



THE
ENVIRONMENT
PARTNERSHIP

Haweswater Aqueduct Resilience Programme Proposed Marl Hill Section

Chapter 9A - Appendix 9A.6

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Water for the North West



Haweswater Aqueduct Resilience Programme

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Appendix A. Bowlands Ecology Bat Tree Assessment Report

Appendix B. Bowlands Ecology Bat Activity Report

1. Bat Survey Technical Appendix

1.1 Introduction

- 1) TEP was appointed by United Utilities to complete an Ecological Impact Assessment (EclA) for the Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section. The EclA is required to inform an Environmental Impact Assessment (EIA) and support production of the Environmental Statement (ES).
- 2) A series of ecological surveys was undertaken to complete the EclA. This Appendix is one of a series of Ecological Technical Reports (ETRs) produced to support the EclA. This ETR documents the methods and findings of the bat surveys undertaken by Bowland Ecology.

1.2 Summary of Findings

- 3) Bat surveys completed by Bowland Ecology for the Proposed Marl Hill Section comprised a ground based assessment of trees for bat roost suitability, bat activity transects and a static bat activity survey comprising two static locations immediately adjacent to the Bonstone Compound and one static location within the Braddup Compound.

1.2.1 Bat Roost Records

- 4) Locations of bat records are illustrated in ES Figure 9A.4 RVBC-MH-FIG-009-01-04.
- 5) Records were obtained for the following bat species within 2 km of the Proposed Marl Hill Section:
 - Daubenton's Bat *Myotis daubentonii*
 - Soprano Pipistrelle *Pipistrellus pygmaeus*
 - Natterer's Bat *Myotis nattereri*
 - Pipistrelle Bat species *Pipistrellus* sp.
 - Common pipistrelle *Pipistrellus pipistrellus*
 - Myotis Bat Species *Myotis* sp.

1.2.2 Bat Tree Assessment

- 6) Locations of trees with bat roost suitability are illustrated in ES Figure 9A.9 RVBC-MH-FIG-009-01-09.
- 7) Trees with bat roost suitability are summarised in the table below, which provides the Jacobs AIA tree reference for consistency (T, W or G prefix) transposed to the relevant tree identification reference applied by Bowland tree identification numbers (BT prefix).
- 8) In some instances, a tree identified by Bowland Ecology to possess potential bat roost features may not be identified by the Jacobs AIA. This is due to a combination in different survey techniques between the AIA and bat survey and the different survey buffers applied as relevant to the feature zone of influence from the application boundary. In these instances, only the Bowland Ecology tree identification reference is applied.

Bat Roost Suitability	Braddup Compound		Bonstone Compound	
	Within compound or on boundary*	Within <50 m	Within compound or on boundary*	Within <50 m
High	G181(BG20)*	-	T156(BT12)*	HARP_T_110/BT6 T145(BT18)
Moderate	-	T179(BT33) BT36	T161(BT7)* T151(BT14)*	T149(BT15) T147(BT16)



Bat Roost Suitability	Braddup Compound		Bonstone Compound	
	Within compound or on boundary*	Within <50 m	Within compound or on boundary*	Within <50 m
		W185(BG3)	T158(BT8)* G158(BT9, 10 & 11)* G157(BT13) T153(BT20)	T146(BT17) G154(BG8)
Low	T165(BT34) T195(BT3) G189(BG1)	BT4 T181(BT31) BT32 T171(BT5) G190(BG19) G187(BG2) W194(BG18)	T150(BT19)	-




1.2.3 Bat Activity Survey




- 9) Bat activity transect routes and static detector locations are illustrated at ES Figure 9A.10 RVBC-MH-FIG-009-01-10.
- 10) Transect 1 encompassed the eastern extent of the Bonstone Compound access road, extending along the southern boundary of the Compound during the 2019 transect surveys. The transect was supplemented by a single static monitoring point immediately adjacent to the compound (T04 static 1). Transect 1 was altered during the 2020 transect surveys to encompass the eastern extent of the Bonstone Compound access road, extending through the eastern and central areas of the Compound, supplemented by two static monitoring points immediately adjacent to the compound (TR4.T1A & TR4.T1B). Statics T1.A and T1.B are cited as North A and North B in the Bowland Ecology Report (Appendix B).
- 11) Bat species recorded during transect and static surveys around the Bonstone Compound included: common pipistrelle, soprano pipistrelle, noctule, brown long-eared bat and Myotis species.
- 12) Transect 2 encompassed the Braddup Compound access road, passed through the centre of the Braddup Compound and extended to the south east of the Compound, supplemented by two static monitoring points adjacent to (TR4.T2A) and approximately 850 m to the south west (TR4.T2B) of the compound. While offsite, the static location is considered representative of habitats present locally within and surrounding the Braddup Compound and targets a potential landscape corridor feature and is therefore considered to be relevant.
- 13) Bat species recorded during transect and static surveys around the Braddup Compound included: common pipistrelle, soprano pipistrelle, noctule, brown long-eared bat and Myotis species.




Appendix A. Bowlands Ecology Bat Tree Assessment Report




1 Project Details			
Project Name:	Haweswater Aqueduct Resilience Programme	Project Number:	80061155
Written:	Ellen Milner, <i>Principal Ecologist</i> Catrin Watkin, <i>Ecologist</i> Eve Loxham, <i>Ecologist</i>	Approved:	Sarah Birtley, <i>Senior Ecologist</i> Alice Helyar, <i>Principal Ecologist</i> Jeremy James, <i>Principal Ecologist</i>
Report reference:	TR4 Bat Tree Assessment Report V1 TR4 Bat Tree Assessment Report V2	Date:	26/11/2019 19/06/2020
2 Project Drawings			
TR4 Bat tree Plans Proposed Marl Hill Section Sheets 1 to 4		BOW167_HARP_9.5_BAT TREE_TR4	
3 Ecology Surveys			
Surveyors:	Eve Loxham MBIolSci (Hons), GradCIEEM Mark Breaks BSc (Hons) Ellen Milner MA, MRes, CEnv, MCIEEM Sophie King MSc, BSc Catrin Watkin MRes, BSc (Hons) Abigail Hamer BSc (Hons)		
Survey date(s):	18/07/2019, 31/07/2019, 07/08/2019, 08/08/2019, 10/10/2019, 20/11/2019, 27/11/2019, 06/02/2020, 14/05/2020, 19/05/2020, 20/05/2020.		
Survey Method:	<p>Trees were surveyed in accordance with Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition). A preliminary ground level assessment to identify trees supporting Potential Roosting Features (PRFs) was undertaken during the extended Phase 1 habitat survey. The assessment was aided by close focus binoculars. All trees were assigned a unique reference number and their locations marked on a plan.</p> <p>Any evidence of bat usage and all PRFs visible from ground level were recorded for future reference, including their approximate height and orientation of access points. Representative photographs were taken and the tree species recorded. Where numerous trees within a group, such as a woodland or tree line were noted to have bat roosting potential, these were assessed as a group.</p> <p>Trees or groups of trees were classified as Low, Moderate or High suitability as bat roosting habitat (groups classified according to the highest potential tree) in accordance with Table 4.1 (Page 35) of The Good Practice Guidelines, summarised as follows:</p> <p>Low – A tree of sufficient size and age to contain PRFs but none seen from the ground, or features seen with only very limited roosting potential.</p> <p>Moderate – A tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitats but unlikely to support a roost of high conservation status.</p> <p>High – A tree with one or more PRFs, that are obviously suitable for 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.</p>		




<p>Weather Conditions:</p>	<p>18/07/2019 – Cloud cover (3/8), Wind Beaufort F3, 19 °C, no precipitation. 31/07/2019– Cloud cover (2/8), Wind Beaufort F2, 20 °C, no precipitation. 07/08/2019– Cloud cover 6/8, Wind Beaufort F3, 22°C, no precipitation. 08/08/2019– Cloud cover (2/8), Wind Beaufort F2, 20 °C, no precipitation. 10/10/2019– Cloud cover (7/8), Wind Beaufort F3-5, 11°C, no precipitation. 14/05/2020 – Cloud cover (4/8), Wind Beaufort F1, 9°C, no precipitation. 19/05/2020 – Cloud cover (3/8), Wind Beaufort F0-2, 14°C, no precipitation. 20/05/2020 - Cloud cover (0/8), Wind Beaufort F0-2, 20°C, no precipitation.</p>
<p>Limitations to the survey:</p>	<p>Some of the surveys were undertaken in the summer months when trees were in leaf, potentially obscuring PRFs. At the edge of access boundaries surveys were only possible from one side. Once the development boundary/route option is finalised, further survey may be required to establish the presence of bat roosts.</p>
<p>4 Survey Results</p>	
<p>Individual Trees</p>	
<p>TR4.BT1</p>	
	<p>NGR: SD 71075 44393 Species: Oak (<i>Quercus</i> sp.) Categorisation: Moderate potential</p>
<p>TR4.BT2</p>	
	<p>NGR: SD 71069 44416 Species: Oak species Categorisation: Moderate potential</p>




TR4.BT3	
	<p>NGR: SD 71006 44715 Species: Oak species Categorisation: Low potential</p>
TR4.BT4	
	<p>NGR: SD 71114 44581 Species: Sycamore (<i>Acer pseudoplatanus</i>) Categorisation: Low potential</p>
TR4.BT5	
	<p>NGR: SD 71057 45090 Species: Sycamore Categorisation: Low potential</p>




TR4.BT6		<p>NGR: SD 69907 48905</p> <p>Species: Ash (<i>Fraxinus excelsior</i>)</p> <p>Categorisation: High potential</p>
TR4.BT7		<p>NGR: SD 69863 48785</p> <p>Species: Ash</p> <p>Categorisation: Moderate potential</p>
TR4.BT8		<p>NGR: SD 69853 48789</p> <p>Species: Beech (<i>Fagus sylvatica</i>)</p> <p>Categorisation: Moderate potential</p>

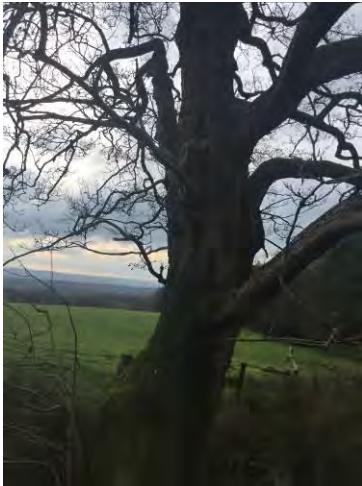


TR4.BT9	
	<p>NGR: SD 69795 48805</p> <p>Species: Ash</p> <p>Categorisation: Moderate potential</p>
TR4.BT10	
	<p>NGR: SD 69785 48808</p> <p>Species: Alder (<i>Alnus glutinosa</i>)</p> <p>Categorisation: Moderate potential</p>
TR4.BT11	
	<p>NGR: SD 69771 48812</p> <p>Species: Alder</p> <p>Categorisation: Moderate potential</p>




TR4.BT12	
	<p>NGR: SD 69759 48815 Species: Ash Categorisation: High potential</p>
TR4.BT13	
	<p>NGR: SD 69747 48898 Species: Alder Categorisation: Moderate potential</p>
TR4.BT14	
	<p>NGR: SD 69749 48940 Species: Ash Categorisation: Moderate potential</p>




TR4.BT15	
	<p>NGR: SD 69766 48940 Species: Ash Categorisation: Moderate potential</p>
TR4.BT16	
	<p>NGR: SD 69764 48987 Species: Alder Categorisation: Moderate potential</p>
TR4.BT17	
	<p>NGR: SD 69743 48999 Species: Alder Categorisation: Moderate potential</p>

TR4.BT18	
	<p>NGR: SD 69724 49008</p> <p>Species: Alder</p> <p>Categorisation: High potential</p>
TR4.BT19	
	<p>NGR: SD 69702 48942</p> <p>Species: Oak species</p> <p>Categorisation: Low potential</p>
TR4.BT20	
	<p>NGR: SD 69742 48921</p> <p>Species: Alder</p> <p>Categorisation: Moderate potential</p>

TR4.BT21	
	NGR: SD 70650 44782 Species: Alder Categorisation: Low potential
TR4.BT22	
	NGR: SD 70698 44667 Species: Alder Categorisation: Moderate potential
TR4.BT23	
	NGR: SD 70853 44616 Species: Alder Categorisation: Low potential

TR4.BT24	
	<p>NGR: SD 70843 44607 Species: Alder Categorisation: Low potential</p>
TR4.BT25	
	<p>NGR: SD 70661 44500 Species: Holly (<i>Ilex aquifolium</i>) Categorisation: Low potential</p>
TR4.BT26	
	<p>NGR: SD 70303 44358 Species: Ash Categorisation: Moderate potential</p>

TR4.BT27	
	<p>NGR: SD 70248 44292</p> <p>Species: Willow (<i>Salix</i> sp.)</p> <p>Categorisation: Low potential</p>
TR4.BT28	
	<p>NGR: SD 70141 44232</p> <p>Species: Oak species</p> <p>Categorisation: High potential</p>
TR4.BT29	
	<p>NGR: SD 70220 44277</p> <p>Species: Oak species</p> <p>Categorisation: Low potential</p>

TR4.BT30	
	<p>NGR: SD 70211 44270</p> <p>Species: Oak species</p> <p>Categorisation: Low potential</p>
TR4.BT31	
	<p>NGR: SD 71921 45020</p> <p>Species: Oak species</p> <p>Categorisation: Low potential</p>
TR4.BT32	
	<p>NGR: SD 71921 45009</p> <p>Species: Alder</p> <p>Categorisation: Low potential</p>
TR4.BT33	
<p>No photo.</p>	<p>NGR: SD 71969 45043</p> <p>Species: Oak species</p> <p>Categorisation: Moderate potential</p>

TR4.BT34



NGR: SD 72251 45131

Species: Oak species

Categorisation: Low potential

TR4.BT35



NGR: SD70653 44786

Species: Alder

Categorisation: Moderate potential




TR4.BT36










NGR: SD71329 44825




Species: Ash




Categorisation: Moderate potential




TR4.BT37	
	<p>NGR: SD71353 44713 Species: Ash Categorisation: Moderate potential</p>
TR4.BT38	
	<p>NGR: SD 71438 44813 Species: Oak species Categorisation: Moderate potential</p>
Tree Groups	
TR4.BG1	
	<p>NGR: SD 71033 44888 Species: Alder, silver birch (<i>Betula pendula</i>), holly Number of trees: 10 Overall categorisation: Low potential</p>





TR4.BG2	
	<p>NGR: SD 71183 44884</p> <p>Species: Alder, oak species, rowan (<i>Sorbus aucuparia</i>), sycamore</p> <p>Number of trees: 6</p> <p>Overall categorisation: Low potential</p>
TR4.BG3	
	<p>NGR: SD 79858 44932</p> <p>Species: Elder (<i>Sambucus nigra</i>), alder, rowan, conifer species</p> <p>Number of trees: 10</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG4	
	<p>NGR: SD 69927 48797</p> <p>Species: Silver birch, oak species, willow species, hazel (<i>Corylus avellana</i>), hornbeam (<i>Carpinus betulus</i>), holly</p> <p>Number of trees: 10</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG5	
	<p>NGR: SD 69592 48801</p> <p>Species: Alder, ash, oak species</p> <p>Number of trees: 7</p> <p>Overall categorisation: Moderate potential</p>


TR4.BG6	
	<p>NGR: SD 69556 48734</p> <p>Species: Ash, oak species, larch (<i>Larix decidua</i>), elm (<i>Ulmus</i> sp.)</p> <p>Number of trees: 10</p> <p>Overall categorisation: High potential</p>
TR4.BG7	
	<p>NGR: SD 69849 49001</p> <p>Species: Ash, oak species, Scots pine (<i>Pinus sylvestris</i>)</p> <p>Number of trees: 15</p> <p>Overall categorisation: High potential</p>
TR4.BG8	
	<p>NGR: SD 69535 48889</p> <p>Species: Alder, ash</p> <p>Number of trees: 10</p> <p>Overall categorisation: Moderate potential</p>

TR4.BG9	
	<p>NGR: SD 70563 44548</p> <p>Species: Alder</p> <p>Number of trees: 4</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG10	
	<p>NGR: SD 70430 44440</p> <p>Species: Alder, ash, oak species, sycamore</p> <p>Number of trees: 8</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG11	
	<p>NGR: SD 69837 48963</p> <p>Species: Alder</p> <p>Number of trees: 5</p> <p>Overall categorisation: Moderate potential</p>

TR4.BG12	
	<p>NGR: SD 69515 48927</p> <p>Species: Alder, ash</p> <p>Number of trees: 3</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG13	
	<p>NGR: SD 70244 44488</p> <p>Species: Alder</p> <p>Number of trees: 4</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG14	
	<p>NGR: SD 70326 44368</p> <p>Species: Sessile oak (<i>Quercus petraea</i>), alder, ash, sycamore</p> <p>Number of trees: 6</p> <p>Overall categorisation: Low potential</p>

TR4.BG15	
	<p>NGR: SD 70089 44432</p> <p>Species: Oak species, alder, sycamore</p> <p>Number of trees: 6</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG16	
	<p>NGR: SD 70165 44270</p> <p>Species: Oak species, ash</p> <p>Number of trees: 5</p> <p>Overall categorisation: Moderate potential</p>
TR4.BG17	
	<p>NGR: SD 70072 44341</p> <p>Species: Sycamore, ash</p> <p>Number of trees: 6</p> <p>Overall categorisation: Moderate potential</p>

TR4.BG18	
	<p>NGR: SD 71220 44749</p> <p>Species: Scots pine, ash, larch, cherry (<i>Prunus</i> sp.)</p> <p>Number of trees: 20</p> <p>Overall categorisation: Low potential</p>
TR4.BG19	
	<p>NGR: SD 71444 44876</p> <p>Species: Scots pine, birch (<i>Betula</i> sp.), ash, larch</p> <p>Number of trees: 6</p> <p>Overall categorisation: Low potential</p>
TR4.BG20	
	<p>NGR: SD 71606 44965</p> <p>Species: Alder, oak</p> <p>Number of trees: 10</p> <p>Overall categorisation: Moderate/high potential</p>
TR4.BG21	
	<p>NGR: SD71364 44482</p> <p>Species: Alder, holly oak</p> <p>Number of trees: 6</p> <p>Overall categorisation: Moderate/high potential</p>

TR4.BG22	
	<p>NGR:</p> <p>Species: Oak species</p> <p>Number of trees: 3</p> <p>Overall categorisation: Moderate potential</p>

References

Collins, J. (Ed). (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition). The Bat Conservation Trust, London.

Appendix B. Bowlands Ecology Bat Activity Report

1 Project Details				
Project Name:	Haweswater Aqueduct Resilience Programme		Project Number:	80061155
Written:	Mark Breaks, <i>Ecologist</i> Eve Loxham, <i>Ecologist</i> Sophie King, <i>Assistant Ecologist</i> Lucy Pocock, <i>Assistant Ecologist</i>		Approved:	V1 2019: Sarah Birtley, <i>Senior Ecologist</i> V1 2020: Matt Clifford, <i>Senior Ecologist</i> V2: Sarah Birtley, <i>Senior Ecologist</i>
Report reference:	TR4 Ecology Survey Data Report Bat Activity 2019 TR4 Ecology Survey Data Report Bat Activity 2020 TR4 Ecology Survey Data Report Bat Activity 2019-2020		Date:	V1 2019: 20/01/2020 V1 2020: 14/08/2020 V2: 19/10/2020
2 Project Drawings				
Bat Transects and Static Locations			BOW167_HARP_9.5_BATS_TR4	
Proposed Marl Hill Section				
3 Ecology Surveys				
Surveyors:	Abigail Hamer BSc (Hons) Eve Loxham MBiolSci (Hons) Sarah Birtley MBiolSci (Hons) Catrin Watkin MRes BSc (Hons) Luke Hall BSc (Hons) Dave Fisher Mark Breaks BSc (Hons) Helena Davies BSc (Hons) Sam Robinson BA		Data analysts:	Jack Taylor BSc (Hons) Mark Breaks BSc (Hons)
Survey date(s):	Visit, Type, Location	Date	Visit, Type, Location	Date
	2019			
	Visit 1, (North) Transect 1, TR4	28/08/19	Visit 1, (North) Transect 1 Static A, TR4	05/09/19 to 15/09/19
	Visit 2, (North) Transect 1, TR4	07/10/19	Visit 2, (North) Transect 1 Static A, TR4	01/10/19 to 06/10/19
	Visit 3, (North) Transect 1, TR4	23/10/19		
	2020			
Visit 1, (North) Transect 1, TR4	06/04/2020	Visit 1, (North) Transect 1 Static A,	22/04/2020 to 03/05/2020	

			TR4	
	Visit 2, (North) Transect 1, TR4	30/06/2020	Visit 2, (North) Transect 1 Static A & B, TR4	26/06/2020 to 30/06/2020
	Visit 3, (North) Transect 1, TR4	23/07/2020	Visit 3, (North) Transect 1 Static A & B, TR4	21/07/2020 to 27/07/2020
	Visit 1, (South) Transect 2, TR4	09/04/2020	Visit 1, (South) Transect 2 Static A & B, TR4	22/04/2020 to 27/04/2020
	Visit 2, (South) Transect 2, TR4	26/05/2020	Visit 2, (South) Transect 2 Static A & B, TR4	18/05/2020 to 26/05/2020
	Visit 3, (South) Transect 2, TR4	19/06/2020	Visit 3, (South) Transect 2 Static A & B, TR4	04/06/2020 to 12/06/2020
	Visit 4, (South) Transect 2, TR4	14/07/2020	Visit 4, (South) Transect 2 Static A & B, TR4	21/07/2020 to 27/07/2020
Survey Method:	<p>BCT – Habitat Evaluation and Survey Effort</p> <p>The transect routes identified for survey cover a variety of habitats throughout the landscape of TR4. These include; agricultural fields lined with hedgerows, watercourses and mature tree lines; hedgerow-lined minor roads; large areas of marshy grassland and plantation woodland. The transect routes have been given the following foraging and commuting classifications in accordance with the Bat Conservation Trust (BCT) survey guidelines (Collins, 2016):</p> <p>2019</p> <ul style="list-style-type: none"> • North Transect – TR4 Transect 1: Low potential <p>2020</p> <ul style="list-style-type: none"> • North Transect – TR4 Transect 1: Moderate potential • South Transect – TR4 Transect 2: Moderate potential <p>A detailed description of the habitats surrounding each transect route is provided in section 4 'Survey Findings'. The transects and static locations were updated to allow for the amended development envelope survey areas released in February and April 2020 to follow on from the data collected in 2019. The transects assessed in 2020 reflect the new development boundaries. North (Transect 1) was extended compared with the 2019 surveys to include the fields to the north. Transect 2 was not included in the 2019 surveys and report. For ease the transect routes were renamed North and South for Transect 1 and Transect 2 respectively.</p> <p>For low potential routes, three bat activity survey visits are required, covering the spring (April to May), summer (June to August) and autumn (September to October) seasons. For moderate potential routes, one survey visit per month (April to October) are required. For high potential routes, up to two survey visits per month (April to October) are required. This report details the results of bat activity surveys carried out in August to October 2019 for North Transect only, and April to July 2020 for North and South Transects. Part way through the survey season in 2020, North Transect 1 was upgraded from low to moderate potential to reflect anecdotal evidence presented in 2020. Subsequently the route had one static detector (Static A) instead of the standard two for Visit 1. Caution should be applied when comparing the results since the transect routes have been updated for the 2020 development boundary.</p> <p>Each transect visit comprises a single transect route, complemented by one static detector (for low potential), two static detectors (for moderate potential) or three static detectors (for high</p>			

potential).

Transect Surveys

The walked transect survey commenced at dusk and included monitoring points, at which surveyors remained stationary for a standardised three to five minute period. Walked sections of the transect between each monitoring point were walked at a slow steady pace. Surveyors carried a broadband full spectrum detector (EM3 Touch attached to iPad) supplemented by heterodyne detectors. Bat passes at each walk and monitoring point were recorded with the number of bats observed, species and any other contextual data such as flight direction, social calling or foraging. The transect route and monitoring points were designed to sample the range of habitats present across the site, whilst avoiding any features which could be difficult to safely navigate in darkness.

Sonogram analysis was undertaken using Anabat Insight at Bowland Ecology by Mark Breaks and Jack Taylor. No automated filters or automated identification packages have been applied during sonogram analysis.

Static Surveys

Static remote monitoring bat detectors (Anabat Express, set to night mode) were deployed at fixed locations for a minimum of five consecutive nights per visit. The static locations were non-random (as micro-siting was determined by habitat and/or potential impacts). Detectors were deployed with standardised sensitivity settings.

Sonogram analysis was undertaken using Anlook software at Bowland Ecology by Mark Breaks and Jack Taylor. No automated filters or automated identification packages have been applied during sonogram analysis. For the purposes of presentation, data have been transformed to calculate bat activity indices (BAI) or bat passes per night. The BAI represents bat passes per hour (bph), to account for different night lengths throughout the recording period.

Weather Conditions – Transect Surveys 2019:			
Transect & Visit	Transect 1 - Visit 1	Transect 1 - Visit 2	Transect 1 - Visit 3
Date	29/08/2019	07/10/2019	23/10/2019
Start Time	20:52	19:32	18:32
End Time	20:32	19:18	19:05
Sunset	20:08	18:32	17:55
Moonlight	Waning crescent	Waxing crescent	Waning crescent
Temp. °C (start)	17	11	9
Rain (start)	0	0	0
Wind ¹ (start)	1-4	2-3	3-4
Cloud ² (start)	8	5	3
Temp. °C (end)	17	11	9
Rain (end)	0	0	0
Wind ¹ (end)	1-4	2-3	3-4
Cloud ² (end)	8	8	3

Weather Conditions – Transect Surveys 2020:			
Transect & Visit	North Transect - Visit 1	North Transect - Visit 2	North Transect - Visit 3
Date	07/04/2020	30/06/2020	23/07/2020
Start Time	19:56	21:45	21:22
End Time	21:17	23:01	22:37
Sunset	19:56	21:45	21:22
Moonlight	Waxing gibbous	Waxing gibbous	Waxing crescent
Temp. °C (start)	8	13	14
Rain (start)	dry	dry	Drizzle
Wind ¹ (start)	1	0	1-2
Cloud ² (start)	8	8	8
Temp. °C (end)	6	11	14
Rain (end)	dry	dry	Drizzle
Wind ¹ (end)	1	0	1-2
Cloud ² (end)	8	0	8
Weather Conditions – Transect Surveys 2020:			
Transect & Visit	South Transect - Visit 1	South Transect - Visit 2	South Transect - Visit 3
Date	09/04/2020	26/05/2020	19/06/2020
Start Time	19:59	21:23	21:48
End Time	21:37	22:44	23:07
Sunset	19:59	21:23	21:46
Moonlight	Waning gibbous	Waxing crescent	New moon
Temp. °C (start)	13	13	12
Rain (start)	dry	dry	Light rain
Wind ¹ (start)	1	0	1
Cloud ² (start)	0	0	8
Temp. °C (end)	10	7.8	10
Rain (end)	dry	dry	Light rain
Wind ¹ (end)	1	0	1
Cloud ² (end)	0	0	8

Weather Conditions – Transect Surveys 2020:			
Transect & Visit	South Transect - Visit 4		
Date	14/07/2020		
Start Time	21:42		
End Time	22:54		
Sunset	21:42		
Moonlight	Waning crescent		
Temp. °C (start)	13		
Rain (start)	Fine drizzle		
Wind ¹ (start)	1		
Cloud ² (start)	8		
Temp. °C (end)	12		
Rain (end)	Fine drizzle		
Wind ¹ (end)	1		
Cloud ² (end)	8		
Weather Conditions – Static Surveys 2019:			
Static & Visit	Transect 1 Static A - Visit 1	Transect 1 Static A – Visit 2	
Date	05/09/2019 to 14/09/2019	01/10/2019 to 06/10/2019	
Location	SD 69940 48808	SD 69940 48808	
Sunset	19:51 to 19:26	18:47 to 18:34	
Sunrise	06:26 to 06:43	07:12 to 07:21	
Start Temp. °C	12 to 15	9 to 12	
Midnight Temp. °C	8 to 15	7 to 12	
End Temp. °C	6 to 16	3 to 12	
Rain	Scattered showers 06/09/2019, drizzle 15/09/2019	Heavy rain 03/10/2019	
Wind kmh (Beaufort Scale ¹)	22 (4), 17 (3), 10 (2), 6 (2), 11 (2), 19 (3), 17 (3), 17 (3), 4 (1), 13 (3)	10 (2), 6 (2), 22 (4), 9 (2), 14 (3), 6 (2)	
Wind Direction	W, NW, NNW, SW, N, W, W, NNW, NW, WSW	ENE, NNW, SE, E, SE, N	
Cloud	Passing clouds and scattered clouds from 05/09/2019 to 12/09/2019 and 15/09/2019, clear 13/09/2019 and 14/09/2019	Passing clouds	

Moonlight	46% to 99%	7% to 57%		
Weather Conditions – Static Surveys 2020:				
Static & Visit	North, Static A, Visit 1	North, Static A & B, Visit 2	North, Static A & B, Visit 3	
Date	22/04/2020 to 03/05/2020	26/06/2020 to 30/06/2020	21/07/2020 to 27/07/2020	
Location	SD 69959 48806	SD 69959 48806 SD 69760 48953	SD 69959 48806 SD 69760 48953	
Sunset	20:25 to 20:45	21:45 to 21:43	21:25 to 21:15	
Sunrise	05:52 to 05:28	04:39 to 04:43	05:06 to 05:15	
Start Temp. °C	7 to 18	13 to 17	14 to 19	
Midnight Temp. °C	2 to 8	10 to 21	7 to 15	
End Temp. °C	6 to 17	12 to 20	14 to 18	
Rain	Light rain 28/04/2020, 30/04/2020 otherwise dry	Scattered showers 26/06/2020 to 29/06/2020 otherwise dry	Light rain 23/07/2020, scattered showers 25/07/2020, drizzle 27/07/2020 otherwise dry	
Wind (kmh)	22 (4), 12 (3), 5 (1), 14 (3), 16 (3), 16 (3), 12 (3), 8 (2), 22 (4), 22 (4), 21 (4), 17 (3)	17 (3), 45 (6), 46 (6), 4 (1)	30 (4), 14 (3), 6 (1), 12 (3), 19 (3), 28 (4), 30 (4)	
Wind Direction	E, NE, N, NW, NW, NNW, ESE, W, W, WNW, WNW, N	NW, WSW, WSW, W, W	WNW, NW, WNW, SE, W, WSW, WNW	
Cloud	Clear 22/04/ 2020 to 25/04/2020, otherwise passing clouds throughout deployment period	Scattered and passing clouds throughout deployment period	Overcast 23/07/2020, otherwise scattered and passing clouds throughout deployment period	
Moonlight	1% to 82%	32% to 94%	1% to 53%	
Weather Conditions – Static Surveys 2020:				
Static & Visit	South, Static A-B, Visit 1	South, Static A-B, Visit 2	South, Static A-B, Visit 3	South, Static A-B, Visit 4
Date	22/04/2020 to 27/04/2020	18/05/2020 to 26/05/2020	04/06/2020 to 12/06/2020	21/07/2020 to 27/07/2020
Location	A: SD 71305 44812 B: SD 70229 44251	A: SD 71305 44812 B: SD 70229 44251	A: SD 71305 44812 B: SD 70229 44251	A: SD 71305 44812 B: SD 70229 44251
Sunset	20:25 to 20:34	21:11 to 21:23	21:35 to 21:41	21:25 to 21:15
Sunrise	05:52 to 05:41	05:01 to 04:50	04:41 to 04:37	05:06 to 05:15
Start Temp. °C	7 to 18	12 to 18	11 to 16	14 to 19

Midnight Temp. °C	2 to 8	6 to 16	5 to 10	7 to 15
End Temp. °C	6 to 17	11 to 22	9 to 16	13 to 18
Rain	Dry	Dry	Scattered showers 05/06/2020, 11/06/2020, otherwise clear	Light rain 23/07/2020, scattered showers 25/07/2020, drizzle 27/07/2020, otherwise dry
Wind (kmh)	22 (4), 12 (3), 5 (1), 14 (3), 16 (3), 16 (3)	25 (4), 14 (3), 9 (2), 12 (3), 54 (7), 48 (6), 14 (3), 14 (3), 13 (3)	18 (3), 48 (6), 22 (4), 14 (3), 11 (2), 9 (2), 21 (4), 22 (4), 17 (3)	9 (2), 25 (4), 16 (3), 9 (2), 19 (3), 18 (3), 30 (4)
Wind Direction	E, NE, N, NW, NW, NNW	W, NW, N, E, WSW, W, W, W, W	WNW, NW, NW, NNW, NW, WNW, ESE, NE, E	W, WSW, WNW, SW, W, WSW, SSE
Cloud	Passing clouds 26/04/2020, 27/04/2020 otherwise clear	Broken and passing clouds throughout deployment period	Scattered and passing clouds throughout deployment period	Broken clouds 22/07/2020, overcast 23/07/2020, scattered clouds throughout deployment period
Moonlight	1% to 82%	15% to 17%	60% to 99%	1% to 53%

¹Wind strength is reported using the Beaufort Scale of Wind Force, this scale runs from 0 to 12, information on the conditions experienced during surveys are as follows: 0 – Calm (vertical smoke); 1 – Light Air (slight smoke drift); 2 – Light Breeze (leaves gently rustle).

²Cloud cover is reported in oktas or eighths (i.e. 0 oktas represents the complete absence of cloud, 1 okta cloud cover of 1 eighth or less, and so on to 8 oktas which represents full cloud cover), with the additional convention that 9 oktas represents sky obscured by fog or mist.

Weather data for the static monitoring surveys including sunset time, sunrise time, temperature, rainfall, wind speed, wind direction, cloud and moonlight have been obtained from timeanddate.com.

<p>Limitations to the surveys:</p>	<p><i>Access</i> No access constraints.</p> <p><i>Detector errors</i> In 2020, South Static A Visit 2 and 4, and South Static B Visit 1 recorded no data for any of the nights. This is likely due to detector error rather than lack of bats since the nearby detectors recorded bats throughout the same monitoring period.</p> <p><i>Lack of bat activity</i> In 2020, dates of note is 28/04 and 27-30/06 which recorded no bat activity across all statics out on those dates. No errors were recorded on the log and therefore it is assumed that this is due to absence of bat activity rather than detector malfunction.</p> <p><i>Timing</i> In 2019, due to time constraints and the proximity of the two transects, this transect (TR4 Transect 1) was coupled with another nearby transect (TR3 Transect 1). The starting transect route alternated on each visit and subsequently the survey started approximately 30 minutes after sunset for Visit 1 and 3. This could affect the number of bats and assemblage of species; however, surveys were completed with 2 hours after sunset and were also complemented by a static detector survey.</p> <p><i>Temperature</i> In 2019, temperatures were below 10°C during Transect 1 Visit 3 and on at least one day of each of the static monitoring dates. However, bats are typically active at temperatures above 6°C and since bat activity was still recorded, this is not considered to be a significant constraint. In 2020, start temperatures for transect surveys were below 10°C during Visit 1 for North transect (8°C). This is typical of spring months in northern England, and not considered to be a significant constraint as bat activity was still recorded and bats are typically active at temperatures above 6°C. Start temperatures for static surveys were below 10°C for at least one night for Visit 1 of North and South statics. No start temperatures below 6°C were noted and temperature is therefore not considered to be a significant constraint to the surveys since bat activity was still recorded. However, lower temperatures can reduce bat activity and may reduce the overall number of bat calls recorded during the survey periods. Where possible and suitable temperatures followed, static monitoring periods were extended to take this into account.</p> <p><i>Rainfall</i> In 2019 heavy rain was recorded on one night of static monitoring Visit 2. This is not considered to be a significant constraint since bat activity was still recorded and the static monitoring period was extended to take this into account. In 2020, no rainfall was recorded during the transect surveys. And no heavy rainfall was recorded across the static monitoring periods. Light rain and scattered showers were recorded on several nights throughout the static monitoring period, however of those dates none recorded no bat calls across all statics and rainfall is therefore not considered to be a significant constraint. Where possible and suitable weather followed, the monitoring period was extended past the initial five days to take this into account.</p> <p><i>Wind</i> In 2019, wind speed was high during some of the transect surveys (Visit 1 and Visit 3). This was recorded as gusts rather than continuous wind. The effect of wind speed on bat activity varies depending on the topography of the landscape. The site is screened by hedges to the south and north, and there are mature trees to the west which are likely to provide shelter from the wind. As bat activity was still recorded this was not considered to be a significant constraint. In 2020, wind speed was not considered high (Beaufort Scale 4 and above*) for any transect. Wind speed was considered high (Beaufort Scale 4 and above*) for several nights of static deployment, in particular;</p> <ul style="list-style-type: none"> • North Static A Visit 1; four nights 22/04, 30/04-01/05; • North Statics A to B Visit 2; two nights 27/06 and 28/06;
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- North Statics A to B Visit 3; three nights 21/07, 26/07 and 27/07;
- South Statics A to B Visit 1; one night 22/04;
- South Statics A to B Visit 2; three nights 18/05, 22/05 and 23/05;
- South Statics A to B Visit 3; four nights 05/06, 06/06, 10/06 and 11/06; and
- South Statics A to B Visit 4; one night 27/07.

Of these dates, only 27/06 and 28/06 recorded no bats at the static locations that were deployed. Wind is considered a constraint for these dates but otherwise not a significant constraint since bat calls were still recorded. The effect of wind speed on bat activity varies depending on the topography of the landscape. The north and south transects are bordered by blocks of woodland and mature tree lines which provide some wind screening. Where possible and suitable weather followed, the monitoring period was extended beyond the initial five days to take this into account.

*Slack and Tinsley (2015) recorded a reduction in bat activity at wind speeds of 5.4 m/s (Beaufort Scale 4).

Species analysis

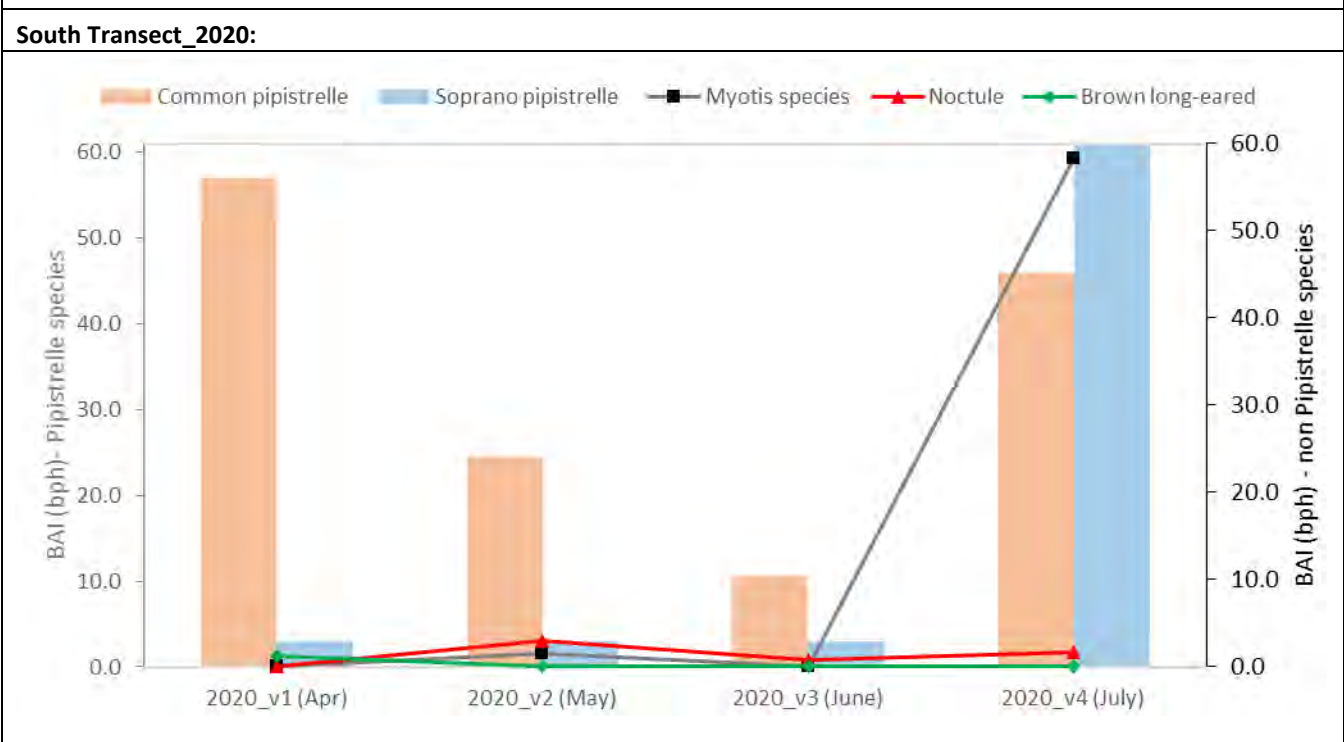
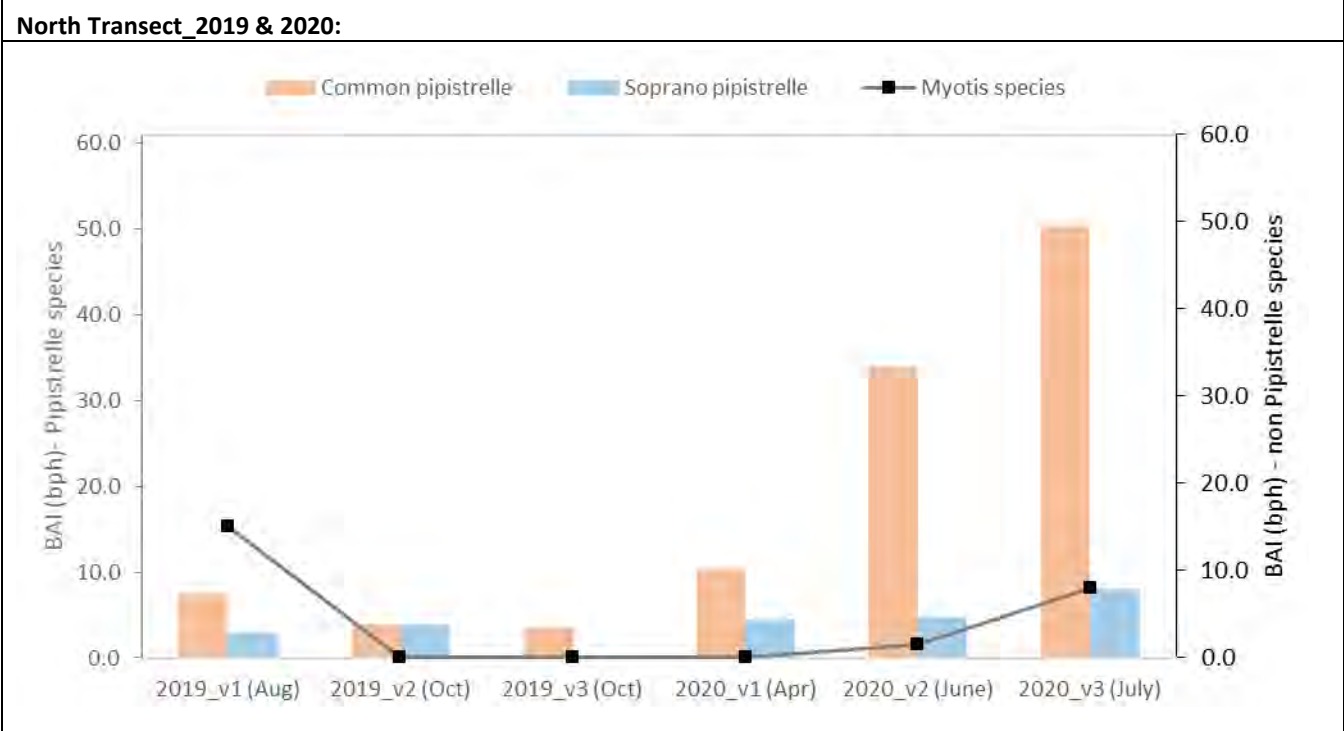
Detectability of some bat species e.g. *Plecotus* is lower than others e.g. *Nyctalus* and *Pipistrellus*, as a consequence of echolocation and hunting strategies. Careful interpretation has been applied when comparing across species.

During data analyses, some pipistrelle bat calls were undeterminable to species level (e.g. peak frequencies at 50kHz). These calls have therefore been classified as pipistrelle species.

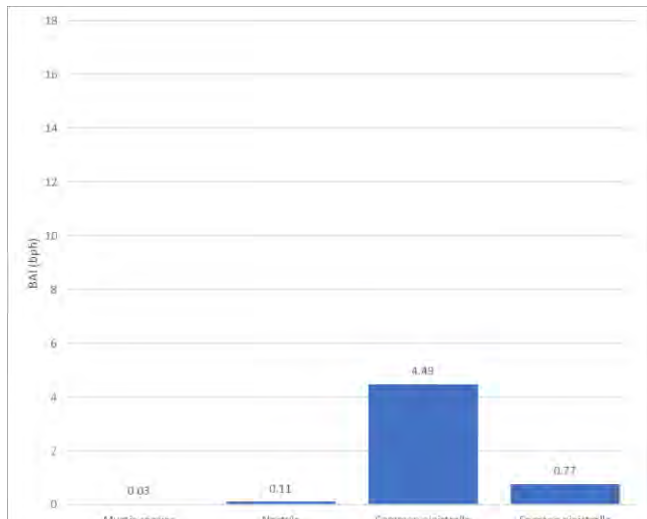
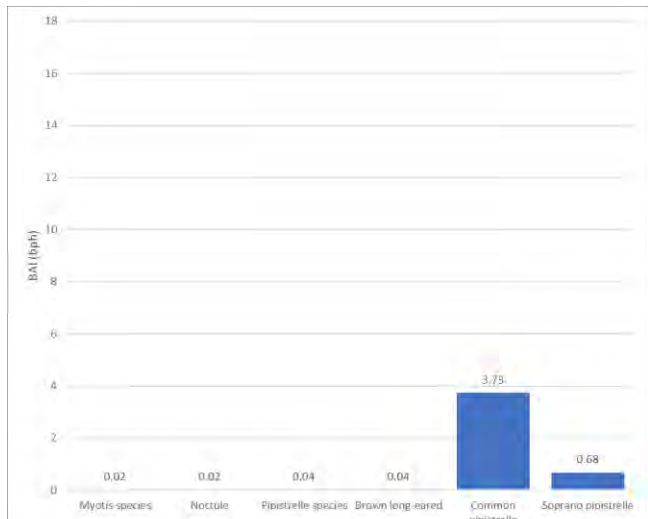
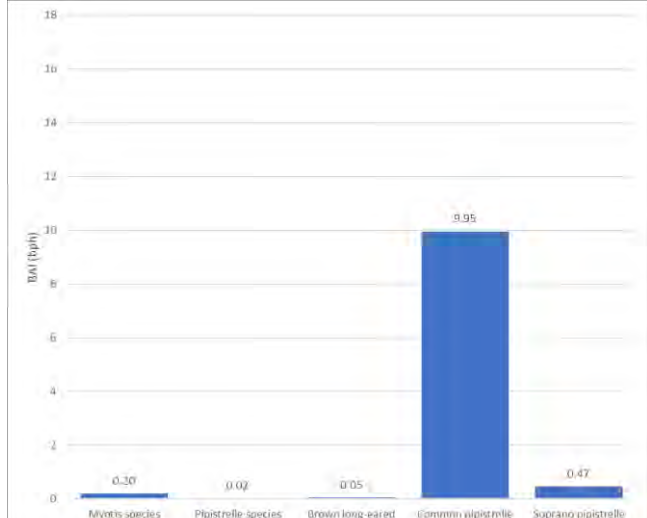
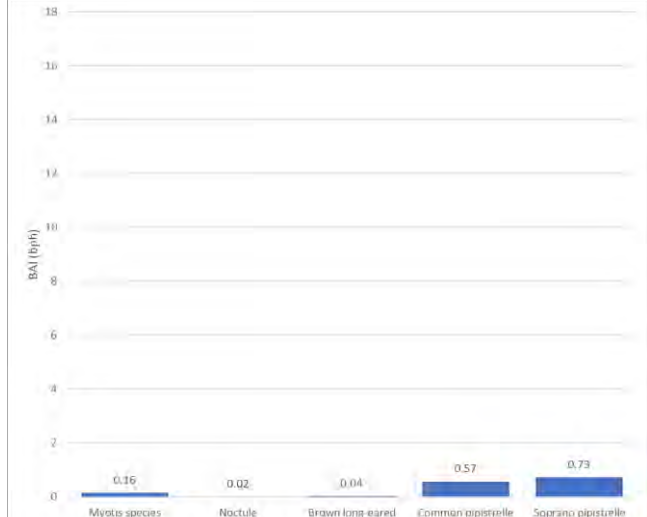
Myotis species have overlapping call characteristics and it is therefore not possible to identify these bats to species level with confidence (at least 80%). Where possible, species have been identified to a smaller group e.g. whiskered/Brandt's bats (*Myotis mystacinus/Myotis brandti*) or Natterer's/Bechstein's bats (*Myotis nattereri/Myotis bechsteinii*) through sonogram analysis. However, *Myotis* data represent a small proportion of the activity recorded and therefore, for the purposes of meaningful data presentation, *Myotis* species have been grouped.

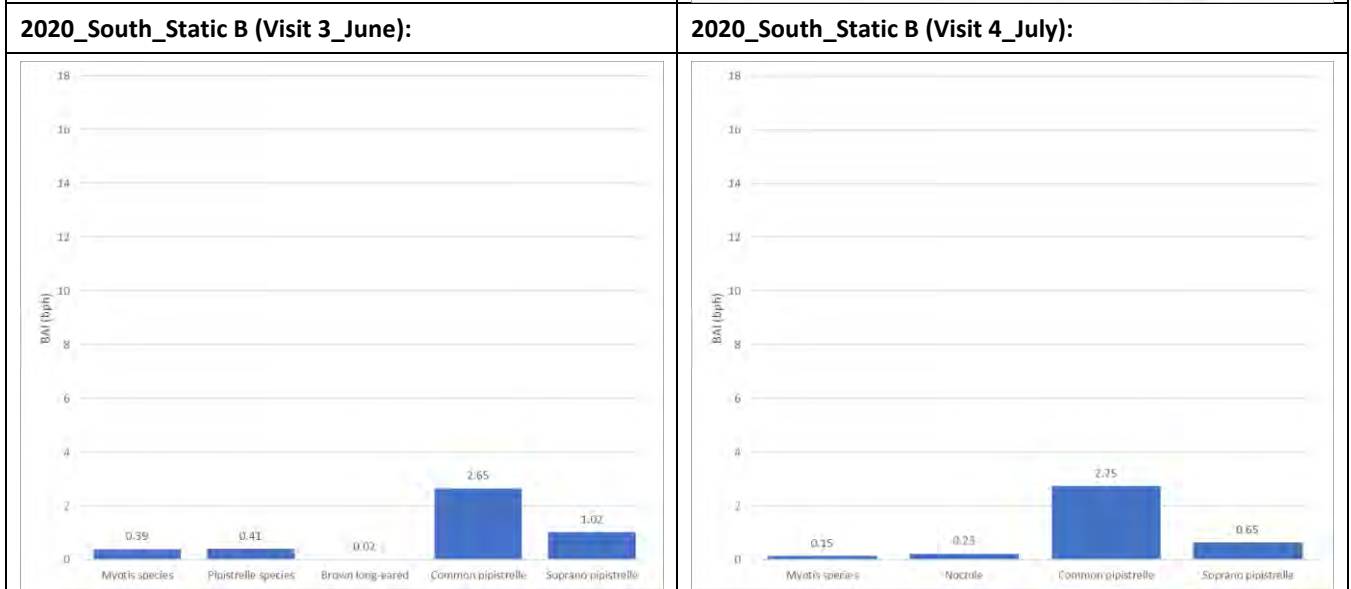
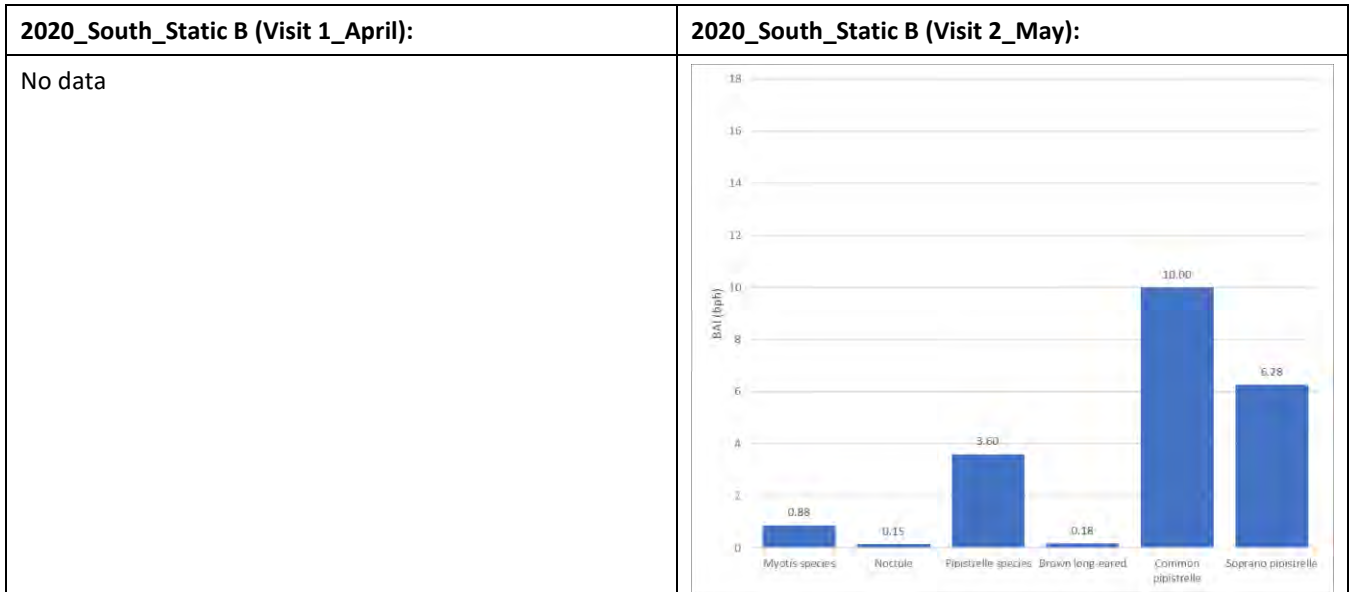
4 Survey Findings	
Habitat Description	
	<p>North; Transect 1</p> <p>2019: The transect route follows the farm track from the B6478 road. The surrounding habitats consist of semi-improved grassland, marshy grassland, mixed plantation woodland, scattered scrub, hedgerows (TR4.H1 and TR4.H2), scattered trees, multiple small scrapes/ponds (TR4.P1 and TR4.P2) and farm buildings. The adjacent trees along the farm track, trees within the woodland and farm buildings were all assessed to provide bat roosting potential (TR4.BT7 to TR4.BT12, TR4.BG4, TR4.BG5, TR4.BG8 and TR4.TN18).</p>
	<p>2020: The transect route follows an access track off Slaidburn Rd (B6478) leading to New Laithe, Ashnott and Storth Farm. The route travels through a section of species-poor semi-improved grassland which slopes down towards the north. There are linear features throughout the transect including hedgerows (TR4.H1 and 2), minor watercourses (a small section of TR4.WC6 and WC7 and an unnamed ditch) and scattered mature tree lines. In the centre of the transect is a small area of plantation broadleaved woodland (TR4.TN12). The main surrounding land use is livestock grazed grassland, and some of the fields are species-rich with damper areas of marshy grassland and open water (TR4.P1 and P2).</p>
	<p>2019 / 2020: Static 1 / Static A</p> <p>Static 1 was positioned on a willow (<i>Salix</i> sp.) tree on the edge of the mixed plantation woodland adjacent to semi-improved grassland. Trees within the woodland were assessed to have bat roosting potential (TR4.BG4). The woodland also has good connectivity to Bonstone Brook to the south (approximately 300m south) via hedgerows and the wooded watercourse valley.</p> <p>2020: Static B</p> <p>Static B was positioned at the edge of plantation woodland adjacent to species-poor semi-improved grassland with a nearby scattered mature tree line and minor watercourse (TR4.WC6).</p>
	<p>South; Transect 2</p> <p>The transect route is roughly east-west orientated and covers a range of habitats along an access route from Slaidburn Rd to Talbot Bridge of Bashall Brook (TR4.WC15). The dominant habitat type covered is species-poor semi-improved grassland, intersected by a number of wooded watercourse valleys (e.g. TR4.WC1, WC16-20), large field of marshy grassland and blocks of plantation woodland. The fields are mainly used for livestock grazing and are bound by mature tree lines and hedgerows (TR4.H9, H11 and H12).</p>
	<p>Statics A and B</p> <p>Static A was positioned at the edge of a small area of plantation woodland (TR4.TN42) within a field of species-poor semi-improved grassland.</p> <p>Static B was positioned at the edge of a coniferous plantation woodland (TR4.TN36) along a minor watercourse (TR4.WC13) which flows west and into Bashall Brook.</p>

Average Bat Activity Recorded During Each Transect Across All Visits (bat passes per hour by species/group)

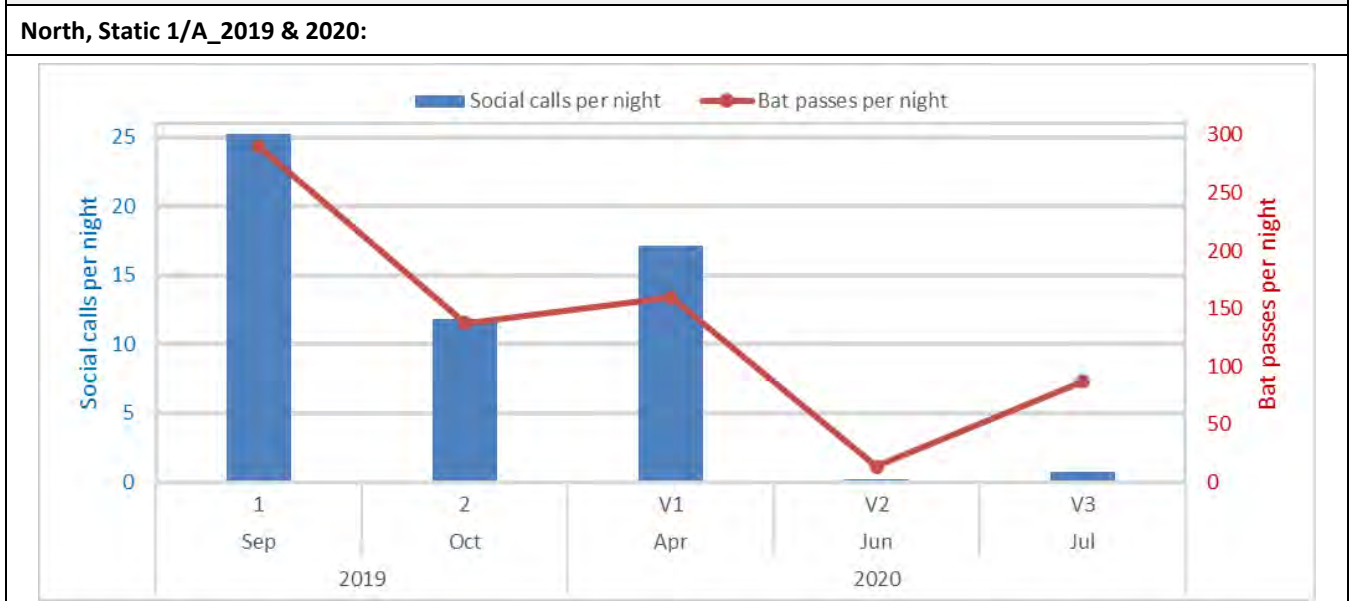


Average Bat Activity Recorded at Each Static Location Across All Visits (bat passes per night by species/group)																									
2019_North_Static A (Visit 1_Sept): <table border="1"> <tr><th>Species</th><th>Bat (bph)</th></tr> <tr><td>Myotis bats</td><td>0.88</td></tr> <tr><td>Noctule bat</td><td>0.02</td></tr> <tr><td>Pipistrelle bats</td><td>0.02</td></tr> <tr><td>Brown long-eared bat</td><td>0.15</td></tr> <tr><td>Common pipistrelle</td><td>17.88</td></tr> <tr><td>Soprano pipistrelle</td><td>3.13</td></tr> </table>	Species	Bat (bph)	Myotis bats	0.88	Noctule bat	0.02	Pipistrelle bats	0.02	Brown long-eared bat	0.15	Common pipistrelle	17.88	Soprano pipistrelle	3.13	2019_North_Static A (Visit 2_Oct): <table border="1"> <tr><th>Species</th><th>Bat (bph)</th></tr> <tr><td>Myotis bats</td><td>3.87</td></tr> <tr><td>Brown long-eared bat</td><td>0.40</td></tr> <tr><td>Common pipistrelle</td><td>1.22</td></tr> <tr><td>Soprano pipistrelle</td><td>4.12</td></tr> </table>	Species	Bat (bph)	Myotis bats	3.87	Brown long-eared bat	0.40	Common pipistrelle	1.22	Soprano pipistrelle	4.12
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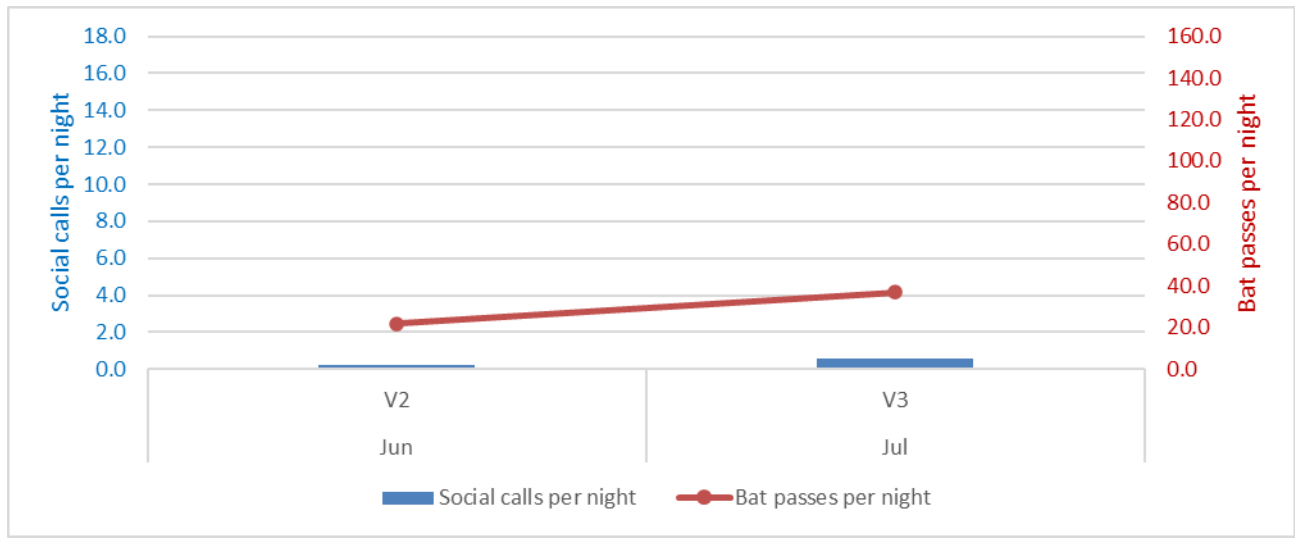
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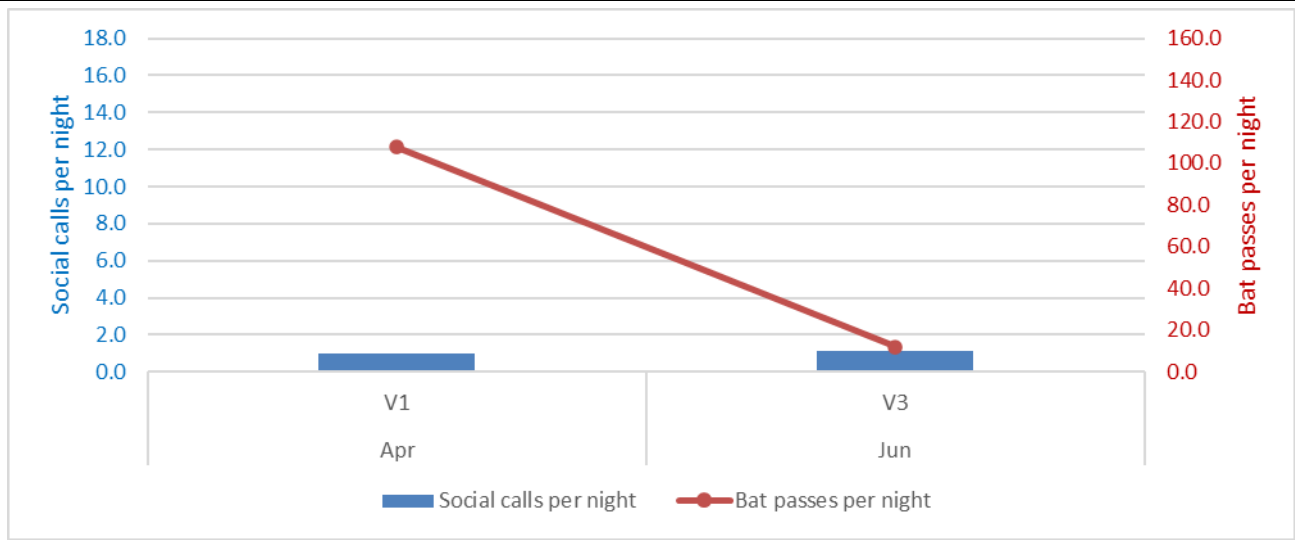
Seasonal Variation in Bat Social Calls Recorded during Static Monitoring (for entire bat assemblage at all locations)



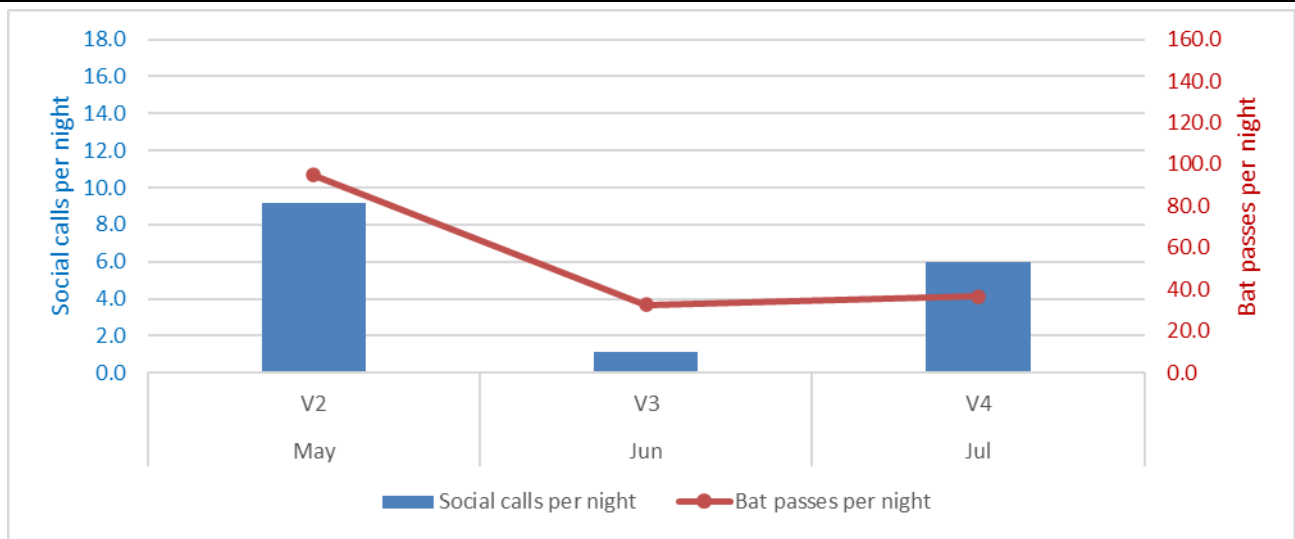
North, Static B_2020:



South, Static A_2020:

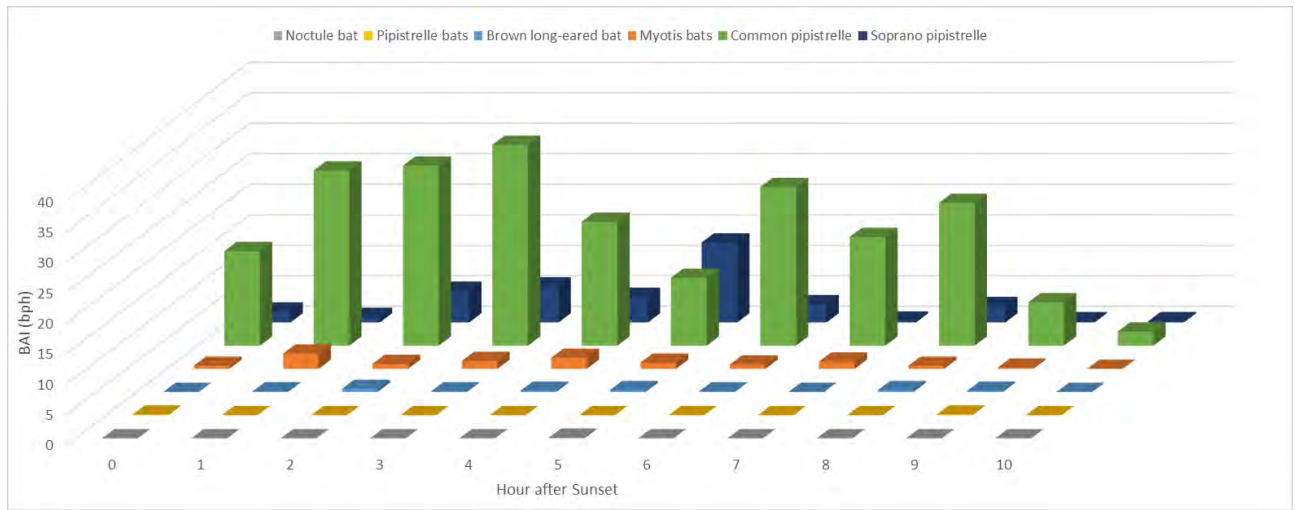


South, Static B_2020:

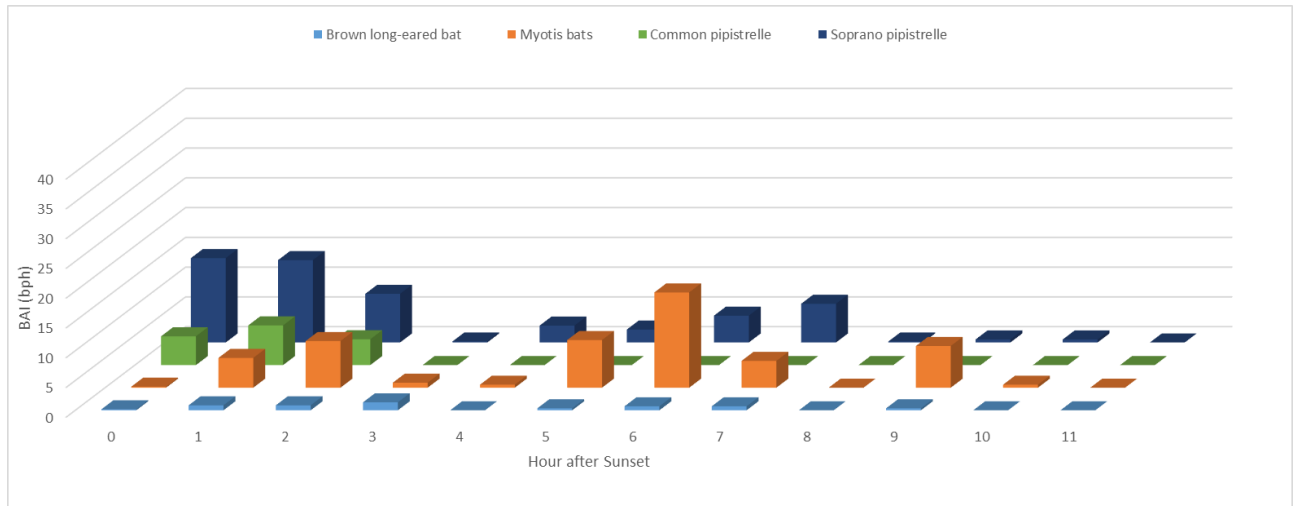


Average Nightly Activity Pattern for each Static Monitoring Locations and Visits (by species/group)

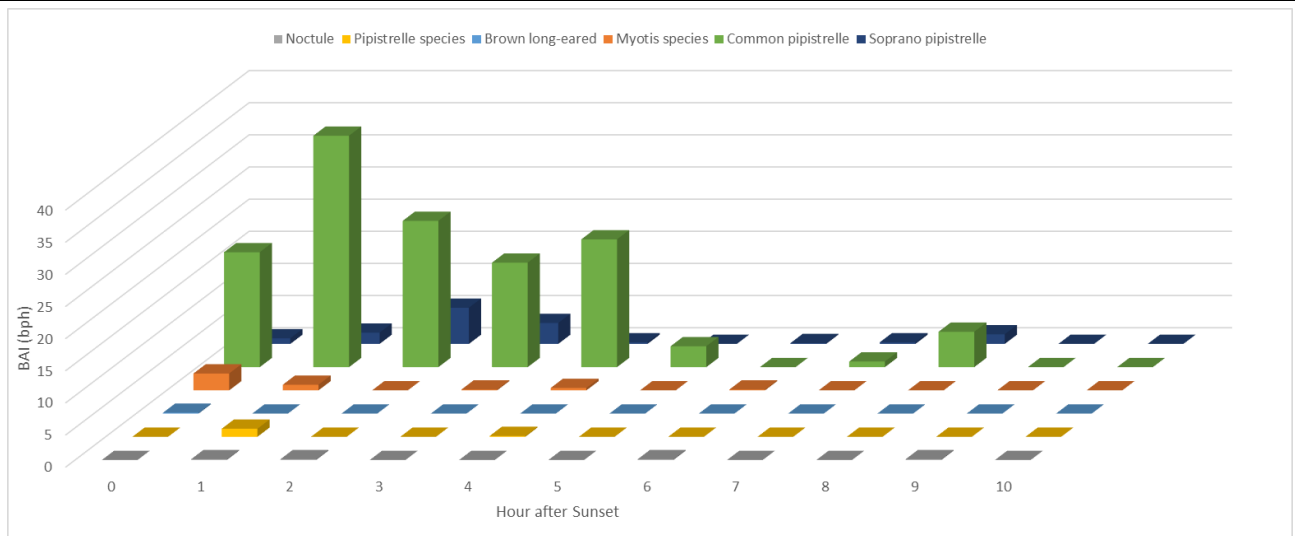
2019_North_Static A_ (Visit 1_Sept):



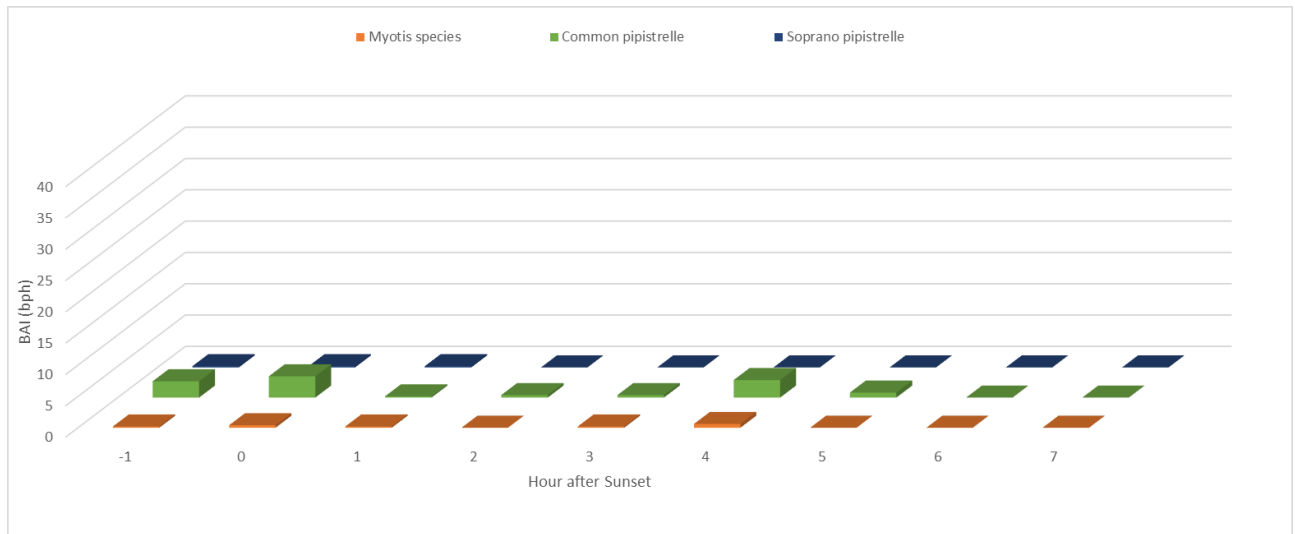
2019_North_Static A_ (Visit 2 - Oct):



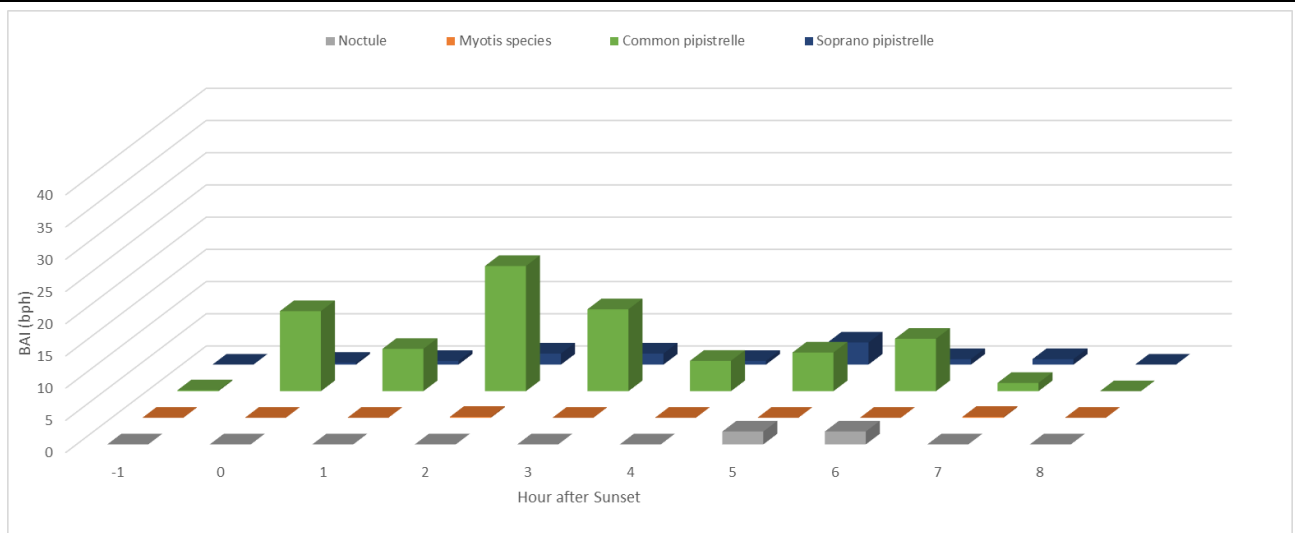
2020_North_Static A_ (Visit 1 - April):



2020_North_Static A_ (Visit 2 - June):



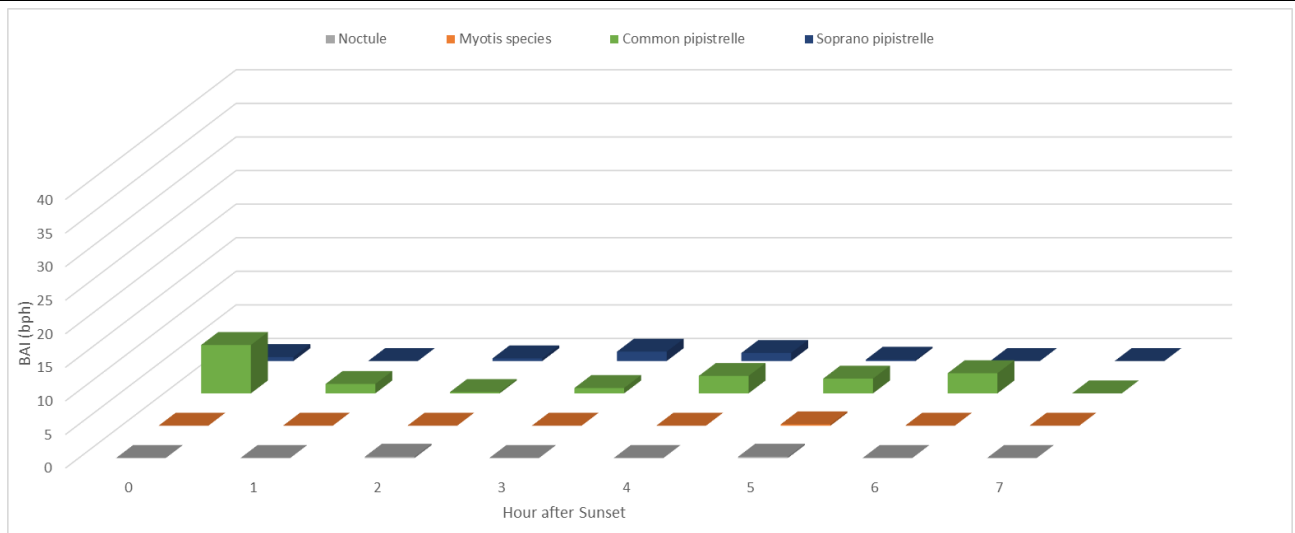
2020_North_Static A_ (Visit 3 - July):



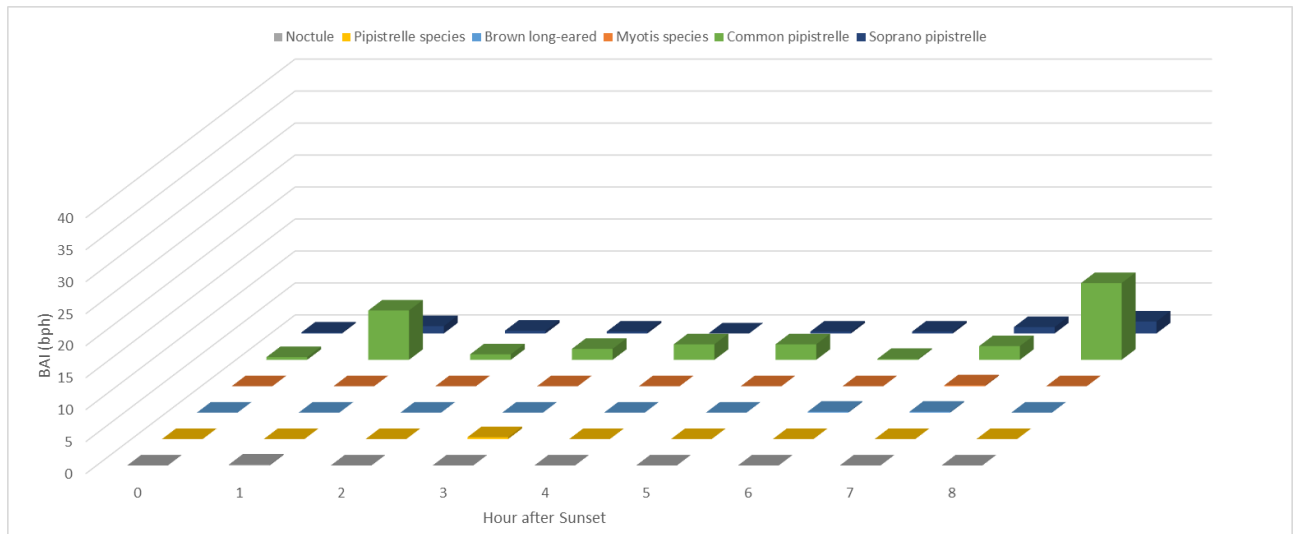
2020_North_Static B_ (Visit 1_April):

No data

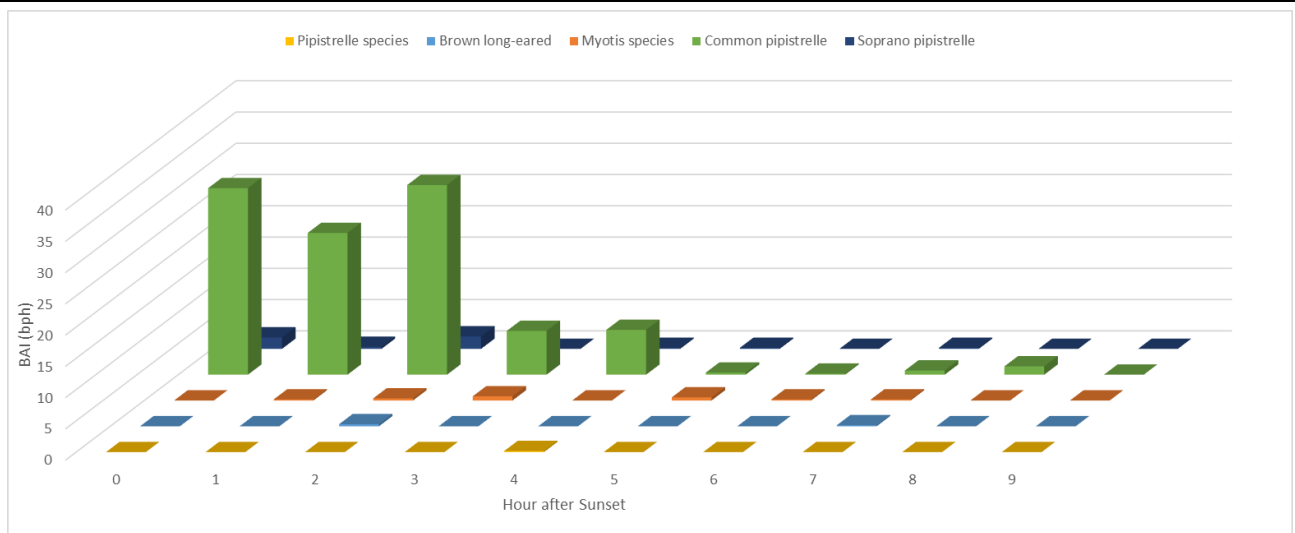
2020_North_Static B_ (Visit 2_June):



2020_North_Static B_ (Visit 3_July):



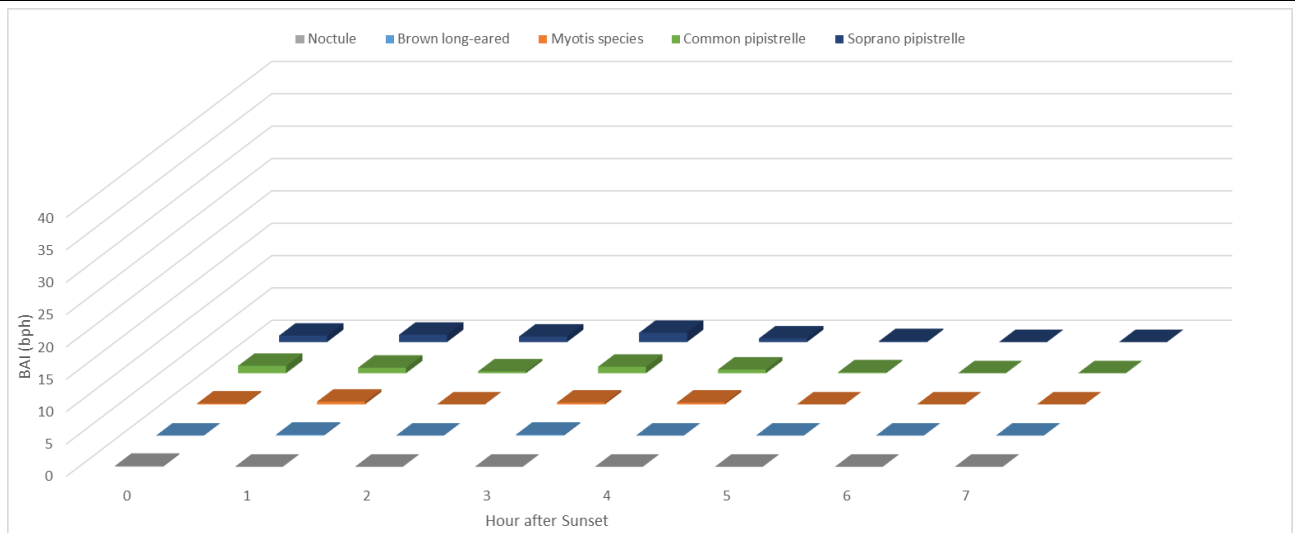
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2020_South_Static A_ (Visit 2_May):

No data

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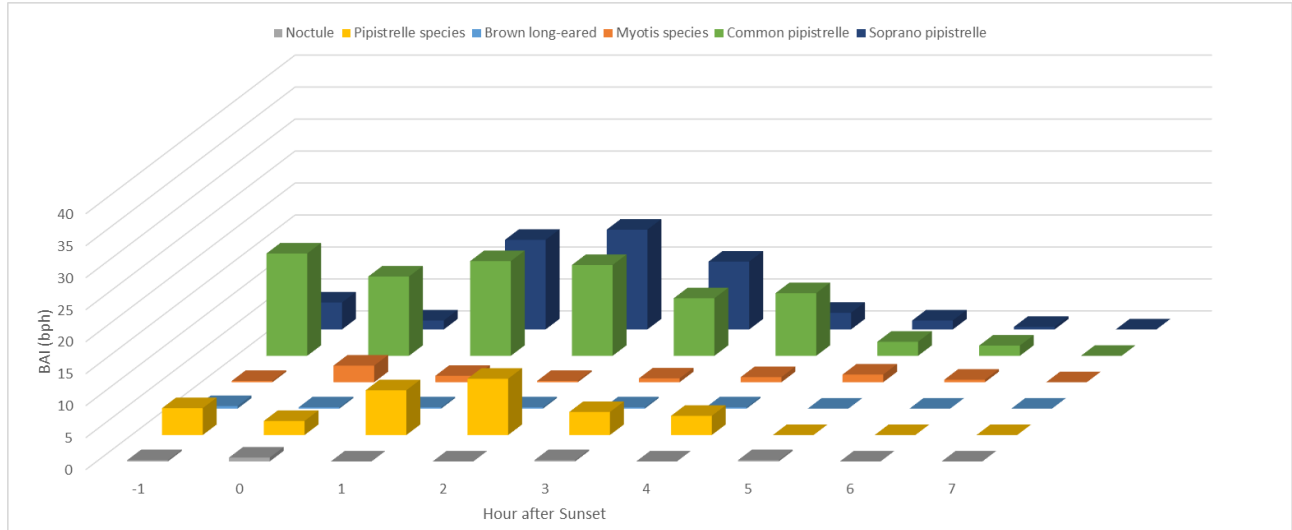
2020_South_Static A_ (Visit 4_July):

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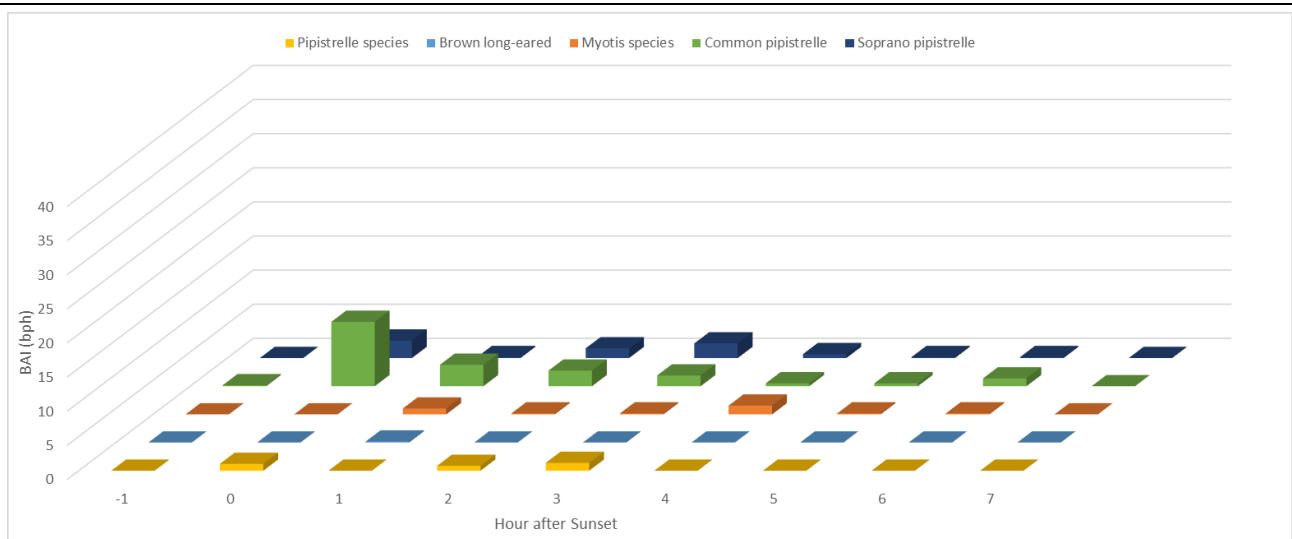
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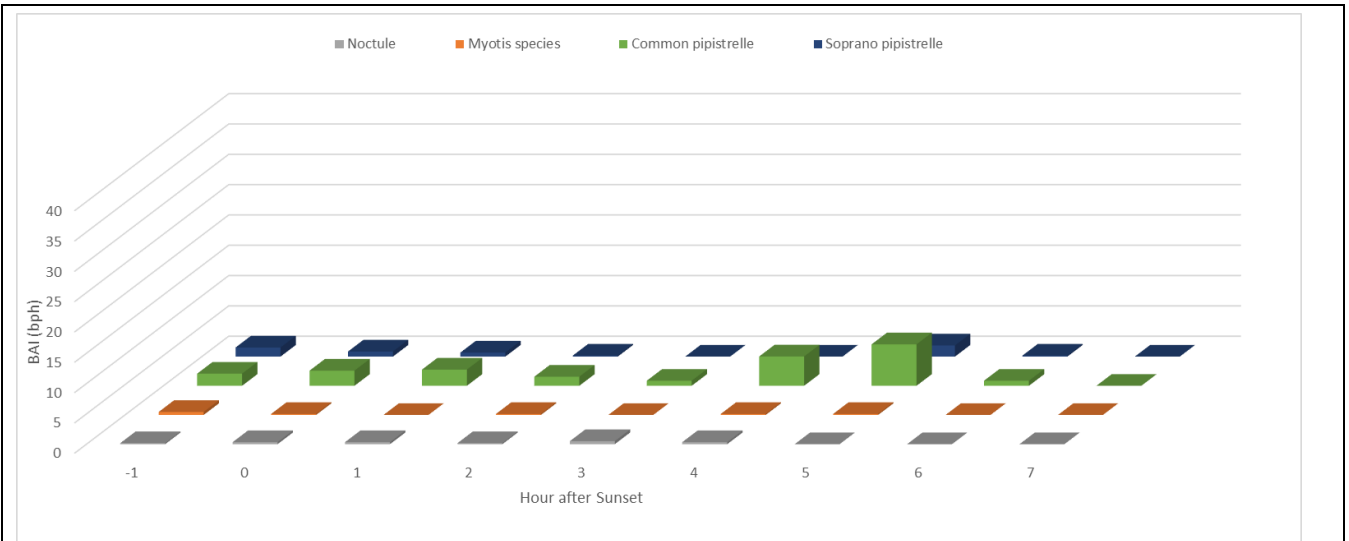
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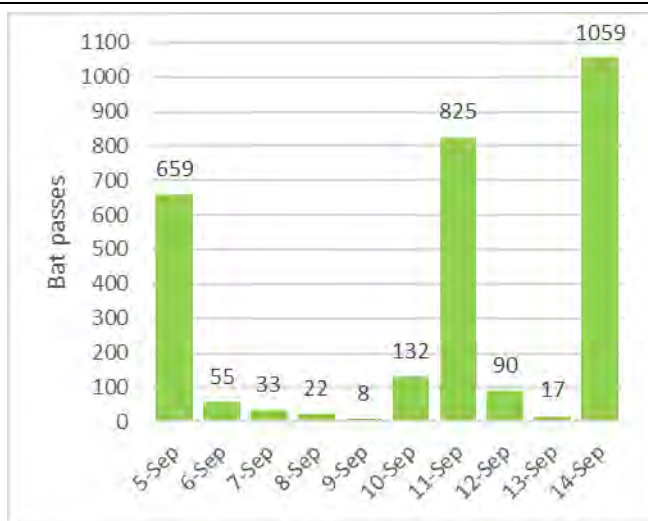


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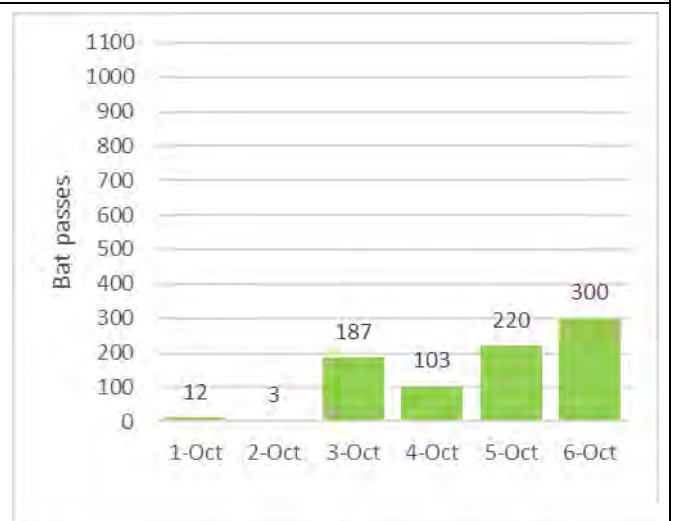


Nightly Bat Activity for each Static Monitoring Locations and Visits (bat passes)

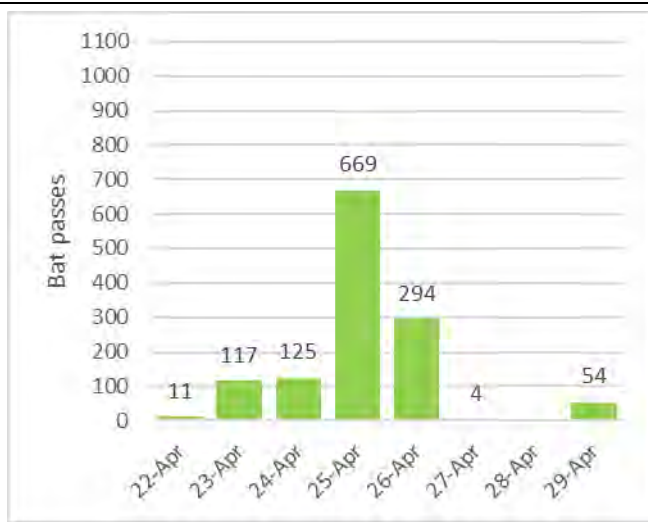
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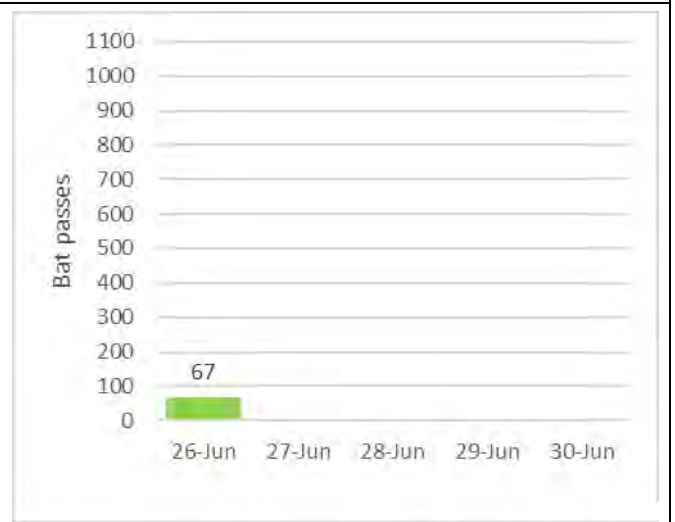
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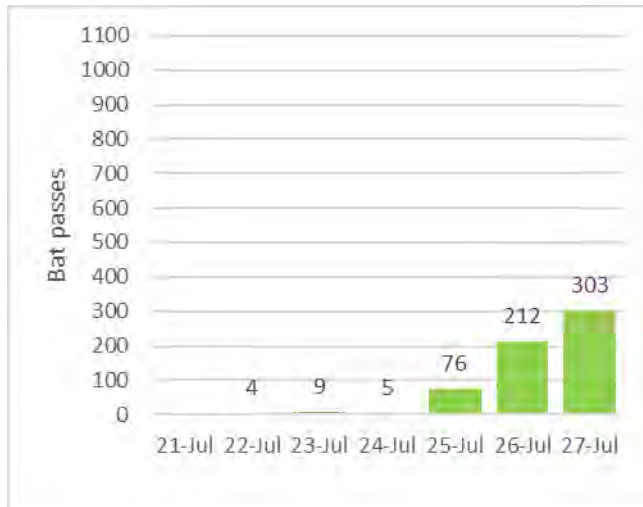
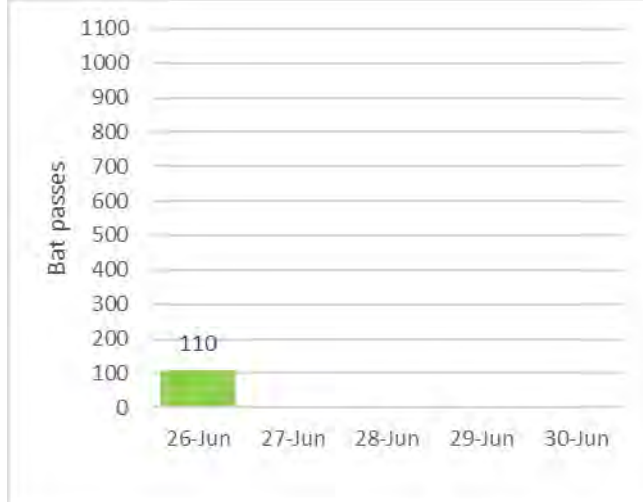
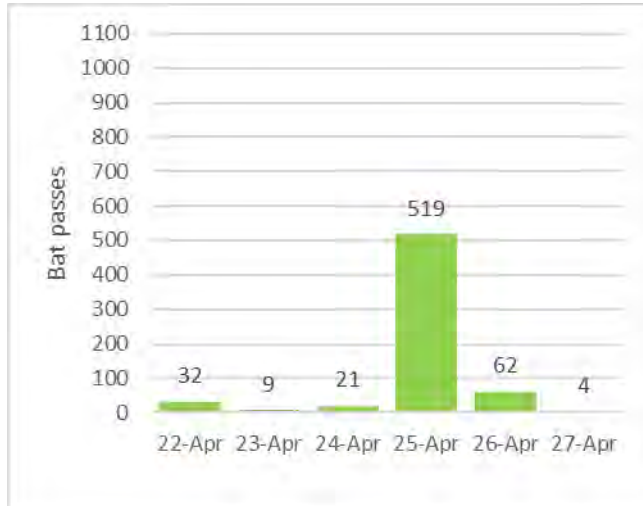


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2020_North_Static A (Visit 2_June):



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5 Summary

Transects

North (Transect 1; moderate potential) recorded in total four species/groups in 2019; common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), noctule (*Nyctalus noctula*) and *Myotis* species (*Myotis* spp.). In 2020 the Transect surveys recorded the same species with the exception of noctule, i.e. three species/groups. The peak BAI (combined species) was recorded on Visit 3 in 2020 (23/07).

South (Transect 2; moderate potential) recorded in total five species/groups; common pipistrelle, soprano pipistrelle, noctule (*Nyctalus noctula*), *Myotis* species and brown long-eared (*Plecotus auritus*). The peak BAI (combined species/group) was recorded on Visit 4 (14/07).

Common pipistrelle was the highest BAI for both north and south transects (combined visits). For south transect the BAI of *Myotis* species is considered high when compared to the BAI for those species on north transect, indicating a higher presence of those species in the southern transect habitats and potentially more suitable habitats.

Both transects were assessed as moderate potential although the northern transect recorded fewer species diversity and overall lower BAIs across all species. With the addition of static data (as detailed below) the differences between the bat species diversity and BAI is reduced.

Statics

Each static, for both north and south, recorded a total of six species/groups: noctule, *Myotis* species, common pipistrelle, soprano pipistrelle, brown long-eared and pipistrelle species (*Pipistrellus* spp.). The peak bat passes (combined species) versus visit was Visit 1 2019 (September) for North Static A, Visit 1 2020 (April/May) for both South Statics and for North Static B was Visit 3 2020 (July).

In general, peak BAI across all species versus hours after sunset was variable. Particular patterns of note include the consistent BAI peaks shortly close to sunset and again at sunrise in 2020 for North Static B across Visits 2 and 3 for common pipistrelle. This could indicate the presence of a nearby summer roost for the species.

It is important to note that high BAI and high bat passes do not necessarily indicate more individual bats but could also indicate a higher frequency of passes of the same individual bat.

References

- Collins. (2016). *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition)*. The Bat Conservation Trust, London.
- Anabat Insight. (2018). Titley Scientific.
- Slack, G. & Tinsley, E. (2015). *Linking bat surveys with meteorological data: a way to target operational wind farm mitigation*. In Practice 87: 34-38.
- Timeanddate.com. (2020). Weather. [ONLINE] Available at: <https://www.timeanddate.com/weather/uk> [Accessed 28/07/2020].