River Avon Horseshoe Bat Monitoring Study

Winter Addendum Report

carried out by

Clarkson & Woods Ecological Consultants

commissioned by

Bath and North East Somerset Council

June 2017

RIVER AVON HORSESHOE BAT MONITORING STUDY

WINTER ADDENDUM REPORT

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The information, data and advice which has been prepared and provided is true, and has been prepared and provided in accordance with the Chartered Institute of Ecology and Environmental Management's (CIEEM) Code of Professional Conduct. We confirm that the opinions expressed are our true and professional bona fide opinions.

EXECUTIVE SUMMARY

SURVEY REMIT

- Following the recommendations of a bat monitoring survey undertaken during the 2016 survey period Clarkson and Woods were commissioned by Bath and North East Somerset Council to carry out a suite of surveys during the winter 2016-2017. The surveys aimed to investigate the value of the urban reaches of the river Avon to bats during the winter season, with particular emphasis on lesser and greater horseshoe bats. The Bath Enterprise Zone (BEZ) encompasses 98 hectares of land on or close to the banks of the Avon in Bath which has begun, and will continue to be, the focus of extensive residential and industrial regeneration development in the city. As internationally important and legally protected populations of both lesser and greater horseshoe bats are present within a network of natural, built and post-industrial features in and around Bath it is important that the Council are able to consider fully the potential impacts of development upon these key natural heritage assets. This report sets out the findings of a five-month survey programme and makes recommendations which can be used to inform and clarify emerging Design Guidance for the BEZ.

METHODOLOGY

- Clarkson and Woods conducted a static bat detector survey using six Wildlife Acoustics SM2+BAT and six Anabat Express devices deployed in twelve bankside locations along the river corridor from New Bridge in the west and Cleveland Pools in the east. Detectors were deployed concurrently for a period of at least six consecutive nights each month from November until March inclusive. Eight of the locations were opposite pairs to compare usage between opposing banks. A variety of natural and hard landscaped banksides were represented.

HEADLINE FINDINGS

- The surveys recorded lesser horseshoe bats within the river corridor during every month, particularly around known and suspected winter roosts in the west and east of the BEZ, which is potentially the first time flight activity has been confirmed in the BEZ. Lesser horseshoe bats were recorded 19 times during November to February inclusive but 687 times in March, during which month they were recorded at every static detector location.

- Greater horseshoe bats were recorded in three locations and only in November and December, being later to emerge from hibernation and more associated with the furthest western and eastern ends of the BEZ.
- Horseshoe bats showed a tendency towards activity in the period shortly after sunset and shortly before dawn.
- In addition, at least eight other species were recorded, including high activity rates from common pipistrelle, soprano pipistrelle and Daubenton's bats.

CONCLUSION

- It is concluded that all recommendations relating to the avoidance of lighting within the river corridor as part of new development proposals, including the avoidance of Part Night Lighting or other automated dimming, adoption of River Corridor Lighting Zones and other light attenuation measures, should be applicable year-round within the operation of all proposed developments in proximity to the River Avon corridor.

1 INTRODUCTION

1.1.1 Clarkson and Woods were originally commissioned by Bath and North East Somerset Council (B&NES) in April 2016 to devise and conduct an investigation into the usage of the River Avon Site of Nature Conservation Interest (SNCI) corridor through the city of Bath by bats. The initial surveys ran April to October inclusive. Full results of the summer surveys can be found in River Avon Horseshoe Bat Monitoring Study (Clarkson & Woods, 2017). In brief, lesser horseshoe bats were recorded every month of the survey and at every location while greater horseshoe bats were also recorded every month but in lower numbers and only at six of the ten locations. The horseshoe bat recordings were found to indicate strong commuting/dispersal behaviour and an abundance of nearby roosts with activity peaking shortly after and before expected emergence/re-entry times. Furthermore a strong association between activity rates and the spring/autumn months was noted. Consequently, the river's importance when moving between known winter hibernation and summer breeding roosts was made clear and the River Avon in Bath is now considered supporting habitat in terms of the Bath and Bradford on Avon Bats Special Area of Conservation. Surveys also found a strong association between horseshoe bats and well-vegetated bankside habitat with greater levels of activity recorded at locations with the lowest levels of ambient light, in keeping with current research linking horseshoe bats and light averse behaviour.

1.1.2 A suite of recommendations was produced following the summer study to focus on guidance for developers in limiting the impacts from lighting and bankside habitat management upon bat populations using the river corridor. These will be formalised within Design Guidance materials to be published in due course. It was also recommended that further surveys be conducted during the winter season to assess to what extent bats use the city during the months November to March inclusive. Small studies and anecdotal evidence points to the continued, albeit reduced, activity during the winter months by horseshoe bats which may have implications for planners, ecologists and developers in mitigating lighting impacts at different times of the year. With mild winter temperatures and the urban heat island effect the extent to which they use the river may be missed by current best practice survey scope and as such this study represents a unique opportunity to study a potentially under-recorded and rarely studied phase of bat activity.

1.1.3 This study gathered a baseline of bat activity over the winter of 2016-2017 when bats are typically hibernating (November 2016 – March 2017 inclusive) across 12 locations on both banks of the river, from New Bridge in the west to Kensington Meadows in the east. The study aimed to investigate where and when through the winter period bat activity was greatest. From this, an assessment of the value of the River Avon corridor to local bat populations during the winter can be made. On this basis, mitigation principles which aim to preserve this value for development have been outlined, with a view to underpinning future planning guidance.

1.1.4 The Bath Enterprise Zone (BEZ – see Figure 1), comprising 98ha of land in close proximity to the Avon in central and western Bath, has potential to result in landscape wide fragmentation for bats associated with the SAC that use the river even during the winter. Riverside land commands a particularly high value, is highly desirable in terms of recreation and visual amenity and can be expected to form a key part of many developments.

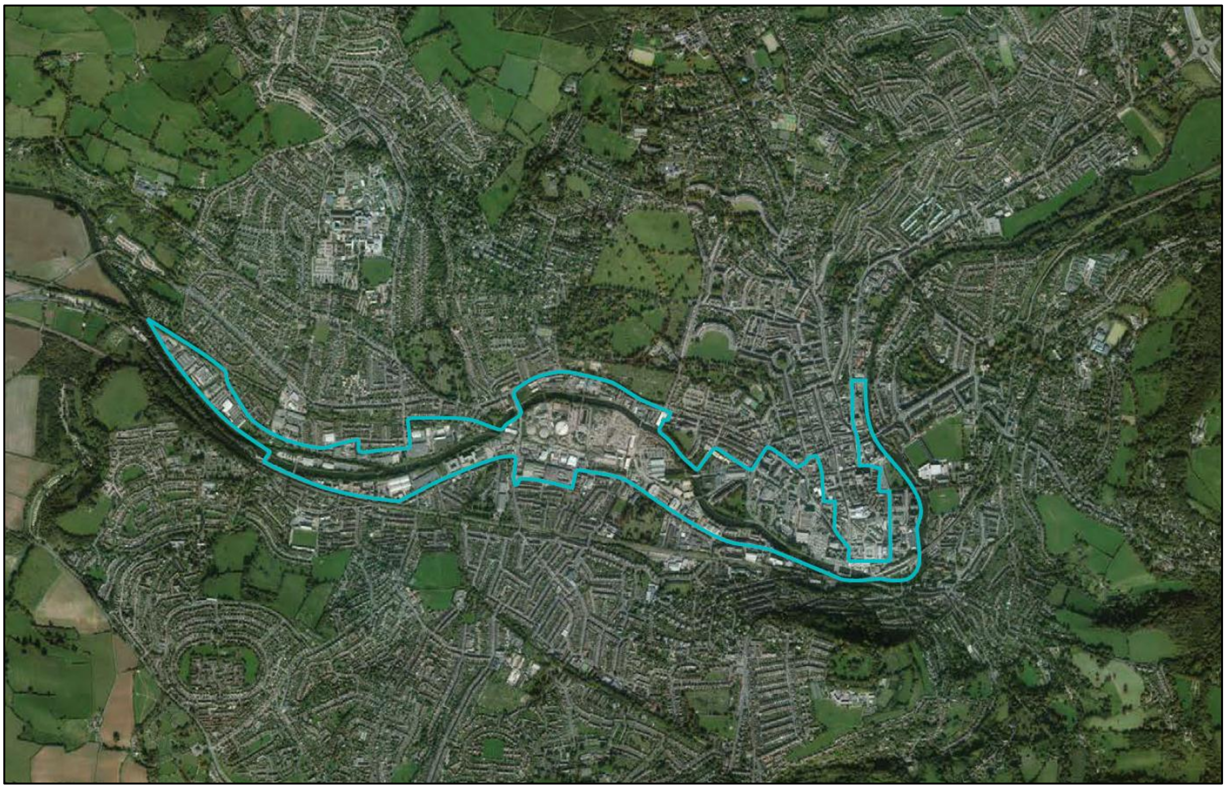

Figure 1. Aerial View of Bath and the River Avon, with the Extent of the Bath Enterprise Zone.

1.1.5 The River Avon is designated as an SNCI in its own right and is listed in the B&NES Placemaking Plan as a key green infrastructure and ecological network site. It has been the subject of a number of ecological studies in previous years and a small number of hibernation roosts for these species have been noted from very close to the riverside, with summer roosts within or very close to the city centre.

1.1.6 All native British bats are predominantly nocturnal animals and an aversion to artificial lighting has been demonstrated in many species. Horseshoe bats are known to be particularly light-averse, with several studies showing that artificial lighting can pose a barrier to movement along previously-used routes in illuminance of as little as 3.6lux (0.1-1lux is generally acknowledged to be equivalent to a clear full moon). As horseshoe bats do not typically cross open space without a linear natural feature to follow, light barrier effects can severely disrupt nocturnal and seasonal movements to foraging, breeding or hibernation sites. Consequently, as the local planning authority with the duty to consider impacts of development upon legally protected species and designated sites, Bath and North East Somerset Council recognised that this study was necessary to add to a robust baseline of bat activity in the river corridor to guide future development proposals within the BEZ.

2 SURVEY METHODOLOGY

2.1 Static Detector Study

2.1.1 12 static bat detectors (six Wildlife Acoustics SM2BAT+ and six Titley Anabat Express) were deployed along the river corridor on a monthly basis for at least five consecutive nights each month between November 2016 and March 2017 inclusive. The number of nights deployed ranged between five and 14. Eight of the detectors were deployed in pairs whereby a detector was placed on opposite sides of the river corridor to allow gathering of rates of bat activity on both sides of the river and a comparison of the use of the different banks and bank structures. One of the SM2BAT+ detectors (Location 2) was fitted with two microphones on extension cables to capture data from the north and the south banks of Weston Island.

2.1.2 The location of each static detector is shown on Figure 5 overleaf and is described in more detail in Table 2. Each location was chosen on account of its relative security and accessibility, as well as the presence of vegetation or structures to which the detectors could be mounted in order to allow a clear 'view' across the river from which echolocation could be detected. Additionally, locations represented a range of habits, bank structures and land use types including green space, industrial, residential and brownfield. In all cases, microphones were placed within 1m laterally from the water's edge and within 3m above average water level. Microphones have an inherent directionality in their sensitivity, although this has reduced in recent years with the introduction of 'omnidirectional' microphones as used in this study. To minimise any effect we aimed slightly downward and slightly up or downstream in order to increase the chances of recording quieter or more directional calls.

2.1.3 The study also aims to investigate the general spatial and temporal patterns of usage of the 12 detector locations by horseshoe bats in particular. A general indication of the intensity of activity by each species at each location can also be afforded by analysis of this data.

2.1.4 Overnight weather conditions in Bath during the survey period are given in Appendix B at the end of this document with an indication of whether each evening was considered suitable. As the study was of bat activity within the area over winter, the majority of the nights surveyed would be considered unsuitable in accordance with survey guidelines however they are typical of the winter months and only periods of extended heavy rain or high winds were considered unsuitable in this study. Appendix C also indicates whether a fault was detected in any of the detectors during the deployment. These will be discussed further within the Limitations section.

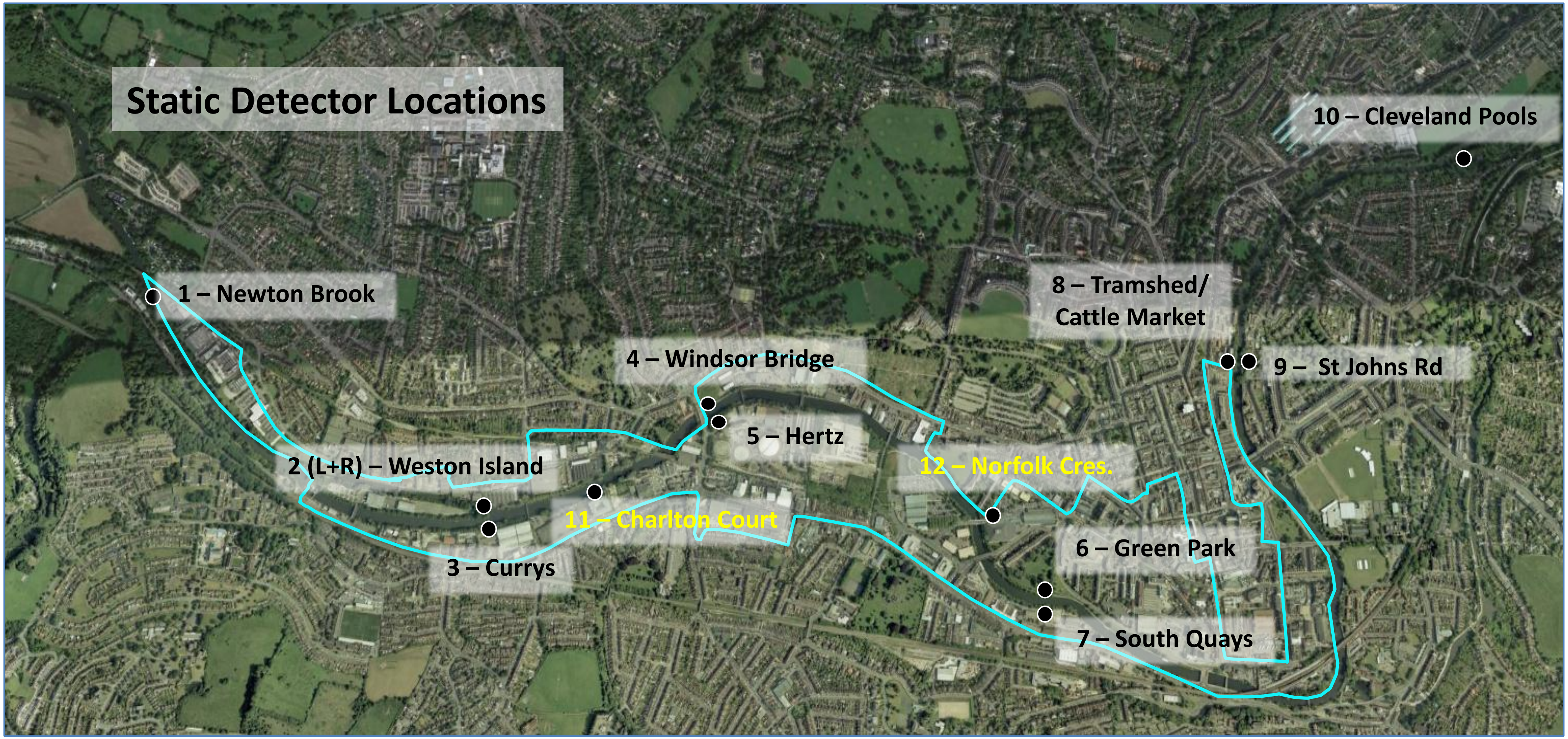

Figure 5 - Locations of Static Bat Detectors – 11 and 12 are new sites since the summer study.
NB. At location 2, the left-channel microphone was installed on the southern bank of the end of Weston Island and the right-channel microphone on the northern (overlooking The Cut)

Table 2. Location and equipment used during static detector study

Location	Description	Equipment Used
1a	Attached to tree on N bank just E of cyclepath bridge at confluence of Newton Brook and Avon. 2m above water strapped to tree.	Titley Anabat Express.
1b	Strapped to a tree, with microphone extending to 1.5m above the water on the S bank of the garden at Bishop Fleming.	Titley Anabat Express.
2	At E end of Weston Island, covering both The Cut to the north (right microphone channel) and the south bank of the island (left microphone channel). Microphones attached to overhanging branches, detector attached to signage. Microphones 1m above water.	Wildlife Acoustics SM2BAT+
3	On bankside tree N from Currys (Weston Lock Retail Park) car park via gap in fencing. Strapped to tree with microphone 1m above water.	Titley Anabat Express
4	On structure of disused pedestrian bridge E of Windsor Road bridge. On N bank (towpath). Microphone hanging from bridge deck 3m above water.	Titley Anabat Express
5	On wire fencing to rear of Hertz depot on S bank of river. Microphone 2m above water.	Wildlife Acoustics SM2BAT+
6	On tree overhanging N bank of river off towpath near Green Park. 1.5m above water strapped to tree.	Titley Anabat Express
7	On overhanging branch of tree on S bank at South Quays site. 1m above water.	Wildlife Acoustics SM2BAT+
8	On overhanging branch of tree on steep bank down from car parking to rear of Tramshed. 1m above water.	Wildlife Acoustics SM2BAT+
9	Strapped to tree overhanging water on S bank adjacent to area of green space next to Bethel Chapel. 1m above water strapped to tree.	Titley Anabat Express
10	On bough of tree overhanging river at Cleveland Pools. 1m above water.	Wildlife Acoustics SM2BAT+

11	Microphone 1.5m over the water, on an overhanging branch on the southern bank in the fenced off portion of the river adjacent university student accomodation.	Wildlife Acoustics SM2BAT+
12	Strapped to an overhanging tree adjacent the tow path, 2m above the water. North bank. Norfolk crescent, opposite Sainsbury's	Titley Anabat Express

Automated Species Identification Protocol and Limitations

2.1.5 The data obtained from the static detectors is uploaded to Clarkson and Woods' data server within 24hrs following their collection. They then undergo automatic species recognition analysis through Wildlife Acoustics' Kaleidoscope Pro software.

2.1.6 Kaleidoscope Pro automatically identifies bat calls using various algorithms and provides statistical levels of confidence associated with each classified call. The confidence levels reflect the fact that there will be certain classification errors related to every classified bat call. With experience of using the software it is, on the whole, reliable when identifying certain bat calls, especially horseshoe bat calls due to their simple and unmistakeable parameters. Other straightforward species are common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle *Pipistrellus pygmaeus*, noctule *Nyctalus noctula* and serotine *Eptesicus serotinus.* However, we have found the software to be less reliable when identifying other species (long-eared *Plecotus sp*., Leisler's *Nyctalus leisleri* and barbastelle *Barbastella barbastellus* bat species).

2.1.7 The software does not distinguish between the various *Myotis* species and simply classifies them to genus level (i.e. *Myotis* sp.). This is in line with classification that would be achieved by manual identification due to the similar nature of *Myotis* calls making species classification subject to a high degree of error. The on-board software used by the EchoMeter Touch does, however distinguish between *Myotis* species but this has been found to be inconsistent.

2.1.8 From experience of using the software, it appears that various species of bat are either under or over recorded and classifications can be inaccurate. Steps have been taken to compensate for this inaccuracy. All records of barbastelle, horseshoe bats, Leisler's, *Myotis* and long-eared species identified by the automated software have been manually verified and where appropriate the call identity corrected. Where the software is unsure of a bat call, it will classify the call as 'NoID'. For completeness, in this study all NoID files (many thousands) were manually double-checked to ensure that no horseshoe or other notable rare species was not wrongly classified by the software.

2.1.9 Additionally, automated detectors are triggered to record when suitable ultrasound is detected and will not cease recording until either a window of 1 second of silence is recorded (or if 30s elapses since the trigger, whichever is sooner). If more than one species is present within a trigger, the software is only able to classify one species per trigger and so is forced to decide which species is 'dominant'. This potentially results in an under-recording of species which are quieter (such as horseshoe bats) or have a longer pulse repetition rate. Consequently, all confirmed bat recordings and NoID files and approximately 20% of noise files have been re-analysed manually to look for horseshoe bat calls.

2.1.10 In conclusion, the classification data produced from Kaleidoscope Pro, along with any manual verification of certain problem/important species, is considered to provide a very accurate record of horseshoe species and an acceptably accurate record of other bat species recorded by a static bat detector and as such has been used within this report.

3 LIMITATIONS

3.1 Bat Survey Limitations

3.1.1 Given the public nature of the locations used the detectors had to be well hidden, this meant that it was not always possible to ensure the microphone was unobstructed. Vegetation surrounding and in front of the microphone may not only reduce the area the microphone can detect bats at but the level of noise also increases. Background noise such as leaves can make it difficult for the Kaleidoscope software to pick out bats which echolocate at lower frequencies such as noctule bats or quieter bats such as barbastelle and long-eared bats.

3.1.2 The need for hiding the detectors and variable bank heights meant that the microphones had to be placed at varying height from the rivers surface from 1-3m. The height of the microphone impacts the likelihood of detecting echoes of bat calls as they bounce off the water's surface,

3.1.3 As the detector deployed at Location 1 was presumably stolen during the December deployment there is no data for this location for December and a detector was not redeployed until a suitable alternative (more secure) location could be found. A suitable alternative location was identified and access arranged for the February and March surveys, as such the detector at this location was moved approximately 90m southeast for these months.

3.2 Technical Issues

3.2.1 As expected different detectors recorded different amounts of data, this meant that during months and in locations with high levels of activity more memory was required and the batteries were used at a higher rate. Given the cold weather the batteries depleted faster than during the summer surveys, particularly the more energy demanding SM2 detectors. On 15 of the 30 SM2 deployments the detectors recorded for less than 6 nights, all Anabats recorded for at least 8.5 nights during each deployment.

3.2.2 The SM2+ high gain microphones failed on 6 occasions, there were faulty microphones in circulation from the manufacturer and despite sending the faulty microphones back new ones also failed. The microphones would come apart and cause sensitivity problems with the recordings.

3.2.3 During the February deployment two of the SM2+ bat detectors only recorded for 1.5 nights, the reason for this fault is unknown.

3.2.4 The Anabat at Location 1 could not be recovered following the December survey, it was missing, presumed stolen, as such there is no data for this month or the following month. The location was moved to avoid further interference, a suitable and secure location was not identified until the February deployment. As such for the February and March deployments this location was moved 90m south along the river bank to the garden of Bishops Fleming.

3.2.5 Full spectrum detectors are known to be more sensitive than zero crossing detectors (a full spectrum recorder is able to detect calls approximately -20dB quieter than a zero-crossing detector[1]). If placed side-by-side, a full spectrum detector will likely record more bat passes than would a zero crossing detector, making comparison between these detectors problematic.

3.2.6 Though the detectors were regularly calibrated each different microphone and detector recorded at a different sensitivity, though the difference in sensitivity was minor the difference may have affected the distance at which different species of bats could be recorded by the detectors.

3.2.7 Bat detectors are known to be more sensitive to certain bat calls than to others for reasons such as varying bat call loudness and directionality of certain calls. For example, a call from a horseshoe bat is directional and a bat detector will only be able to record the call if the bat echo-locates directly at the detector whereas a common pipistrelle call is less directional and can be recorded even when the call is aimed away from the microphone. This can result in certain bat species (notably horseshoe bats and long-eared bats) being under-recorded due to the limitations of the current bat detectors. The difference in recording efficiency may therefore bias any results and this has been taken into account where possible during any assessment of the results.

3.3 Kaleidoscope Software Limitations

3.3.1 Anabat Express and SongMeter2 static detector data has been analysed using the latest Kaleidoscope Pro automated analysis software. This software has been specifically designed to automatically classify the known bat calls of Britain and Ireland.

3.3.2 The programme automatically identifies bat calls using various algorithms and provides statistical levels of confidence associated with each classified call. The confidence levels reflect the fact that there will be certain classification errors related to every classified bat call. With experience of using the software it appears that, on the whole, it is accurate when identifying certain bat calls (common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle *P. pygmaeus*, noctule *Nyctalus noctula*, serotine *Eptesicus serotinus*, Leisler's *Nyctalus leisleri*, lesser horseshoe *Rhinolophus hipposideros* and greater horseshoe *R. ferrumequinum* bats) but less reliable when identifying other species (long-eared *Plecotus* sp. and barbastelle *Barbastella barbastellus* bat species).

3.3.3 Where multiple species are recorded in one file, the software can only identify the loudest or clearest bat, meaning that under recording of busy locations is guaranteed. Quieter bats such as barbastelle and horseshoes are often overshadowed by pipistrelle bats which leads to under recording of the species.

3.3.4 Similarly, a very low number might indicate a reduced level of foraging activity by one bat in close proximity to the detector, but might also have derived from a small number of individuals commuting at speed past the microphone and so only one pass per bat is recorded, such is the ambiguity of static detector data. Despite this, it is considered that the number of detectors,

[1]Ian Agranat (March 2015). Unravelling Zero Crossing and Full Spectrum What does it all mean? Wildlife Acoustics Inc.

detector-nights and monthly repeats used within this study should enable a reasonable comparison of pass rates between locations over time to be made.

3.3.5 The software does not distinguish between the various *Myotis* species and simply classifies them to genus level (i.e. *Myotis* sp.). This is in line with classification that would be achieved by manual identification due to the similar nature of *Myotis* calls making species classification subject to a high degree of error.

4 RESULTS

4.1 Static Detector Survey

General Summary

4.1.1 In total 70,069 confirmed bat passes were recorded by all 12 detectors (13 microphones) during the entire deployment duration, aggregating 30 nights of detector data (390 microphone-nights) between November and March inclusive. At least nine species of bat were recorded during the static detector study, and this is likely to be higher as it is considered that at least two species of *Myotis* bats were detected, (including Natterer's, Daubenton's and potentially whiskered or Bechstein's bat) and that Leisler's bats are likely to have been present alongside their more common close relative the noctule bat. These species are notoriously difficult to differentiate through call sonogram analysis alone therefore we have listed them under their respective genus (*Myotis* and *Nyctalus*). Therefore of a possible 18 species, it is likely that 12 have been recorded during this study.

4.1.2 Table 4 overleaf shows the number of passes by bat species at each of the static detector locations aggregated over the entire deployment duration. It also highlights the locations with the top three pass totals for each species (gold, silver and bronze fills). It should be noted that the majority of these passes were derived from March as activity rates increased greatly during this month.

Table 4. Total Number of Bat Passes by Species at Each Location. Note: Gold, silver and bronze fills indicate the 1st, 2nd and 3rd highest detector totals per species.

Detector Location / Species	1	2 L	2 R	3	4	5	6	7	8	9	10	11	12	Total	%age of total passes
Greater Horseshoe	1	0	0	0	0	0	0	0	0	1	0	0	1	**3**	0.00%
Lesser Horseshoe	103	98	9	103	1	5	17	24	43	191	60	28	24	**706**	1.01%
Common Pipistrelle	2265	1244	522	3496	1959	145	901	94	357	719	199	534	91	**12526**	17.88%
Soprano Pipistrelle	2173	3187	808	5593	8139	1153	3538	977	1376	1335	381	2442	2671	**33773**	48.20%
Nathusius pipistrelle	0	0	0	0	0	0	0	0	0	1	0	0	4	**5**	0.01%
***Myotis* sp.**	1114	1944	449	3379	630	560	1728	307	1250	1570	1602	8191	194	**22918**	32.71%
Serotine	2	3	3	2	4	1	2	2	2	2	9	0	0	**32**	0.05%
Noctule	2	2	1	2	4	2	2	0	0	4	1	0	0	**20**	0.03%
Nyctalus sp.	26	13	9	6	1	1	9	0	0	8	9	1	1	**84**	0.12%
Barbastelle	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0.00%
Plecotus sp.	0	0	0	0	0	0	0	0	1	0	1	0	0	**2**	0.00%
Total	**5686**	**6491**	**1801**	**12581**	**10738**	**1867**	**6197**	**1404**	**3029**	**3831**	**2262**	**11196**	**2986**	**70069**	
%age total passes	8.11%	9.26%	2.57%	17.96%	15.32%	2.66%	8.84%	2.00%	4.32%	5.47%	3.23%	15.98%	4.26%		
No ID	39	7	5	55	377	1	31	1	3	554	20	3	24		
Noise	4899	2311	4003	10113	12801	286	5133	435	1282	8827	647	1591	2173		

__Horseshoe Bats__

4.1.3 Table 4 shows that lesser horseshoe bats were recorded 706 times, with clear peaks in the far west and east of the study area (detectors, 1, 2L, 3, 9 and 10 in particular), while greater horseshoe bats were only recorded a total of 3 times, at locations 1, 9 and 12. This distribution has been graphically represented in Figure 9 overleaf.

4.1.4 The three greater horseshoe bat passes were recorded at Locations 1, 9 and 12. Location 12 is comparatively central within Bath along the tow path on the northern river bank near Norfolk Crescent while Location 1 is at the western edge of the city near the Newton Brook confluence.

4.1.5 As in the summer study, horseshoe bat activity was widespread but generally focussed within areas with greater vegetation cover and lower illumination levels.

Temporal Patterns

4.1.6 Monthly peak lesser horseshoe activity was recorded in March with 687 passes (97.3% of the passes – see Figure 8 and Table 6), while two of the three greater horseshoe passes were recorded in November. These numbers suggest that greater horseshoe bats are significantly less active within the River Avon corridor over the coldest winter months comparative to lesser horseshoe bats, although behavioural differences between the species such as different choice of habitat/bank to use for navigation may have reduced detection to a degree.

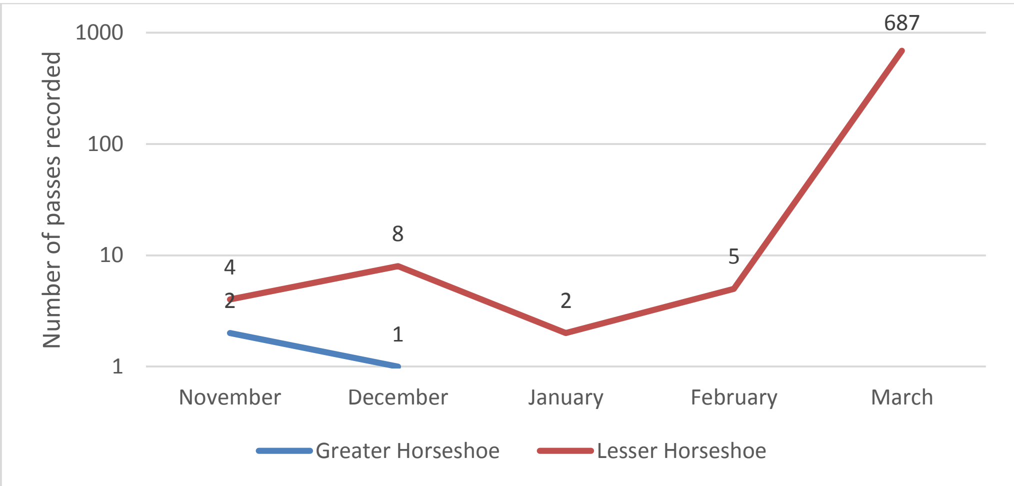

Figure 8. Graph to Show Total Monthly Horseshoe Bat Passes (*note logarithmic scale*)

4.1.7 The fact that March recorded a good number and spread of lesser horseshoe passes and no greater horseshoe passes suggests that the majority of lesser horseshoe bats come out of hibernation well in advance of greater horseshoe bats, assuming that both bats utilise the river corridor for dispersal soon after coming out of torpor. In March most species of bat are in transition between winter and summer roosts, typically flying longer distances during movements between roost types. Greater horseshoe bats are known to emerge from hibernation later than lesser horseshoe, often being found at transitional roosts in April and May with females often active earlier than males[2].

4.1.8 A peak in March of 687 lesser horseshoe bats ties in well with the number for April from the summer study (627), serving to reinforce the post-hibernation value of the river corridor to bats dispersing from their winter roosts. The strength of this peak is significant in shaping our understanding of horseshoe bat emergence activity. In the case of the river Avon the bats may be responding to a combination of favourable climatic, foraging and navigational factors associated with the river which makes it particularly attractive at this time.

4.1.9 22 horseshoe bat passes were recorded during the months November to February inclusive. As may be expected from the prevailing temperatures, January only saw two horseshoe bat passes, both from lesser horseshoes at Location 8, a peak location within the summer study. No horseshoe bats were recorded by detectors 3-7 between November and February inclusive, these being locations closest to some of the most industrial parts of the city, with continuous stretches of hard bank edges. This possibly indicates that these stretches are the furthest within the BEZ from a winter roost.

4.1.10 Overall, the low numbers are not unexpected given the hibernation season, however it is significant to have recorded any horseshoe bat activity within the river corridor outside of the 'active season', especially as detectors were generally deployed for a handful of nights each month. It is also significant that while the Bath and Bradford on Avon Bats SAC is a known major hibernation roost, it does not appear to account for all of the wintering lesser horseshoe bat population, some choosing to remain in or close to the boundaries of the BEZ throughout the winter months.

4.1.11 Analysis of the time-of-night data for horseshoe bat passes is shown in Table 5 below.

Table 5. Breakdown of Total Lesser and Greater Horseshoe Passes by Time of Night

Species	Sunset -1hr to +1hr	Sunset +1hr to +3hr	Middle of Night	Sunrise -3hr to -1hr
Lesser horseshoe	90	300	280	35
Greater horseshoe	2	0	0	1

Spatial Patterns

4.1.12 The peak location for lesser horseshoe bats with 191 passes was Location 9, which was located at the south bank of the river adjacent a small area of public open space and Bethel Chapel. Interestingly the detector placed on the other side of the river at Location 8 recorded 43 lesser horseshoe passes. There is a known greater and lesser horseshoe hibernation roost at the old

[2] Flanders, J & Jones, G., (2009). Roost Use, Ranging Behavior, and Diet of Greater Horseshoe Bats (*Rhinolophus ferrumequinum*) Using a Transitional Roost. Journal of Mammalogy

cattle market vaults, approximately 85m southwest of Location 8 on the western bank of the river (117m west of Location 9).

4.1.13 This shows that in Location 9, 157 of the 191 lesser horseshoe passes occurred within 3 hours of sunset/sunrise, including two passes four minutes after sunset (10 within the first 15minutes after sunset) on 26th March indicating a cluster of activity emerging from (presumably) the nearby roost. On 6th November a greater horseshoe bat was recorded here approximately 19minutes after sunset, no other greater horseshoe bats were recorded at this location. Notably, 14 lesser horseshoe passes were recorded prior to sunset, all at Location 9.

4.1.14 Location 8 recorded a peak of 22 passes within 3 hours of sunset on 20th March, this is more than the 11 at Location 9 over the river on this night. These detectors recorded peaks in sunset/sunrise activity on different nights, which could indicate that the bats roosting locally may potentially use the different river banks on different nights.

4.1.15 Location 9 also recorded a greater horseshoe pass at 16:21 on the 6th December 2016, 19 minutes after sunset. The cattle market vaults are also a known hibernation site of greater horseshoe bats though no other greater horseshoe passes were recorded at this location throughout the survey. Similarly Location 12 recorded an individual greater horseshoe pass on 28th December at 24minutes past sunset. Location 12 is central within the BEZ and this recording so close to sunset would also indicate an emergence from a hibernation roost, although as this species can cover significant distances relatively quickly a location cannot be assumed. Given the temperatures (minimum night temperature of 4°c) it is possible the bat was moving to find an alternative roost or productive winter foraging grounds.

4.1.16 More passes were recorded at Location 7 (South Quays – hard edged and darker) than at Location 6 (Green Park – soft edged and brighter due to light spill from the opposite banktop), 24 compared to 17 passes. This supports the theory that while lesser horseshoe bats use both banks, light levels are a key in determining a preference for a certain bank and while bankside vegetation at Green Park screens light spill and glare from the city, it cannot screen light spill from the opposite bank.

4.1.17 While the detectors placed either side of the river at Locations 2 and 3 recorded similar numbers of passes (107 and 103 respectively with all but one pass in December at Location 2 recorded in March). Location 2 had two microphones; one set to detect bats along the northern edge of the Weston Island and one along the southern edge. The microphones were set approximately 14m apart, yet the microphone at the south bank recorded 98 of the 107 horseshoe passes. The microphone at 2S and the detector at 3 recorded some lesser horseshoe bats within the same minute of each other, though the distance between the microphones and timings between calls shows that horseshoe bats are using both sides of the river here.

4.1.18 Despite missing two months' worth of data, location 1 recorded the second highest number of lesser horseshoe passes (103) 69 of which were within 3 hours of sunset, 13 within 1 hour of sunset, all during the March deployment. This location also recorded one greater horseshoe pass within

3 hours of sunrise (126 minutes before sunrise) on 30th November. This was the only greater horseshoe bat recorded at this location, however as the detector was removed and then relocated it is not possible to draw assumptions from this location or low level of greater horseshoe recordings.

Figure 9. Location of Horseshoe Passes During November to February (N.B. EXCLUDES MARCH). Blue Circles = Lesser horseshoe, Orange Circles = Greater horseshoe

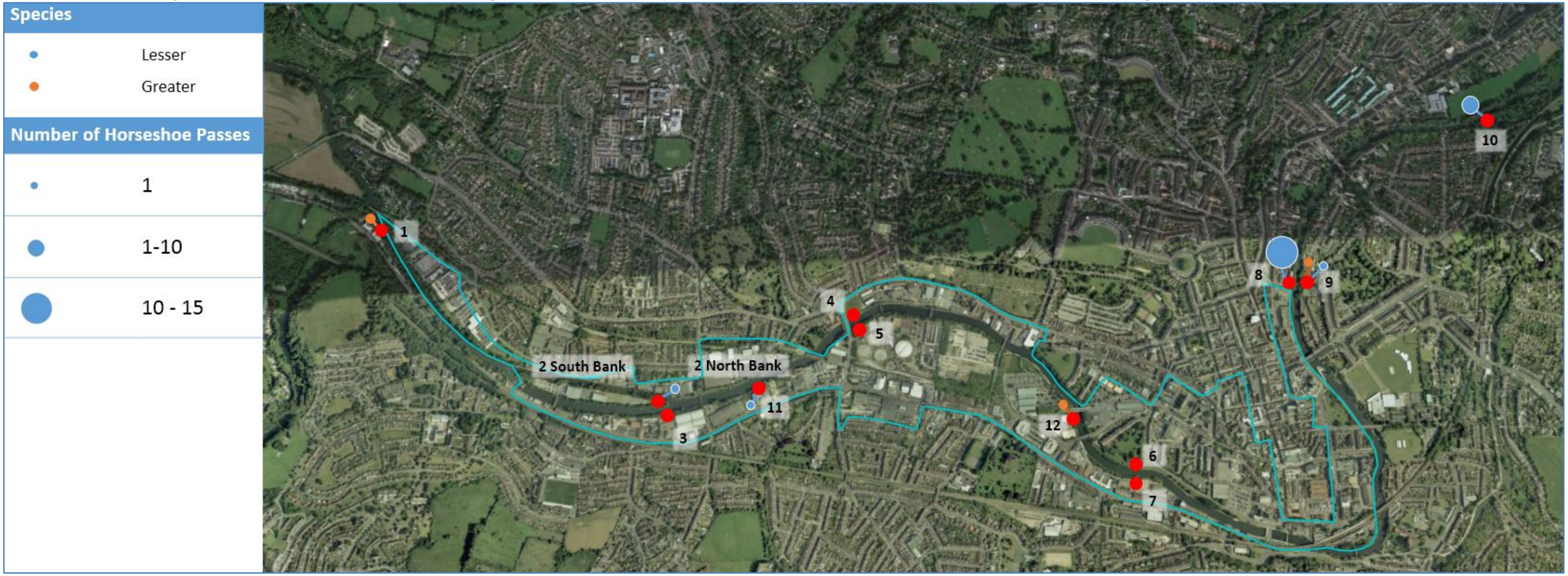

Table 6. Total Horseshoe Passes by Detector by Month. Blue fill = lesser horseshoe, orange fill = greater horseshoe

Detector Location / Month	1	2S	2N	3	4	5	6	7	8	9	10	11	12	Total
November	1	0	0	0	0	0	0	0	4	1	0	0	0	**4 + 2**
December	0	0	1	0	0	0	0	0	5	0	1	1	1	**8 + 1**
January	0	0	0	0	0	0	0	0	2	0	0	0	0	**2**
February	0	0	0	0	0	0	0	0	2	1	2	0	0	**5**
March	103	98	8	103	1	5	17	24	30	190	57	27	24	**687**
Total per location	**103 + 1**	**98**	**9**	**103**	**1**	**5**	**17**	**24**	**43**	**191 + 1**	**60**	**28**	**24 + 1**	**706 + 3**

__Other Bat Species__

4.1.19 Of the other bat species recorded, pipistrelle bat passes made up approximately 66% of the total recorded bat passes, soprano pipistrelle 48.2% and common pipistrelle 17.9%. While bats of the Myotis genus made up 32.7% of recorded passes. Common and soprano pipistrelles are two of the commonest and most light-tolerant species in the UK. Soprano pipistrelles made 33,773 recorded passes during the study. Pipistrelle and *Myotis* bats also have considerably more powerful echolocation calls than horseshoe bats and tend to be detected over a greater distance.

4.1.20 Soprano and common pipistrelles as well as Myotis bats were recorded at every location, ranging from 381 soprano passes at Location 10 to 8139 passes as Location 4, compared to a maximum of 3496 common pipistrelle passes at Location 3 down to 91 passes at Location 12. Levels of Myotis activity ranged the most with 194 passes at Location 12 and 8191 passes at location 11.

4.1.21 Rates of recorded passes from these species were relatively consistent throughout the study, with the exception of the month of March which was greatly elevated. This indicates that while these bats do hibernate over the winter, activity does not completely cease and many foraging bouts do occur. Additionally, March has always been seen as a month of hibernation and 'transition', something supported by these findings, but the rates of activity recorded were significantly higher than may traditionally be expected. Activity in March appeared to be comparable to that in April when looking at figures derived from the summer study, therefore this study suggests that bat activity is well under way with potentially complete emergence from hibernation in March.

4.1.22 Figure 10 shows how the pattern of abundance of Myotis bats, common and soprano pipistrelle bats changed throughout the study duration, with a clear peak of activity in March and marked decline in January. The January decline may be a result of the poor weather with minimum nightly temperatures getting as low as -5°c in Bath during the months deployment. Of the ten different species recorded, all but long-eared, unidentified *Nyctalus* (likely Liesler's) and greater horseshoe bats peaked in March, this is particularly noticeable in the pipistrelle species and *Myotis* bats, 97.5% of soprano passes were recorded in March as were 96.4% of common pipistrelle and 94.7% of *Myotis* sp passes.

4.1.23 The *Myotis* genus comprises six breeding species and it is believed that Daubenton's bats were the most regularly recorded by the study. Daubenton's bats are closely associated with water and are known to regularly roost in tunnels, bridges and structures within proximity to rivers or still water with a known hibernation roost within the cattle market vaults. Natterer's bats and whiskered bats are anticipated to be the next most abundant species. In this case, the river corridor is likely to be similarly important for *Myotis* bats as a conduit for dispersal between key roosts. Indeed, it is known that Daubenton's bats regularly occur within the same hibernation roosts as horseshoe bats. Additionally, the river is just as likely to be important for foraging considering how closely associated Daubenton's bats are with water.

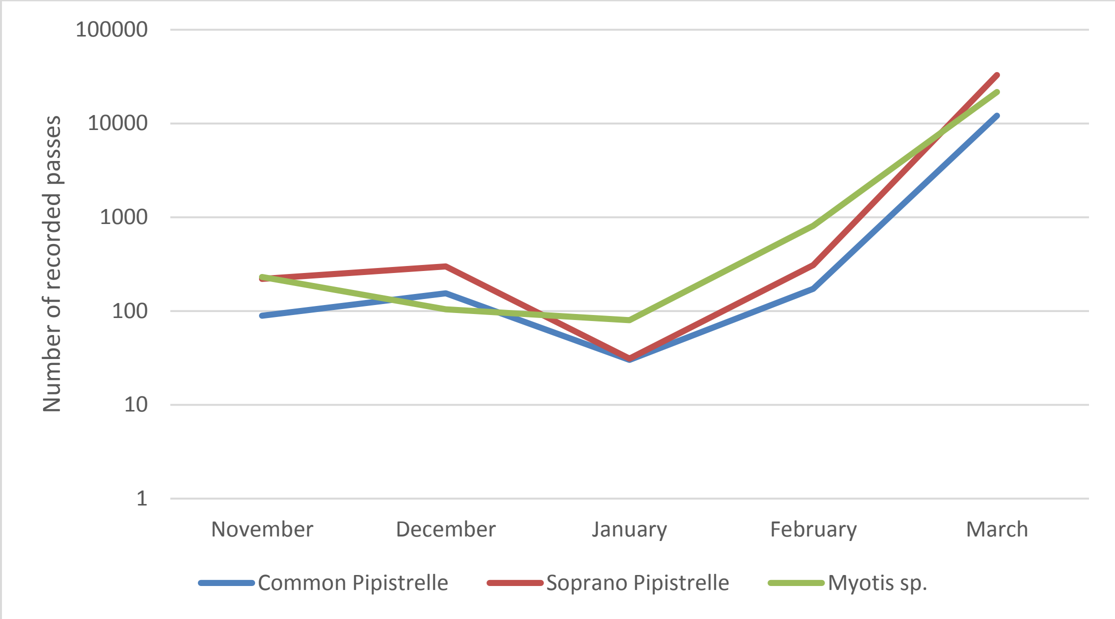

Figure 10. Graph to Show Total Monthly Passes by Pipistrelle and Myotis Bats

4.1.24 The results in Table 4 show that more calls were recorded in western and eastern locations, with a particular association with location 1 which is the location perhaps closely linked to woodland and farmland. These species were still recorded in almost every detector location, owing to their wide-ranging and light-tolerant nature.

4.1.25 Serotine calls were recorded at all locations baring 11 and 12, given serotines were recorded at the more central locations (4 and 5) this cannot be explained. As with most other species serotine activity peaked in March, there was also a peak in February with a drop of activity in November (1 pass), though the low number of passes makes drawing conclusions of this type difficult. As serotine bats are largely dependent on pre-war era buildings, it is perhaps not surprising that the peak location for this species was in the fareast (Location 9, close to dark habitats and the housing of the Bathwick area).

4.1.26 A total of 5 Nathusius' pipistrelle passes were recorded during the study at locations 9 and 12 during the March deployment (1 and 4 respectively).

4.1.27 Long-eared calls were picked up on two detectors (Locatins 8 and 10) with a peak count of only one, making any meaningful interpretation difficult. This result highlights the relative difficulty in detecting low-amplitude calls from species such as long-eareds and horseshoe bats, especially as brown long-eared bats are thought to be the second most abundant species in the UK. This species typically flies within and between trees and other vegetation and may not be present within the fringes of the river and space over the water to where the microphones were directed.

Noise and NoID Files

4.1.28 The numbers of 'Noise' and 'NoID' files across detectors did not seem to fit any strong pattern and were seen to fluctuate widely. As each detector was installed in proximity to at least one of either; running water, leafy vegetation or roads, false triggers can be derived from any of these sources, as well as some weather conditions including high winds affecting vegetation. This is corroborated by the lack of consistency among the detectors indicating that noise files were site/conditions-specific rather than due to a problem with a particular detector. All NoID files were manually reviewed to ensure they did not contain missed horseshoe and other rare bats.

5 DISCUSSION AND RECOMMENDATIONS

5.1.1 The section does not seek to re-iterate or replace the discussion and recommendations given within the summer horseshoe bat study report and as such should be read in conjunction that document. This section provides additional clarity to the recommendations previously given.

5.2 Key Findings

5.2.1 The key findings of the study can be summarised as follows.

- Findings were derived from a small sample of possible surveying nights between November and March inclusive and result should not be seen as an absolute inventory of activity.
- Lesser horseshoe bats have been recorded during every month of the winter study, although numbers were low (2-8 passes) between November and February.
- 687 Lesser horseshoe bat passes were recorded in March, in line with 627 recorded in April during the summer study. This species was recorded at every detector location during this month. This species is therefore likely to emerge sooner than greater horseshoe bats and strongly associated with the river corridor for favourable climatic, prey abundance and navigational reasons.
- Low numbers (1-2 passes) of greater horseshoe recordings were made in November and December, with none in the other months.
- No bats were recorded at locations 3-7 during the months of November and February. These were located between the Curry's Weston Lock retail development in the west and the recent Weston Riverside development in the east.
- When most active, horseshoe bats were seen to favour the darkest and most vegetated locations along the river.
- Horseshoe bat winter activity shows a peak shortly after sunset and before sunrise, in line with the findings of the summer study.
- Significant *Myotis* and pipistrelle bat activity rates were recorded throughout the study area during the entire winter study period.

5.3 Implications Arising From This Study

5.3.1 This study confirms that horseshoe bats, particularly lesser horseshoe bats, remain active (flying outside of roosts) at a reduced rate throughout the winter months compared to the spring and summer. The findings confirms (potentially for the first time) winter flight activity within the River Avon corridor, as distinct from the SAC hibernation roosts.

5.3.2 This activity appeared to be largely confined to the vicinity of their winter roosts. These roosts are assumed to be present within the Cattle Market Vaults in the east of the study area and in the region of Weston Lock in the west. However, other locations for potential horseshoe roosts were given in the summer study report, including at Bath Quays South and use of these during the winter has not been confirmed by this study.

5.3.3 Additionally, lesser horseshoe bat activity rises to approximately annual peak levels (when compared with the summer study results in the month of March), with activity seen throughout the entire study area. No greater horseshoe bats were recorded during March. While lesser horseshoe bats are known to emerge from hibernation sooner than greater horseshoe bats, the rates and of activity recorded were surprising for such an early point in the season. This may indicate an increased reliance on this species on the habitats within the BEZ at this time of year than for greater horseshoe bats, but also potentially the presence of a winter/transitional roost network closer to the BEZ than that which was previously thought to be confined to the SAC.

5.3.4 Horseshoe bats are reliant on dispersal and roost-switching to enable sufficient genetic mixing at different mating sites, for which a proportion of the SAC population uses the river corridor. While no horseshoe bats were recorded in the central areas (Locations 3-7) during the months of November to February, it is difficult to conclude that no movement of bats at these points along the river takes place during the winter, especially as this study involved a short sample of available survey nights. Movements of bats between roosts, and over longer distances than demonstrated by this study at this time of year are likely to be only occasional and brief, and therefore of low detectability.

5.3.5 As stated within the summer study report, development within the BEZ can be expected to result in an increase in both the level of human activity (pedestrians, recreational activity, vehicle movements, industrial noise and residential noise) and nocturnal lighting either through external security or public-realm lighting or the trespass of light through windows. Development has the potential to also result in the reduction of vegetation cover as land is cleared to enable construction or is opened up in order to facilitate improved human access to formerly vegetated areas.

5.3.6 Consequently, nocturnal illumination and habitat fragmentation from development are considered the major potential sources of impacts upon bats. As horseshoe bats have been shown to associate most strongly with unlit, vegetated routes for movement, any significant degradation in habitat value or lighting barriers to movement has the potential to impact on the favourable conservation status of the SAC. This sensitivity can now be assumed to apply throughout the winter given these findings, especially given the fact that mating occurs from late autumn to early spring in these species and any roost switching at this time represents an increased chance of genetic mixing within the population. Therefore, mating success over winter is likely to be a key factor in the component of the SAC bat population which roosts in and close to the river corridor and potential for impacts upon this should be mitigated for.

5.4 Recommendations for Avoidance and Mitigation of Potential Effects

5.4.1 A raft of recommendations has already been made within the summer study report which are currently being transposed into a Design Guidance Note to be published by BaNES in due course. The Note will clarify and simplify an approach to mitigating potential impacts of development upon bats and the SAC arising from lighting and habitat change through good design practises. This will be in return for a reduced need for a survey baseline for each development.

5.4.2 The findings of this study are not thought to affect recommendations given for the design of landscaping and habitat management proposals, but do emphasise the need to apply lighting reduction and attenuation measures for every month of the year.

5.4.3 To our knowledge, this is the first study which has confirmed flight activity by horseshoe bats within the River Avon corridor during the winter. That the findings were derived from a small sample of locations and suitable recording nights makes this significant. Given the low detectability of horseshoe bat echolocation together with an understanding of their somewhat unpredictable roost-switching behaviour during the winter, it is therefore recommended that previous measures for the avoidance of lighting on the river, the banks and adjacent habitats and the adoption of the various River Corridor Lighting Zones should be followed year-round. This should be demonstrated by the absence of any such seasonal automation or control measures within the proposed lighting designs and, if needs be, explicitly stated within the proposals or enforced through a specific condition.

5.4.4 Additionally, the findings significantly support the recommendation that 'Part Night Lighting' (dimming or switching off luminaires at certain times of the evening) should not be employed within lighting schemes in the BEZ. Winter horseshoe bat activity showed a tendency towards the period shortly after sunset and before sunrise. These are typically when lighting schemes aim to have luminaires operating at maximum output and therefore potentially conflict with bat movements the most. The stated aim of Part Night Lighting schemes to preserve the majority of bat activity is unlikely to be achieved in the case of the BEZ and may have a proportionately greater impact.

5.4.5 No other alteration or clarification of previously given recommendations is considered necessary as a result of this study.

APPENDIX A: DETAILS OF SETTINGS USED WITH STATIC DETECTORS

Bat Detector	Microphone	Settings	
SM2BAT+	SMX-U1	Trigger Window	1.0s
		Trigger Max.	30s
		High Pass Filter	12,000kHz (fs/32)
		Trigger level Left	15 SNR
		Bits	16
		Division Ratio	16
		File Format	.WAV
		Gain (digital)	0.0dB
		Gain (hardware)	12dB
Anabat Express	Anabat Express	Sensitivity	8
		File length max.	15.0s

Clarkson and Woods Ltd.
Overbrook Business Centre,
Poolbridge Road, Blackford,
Somerset BS28 4PA

t: 01934 712500
e: info@clarksonwoods.co.uk

www.clarksonwoods.co.uk