbines, excluding the proposed access tracks as shown in Figure 7.6.

4.5 Survey Design

4.5.1 Preliminary Bat Roost Assessment

In accordance with guidelines (Hundt, 2012), structures with potential roost features such as buildings, bridges, tunnels, kilns, cellars, stone walls and trees etc. within 200 m of the proposed turbine locations, and within 30 m of the proposed access track were surveyed. Due to the possibility of developers moving or micro-siting turbines within the study area, this search area was extended to cover the entirety of the study area as shown in Figures 7.7 to 7.11. Surveys were carried out as part of protected species surveys on the following dates;

- 24th May 2018; and
- 21st June 2018.

The preliminary bat roost surveys followed the assessment methodology as set out in Collins (2016) whereby a potential bat roost is assigned a value of low, moderate or high suitability which determines the likelihood of bats being present and the need for further survey work such as a climbing inspection and/or dusk and dawn surveys (refer to Annex 5).

4.5.2 Temporal (Static) Surveys

Prior to and during the baseline survey period, MacArthur Green was in consultation with SNH regarding unpublished new survey guidelines for bats and onshore wind farms (since released as

SNH *et al*., 2019). Based on this consultation the baseline survey effort was planned in accordance with this unpublished guidance, while also incorporating required elements of the current guidelines at the time of survey (i.e. Hundt, 2012).

Consequently, a total of ten Anabat detector locations were used monthly for the proposed 13-turbine Proposed Development, with at least ten nights of data recorded per deployment[1]. The ten locations remained the same for the duration of the surveys with detectors placed near proposed wind turbine locations based on the layout plans received from the Applicant in May 2018. Anabat detectors were placed as close as possible to turbines in closed plantation habitat, using rides and tracks. Due to the iterative design process for the Proposed Development, the wind turbine layout that was used to determine the location of the detectors in May was altered slightly (see Figures 7.7 to 7.11 for final Proposed Development layout and Anabat locations). The distance of the Anabat locations to the nearest respective wind turbine is shown in Table 3.2 below.

BCT guidance (Hundt, 2012) was followed for survey effort, which recommends a minimum survey effort of at least one temporal survey visit per month for a medium risk site (Annex 3).

BCT guidance (Hundt, 2012) for proposed wind farm sites indicates that the survey period is from April to October. Surveys were carried out from May to September, excluding April and October as Scotland often experiences suboptimal weather conditions for bat surveys during these months. The Bat Survey Guidelines (Collins, 2016) define the optimal survey period for static detector surveys in Scotland as from May to August with sub-optimal surveys possible in April and September, therefore the survey season applied to this study is within survey guideline requirements (Collins, 2016).

Anabat detectors (Express and Swift) were used for the temporal surveys and were placed on 1.2 m wooden stakes that were placed in the ground (approximate height from the ground 1 m) with the direction (bearing) of the microphone recorded during the first deployment and standardised for the duration of the surveys.

In a small number of cases, Anabat detectors malfunctioned and did not record for the entirety of their deployment period, with location 9 in May only recording for one night and location 3 in September only recording for two nights. Table 3-2 shows a summary breakdown of the temporal survey effort.

[1] Two detectors malfunctioned and did not recorded for ten nights - see Table 3-2

Table 3-2 Summary of Temporal Surveys

Summary of Survey Design	Number of Locations	Minimum Number of Nights per deployment	Survey Effort	Survey Period	Detector Time Parameters
	10	10	Monthly	May to September	30 minutes before sunset and 30 minutes after sunrise

Survey Date	Location	Total Survey (hrs:mins:secs)	Total Number of Complete Survey Nights	Distance from nearest proposed turbine
May 01-11/05/18	1	93:31:00	10	72
	2	72:11:00	8	112
	3	93:31:00	10	61
	4	92:41:24	10	121
	5	72:10:00	8	92
	6	72:10:00	8	85
	7	72:10:00	8	69
	8	92:41:11	10	134
	9*	09:39:00	1	71
	10	72:11:00	8	112
	Total	**742:55:37**	**81**	
June 07-18/06/18	1	83:30:00	11	72
	2	83:30:00	11	112
	3	82:32:00	11	61
	4	83:09:32	11	121
	5	83:29:00	11	92
	6	83:08:22	11	85
	7	83:29:00	11	69
	8	83:31:00	11	134
	9	83:31:00	11	71
	10	83:08:41	11	112
	Total	**832:58:34**	**110**	
July 13-23/07/18	1	82:40:10	10	72
	2	82:19:00	10	112
	3	82:19:00	10	61
	4	82:15:00	10	121
	5	82:18:00	10	92
	6	82:18:00	10	85
	7	82:18:00	10	69
	8	82:19:00	10	134
	9	82:20:00	10	71
	10	82:18:00	10	112
	Total	**823:24:10**	**100**	
August 10-20/08/18	1	99:36:00	10	72
	2	100:09:30	10	112
	3	100:09:51	10	61
	4	99:36:00	10	121
	5	100:09:15	10	92
	6	99:35:00	10	85
	7	99:40:00	10	69

Summary of Survey Design	Number of Locations	Minimum Number of Nights per deployment	Survey Effort	Survey Period	Detector Time Parameters
	10	10	Monthly	May to September	30 minutes before sunset and 30 minutes after sunrise
Survey Date	**Location**	**Total Survey (hrs:mins:secs)**	**Total Number of Complete Survey Nights**	**Distance from nearest proposed turbine**	
	8	99:37:00	10	134	
	9	99:05:00	10	71	
	10	100:09:02	10	112	
	Total	**997:46:37**	**100**		
September 06-17/09/18	1	144:14:00	12	72	
	2	144:56:02	12	112	
	3*	23:24:14	2	61	
	4	144:14:00	12	121	
	5	144:56:00	12	92	
	6	144:55:57	12	85	
	7	144:56:00	12	69	
	8	144:13:00	12	134	
	9	144:13:00	12	71	
	10	144:55:57	12	112	
	Total	**1324:58:11**	**110**		
Total Survey (hrs:mins:secs)	**4,722:03:12**	**Total Survey (complete nights)**	**501**		

* detector malfunctioned – loss of data

4.6 Method of Analysis

The analysis of bat data is subject to required expertise and experience, therefore the Anabat data was analysed by an Ecologist experienced in bat call analysis using Kaleidoscope Viewer and AnalookW 4.3.19 software.

A bat registration is a sequence of bat pulses which is captured on a 15 second Anabat sound file when a bat echolocates close to an Anabat detector. One sound file is counted as one bat registration. As an individual bat can pass a detector while foraging and record numerous registrations, it is therefore not possible to estimate the number of individual bats. Therefore, in accordance with BCT guidance (Hundt, 2012) an activity index is used instead which calculates bat registrations per hour or per night. This allows the analysis of bat activity to estimate abundance and/or activity. The bat activity index (BAI) is calculated as bat registrations per night (brpn) or per hour (brph) using the following equation:

BAI (per hour) = Total number of bat registrations / number of hours of recording [brph].

BAI (per night) = Total number of bat registrations / number complete recording nights [brpn].

The data was analysed using Kaleidoscope Auto ID classifier. The Auto ID classifier identifies Scottish bat species and has an accuracy rate of 96% for soprano and common pipistrelles (Wildlife Acoustics, 2016). The accuracy rate for other Scottish bat species is lower; therefore, for all other bat species their identification was manually reviewed using Kaleidoscope Viewer and AnalookW software. This method of analysis is in line with current guidelines (Collins, 2016) for data analysis which recommends the manual checking of all non-*Pipistrellus* calls (excluding Nathusius' pipistrelle) when using automated methods. Sound files labelled as noise (non-bat files) were not reviewed manually.

The new SNH *et al.* (2019) guidance recommends the use of the Ecobat analysis tool to determine and categorise bat activity levels. This analysis tool is still currently in development. It was not used in the preparation of the report. Instead, in the absence of any recognised standard criteria to define levels of bat activity (e.g. what quantifies low, medium or high activity), professional judgement was used to determine, if species levels within the study area were low, moderate or high, taking into consideration geographical location and experience gained through conducting similar surveys at other wind farms nearby, in the region and throughout Scotland. This has been the standard method of assessment prior to the issue of the 2019 guidance.

5 BAT SURVEY LIMITATIONS

5.1 Detector Data Loss and Data Accuracy

On two occasions the detectors malfunctioned with only one night recorded at location 9 in May and only two nights of data recorded at location 3 in September, as shown in Table 3-2. This loss of data is not considered to be significant in the context of the amount of data collected and the number of locations surveyed for a medium risk site.

Anabat detectors are a commonly used bat detector for acoustic monitoring at wind farm sites, however all bat detectors have limitations and will only monitor bat activity within a limited area, for Anabats usually around 30 m, depending on a variety of environmental factors. Furthermore, due to passive monitoring methodologies depending on sound reaching the microphone, the detection rate of bat calls varies with a bias towards loud bat calls with quieter calls, e.g. brown long-eared bats, potentially being under recorded. As a result of equipment limitations, only relative rather than direct statistical comparisons of bat activity can be made between species and only a set area within the study area can be sampled.

Myotis species calls often overlap in call frequency depending on their surrounding environs i.e. cluttered or open space. This often makes it difficult to identify *Myotis* bats to species level. If *Myotis* calls could not be identified to species level, they were recorded as *Myotis* species. It is possible that for *Myotis* spp. these recordings could represent *Myotis* species not identified.

Due to overlap in the call structure of Leisler's and noctule bat calls and the resulting uncertainty of identification of some calls, BAI was summarised to genus level i.e. *Nyctalus* spp., even when identification to species level was undertaken. Both species are categorised as high collision and population risk species. Some temporal calls were assigned an unknown value (NoID), due to a very faint call or incomplete calls that could not be identified to species level on the spectogram.

Kaleidoscope Auto ID classifier can mislabel bat calls as noise files. As noise files were not manually checked, it can be assumed that there was a small loss of bat data.

5.2 Detector Numbers and Placement

The survey design used the proposed locations of wind turbines provided in May 2018, with Anabat detectors placed as close as possible to these locations. Subsequently, the final turbine layout was altered slightly, resulting in some Anabat detectors not being located in exactly the same position as a wind turbine, as described in Section 3.5 above and as per Table 3-3 (Figures 7.7 to 7.11). With habitat relatively uniform across the site, this is not however seen as a significant limitation to assessment.

SNH *et al*. (2019) guidance specifies that for a wind farm with 13 turbines that 11 detectors should be deployed (1 detector for every turbine up to ten turbines with an additional detector for every third turbine thereafter). There were only 10 detectors deployed during surveys due to the closed nature of the study area and the homogenous habitats present. Ten detectors across the study area is considered to have given a representative sample of the species present and their activity levels.

5.3 Ecological Knowledge

Recent research work by Exeter University found that activity levels do not necessary determine the risk level of the site to bats, with sites that recorded high levels of bat activity recording no casualties, while sites with low levels of bat activity recording casualties (DEFRA, 2016). The report concluded that it is important to not just rely on activity rates, when making an assessment of the site on bats, but to also incorporate factors such as geographical location, habitat suitability, flight corridors, roost suitability and nearby roost locations into the assessment. The information currently available on bat behaviour in the UK is not sufficient to fully assess the threat that wind turbines may pose to populations (Natural England, 2014), therefore any assessment is made based on the best available information.

5.4 Recording Higher Altitude Activity

A study by DEFRA (2016) concluded that ground level monitoring may be sufficient for evaluating common and soprano pipistrelle risks, because activity at ground rather than at height was a better predictor of fatality. However, in closed canopy situations where key-holing of turbines is proposed, it was recommended that monitoring at height should be considered because of the difficulty of inferring above-canopy level activity from ground-based detectors.

Due to the closed nature of the study area and when considering the overall evidence, it is likely that ground-based surveys gave an accurate account of species composition of bat populations, with the possible exception of high flying *Nyctalus* species over closed canopy woodland situations. *Nyctalus* spp. are judged by SNH *et al.* (2019) to be at high risk of collision due to their propensity to fly at a range of heights, including typical turbine rotor height.

Table 4-1 – Pipistrelle and *Nyctalus* Activity at Wind Farms within 10 km of Site (information sourced from Technical Appendices of EIA Reports)

Site	Status	Survey Period	Roosts	Ground level static survey nights	At-height survey nights	Static Counts (all locations)				Static Counts (at-height)				Mean bpph rate (all locations)		Mean bpph rate (at-height)		Peak monthly *Nyctalus* rates	At-height method
						PIPPYG	PIPPIP	PIP Sp.	NYC	PIPPYG	PIPPIP	PIP Sp.	NYC	Medium Risk*	NYC	Medium Risk*	NYC		
Broken Cross	Consented (revised)	2011 and 2012	No roost features.	129.5	41	1,954 (49.2%)	1,367 (34.4%)	398 (10.0%)	12 (0.3%)	3	3	4	1	2.02	0.007	0.02	0.002	August	Microphone attached to a detector, on a met mast at 50 m height.
Cumberhead	Consented (revised)	2014	No roost sites recorded.	190.75	75	1,078 (35.4%)	1,186 (39.0%)	471 (15.4%)	168 (5.5%)	45 (54.9%)	23 (28.0%)	9 (11.0%)	1 (1.2%)	c. 6.5	c. 1.0 (near 5.0 max in July)	c. 0.9	0.01	July	10 m temporary met mast with a microphone attached to the top.
Dalquhandy	Consented (revised)	2011 and 2012	No roost sites were confirmed from inspection surveys in 2012, and it was concluded, based on low activity levels around dusk and dawn, that bats are not likely to roost within, or near the site.	240	45	1,626 (37.3%)	1,761 (40.3%)	615 (14.1%)	39 (0.9%)	3	5	5	1	1.49	0.02	0.03	0.002	June or August	Microphone attached to a detector, on a met mast at 50 m height.
Douglas West	Approved	2014 and 2015	One bat roost was confirmed in a derelict building over 1.0 km from the site boundary, which was concluded to be pipistrelle and/or brown long-eared bat.	155	6	802 (36.1%)	555 (25.0%)	718 (32.3%)	105 (4.7%)	0	2	0	1	1.28	0.07	0.03	0.17	July	Blimp at 60 m.
Hagshaw Hill Repowering	Application	2018	No roost sites were recorded, although there were a small number of trees with roost potential along access route.	510	0	222 (32.9%)	359 (53.3%)	0	66 (9.8%)	n/a	n/a	n/a	n/a	0.12	0.01	n/a	n/a	July and August	
Kennoxhead	Approved	2012	No roost sites. Low suitability buildings.	509	0	14 (5.2%)	248 (91.8%)	0	2 (0.7%)	n/a	n/a	n/a	n/a	0.61	0.004	n/a	n/a	August	
Middle Muir	Approved	2011	No roost structures within 1 km.	173	0	17.20%	61.60%	13.60%	4 (5.1%)	n/a	n/a	n/a	n/a	1.83	0.01	n/a	n/a	August	
Poniel	Approved	2011 and 2012	No roost sites were recorded, although there were a small number of trees with roost potential.	112	38	1,393 (79.8%)	206 (11.8%)	46 (2.6%)	20 (1.1%)	6	0	0	2	1.05	0.01	0.01	0.004	May	Microphone attached to a detector, on a met mast at 50 m height.

* Some project reports only provide mean activity rates for "medium risk" species combined. This in effect equates to all common, soprano or unidentified pipistrelle rates combined.

No at-height bat detector surveys were undertaken for the Proposed Development. However, such surveys were undertaken for a number of projects within the vicinity of the Proposed Development site (see Table 4-1 and Figure 7.2). These sites comprised a variety of open habitats and conifer woodland. Table 4-1 shows that for all of these local projects, mean pipistrelle and *Nyctalus* spp. activity rates recorded at-height were consistently lower than recorded by ground level detectors, with the exception of Douglas West (although here, sample size was very low, with only one *Nyctalus* registration made at-height during the one night of survey). Overall, the data suggest that locally at least, it is unlikely that significant *Nyctalus* activity at higher altitude (i.e. equivalent to rotor height) was unrecorded during baseline surveys for the Proposed Development, and indeed that activity rates may well be much lower at rotor height.

5.5 Weather Data

SNH *et al.* (2019) recommends that weather data is collected along with temporal (static) data, to better understand bat activity within the survey area and to inform mitigation measures if required. No weather data was collected as part of these surveys, as this was not a requirement of the applicable survey guidance during the period surveys were undertaken in 2018.

6 SURVEY RESULTS

6.1 Desk-based Study

A 20 km search area from the location of proposed turbine locations was carried out on records from the 'Scottish Leisler's Bat Project' supplied to MacArthur Green by John Haddow in May 2015, which is shown in Table 5-1. In total five *Nyctalus* spp. records were found to be within 20 km of turbines. These records are passive monitoring records from Anabat detectors.

Table 5-1 Nearest *Nyctalus* records to the study area

ID	Location	Distance to Nearest Turbine (km)	Year	Record Type	Species
1	Near Strathaven	11	2010	Anabat	Leisler's
2	Near Douglas	2	2008	Anabat	Leisler's
3	Lesmahagow	6	2012	Anabat	Leisler's
4	Coalburn	3	2014	Anabat	Leisler's
5	Abington	15	2013	Anabat	Leisler's

6.2 Tree Surveys

In accordance within BCT Guidelines (Hundt, 2012) potential roost features (PRF) such as buildings, stone walls, and trees within 200 m of a proposed turbine or adjacent to the (30 m) proposed access track were surveyed for potential roost features as part of the protected species surveys.

There were no potential roost features recorded.

6.3 Temporal Surveys – Static Detectors

The total bat registrations recorded for each species is shown in Table 5-2. In total four bat species (common pipistrelle, soprano pipistrelle, Daubenton's and brown long-eared bat) and two genus groups (*Nyctalus* spp. and *Myotis* spp.) were recorded during the temporal (static) surveys with a total registration count of 2,688 and a mean BAI of 5.37 brpn (bat registrations per night).

The most commonly recorded by BAI was common pipistrelle (1,331 registrations and mean 2.66 brpn), followed by;

- Soprano pipistrelle (1,033 registrations and 2.06 brpn);
- *Nyctalus* spp. (173 registrations and 0.35 brpn);
- *Myotis* spp. (92 registrations and 0.18 brpn);
- Unknown bat species (34 registrations and 0.07 brpn);
- Daubenton's (22 registrations and 0.04 brpn); and
- Brown long-eared bat (3 registrations and 0.01 brpn).

Species composition of the study area is shown in Graph 1, Tables 5-2 and Figures 7.7 to 7.11. Table 5-2 shows the temporal (static) activity in the study area per survey month while Table 5-3 categorises species into their collision risk category for Scotland as per SNH *et al*. (2019) guidelines, which is further illustrated in Graphs 2 to 4.

May had a very low activity rate with 11 registrations (0.14 brpn) which increased in June to 775 registrations (7.05 brpn). Numbers peaked in July with 1,421 registrations (14.21 brpn) and then fell in August to 379 (3.79 brpn) and again in September to 103 registrations (0.93 brpn).

The majority of registrations recorded per month were from *Pipistrellus* species (common and soprano pipistrelle bats) with this genus accounting for 87.9% of the registrations recorded for the study area.

Nyctalus species were recorded across the study area in June over six locations, in July over five locations and in August over six locations. The following locations recorded *Nyctalus spp.* rates of >1.0 brpn over the following months:

- June
  - Location 1 (64 registrations and 5.82 brpn); and
  - Location 10 (14 registrations and 1.27 brpn).
- July
  - Location 1 (23 registrations and 2.30 brpn).
- August
  - Location 1 (22 registrations and 2.20 brpn); and
  - Location 9 (11 registrations and 1.10 brpn).

Table 5-2 Summary of Temporal Survey Results (BAI/night [brpn: bat registrations per night])

		PIPPYG		PIPPIP		NYC		MYODAU		MYO		PLEAUR		NoID		Total	Total
Location	**Visit**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**
loc1	May	2	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.20
loc2	May	0	0.00	1	0.13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.13
loc3	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc4	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc5	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc6	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc7	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc8	May	1	0.10	0	0.00	0	0.00	0	0.00	1	0.10	0	0.00	1	0.10	3	0.30
loc9	May	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc10	May	2	0.25	2	0.25	0	0.00	0	0.00	1	0.13	0	0.00	0	0.00	5	0.63
Total		**5**	**0.06**	**3**	**0.04**	**0**	**0.00**	**0**	**0.00**	**2**	**0.02**	**0**	**0.00**	**1**	**0.01**	**11**	**0.14**
loc1	June	13	1.18	20	1.82	64	5.82	1	0.09	2	0.18	0	0.00	0	0.00	100	9.09
loc2	June	1	0.09	31	2.82	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	32	2.91
loc3	June	9	0.82	6	0.55	1	0.09	2	0.18	2	0.18	0	0.00	0	0.00	20	1.82
loc4	June	2	0.18	3	0.27	0	0.00	0	0.00	2	0.18	0	0.00	0	0.00	7	0.64
loc5	June	7	0.64	26	2.36	3	0.27	0	0.00	0	0.00	0	0.00	1	0.09	37	3.36
loc6	June	17	1.55	71	6.45	11	1.00	0	0.00	4	0.36	0	0.00	5	0.45	108	9.82
loc7	June	3	0.27	31	2.82	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	34	3.09
loc8	June	76	6.91	36	3.27	2	0.18	2	0.18	6	0.55	0	0.00	0	0.00	122	11.09
loc9	June	69	6.27	37	3.36	0	0.00	0	0.00	1	0.09	0	0.00	5	0.45	112	10.18
loc10	June	111	10.09	45	4.09	14	1.27	13	1.18	18	1.64	2	0.18	0	0.00	203	18.45
Total		**308**	**2.80**	**306**	**2.78**	**95**	**0.86**	**18**	**0.16**	**35**	**0.32**	**2**	**0.02**	**11**	**0.10**	**775**	**7.05**
loc1	July	57	5.70	74	7.40	23	2.30	2	0.20	1	0.10	0	0.00	1	0.10	158	15.80
loc2	July	40	4.00	142	14.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	182	18.20
loc3	July	8	0.80	25	2.50	0	0.00	0	0.00	3	0.30	0	0.00	0	0.00	36	3.60
loc4	July	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc5	July	3	0.30	16	1.60	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	1.90
loc6	July	44	4.40	181	18.10	1	0.10	0	0.00	0	0.00	0	0.00	4	0.40	230	23.00
loc7	July	110	11.00	93	9.30	3	0.30	0	0.00	1	0.10	0	0.00	2	0.20	209	20.90
loc8	July	54	5.40	96	9.60	1	0.10	0	0.00	5	0.50	1	0.10	0	0.00	157	15.70
loc9	July	57	5.70	51	5.10	0	0.00	0	0.00	3	0.30	0	0.00	0	0.00	111	11.10
loc10	July	116	11.60	175	17.50	2	0.20	2	0.20	23	2.30	0	0.00	1	0.10	319	31.90
Total		**489**	**4.89**	**853**	**8.53**	**30**	**0.30**	**4**	**0.04**	**36**	**0.36**	**1**	**0.01**	**8**	**0.08**	**1421**	**14.21**
loc1	August	14	1.40	10	1.00	22	2.20	0	0.00	0	0.00	0	0.00	0	0.00	46	4.60
loc2	August	19	1.90	3	0.30	8	0.80	0	0.00	2	0.20	0	0.00	3	0.30	35	3.50
loc3	August	9	0.90	13	1.30	1	0.10	0	0.00	0	0.00	0	0.00	1	0.10	24	2.40
loc4	August	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc5	August	21	2.10	12	1.20	3	0.30	0	0.00	0	0.00	0	0.00	2	0.20	38	3.80
loc6	August	23	2.30	18	1.80	0	0.00	0	0.00	1	0.10	0	0.00	0	0.00	42	4.20
loc7	August	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc8	August	15	1.50	13	1.30	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	28	2.80
loc9	August	40	4.00	49	4.90	11	1.10	0	0.00	0	0.00	0	0.00	5	0.50	105	10.50
loc10	August	27	2.70	28	2.80	3	0.30	0	0.00	1	0.10	0	0.00	2	0.20	61	6.10
Total		**168**	**1.68**	**146**	**1.46**	**48**	**0.48**	**0**	**0.00**	**4**	**0.04**	**0**	**0.00**	**13**	**0.13**	**379**	**3.79**
loc1	September	5	0.42	3	0.25	0	0.00	0	0.00	2	0.17	0	0.00	1	0.08	11	0.92
loc2	September	0	0.00	2	0.17	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.17
loc3	September	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc4	September	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
loc5	September	3	0.25	1	0.08	0	0.00	0	0.00	1	0.08	0	0.00	0	0.00	5	0.42
loc6	September	5	0.42	3	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	8	0.67
loc7	September	3	0.25	3	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	6	0.50
loc8	September	18	1.50	3	0.25	0	0.00	0	0.00	5	0.42	0	0.00	0	0.00	26	2.17

		PIPPYG		PIPPIP		NYC		MYODAU		MYO		PLEAUR		NoID		Total	Total
Location	**Visit**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**	**Reg.**	**BPPN**
loc9	September	7	0.58	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	0.58
loc10	September	22	1.83	8	0.67	0	0.00	0	0.00	7	0.58	0	0.00	0	0.00	37	3.08
Total		**63**	**0.57**	**23**	**0.21**	**0**	**0.00**	**0**	**0.00**	**15**	**0.14**	**0**	**0.00**	**1**	**0.01**	**102**	**0.93**
Total Registrations		**1033**	**-**	**1331**	**-**	**173**	**-**	**22**	**-**	**92**	**-**	**3**	**-**	**34**	**-**	**2688**	**-**
Total BRPN		**-**	**2.06**	**-**	**2.66**	**-**	**0.35**	**-**	**0.04**	**-**	**0.18**	**-**	**0.01**	**-**	**0.07**	**-**	**5.37**

(Abbreviations: PIPPYG – soprano pipistrelle; PIPPIP - common pipistrelle; NYC – *Nyctalus* spp.; MYODAU – Daubenton's; MYO– *Myotis* spp. PLEAUR – brown long-eared; NoID – unknown bat species; Reg. – Registrations and BRPN – Bat registrations per night).

Table 5-3 Temporal Summary Activity Totals with Species Grouped by Collision Risk & Population Vulnerability in Scotland[2].

High Collision Risk/High Population vulnerability = *Nyctalus* spp.

High Collision Risk/Medium Population vulnerability = *Common and soprano pipistrelle*

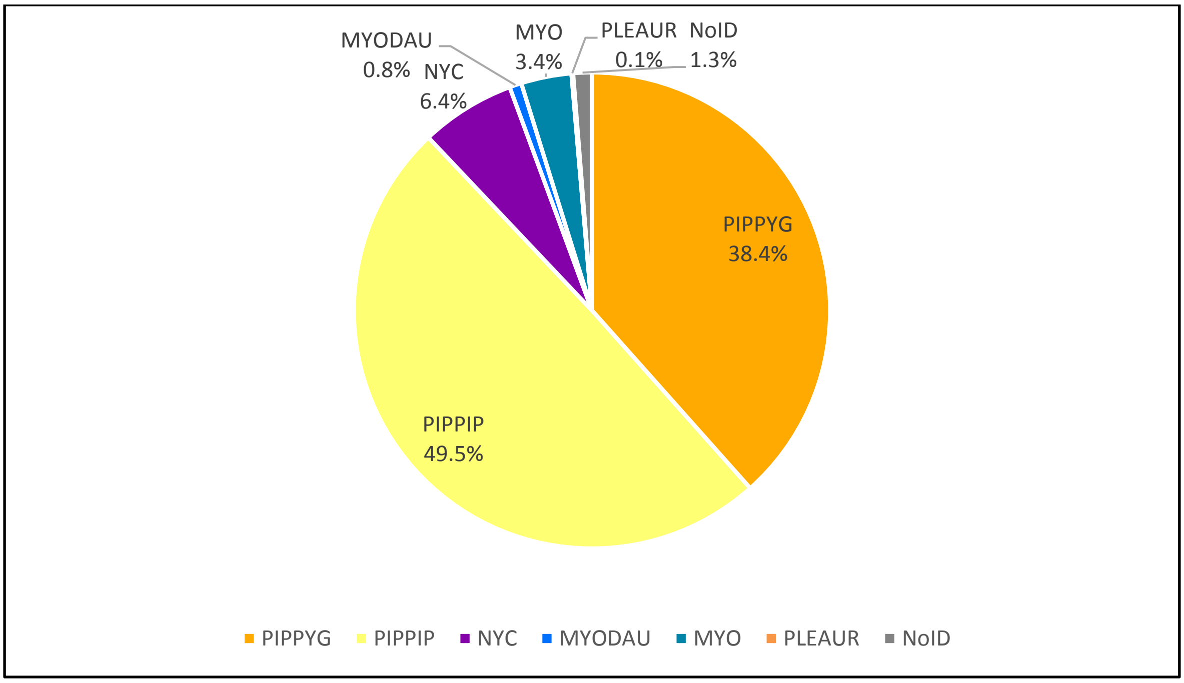
Low Collision Risk/Medium to Low Population vulnerability = *Myotis* spp.

(Abbreviations: Reg.– registrations; BRPN. – Bat registrations per night; and BRPH – Bat registrations per hour)

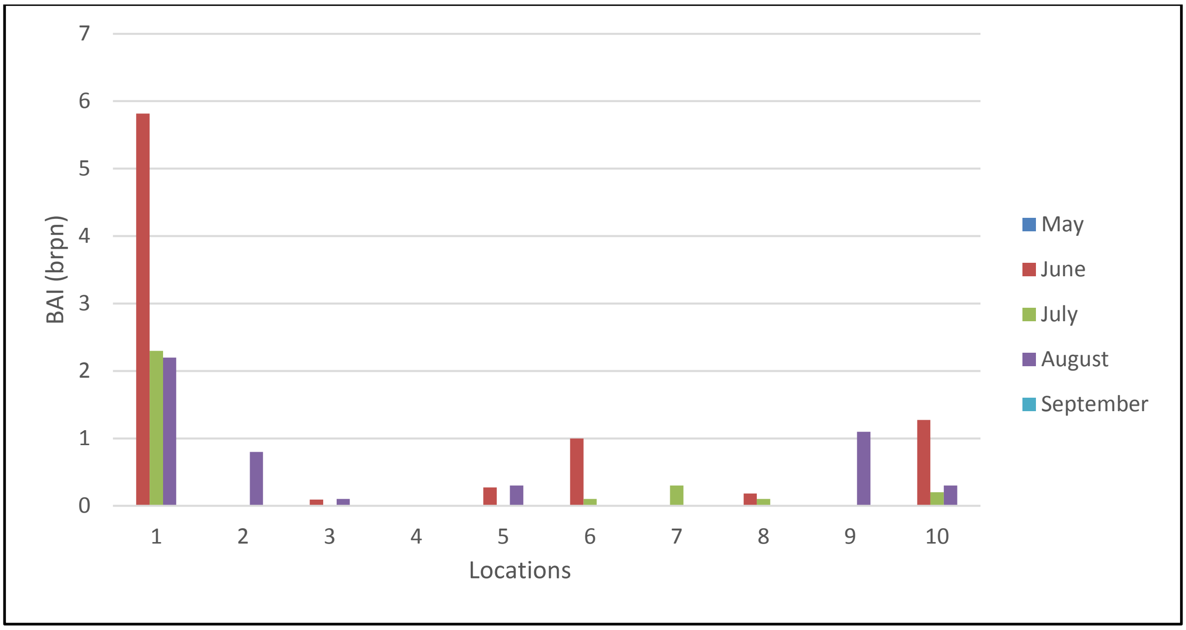
Location	Visit	High Collision Risk spp. High Population Vulnerability			High Collision Risk spp. Medium Population Vulnerability			Low Collision Risk spp. Low – medium Population Vulnerability		
		Reg	BRPN	BRPH	Reg	BRPN	BRPH	Reg	BRPN	BRPH
loc1	May	0	0.00	0.00	2	0.20	0.02	0	0.00	0.00
loc1	June	64	5.82	0.77	33	3.00	0.40	3	0.27	0.04
loc1	July	23	2.30	0.28	131	13.10	1.58	3	0.30	0.04
loc1	August	22	2.20	0.22	24	2.40	0.24	0	0.00	0.00
loc1	September	0	0.00	0.00	8	0.67	0.06	2	0.17	0.01
loc2	May	0	0.00	0.00	1	0.13	0.01	0	0.00	0.00
loc2	June	0	0.00	0.00	32	2.91	0.38	0	0.00	0.00
loc2	July	0	0.00	0.00	182	18.20	2.21	0	0.00	0.00
loc2	August	8	0.80	0.08	22	2.20	0.22	2	0.20	0.02
loc2	September	0	0.00	0.00	2	0.17	0.01	0	0.00	0.00
loc3	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc3	June	1	0.09	0.01	15	1.36	0.18	4	0.36	0.05
loc3	July	0	0.00	0.00	33	3.30	0.40	3	0.30	0.04
loc3	August	1	0.10	0.01	22	2.20	0.22	0	0.00	0.00
loc3	September	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc4	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc4	June	0	0.00	0.00	5	0.45	0.06	2	0.18	0.02
loc4	July	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc4	August	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc4	September	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc5	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc5	June	3	0.27	0.04	33	3.00	0.40	0	0.00	0.00
loc5	July	0	0.00	0.00	19	1.90	0.23	0	0.00	0.00
loc5	August	3	0.30	0.03	33	3.30	0.33	0	0.00	0.00
loc5	September	0	0.00	0.00	4	0.33	0.03	1	0.08	0.01
loc6	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc6	June	11	1.00	0.13	88	8.00	1.06	4	0.36	0.05
loc6	July	1	0.10	0.01	225	22.50	2.73	0	0.00	0.00
loc6	August	0	0.00	0.00	41	4.10	0.41	1	0.10	0.01
loc6	September	0	0.00	0.00	8	0.67	0.06	0	0.00	0.00
loc7	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc7	June	0	0.00	0.00	34	3.09	0.41	0	0.00	0.00

[2] As per SNH *et al*. (2019)

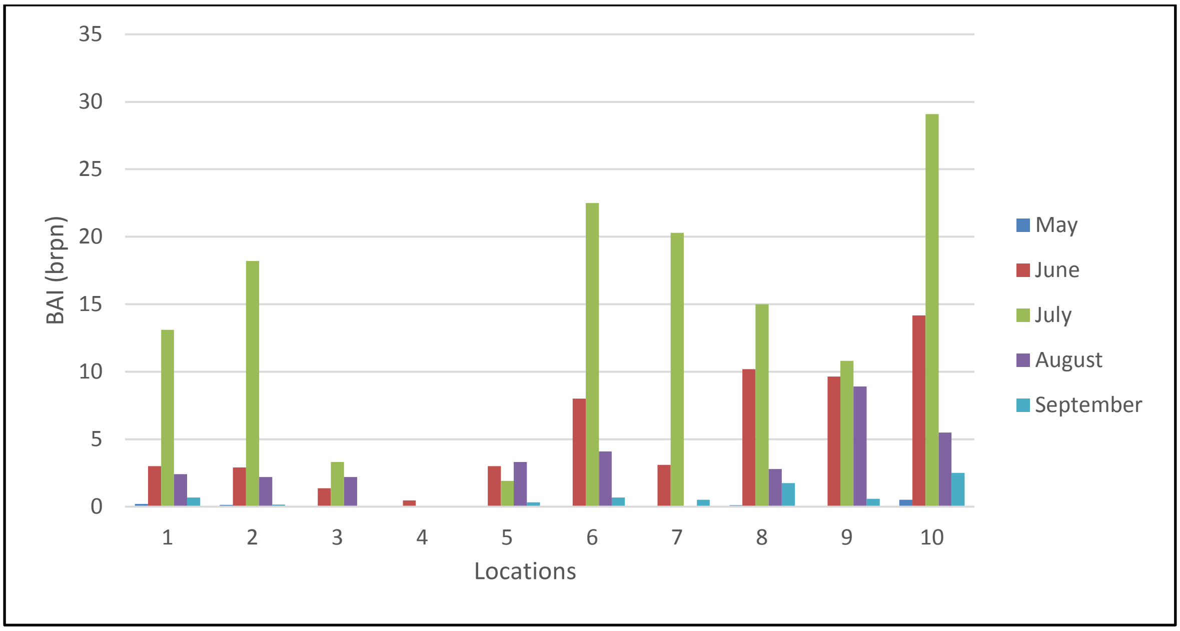
Location	Visit	High Collision Risk spp. High Population Vulnerability			High Collision Risk spp. Medium Population Vulnerability			Low Collision Risk spp. Low – medium Population Vulnerability		
		Reg	BRPN	BRPH	Reg	BRPN	BRPH	Reg	BRPN	BRPH
loc7	July	3	0.30	0.04	203	20.30	2.47	1	0.10	0.01
loc7	August	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc7	September	0	0.00	0.00	6	0.50	0.04	0	0.00	0.00
loc8	May	0	0.00	0.00	1	0.10	0.01	1	0.10	0.01
loc8	June	2	0.18	0.02	112	10.18	1.34	8	0.73	0.10
loc8	July	1	0.10	0.01	150	15.00	1.82	6	0.60	0.07
loc8	August	0	0.00	0.00	28	2.80	0.28	0	0.00	0.00
loc8	September	0	0.00	0.00	21	1.75	0.15	5	0.42	0.03
loc9	May	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
loc9	June	0	0.00	0.00	106	9.64	1.27	1	0.09	0.01
loc9	July	0	0.00	0.00	108	10.80	1.31	3	0.30	0.04
loc9	August	11	1.10	0.11	89	8.90	0.90	0	0.00	0.00
loc9	September	0	0.00	0.00	7	0.58	0.05	0	0.00	0.00
loc10	May	0	0.00	0.00	4	0.50	0.06	1	0.13	0.01
loc10	June	14	1.27	0.17	156	14.18	1.88	33	3.00	0.40
loc10	July	2	0.20	0.02	291	29.10	3.54	25	2.50	0.30
loc10	August	3	0.30	0.03	55	5.50	0.55	1	0.10	0.01
loc10	September	0	0.00	0.00	30	2.50	0.21	7	0.58	0.05



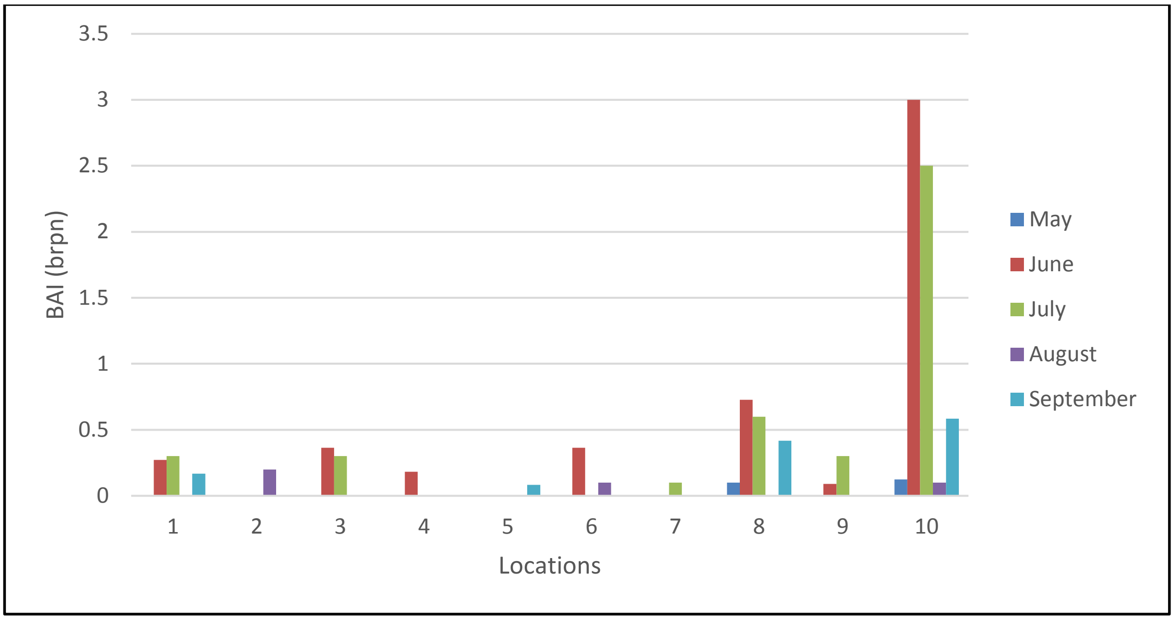
Graph 1 Temporal Survey Results: Species Composition of study area (BAI/night [brpn])



Graph 2 Temporal Activity of High Collison Risk Species (*Nyctalus* spp.) within Study Area (BAI/night)



Graph 3 Temporal Activity of High Collison Risk Species (Common and Soprano Pipistrelle) within Study Area (BAI/night)



Graph 4 Temporal Activity of Low Collison Risk Species (*Myotis* spp. and Brown Long-Eared Bat) within Study Area (BAI/night)

7 COLLISION AND POPULATION RISK FROM TURBINES

7.1 High Collision Risk Species

7.1.1 Nyctalus spp.

For *Nyctalus* species an average registration per survey period of more than one BAI was recorded at location 1, location 9 and location 10, which is illustrated in Table 5-3, Graph 2 and Figures 7.7 to 7.11.

Location 1 recorded the highest brpn (5.82) in June and recorded >1.0 brpn in July (2.30 brpn) and August (2.20 brpn). Location 1 was located in the south-western section of the study area adjacent to an existing forestry track and is 72 m from the nearest proposed turbine location. Location 10 which is situated in the north-eastern corner of the study area was placed along a ride and is 112 m from the nearest proposed turbine location. This location recorded greater than one brpn in June (1.27). Location 9 which is also situated along a ride but in the south-eastern area of the study area and is 71 m from the nearest proposed turbine location, recorded more than one brpn in August (1.10).

SNH *et al.* (2019) identifies *Nyctalus* species in Scotland to be at high risk of collision with wind turbines and as having a high population vulnerability. It is possible that *Nyctalus* species recorded within the study area are feeding and/or commuting within the study area. Leisler bats are known to fly a mean maximum distance of 4.2 km from the roost with a minimum area average of 7.4 km^2 up to 18.4 km^2 (Waters et al. 2006). A study in Germany which used GPS tracking devices recorded noctule bats to fly an average distance from the roost of 5.8 km (+/- 2.9 km) with one bat recorded 13.7 km from the roost. Males were recorded to fly shorter distances, at lower heights and 1.5 times faster compared to female bats (Roeleke *et al.,* 2016).

The Anabat detectors at locations 1, 9 and 10 were placed along a forestry track and two large forestry rides. *Nyctalus* species could be utilising these edge habitats for foraging and commuting.

From June to July all ten of the Anabat locations recorded *Nyctalus* registrations. *Nyctalus* species also utilise open water bodies, and there are small ponds to the immediate north of the study area at South Bankend which may be used. There is also a river valley to the south with the Douglas Water approximately 1.9 km from the study area which has ponds along its channel and broadleaved woodland.

A German study which recorded the flight and foraging behaviour of noctule bats in an area with a high density of wind farms, showed female bats to forage more closely to turbines than males with two female bats recorded foraging for several minutes within several hundred metres of turbines (Roeleke *et al.* 2016). More than a quarter of female flights over open habitats were recorded at heights between 70 m and 130 m, which equates to typical wind turbine rotor height.

Key-holing for the placement of turbines may therefore have an impact on the way *Nyctalus* species are currently utilising the study area.

7.1.2 Common and Soprano pipistrelle

The greatest activity seen throughout the temporal survey was a result of common pipistrelle and soprano pipistrelle numbers (accounting for 88% of registrations). SNH *et al.* (2019) classes both of these species in Scotland as high collision risk species with medium population vulnerability.

Both species were recorded at every location with registrations peaking in July apart from location 4 and location 5 which recorded their greatest registrations in June. The highest activity rate for these species was recorded in June at location 10 (29.1 brpn) (112 m from the nearest proposed turbine location) and at location 7 (20.3 brpn) (69 m from the nearest proposed turbine location) as illustrated in Table 5-3 and Graph 3. Both locations 10 and 7 are situated in the north-eastern section of the study area along the edge of conifer planation with Location 7 near the Shiel Burn. Common and soprano pipistrelle bats typical forage along edges such as treelines, large hedgerows and water edge (Russ, 1999). Plantation edge gives shelter to invertebrate species especially when there are environmental conditions such as wind and rain (Verboom and Spoelstra, 1999). The increase in common and soprano pipistrelle activity rates at locations 10 and location 7 in June is likely to be the result of optimal environmental conditions and suitable foraging habitats at these locations with connectivity to other suitable forging habitats in the study area such as the Shiel Burn.

The BAI for common pipistrelle and soprano pipistrelle within the study area is considered to be of moderate activity at location 10 and location 7 in June. For all other locations across the survey period their activity levels were considered to be low.

7.2 Low Collision Risk Species

7.2.1 Myotis spp. and brown long-eared bat

SNH *et al.* (2019) classes Daubenton's bat, Natterer's bat and brown long-eared bat in Scotland as low collision risk species with low population vulnerability.

The highest activity rate for low collision risk species was recorded in June at location 10 (3 brpn).

The BAI for *Myotis* spp. and brown-long eared bats within the study area is considered to be low as shown in Table 5-3 and Graph 4.

8 DISCUSSION

In total four bat species (common pipistrelle, soprano pipistrelle, Daubenton's and brown long-eared bat) and two genus groups (*Nyctalus* spp. and *Myotis* spp.) were recorded during the temporal (static) surveys in 2018.

Much of the variation in activity between and within bat surveys can be accounted for by changes in weather but also by the fidelity of bats to particular foraging areas and commuting routes.

For *Nyctalus* spp. an average registration per survey period of >1.0 BAI/night (brpn) was reached at location 1, location 9 and location 10. Moderate activity levels were recorded for common and soprano pipistrelle bats in June at location 10 and at location 7.

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Annex 1. Protected Species Legal Status

All bat species receive protection under the Conservation Regulations (1994) (as amended).

The information contained in this Annex is a summarised version of the legislation and should be read in conjunction with the appropriate legislation as set out in its complete form.

It is an offence to:

- Deliberately or recklessly to capture, injure or kill a wild animal of a European protected species;
- Deliberately or recklessly:
    - Harass a wild animal or group of wild animals of a European protected species;
    - Disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
    - Disturb such an animal while it is rearing or otherwise caring for its young;
    - To obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place (i.e. roost sites);
    - To disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs; or
    - To disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;
- To damage or destroy a breeding site or resting place of such an animal

Legal and Conservation Status of UK Bat Species taken from Bat Conservation Trust

Source: http://www.bats.org.uk/pages/bats_and_the_law.html

Species	Legislation / Convention													
	Bern Convention Appendix II	Bonn Convention Appendix II	WCA	Habitats Directive Annex IV	Habitats Directive Annex II	Habs Regs 1994 (as amended) *Scotland*	Conservation of Habs & Species Regs 2010	Conservation Regs (N Ireland) 1995	CROW Act 2000	NERC Act 2006	Wild Mammals Protection Act	UK BAP Priority species	IUCN Red List*	EUROBATS Agreement
Greater horseshoe bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	✓
Lesser horseshoe bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	✓
Daubenton's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Natterer's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Whiskered bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Brandt's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Bechstein's bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	✓
Alcathoe bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		DD	✓
Noctule	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Leisler's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Serotine	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Common pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Soprano pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Nathusius' pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Brown long-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Grey long-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Barbastelle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	✓
Greater mouse-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓

*IUCN categories: LC is Least Concern, NT is Near Threatened, DD is Data deficient; see www.iucnredlist.org for more details.

Annex 2. Determining Survey Effort

Factors to consider when determining the survey effort and site risk (taken from Hundt, 2012)			
Quality of habitat and number of habitat features likely to affect bat mortality rates if altered by development*	**Species likely to use the site***	**Importance of roosts, of species likely to use site, which may be affected by development***	**Potential risk level of development**
No potential habitat for roosting, foraging or commuting bats	None	Local	Lowest
Small number of potential roost features, of low quality. Low quality foraging habitat that could be used by small numbers of foraging bats Isolated site not connected to the wider landscape by prominent linear features.	Low number, single low risk species High number, several low risk species	Parish	Low
Buildings, trees or other structures with moderate high potential as roost sites on or near the site. Habitat could be used extensively by foraging bats. site is connected to the wider landscape by linear features such as scrub, tree lines and streams.	Low number, medium risk species High number, medium risk species	District County	Medium
Numerous suitable buildings, trees (particularly mature ancient woodland) or other structures with moderate-high potential as roost sites on or near the site, and/or confirmed roosts present close to or on the site. Extensive and diverse habitat mosaic of high quality for foraging bats. site is connected to the wider landscape by a network of strong linear features such as rivers, blocks of woodland and mature hedgerows.	High number, single high risk species High number, several high risk species High number, all high risk species	National International	High

*As outlined in current scientific research, SNCO guidance and illustrated in Wray *et al*. (2010).

Annex 3. Minimum Standards for Bat Surveys

Source: Hundt, 2012.

	Site Risk Level		
	Low risk	**Medium risk**	**High risk**
	Roost survey		
Selection of roosts requiring further survey	If evidence of roosting by medium or high-risk species and/or roosts of district importance is found, further survey should follow SNCO guidance and Hundt (2012) guidelines wherever possible.		
Survey period	Surveys should provide data for one season as a minimum.		
Survey area	Up to 200 m + rotor radius from turbine locations or potential turbine locations	Up to 200 m + rotor radius from turbine locations or potential turbine locations	Up to 200 m + rotor radius from turbine locations or potential turbine locations
Ground level transect surveys	One visit per transect each season (spring, summer and autumn)	One visit per transect each month (April-Oct)	Up to two visits per transect each month may be required (April-Oct)
Automated surveys at ground level	5 consecutive nights for each single or pair of locations within the survey area, per season	5 consecutive nights for each single or pair of locations within the survey area, per month	Up to 2 sets of 5 consecutive nights for each single or pair of locations within the survey area, per month
Automated surveys at height	See Section 10.5.6 [of Hundt, 2012] for situations where at-height survey may be appropriate For surveys undertaken from masts (met mast or other) survey effort is as outlined above for surveys at ground level.		

Annex 4. Initial Site Risk Assessment

(Taken from Scottish Natural Heritage, 2019)

Site Risk Level (1-5)*	**Project Size**			
		Small	**Medium**	**Large**
Habitat Risk	**Low**	1	2	3
	Moderate	2	3	4
	High	3	4	5

Key: Green (1-2) – low/lowest site risk; Amber (3) – medium site risk; Red (4-5) – high/highest site risk

*Some sites could conceivably be assessed as being of no (0) risk to bats. This assessment is only likely to be valid in more extreme environments, such as above the known altitudinal range of bats, or outside the known geographical distribution of any resident British species.

Habitat Risk	**Description**
Low	Small number of potential roost features, of low quality. Low quality foraging habitat that could be used by small numbers of foraging bats. Isolated site not connected to the wider landscape by prominent linear features.
Moderate	Buildings, tree or other structures with moderate-high potential as roost sites on or near the site. Habitat could be used extensively by foraging bats. site is connected to the wider landscape by linear features such as scrub, treelines and streams.
High	Numerous suitable buildings, trees (particularly mature ancient woodland) or other structures with moderate-high potential as roost sites on or near the site, and/or confirmed roosts present close to or on the site. Extensive and diverse habitat mosaic of high quality for foraging bats. site is connected to the wider landscape by a network of strong linear features such as rivers, blocks of woodland and mature hedgerows. At/near edge of range and/or on an important flyway. Close to key roost and/or swarming.

Project Size	**Description**
Small	Small scale development (≤10 turbines). No other wind energy developments within 10km. Comprising turbines <50 m in height.
Medium	Larger developments (between 10 and 40 turbine). May have some other wind developments within 5km Comprising turbines 50-100 m in height
Large	Largest developments (>40 turbines) with other wind energy developments within 5km. Comprising turbines >100 m in height.

Annex 5. Guidelines for Assessing the Potential Suitability of Roost Features

(Taken from Collins, 2016)

Suitability	Description Roosting Habitats	Commuting and Foraging Habitats
Negligible	Negligible habitat features on site likely to be used by roosting bats.	Negligible habitats features on site. Likely to be used by commuting or foraging bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions and/or suitable surrounding habitats to be used on a regular basis or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation). A tree of sufficient size and age to contain PRFs but with none seen from the ground or features seen with only limited roosting potential.	Habitats that could be used by small numbers of commuting bats such as a gappy hedgerow or un-vegetated steam, but isolated i.e. not very well connected to the surrounding landscape by other habitat. Suitable, but isolated habitat that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch or scrub.
Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the assessment in this table are made irrespective of species conservation status, which is established after presence is confirmed).	Continuous habitat that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection, conditions and surrounding habitat.	Continuous, high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, tree lined watercourses and grazed parkland. site is close to and connected to known roosts.

Annex 6. Illustration to Show 50 m Buffer Zone

(Taken from Scottish Natural Heritage, 2019)

Estimating buffer distance: Calculate the distance between the edge of the feature and the centre of the tower (b) using the formula:

$b=\sqrt{(50+bl)2-(hh-fh)2}$

Where: bl = blade length, hh = hub height, fh = feature height (all in meters). For the example shown, b = 69.3 m