BTO RESEARCH REPORT 749

Ryevitalise – Bats and Ancient Trees: 2022 Report

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SUMMARY

Background Working with a network of volunteers, static acoustic bat detectors were deployed over a long survey season, to provide the third season of extensive bat data for the Ryevitalise Landscape Partnership Scheme area of the North York Moors National Park. This report provides an overview of the survey coverage and main results from 2022.

Coverage Over 2022, 100 different locations across the Ryevitalise Landscape Partnership Scheme area were surveyed. Recording was undertaken on a minimum of 160 different nights mainly between May and the end of September, amounting to a total of 413 nights of recording effort across sites. Sound recordings (wav files) were uploaded by volunteers to the BTO Acoustic Pipeline, through which a first automated analyses was carried out and provisional results returned. Recordings were then moved to deep glacial storage for later auditing. At the end of the survey season, a copy of the recordings was pulled back and manual auditing of the results / recordings carried out.

Results Overall, 581,251 recordings were collected which, following analyses and validation, were found to include 278,447 bat recordings, and 427 small terrestrial mammal recordings. Bush-crickets and audible moth species were also recorded as ‘by-catch’, for which we report species presence on a site and night basis. Following validation, the study confirmed the presence of at least 8 bat species, 3 small mammal species, 1 species of bush-cricket, and 2 audible moth species. This includes the first record of Leisler’s Bat *Nyctalus leisleri* for the project. More generally, this season of data adds to our understanding of the status of all species of bats across the Ryevitalise Landscape Partnership area, and of the relative importance of different areas. In addition, the bush-cricket species Long-winged Conehead *Conocephalus fuscus* was recorded for the first time for the survey from two locations. Lastly, the project provides data on the distribution and activity of several species of small terrestrial mammals for the Ryevitalise Landscape Partnership Scheme area. The report includes a full species-by-species breakdown of spatial, seasonal, and through-the-night patterns of activity.

1. BACKGROUND

Good decision making on managing the built and natural environment will be enabled by identifying key areas and habitats for different species. This requires surveys and analyses that provide a robust understanding of large-scale patterns in species' distributions and abundance (Pereira & Cooper, 2006; Jones, 2011). This is particularly challenging for bats, because most species are nocturnal, wide ranging and difficult to identify. As a consequence, the majority of published studies on bats have used presence-only data (i.e. where there is no direct information collected about either real absence or non-detection), collected through unstructured opportunistic sampling. Working with a network of volunteers, static acoustic bat detectors were deployed over a long survey season, building on work from two previous seasons, to provide extensive data for bats for the Ryevitalise Landscape Partnership Scheme area.

2. AIMS AND OBJECTIVES

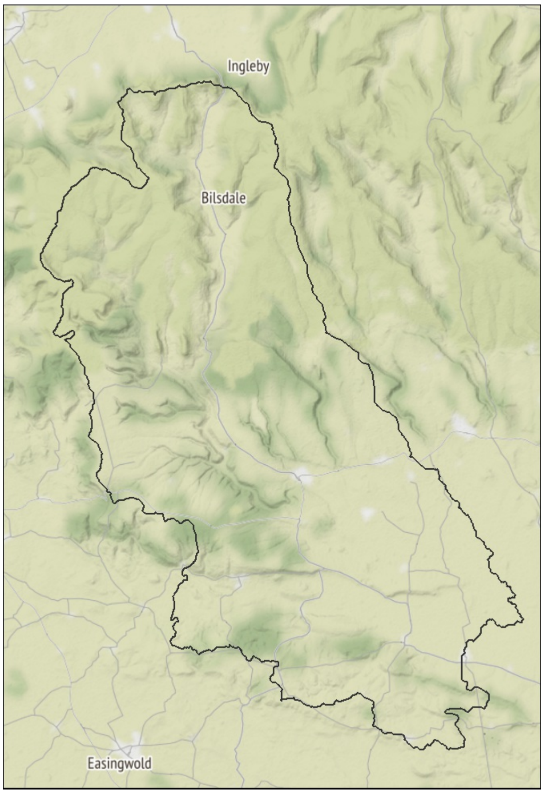
The Ryevitalise - Bats and Ancient Trees project capitalises on the interest and enthusiasm of volunteers to participate in biodiversity monitoring to systematically collect bat distribution and activity data across the Ryevitalise Landscape Partnership Scheme area, through a project that is now in its third survey season. This has resulted in the production of a robust dataset, which has increased knowledge and understanding of bat distribution and activity across the Ryevitalise Landscape Partnership Scheme area.

Whilst the focus of this work is bats, results for small terrestrial mammals, bush-crickets and audible moths which are recorded as 'by-catch' during bat surveys were also returned (Newson *et al*., 2017b; Newson *et al*., 2021). In this report we present results from the third survey season of 2022.

In addition to the above, the project has the following objectives:

- Improve our understanding of the status, distribution and timing of occurrence of bats, bush-crickets if present and small mammal species that occur in the Ryevitalise Landscape Partnership Scheme area.
- Involve and inspire a large section of the wider community to connect and engage with an aspect of nature that is poorly known and understood.
- Help develop a community awareness of what bats do for us, what they require, and why it is important to conserve them.

Map of the Ryevitalise Landscape Partnership Scheme area.



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3. METHODS

3.1 Static detector protocol

Our survey approach is based on the Norfolk Bat Survey and Southern Scotland Bat Survey (Newson *et al.*, 2015; Newson *et al.*, 2017a) which was set up to assess the season-wide status of bat species throughout large regions. Our protocol enabled volunteers in the Ryevitalise Landscape Partnership Scheme area to have access to passive real-time bat detectors which they left outside to automatically trigger and record the calls to a memory card every time a bat passes throughout a night.

Bat detectors (the SM4Bat FS), were placed out to record for a minimum of four consecutive nights at each location. The recommendation of four nights, follows analyses of bat data carried out by ourselves as part of a Defra funded project to inform the most cost-effective sampling regime for detecting the effect of local land-use and land management (BTO, unpublished data). Multiple nights of recording are likely to smooth over stochastic and weather-related variation, whilst also being easy to implement logistically (once a detector is on site, it is easy to leave it in situ for multiple nights).

The bat detectors were set to record with a sample rate of 384 kHz and to use a high pass filter of 8 kHz which defined the lower threshold of the frequencies of interest for the triggering mechanism. Recording was set to continue until no trigger is detected for a 2 second period up to a maximum of 5 seconds. Detectors were deployed before sunset and detectors set to switch on and record 30 minutes before sunset until 30 minutes after sunrise the following day. The microphone was mounted on 2-m poles to avoid ground noise and reduce recordings of reflected calls. Guidance was provided to volunteers on the placement of microphones should be deployed at least 1.5-m in any direction from vegetation, water or other obstructions.

3.2 Survey effort and timing

The survey period ran from the beginning of May to the mid-October, but with a small amount of recording outside this period. A long survey season covers the main period of bat activity, and maximises use of the equipment during the year.

3.3 Processing recordings and species identification

Automated passive real-time detectors are triggered when they detect sound within a certain frequency range. Monitoring on this scale can generate a very large volume of recordings, efficient processing of which is greatly aided by a semi-automated approach for assigning recordings to species.

At the end of a recording session, the files recorded by the bat detector (uncompressed wav format), along with associated information on where the recording was carried out were uploaded by the volunteer to the BTO's Acoustic Pipeline http://bto.org/pipeline for processing. With this, the volunteer had their own online user account, and desktop software through which they could upload recordings directly to the cloud-based BTO Acoustic Pipeline for processing. This system captures the metadata (name and email address of the person taking part, the survey dates and locations at which the detectors were left out to record), which are matched automatically to the bat results. Once a batch of recordings is processed, the user is emailed automatically, and the raw results are then downloadable through the user account as a csv file. These first results are provided with the caveat that additional auditing of the results and recordings is carried out at the end of the survey season.

Because the cost of cloud processing and storage is expensive, and there is a significant cost every time data is pulled out or moved, particularly if it is in the most accessible storage tier, recordings were automatically moved to deep glacial storage after processing. The recordings were then not easily accessible during the survey season itself, but a complete copy of the recordings was pulled back at the end of the survey season for auditing.

The BTO Acoustic Pipeline applies machine learning algorithms to classify sound events in the uploaded recordings. The classifier allows up to four different "identities" to be assigned to a single recording, according to probability distributions between detected and classified sound events. From these, species identities are assigned by the classifier, along with an estimated probability of correct classification. Specifically this is the false positive rate, which is the probability that the Pipeline has assigned an identification to the wrong species. However, we scale the probability, so that the higher the probability, the lower the false positive rate. To give an example, given a species identification with a probability of 0.9, there is a 10% chance that the identification is wrong.

Our recommendation, which is supported in Barré *et al.* (2019), is that identifications with a probability of less than 0.5 (50%) are discarded. However, manually auditing of a sample of recordings (wav files) that are below this threshold, was carried out to be confident that we were losing very little by doing this.

For bats and small mammals where we were interested in producing a measure of activity, we manually checked all the recordings of a species. With the exception of the most common species, Common Pipistrelle *Pipistrellus pipistrellus* and Soprano pipistrelle *Pipistrellus pygmeaus*, we checked a random sample of 1,000 recordings to quantify the error rate in the dataset. For bushcrickets and audible moths where there can be a large number of recordings, often of the same individual, we instead focus on producing an inventory of species presence instead, where the three recordings with the highest probability for each site and night were selected for auditing.

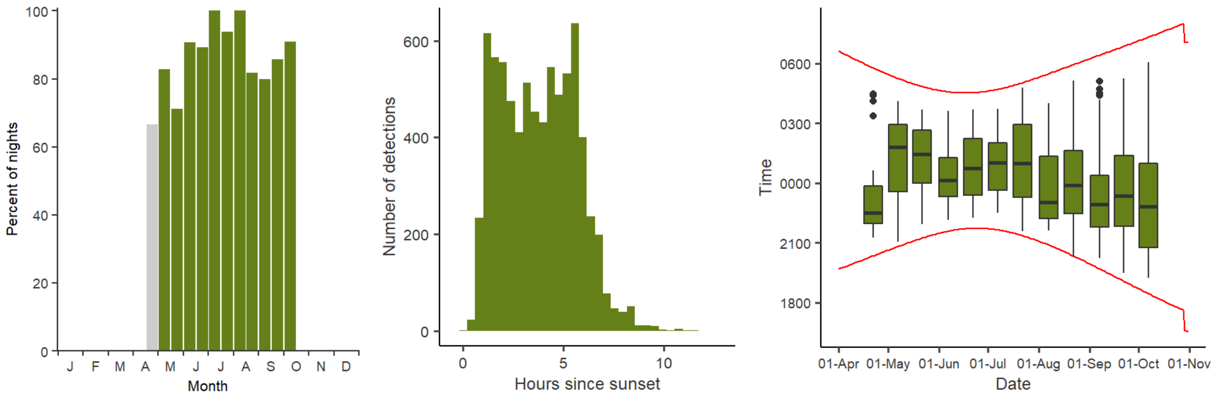
Verification of species identification was carried out through the manual checking of spectrograms using software SonoBat (http://sonobat.com/) which was used as an independent check of the original species identities assigned by pipeline. The spectrograms shown in this report, were also produced using SonoBat. All subsequent analyses use final identities upon completion of the above inspection and (where necessary) correction steps.

It is important to note that the criteria for distinguishing Whiskered Bat *Myotis mystacinus* and Brandt's Bat *Myotis brandtii* are very subtle and poorly defined. For this reason, until further ground-truthing of the identification can be carried out, we treat these two species as a species pair.

3.4 Seasonal and nightly patterns of activity

Important for improving our understanding of the species present, we examine how bat activity varied by time of night and by season. Nightly activity was determined for each half-month period and presented according to the percentage of survey nights on which each bat species was detected. Activity through the night was analysed by first converting all bat pass times to time since sunset based on the location and date and calculated using the R package suncalc (Thieurmel & Elmarhraoui, 2019) and then assessing the frequency distribution of passes relative to sunset for the whole season and in half-month periods. By looking at nightly activity in this way, it allows us to visualise general patterns in activity for a species according to time of night and season, accepting that activity on any given night will be influenced by weather and potentially other factors.

To explain the figures in the following results section, we show an example below for Natterer's Bat. The left plot shows the percentage of nights on which the species was detected every half-month through the season, showing the periods of main activity for this species. If present, pale grey bars represent periods with fewer than 10 nights of recording where accuracy of the reporting rate may be low. The middle plot shows the overall spread of recordings with respect to sunset time, calculated over the whole season. The right plot shows the spread of recordings with respect to sunset and sunrise times (red lines) summarised for each half-month through the season. For this last seasonal plot, the individual boxplot show quartiles (lower, median and upper) with lines extend to 1.5 times the interquartile range, and small dots show outliers.



3.5 Spatial patterns of activity and distribution

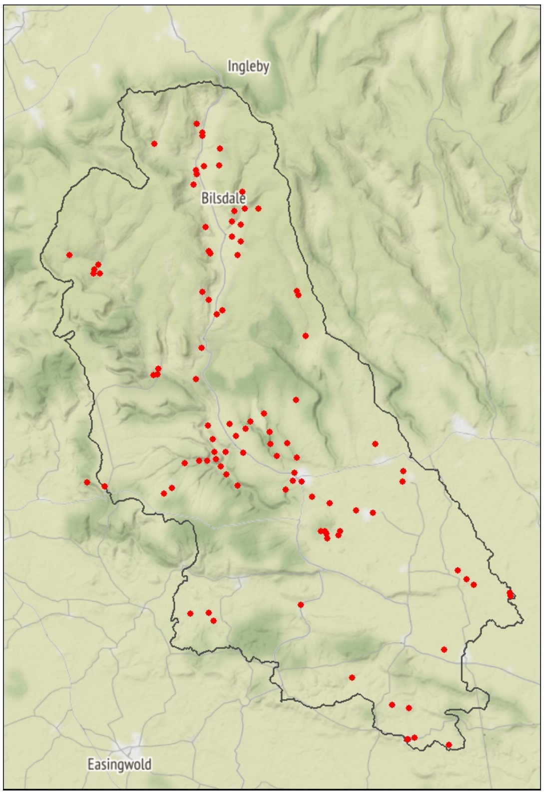
We produce maps of bat and small mammal activity. With these, dots are scaled according to the total number of recordings of this species at each location. Activity here represents usage of an area, which will be a combination of species abundance, and time spent in the area. For bush-crickets and audible moths, the results focus instead on species presence.

4. RESULTS

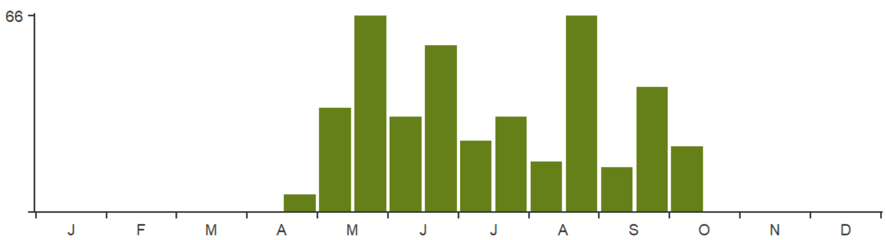
4.1 Survey coverage

During 2022, 100 different locations were surveyed for bats across the Ryevitalise Landscape Partnership Scheme area. The distribution of these locations is shown below. Collectively across all these sites, 413 complete nights of recording effort was conducted. The recording effort spanned 160 different nights and 7 months. The seasonal pattern of recording effort is shown in the bottom figure. Manual checking of recordings was carried out for all species and recordings, except for Common Pipistrelle and Soprano Pipistrelle for which 1000 randomly selected recordings were checked. For both of these species 2 (0.2%) recordings were assigned to the wrong species.

Map of the study area showing locations where detectors were deployed in 2022.



Number of locations surveyed.



4.2 General results

Overall, 581,251 recordings were collected which, following analyses and validation, were found to include 278,447 bat recordings, and 427 small terrestrial mammal recordings. In addition, one bush-cricket species and two species of audible moth species were recorded (see table below). Following validation, the presence of at least 9 bat species, 3 small mammals species (or species groups e.g. shrew species), 1 bush-cricket species and 2 audible moth species can be confirmed.

Species detected, number of recordings of each species following validation and a summary of the scale of recording.

Bats

Species (/call type)	No. of recordings following validation	No. of different locations (% of total)
Alcathoe Bat, Myotis alcathoe	23	2 (2%)
Daubenton's Bat, Myotis daubentonii	32492	95 (95%)
Whiskered or Brandt's Bat, Myotis mystacinus or M. brandtii	32282	99 (99%)
Natterer's Bat, Myotis nattereri	7568	98 (98%)
Leisler's Bat, Nyctalus leisleri	2	1 (1%)
Common Noctule, Nyctalus noctula	7657	76 (76%)
Common Pipistrelle, Pipistrellus pipistrellus	149823	100 (100%)
Soprano Pipistrelle, Pipistrellus pygmaeus	43763	99 (99%)
Brown Long-eared Bat, Plecotus auritus	4837	91 (91%)

Small mammals

Species	No. of recordings following validation	No. of different locations (% of total)
Brown Rat, Rattus norvegicus	322	3 (3%)
Common Shrew, Sorex araneus	19	11 (11%)
Eurasian Pygmy Shrew, Sorex minutus	86	9 (9%)

Bush-crickets

Species	No. of different locations (% of total)
Long-winged Conehead, Conocephalus fuscus	2 (2%)

Moths

Species	No. of different locations (% of total)
Green Silver-lines, Pseudoips prasinana	4 (4%)
Bird Cherry Ermine, Yponomeuta evonymella	21 (21%)

4.3 Species and call-type results

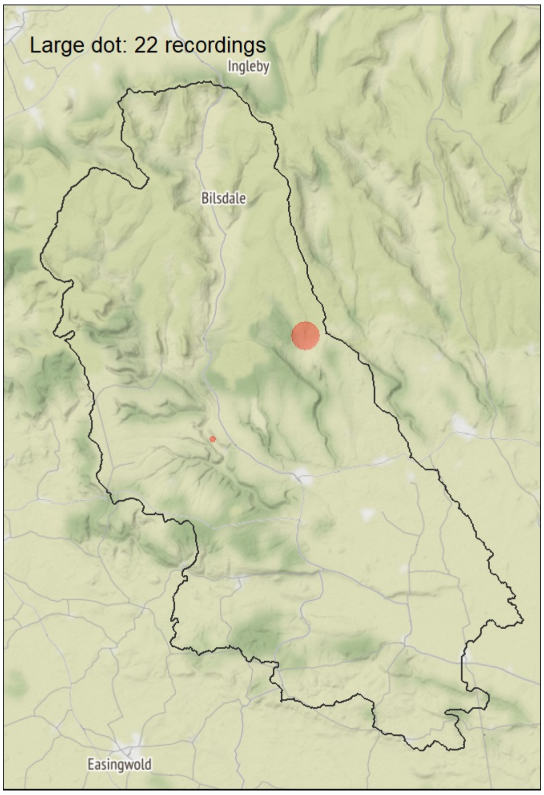
The following sections provide results for each species and/or call type.

4.3.1 Bat species

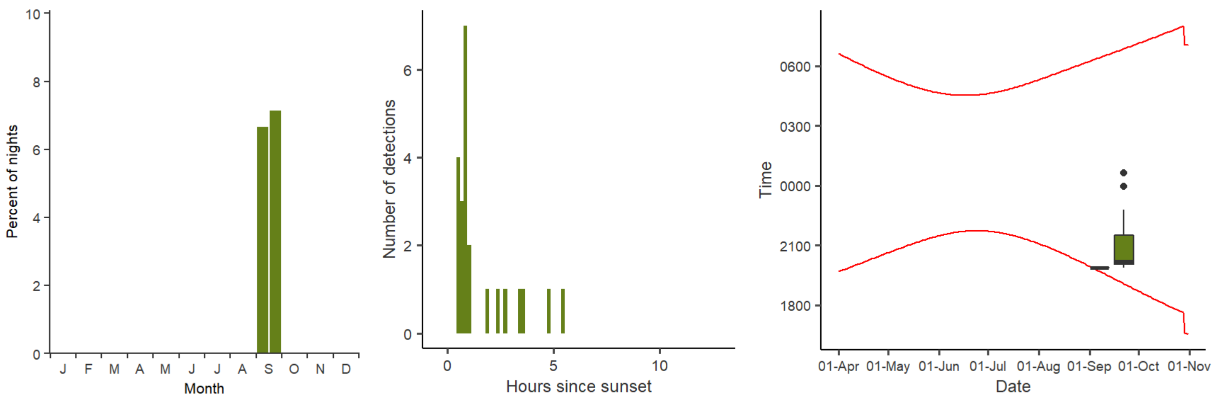
Alcathoe Bat

Alcathoe Bat *Myotis alcathoe* was recorded on four nights, from two locations, giving a total of 23 recordings.

Spatial pattern of activity



Seasonal and nightly activity

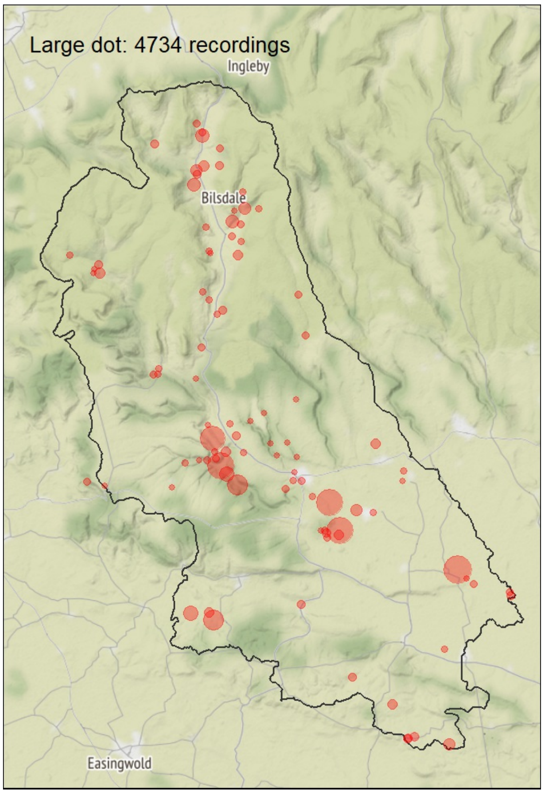


Alcathoe Bat we believe is the most range restricted *Myotis* species present in Ryevitalise Landscape Partnership Scheme area. Of other *Myotis* species, the most likely confusion is with Whiskered Bat. As a general rule, comparable calls of the same duration tend to be higher in frequency in Alcathoe Bat than with Whiskered Bat, but in a cluttered environment, Whiskered Bat can exceptionally produce calls that end above 40 kHz. However, even in this situation, there is a difference in call shape between these two species which should still allow these species to be distinguished. See Identification appendix 1 for further information on the sound identification of Alcathoe Bat.

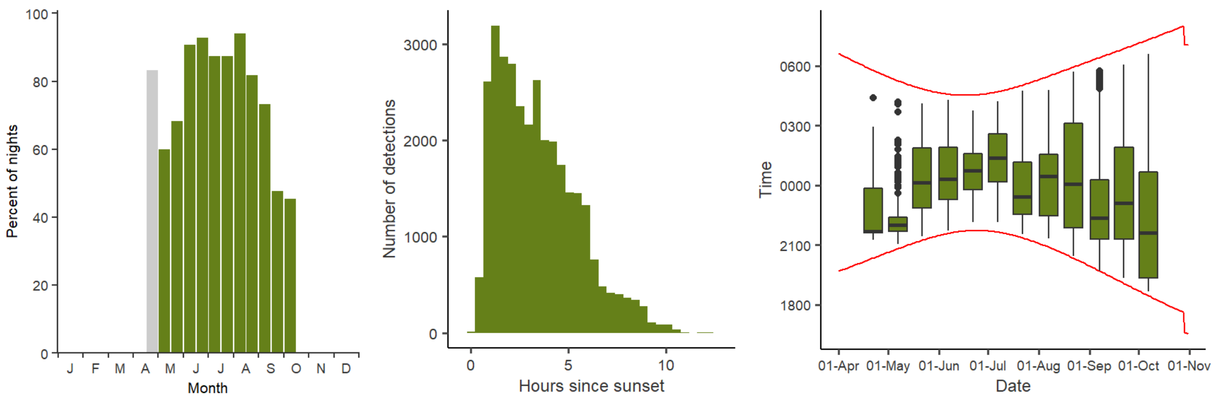
Daubenton's Bat

Daubenton's Bat *Myotis daubentonii* was recorded on 132 nights, from 95 locations, giving a total of 32,492 recordings.

Spatial pattern of activity



Seasonal and nightly activity

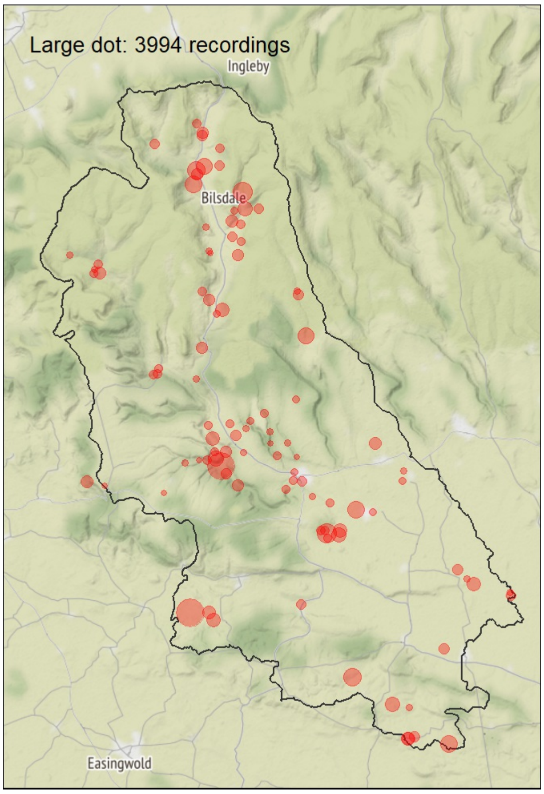


Daubenton's Bat was widely recorded in 2022, but with particularly high activity where detectors were left to record at locations along the River Rye. It was typical for there to be over 1,000 Daubenton's recordings a night from locations along the River Rye, with a maximum of 2,082 recordings of Daubenton's Bat recorded over one night from a bat detector positioned along the River Rye close to Rievaulx. See Identification appendix 2 for further information on the sound identification of Daubenton's Bat in comparison to Natterer's Bat.

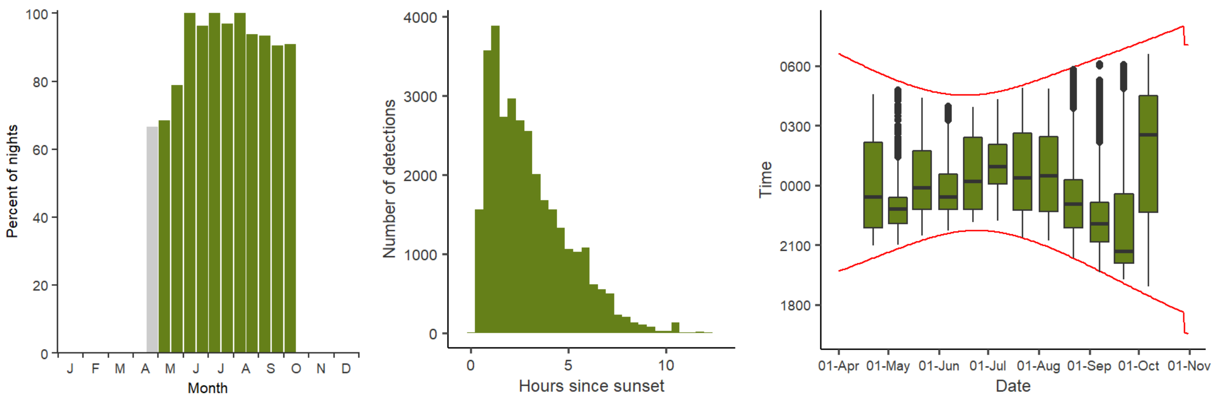
Whiskered or Brandt's Bat

Whiskered or Brandt's Bat *Myotis mystacinus or M. brandtii* was recorded on 151 nights, from 99 locations, giving a total of 32,282 recordings.

Spatial pattern of activity



Seasonal and nightly activity

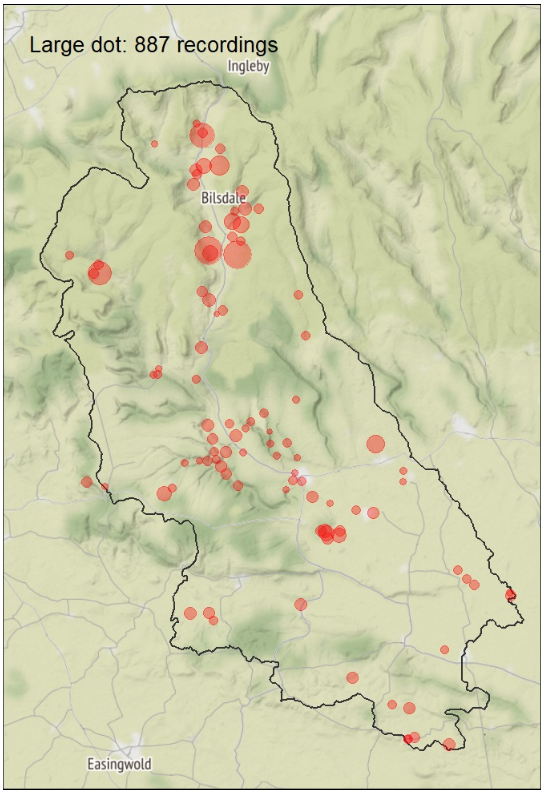


Whiskered or Brandt's Bat were very widely recorded. Different to Daubenton's Bat where the highest activity was recorded close to water, the highest activity of Whiskered or Brandt's bat was in the vicinity of woodland patches, with a maximum of 1,678 recordings in one night at one location between Thorpe Hall and Coxwold in August. At the current time, there are no good clear criteria for distinguishing Whiskered and Brandt's Bat acoustically with confidence. Looking across recordings there is an indication from the call measurements and social calls that Brandt's Bat is likely to be the most common and widespread of the two species, but this would need to be proven by some other means (e.g. DNA evidence or trapping). For further discussion on our approach to the sound identification of *Myotis* see Identification appendix 3.

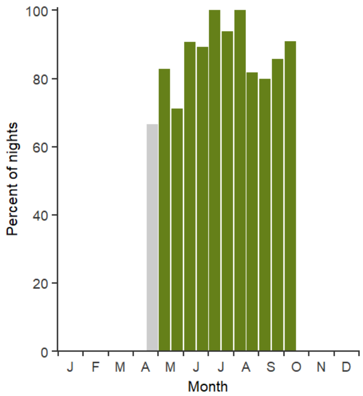
Natterer's Bat

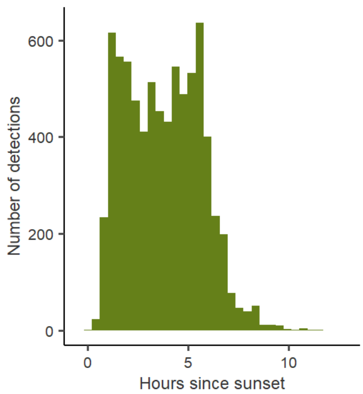
Natterer's Bat *Myotis nattereri* was recorded on 149 nights, from 98 locations, giving a total of 7,568 recordings.

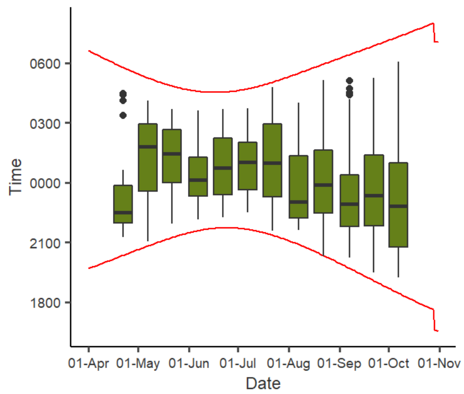
Spatial pattern of activity



Seasonal and nightly activity





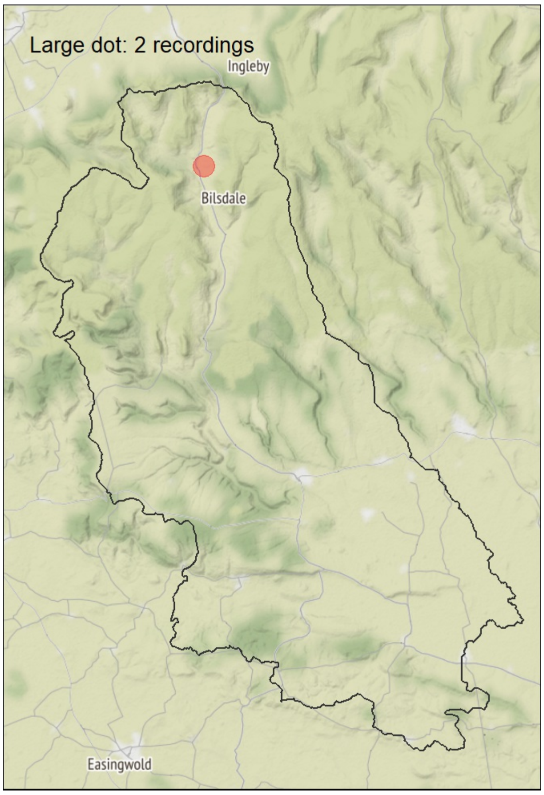


Natterer's Bat was widely recorded in 2021, with some of the highest concentrations of activity in the north of the survey area. Compared with the other *Myotis* species, the highest activity of Natterer's Bat was recorded in more open grassland areas, bordering moorland, with a maximum of 398 recordings a night recorded close to Fangdale Beck in July. As with Whiskered and Brandt's Bat above, the first consideration when looking at recordings is the quality of the recording, to consider whether the quality is good enough to try and assign the recording to species. See Identification appendix 4 for further information on the sound identification of Natterer's Bat.

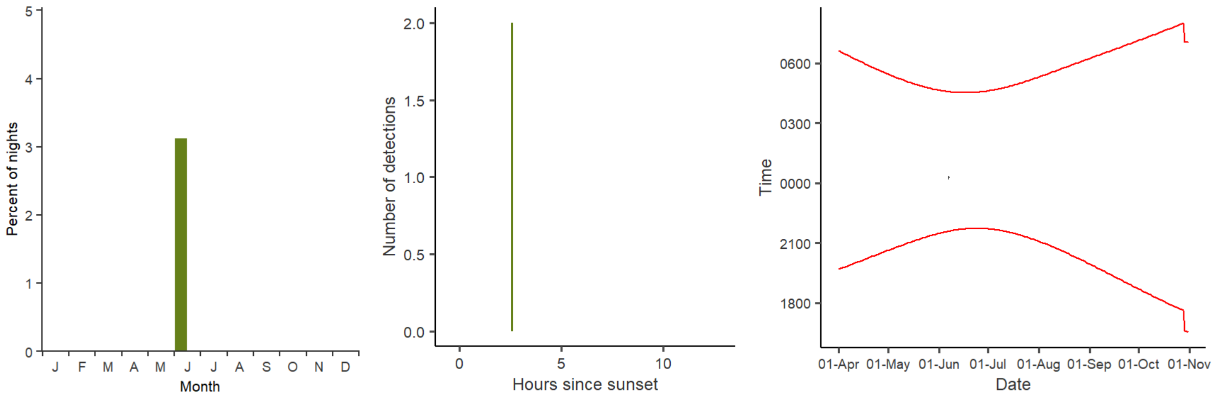
Leisler’s Bat

Leisler’s Bat *Nyctalus leisleri* was recorded on one night, from one location, giving a total of 2 recordings.

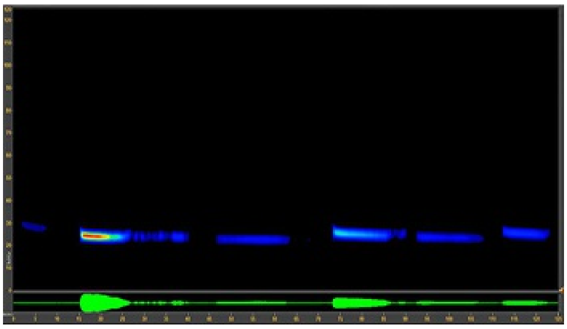
Spatial pattern of activity



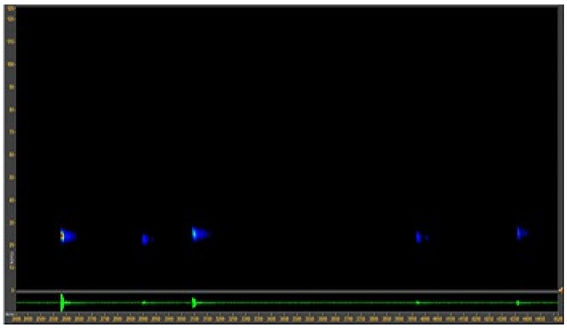
Seasonal and nightly activity



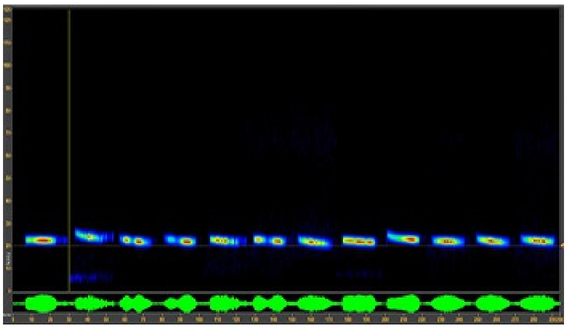
Leisler’s Bat - new species for the project was recorded close to Chop Gate on the night of the 11th June (two recordings). In these recordings, there are alternating call frequencies, which is typical for *Nyctalus*. Narrowing down the identification further, given the call durations in the presumed Leisler’s Bat recordings, it is clear the frequency of the calls, is higher than would be expected for Noctule given the flat call shape. In the spectrograms below, we include a comparison between the calls in one of the recordings with known Leisler’s Bat and known Noctule calls of similar duration. This highlights that the calls here are very typical for Leisler’s bat but are high in frequency for Leisler’s Bat to be likely. See Identification appendix 5 for further information on the sound identification of Leisler’s bat and Noctule.



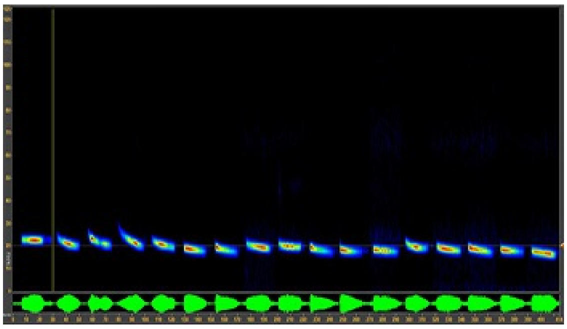
Leisler's Bat - Chop Gate, 11th June



Leisler's Bat (same recording, different scale)



Leisler's Bat call (same recording left), against known Leisler's Bat calls (right)

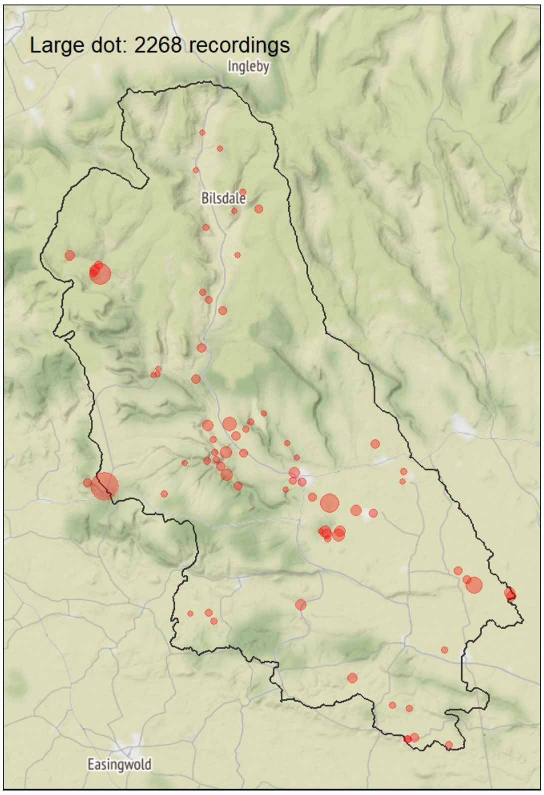


Leisler's Bat call (same recording left), against known Noctule calls (right)

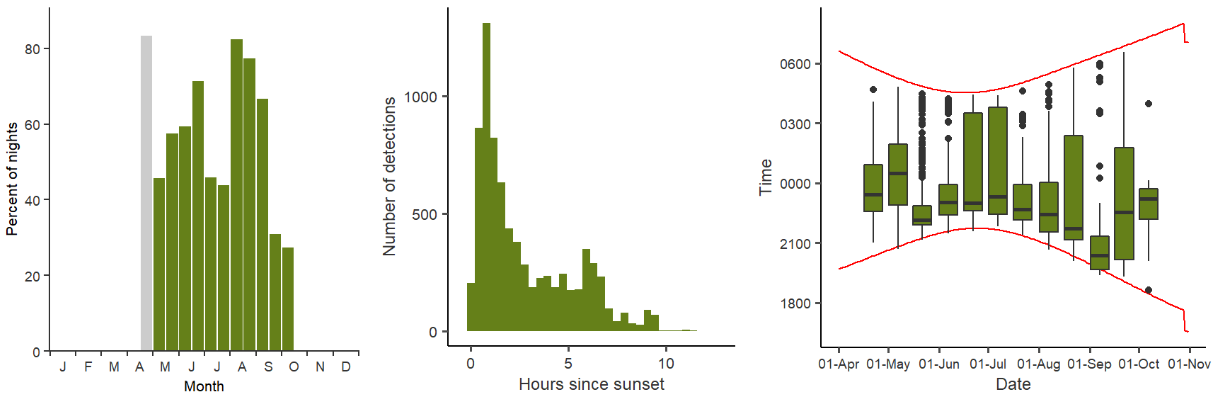
Common Noctule

Common Noctule *Nyctalus noctula* was recorded on 105 nights, from 76 locations, giving a total of 7,657 recordings.

Spatial pattern of activity



Seasonal and nightly activity

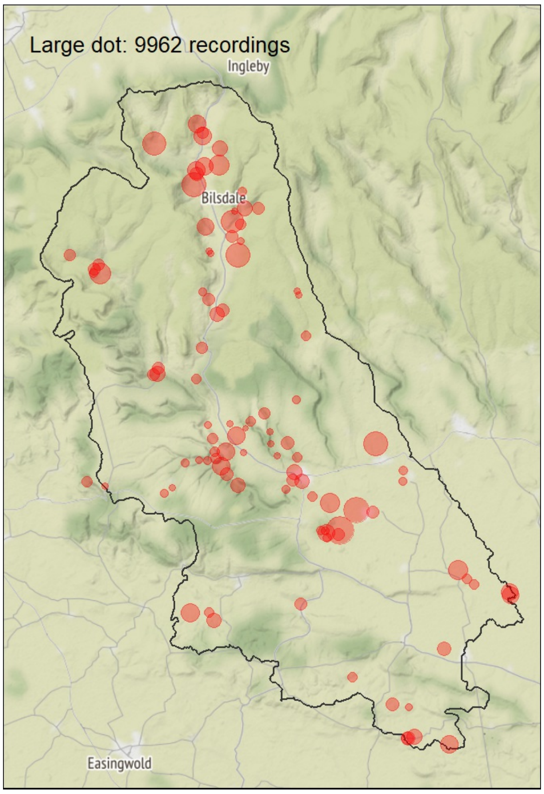


Common Noctule was widely recorded across the survey area, but there were a small number of locations where particularly high activity of Noctule was recorded. The maximum number of recordings of Noctule from a night was 1,376 recordings of Noctule from the Sutton Bank National Park Centre on the 1st May. See Identification appendix 3 for further information on the sound identification of Leisler's bat and Noctule.

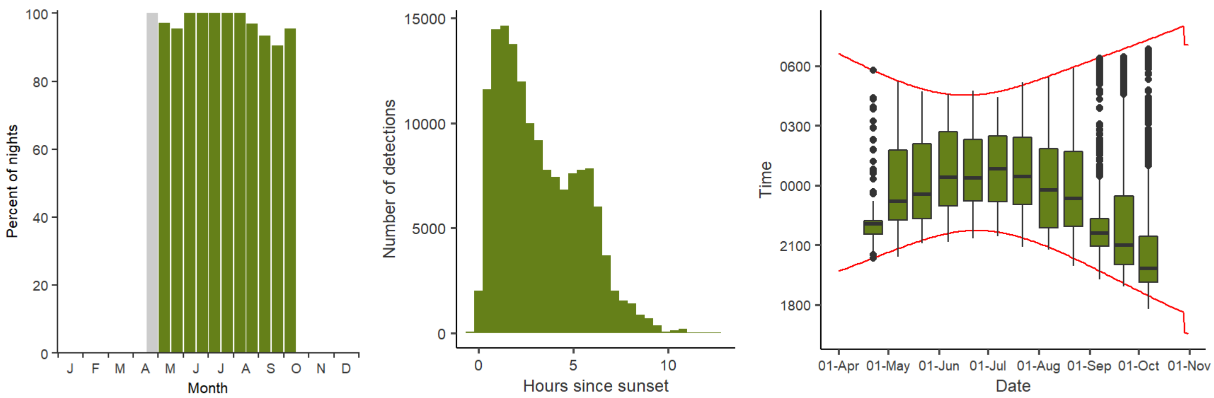
Common Pipistrelle

Common Pipistrelle *Pipistrellus pipistrellus* was recorded on 158 nights, from 100 locations, giving a total of 149,823 recordings.

Spatial pattern of activity



Seasonal and nightly activity



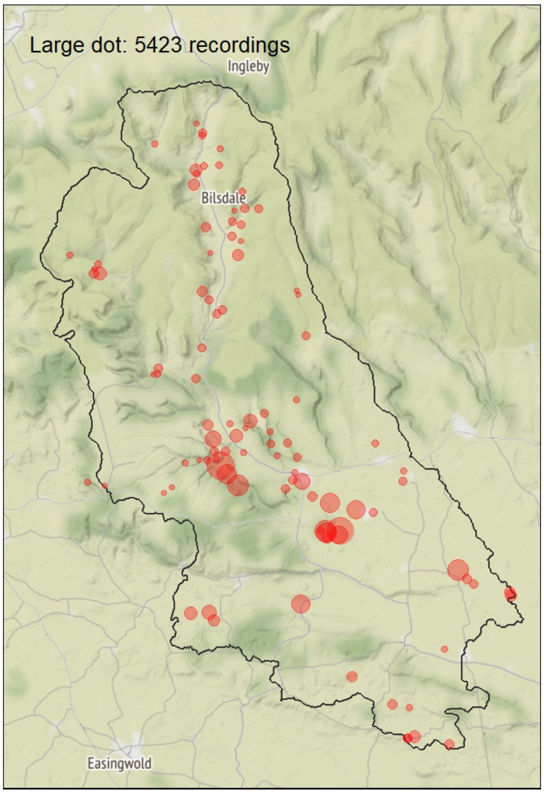
Common Pipistrelle was by far the most common and widely recorded bat species, with 152,432 recordings from 105 different locations (100% of survey locations).

Common Pipistrelle is normally straightforward to identify acoustically, but particular care is needed given calls at the low or high frequency end of the range for this species, which could be mis-identified as Nathusius' Pipistrelle or Soprano Pipistrelle respectively. For these it is important to consider the call duration, and not just the peak or end frequency of the calls. For example, considering the possibility for mis-identification with Soprano Pipistrelle in extreme clutter, Common Pipistrelle typically produces very short calls that are elevated in frequency, where they could be mis-identified as Soprano Pipistrelle. In addition, where there are multiple individuals of the same species present, there can be frequency shifting as one or both individuals 'shift' their frequencies to avoid acoustic interference, which again can result in some calls in a sequence that are higher in frequency than would be typical for the species. It is normally possible to diagnose what is happening in most situations by looking at the sequence of calls, and if there are neighbouring recordings in close time of potentially the same bat.

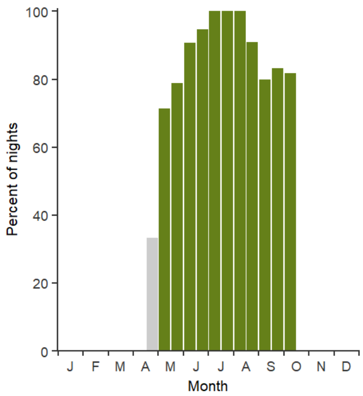
Soprano Pipistrelle

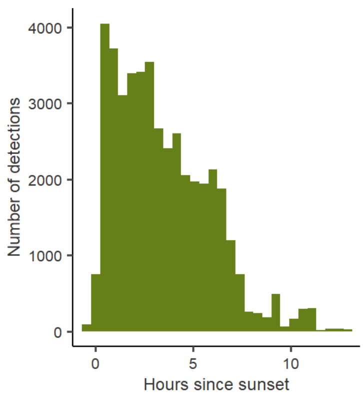
Soprano Pipistrelle *Pipistrellus pygmaeus* was recorded on 146 nights, from 99 locations, giving a total of 43,763 recordings.

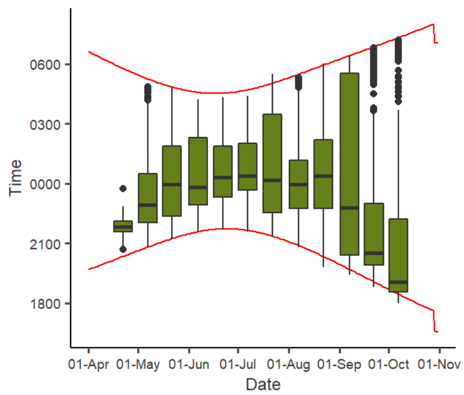
Spatial pattern of activity



Seasonal and nightly activity





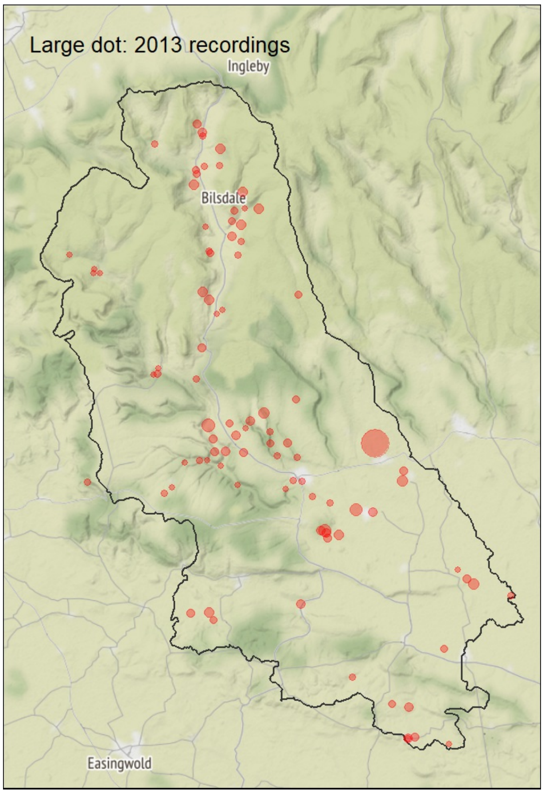


Soprano Pipistrelle was the second most common and widely recorded bat species, with 45,112 recordings from 104 different locations (99% of survey locations), but compared with Common Pipistrelle highest activity was more localised and centered along the River Rye. A maximum of 2,019 recordings of Soprano Pipistrelle were collected from a night of recording from along the River Rye close to Harome on the 26th August.

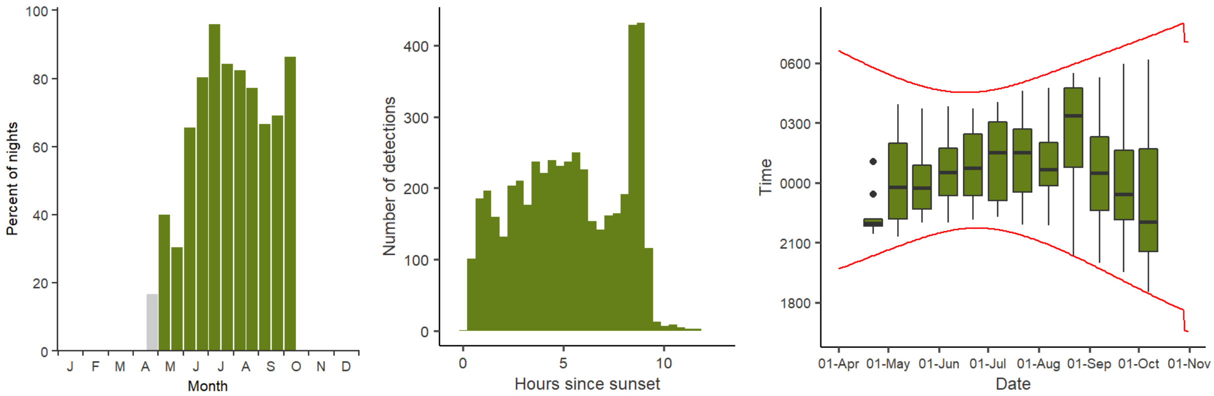
Brown Long-eared Bat

Brown Long-eared Bat *Plecotus auritus* was recorded on 126 nights, from 91 locations, giving a total of 4,837 recordings.

Spatial pattern of activity



Seasonal and nightly activity



Brown Long-eared Bat was widely recorded across the survey area. Exceptionally, 2,013 recordings, 42% of the total recordings of Brown Long-eared Bat from this season were from one location, just north of Nawton in August.

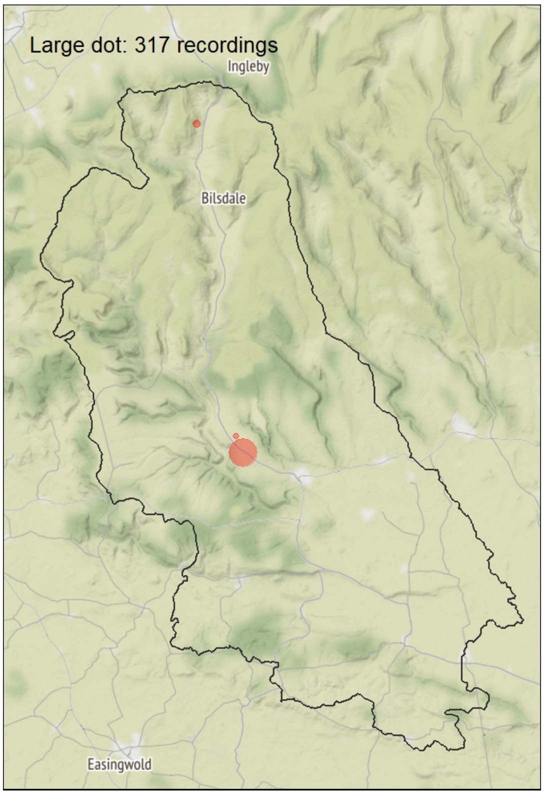
4.3.2 Small terrestrial mammal species

In this section we look at the recordings that we can assign to small terrestrial mammals, but for most mammal recordings it was not currently possible to assign these to species.

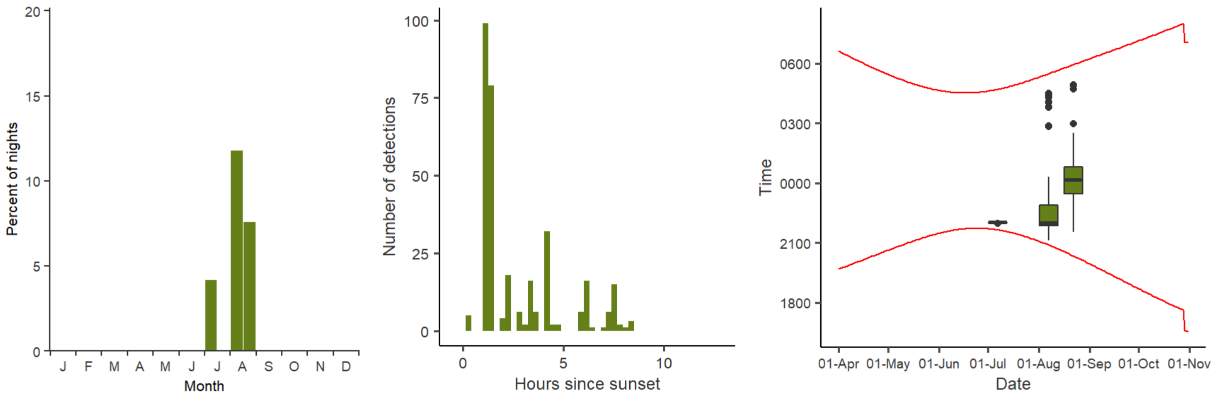
Brown Rat

Brown Rat *Rattus norvegicus* was recorded on seven nights, from three locations, giving a total of 322 recordings.

Spatial pattern of activity



Seasonal and nightly activity

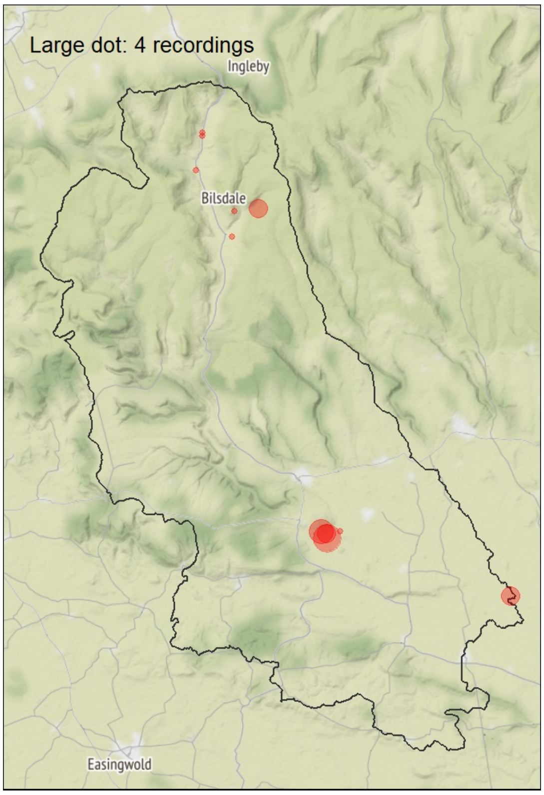


Brown Rat is a highly vocal species that is relative easy to detect using ultrasonic microphones and is regularly recorded incidentally during static bat detector surveys (Newson & Pearce 2022). This was only recorded from a few locations in 2022, of which 317 of 322 recordings (98%) were from one location.

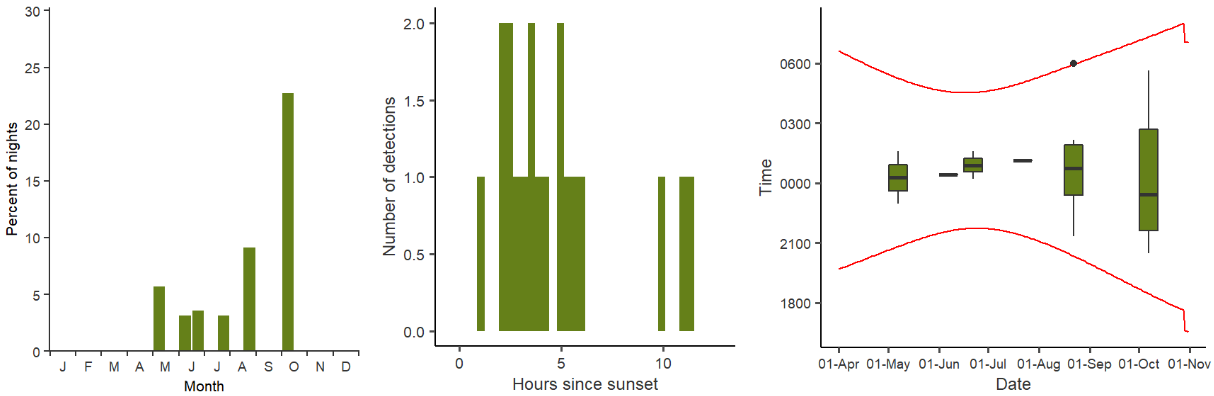
Common Shrew

Common Shrew *Sorex araneus* was recorded on 13 nights, from 11 locations, giving a total of 19 recordings.

Spatial pattern of activity



Seasonal and nightly activity

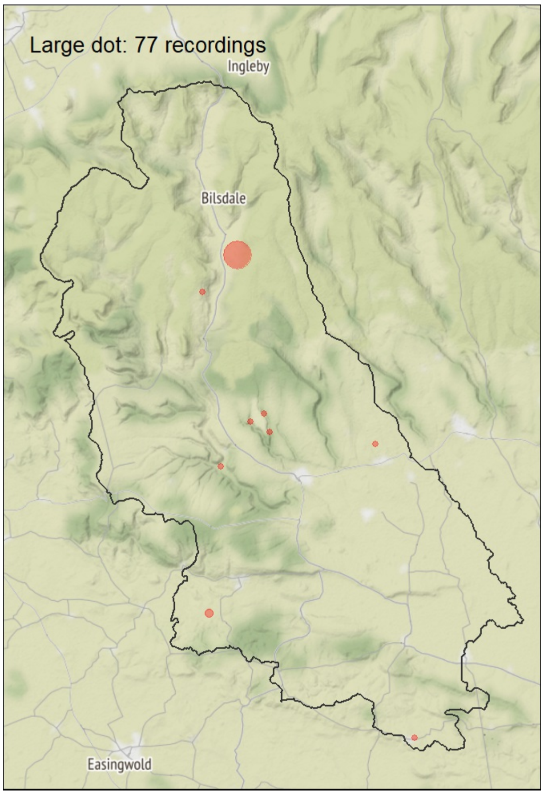


Common Shrew was recorded quite widely across the Ryevitalise Landscape Partnership Scheme are in 2022. Common and Pygmy Shrew produce calls that are notably different from those of Rodents in having multiple harmonics that when played slowed down, produces a warbling sound. In most cases it is possible to separate Common Shrew and Pygmy Shrew, the former producing quite simple calls with much less variability in frequency and call structure than the latter. In the case of Common Shrew, the first harmonic (i.e. the fundamental) of the call (if present) ends at around 10 kHz, while the often stronger second harmonic ends at double the frequency to the first (i.e. about 20 kHz). Up to three further harmonics may be recorded, depending on how close the shrew is to the microphone. The complex calls of the Pygmy Shrew, in contrast, often include five or more harmonics, where no two calls in a single recordings being quite the same. For more information on the sound identification of shrews, see Newson *et al.*, (2021).

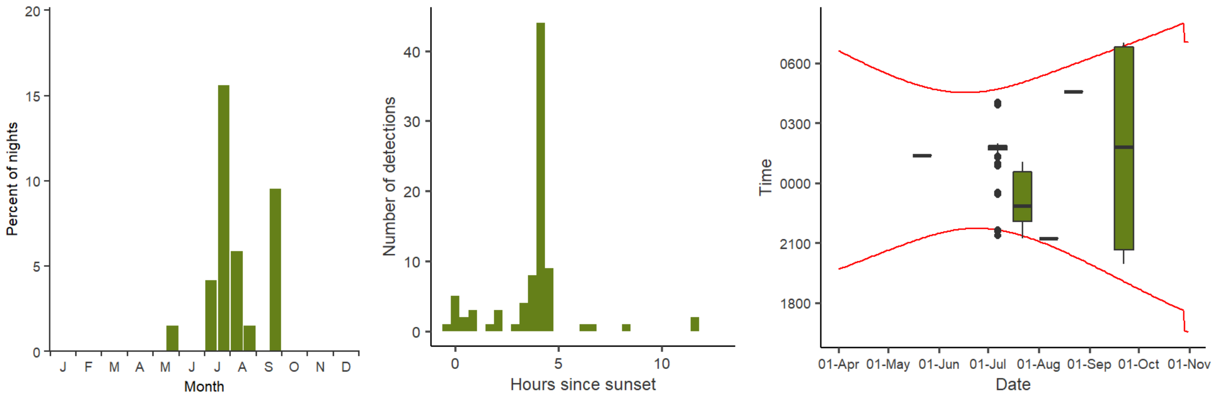
Eurasian Pygmy Shrew

Eurasian Pygmy Shrew *Sorex minutus* was recorded on 13 nights, from nine locations, giving a total of 86 recordings.

Spatial pattern of activity



Seasonal and nightly activity



Pygmy Shrew was recorded quite widely during the project, but particularly notable is one location, close to Fangdale Beck where it was recorded every night that a detector was deployed in May, with up a maximum of 77 recordings on one night. As discussed in the previous section (and see Newson *et al*., 2021), it is normally straightforward to distinguish this species acoustically from Common Shrew.

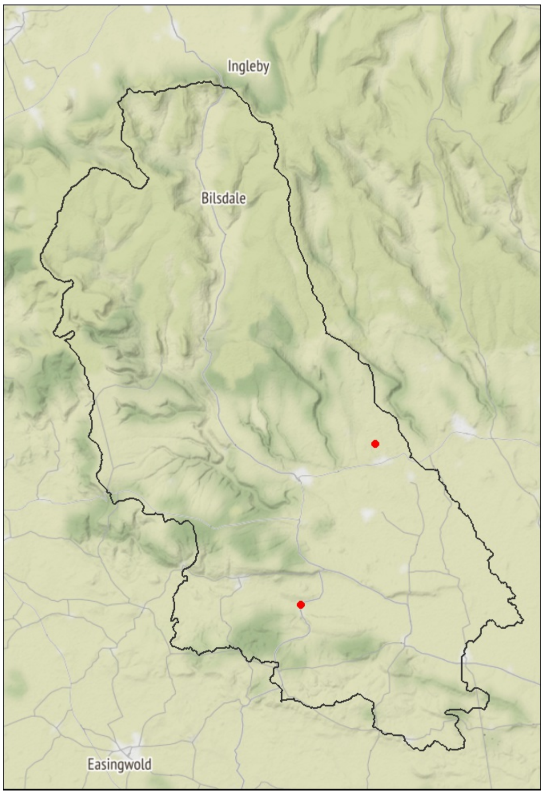
4.3.3 Bush-crickets

Being stationary, and calling for long periods, the number of recordings is not an informative measure of abundance. For this reason, bush-cricket data are shown as presence information rather than activity information.

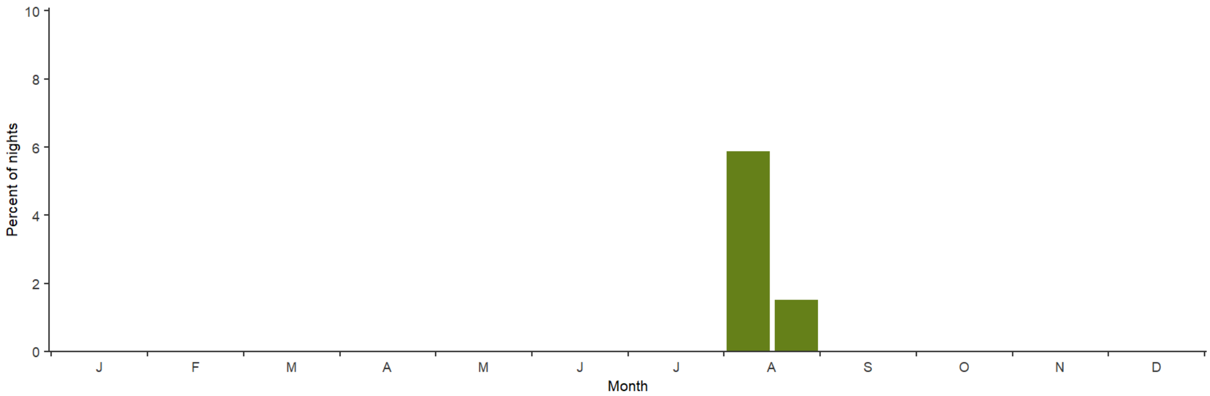
Long-winged Conehead

Long-winged Conehead *Conocephalus fuscus* was recorded on two nights, from two locations.

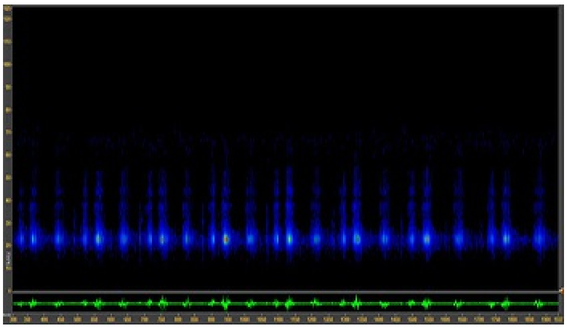
Spatial pattern of detections



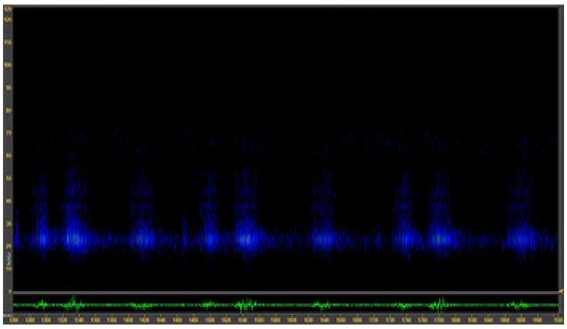
Seasonality



Long-winged Conehead - new species for the Ryevitalise survey area were recorded from 2 locations between mid-July and mid-August Long-winged Conehead produces ‘calls’ with a peak frequency about 26 kHz. It is most similar acoustically to Short-winged Conehead (Middleton 2020), which has not yet been recorded in the survey area, but Long-winged Conehead produces three-syllable calls (two short calls, pause, followed by one longer duration call).



Long-winged Conehead



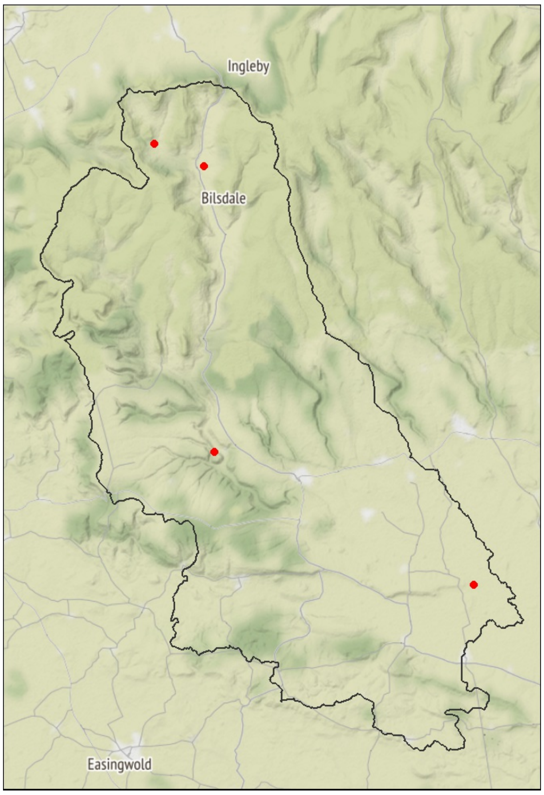
Long-winged Conehead (as left, different scale)

4.3.4 Audible moth species

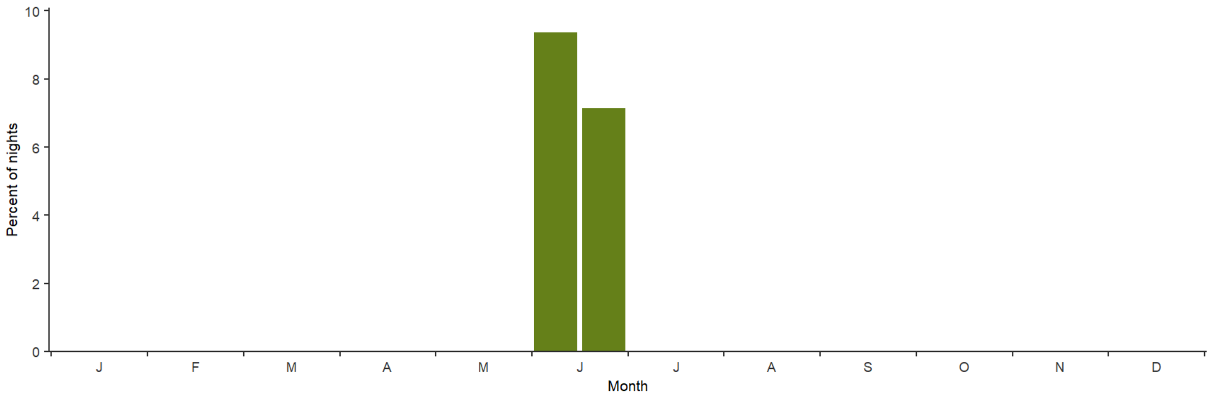
Green Silver-lines

Green Silver-lines *Pseudoips prasinana* was recorded on seven nights, from four locations.

Spatial pattern of detections



Seasonality

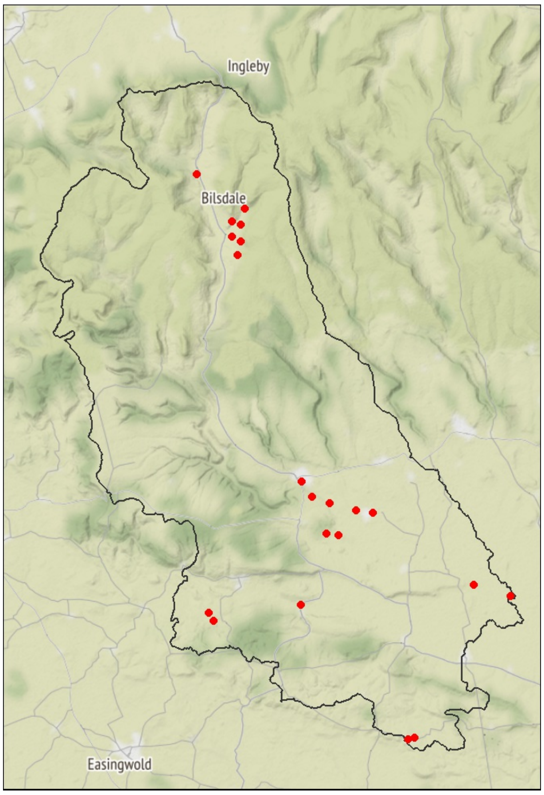


Green Silver-lines was recorded from 4 locations. Green Silver-lines produce ‘calls’ that form a very distinctive shape. See Barataud & Skals, (2018) for a description of the sound identification of Green Silver-lines.

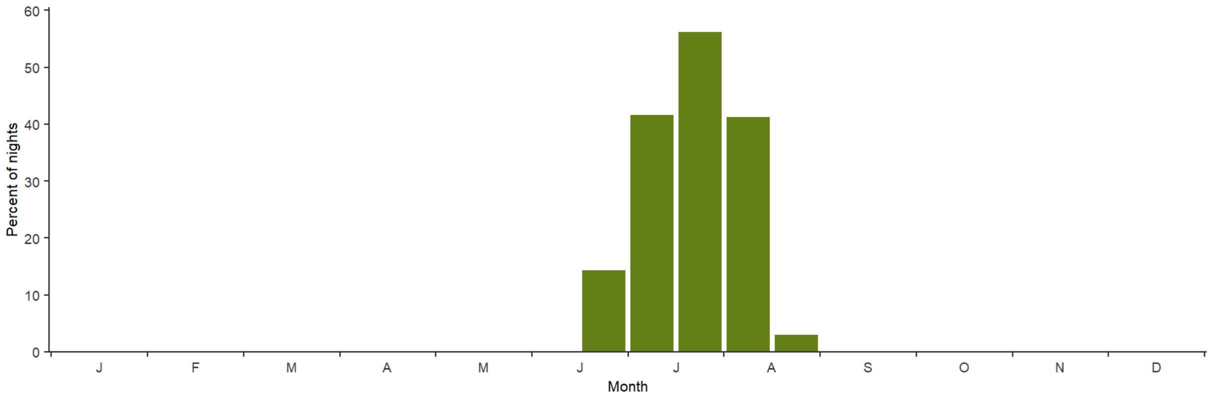
Bird Cherry Ermine

Bird Cherry Ermine *Yponomeuta evonymella* was recorded on 33 nights, from 21 locations.

Spatial pattern of detections



Seasonality



Bird Cherry Ermine The micro-moth Bird Cherry Ermine was recorded from 22 locations. This species of moth is deaf itself, but it produces ultrasonic clicks when it flies, to interfere with the echolocation of bats and reduce predation. The sound produced by the Bird Cherry Ermine is very different from Green Silver-lines. Whilst we have assigned all recordings like this to this species, we can not exclude the possibility that other closely related species produce similar sounds. In addition to recordings that we have assigned to the two moth species here, we believe that several other currently unidentifiable insect species (probably moths or beetle species), were also recorded in 2022.

5. DISCUSSION

The current dataset of 278,447 bat recordings has been very valuable in adding to our understanding of patterns of occurrence and activity of bats across the Ryevitalise Landscape Partnership Scheme area, but it also adds to our understanding of some other species groups that were recorded as 'by-catch' during bat surveys. The results from this season includes Leisler's Bat that had not previously been recorded in the Ryevitalise survey area, and one new species of bush-cricket, Long-winged Conehead.

Compared with other studies that we have been involved with in other parts of the country, the activity of bats of the genus *Myotis*, which includes Daubenton's, Natterer's, Whiskered, Brandt's and Alcathoe Bats, was very high. Bat activity can be used as a proxy for relative abundance that can be used within species, with high levels of activity typically occurring where the species is most abundant. However, bat activity cannot be compared between species. This is because the distance at which different species are detected is very different. For example, at two extremes, the detection distance of Noctule flying in an open to semi-open environment can be up to 100-m, compared with a detection distance of Brown Long-eared Bat in closed woodland which is about 5-m (Barataud 2015).

As discussed previously, Brandt's Bat is extremely similar acoustically to whiskered bat, so these species have been treated here as a species pair, but looking across recordings, as last year, we continue to believe that Brandt's Bat is perhaps the most abundant *Myotis* species after Daubenton's Bat. Nationally Brandt's Bat is thought of as one of the most range restricted *Myotis* species in England, but there is some support for the view that the abundance of this species increases from south-west to north-east England. Of the *Myotis* species, we believe that Alcathoe Bat, which was recorded from two locations this season is the most range restricted. Further work to ground-truth the identification would be needed to confirm this.

In relation to other species groups recorded as 'by-catch' during bat surveys, for small terrestrial mammal species were recorded, comprising 20 recordings of Common Shrew, 94 recordings of Pygmy Shrew and 322 recordings of Brown Rat. For further information on the sound identification of terrestrial small mammals in Britain see Newson *et al*. (2020). The macro-moth Green Silver-lines was recorded from 4 locations and the micro-moth Bird Cherry Ermine was also recorded from 23 locations. This second species of moth is deaf itself, but it produces ultrasonic clicks when it flies, to interfere with the echolocation of bats and reduce predation.

6. ACKNOWLEDGEMENTS

We would like to thank all the fieldworkers who took part in Ryevitalise - Bats and Ancient Trees project in 2022 and the landowners that gave volunteers access to their land. We would also like to thank the Sutton Bank National Park Centre for hosting bat detectors for the project. We would also like to thank Matt Baxter, Steve Pritchard from the BTO IS team for development and support of the online systems that were used in this project. Lastly we would like to thank the National Lottery Heritage Fund for funding this project.

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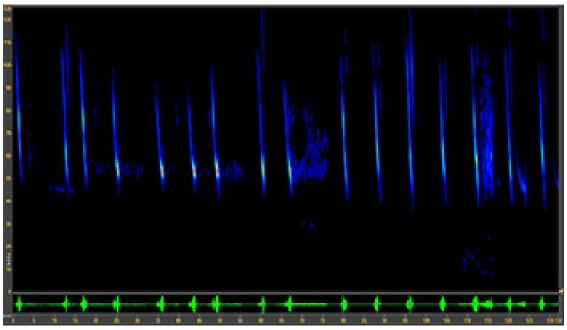
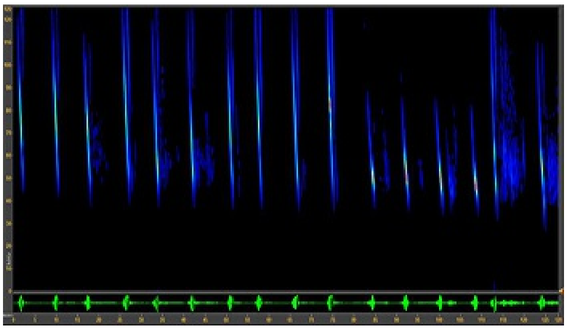
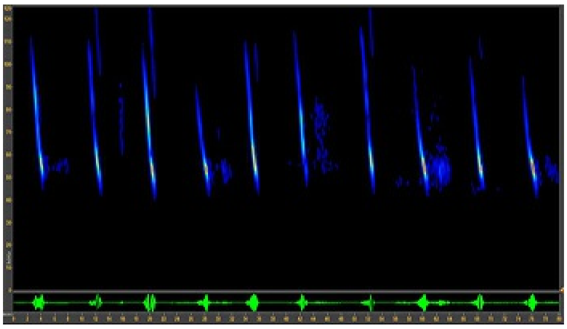
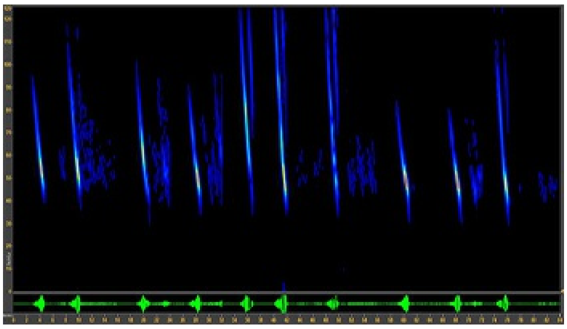
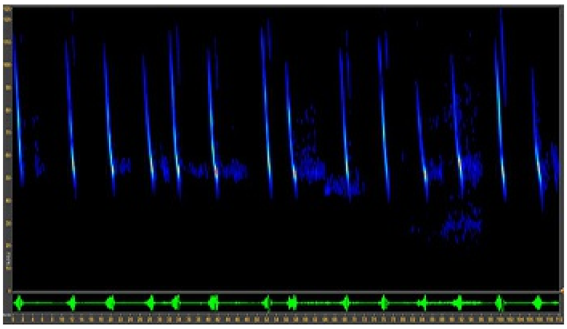
Identification appendix 1: Alcathoe Bat *Myotis alcathoe* and Whiskered Bat *Myotis mystacinus*

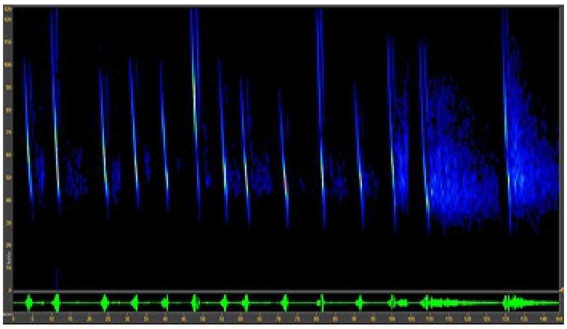

Alcathoe Bat - call duration 1.3-1.6 ms

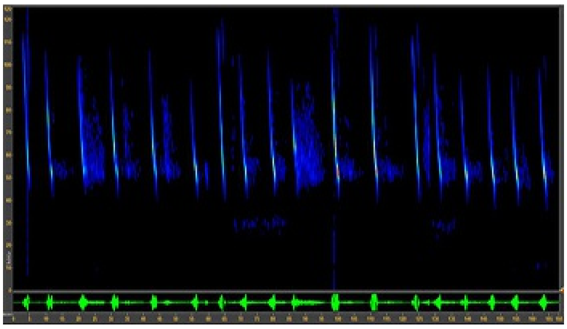

Whiskered Bat - call duration 1.3-1.6 ms

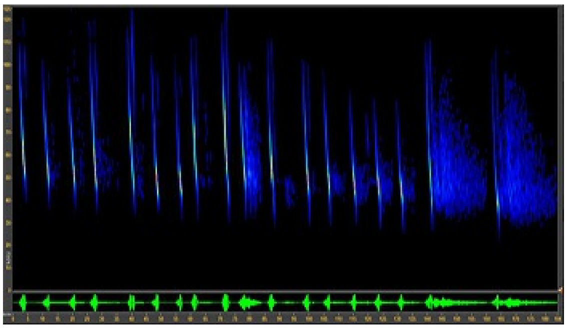

Alcathoe Bat - call duration 1.7-1.8 ms

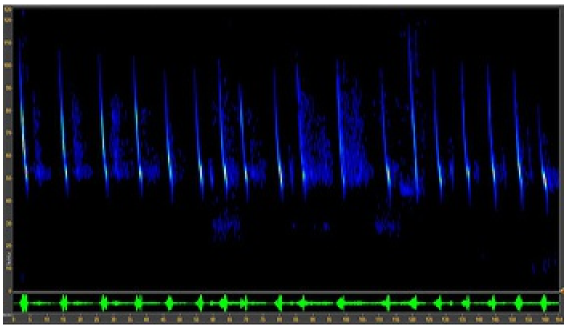

Whiskered Bat - call duration 1.7-1.8 ms

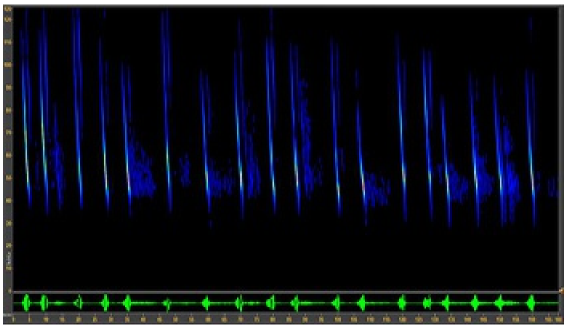

Alcathoe Bat - call duration 1.9-2.0 ms

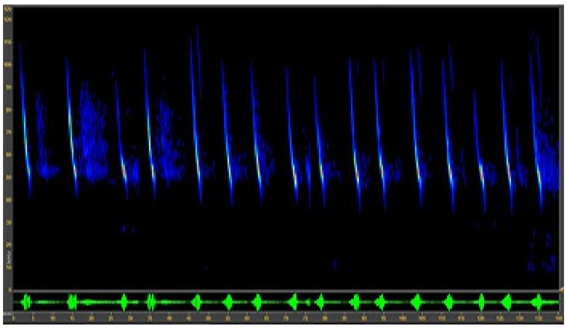

Whiskered Bat - call duration 1.9-2.0 ms

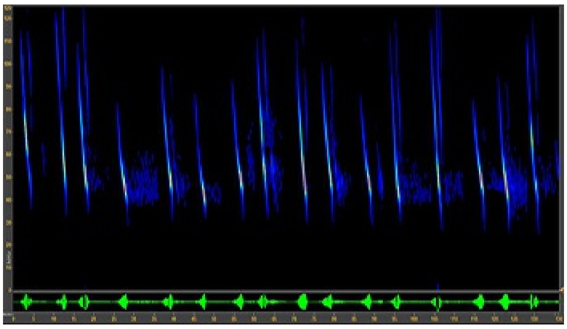

Alcathoe Bat - call duration 2.1-2.2 ms

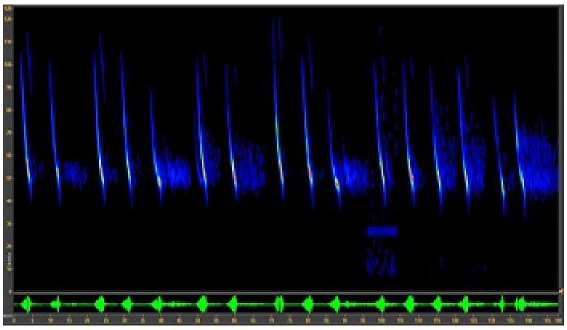

Whiskered Bat - call duration 2.1-2.2 ms

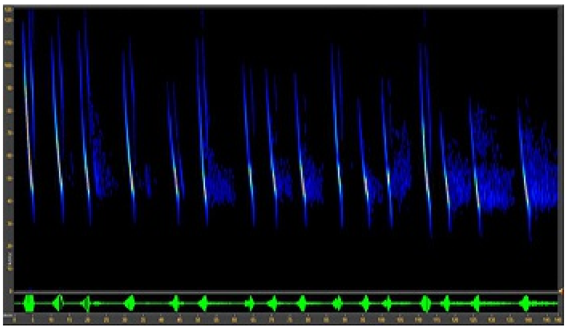

Alcathoe Bat - call duration 2.3-2.4 ms

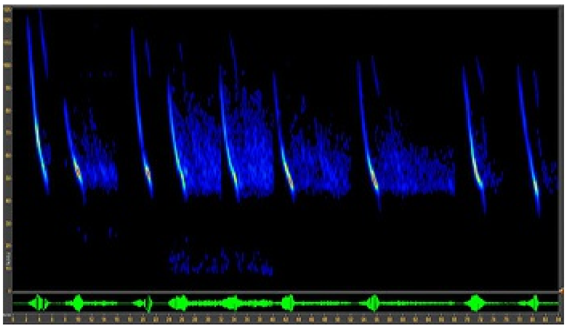

Whiskered Bat - call duration 2.3-2.4 ms

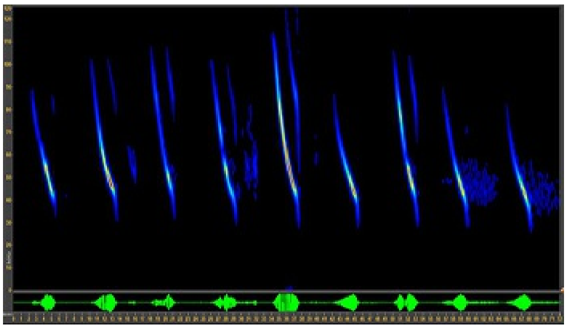

Alcathoe Bat - call duration 2.5-2.6 ms

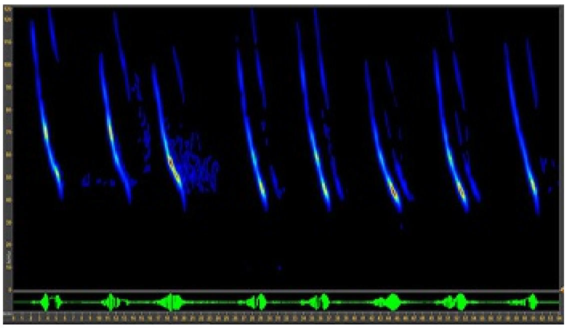

Whiskered Bat - call duration 2.5-2.6 ms

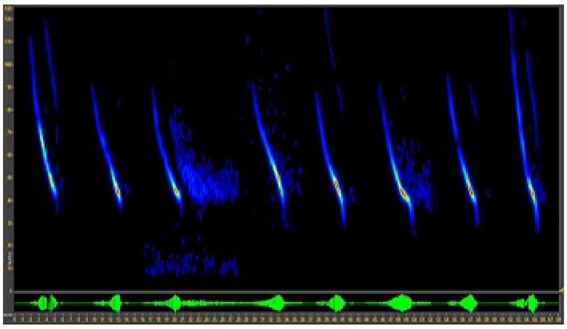

Alcathoe Bat - call duration 2.7-2.9 ms


Whiskered Bat - call duration 2.7-2.9 ms

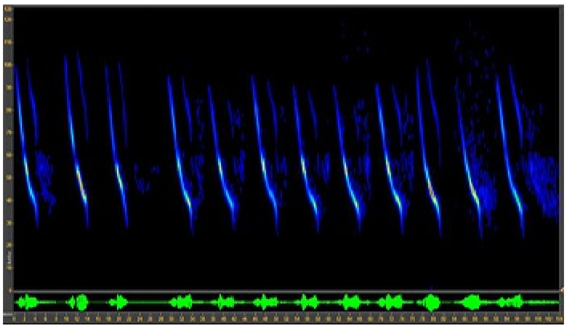

Alcathoe Bat - call duration 3.0-3.2 ms


Whiskered Bat - call duration 3.0-3.2 ms


Alcathoe Bat - call duration 3.3-3.9 ms


Whiskered Bat - call duration 3.3-3.9 ms

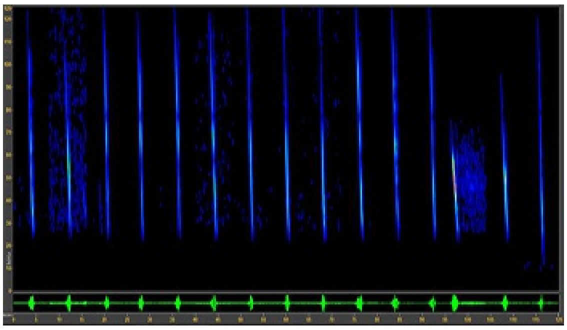
Alcathoe Bat - no examples for this call duration



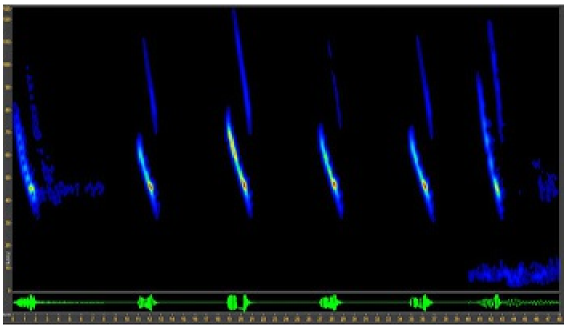
Whiskered Bat - call duration 4.0-5.1 ms

Identification appendix 2: Daubenton's Bat *Myotis daubentonii* and Natterer's Bat *Myotis nattereri*

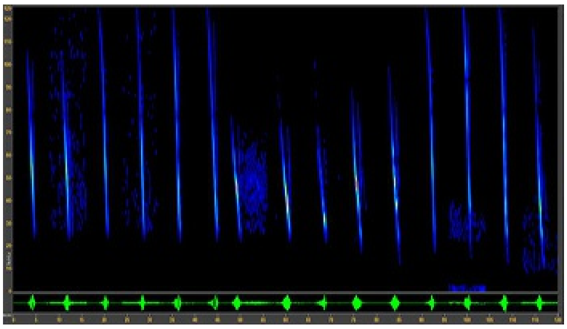
Daubenton's Bat - call duration up to 1.4 ms no examples



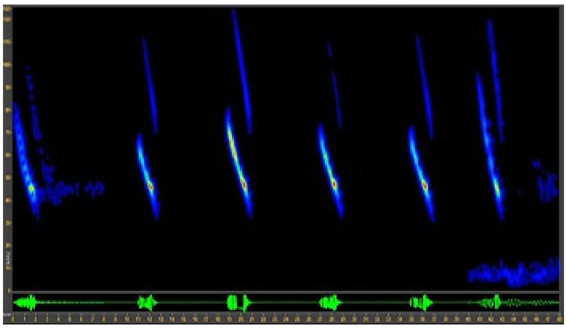
Natterer's Bat - call duration up to 1.4 ms



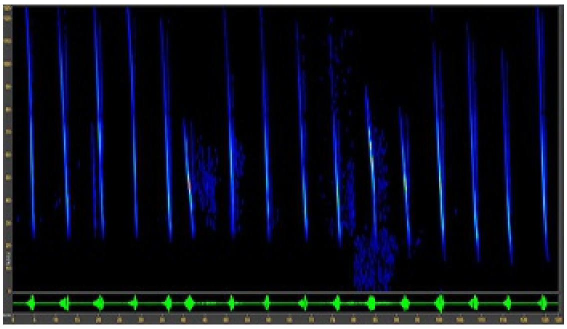
Daubenton's Bat - call duration 1.5-2.0 ms



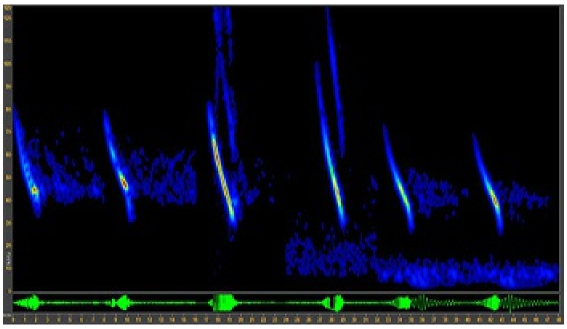
Natterer's Bat - call duration 1.5-2.0 ms



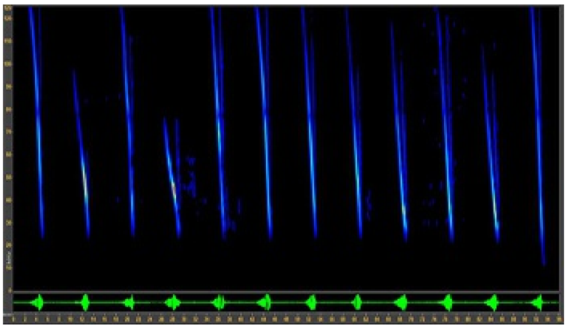
Daubenton's Bat - call duration 2.1-2.3 ms



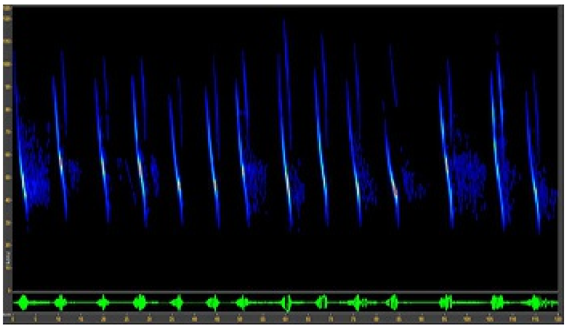
Natterer's Bat - call duration 2.1-2.3 ms

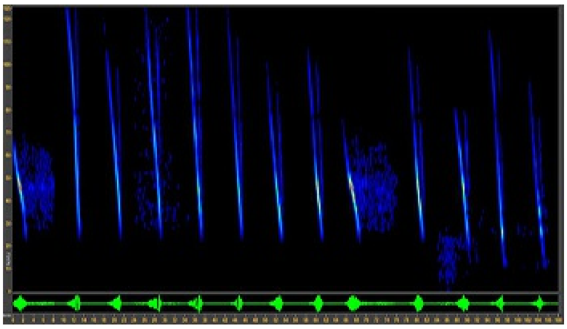


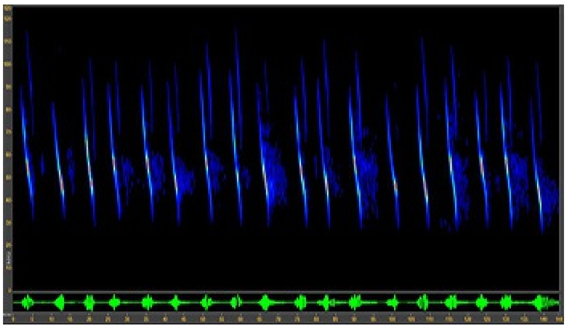
Daubenton's Bat - call duration 2.4-2.5 ms

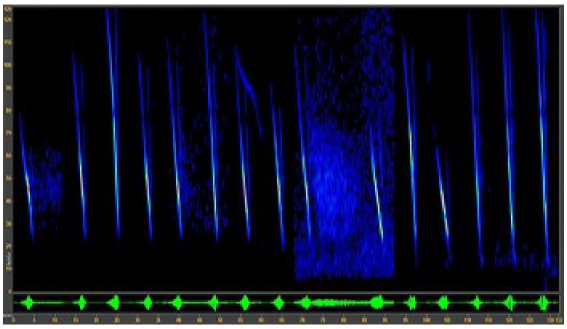


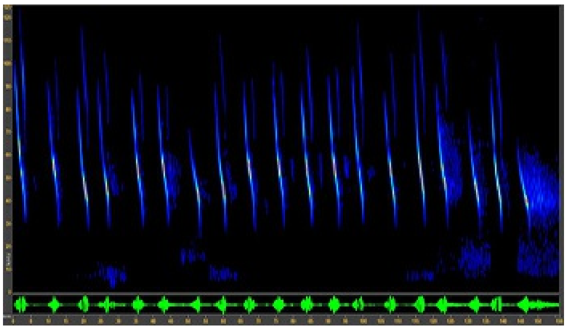
Natterer's Bat - call duration 2.4-2.5 ms

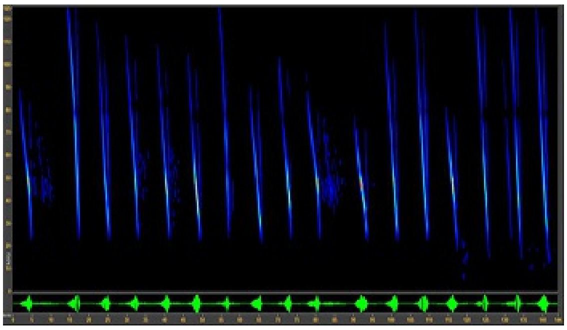

Daubenton's Bat - call duration 2.6-2.7 ms

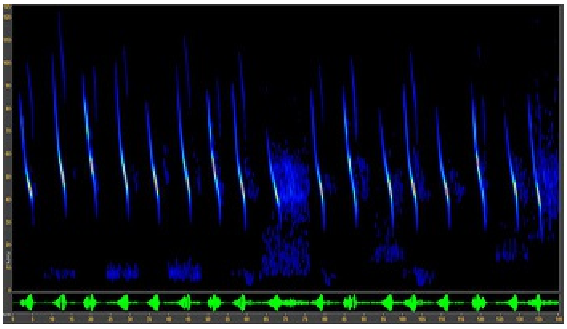

Natterer's Bat - call duration 2.6-2.7 ms

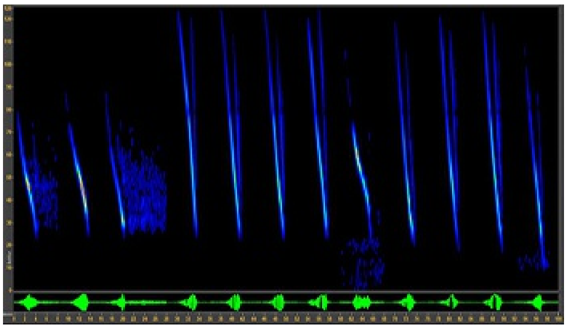

Daubenton's Bat - call duration 2.8-2.9 ms

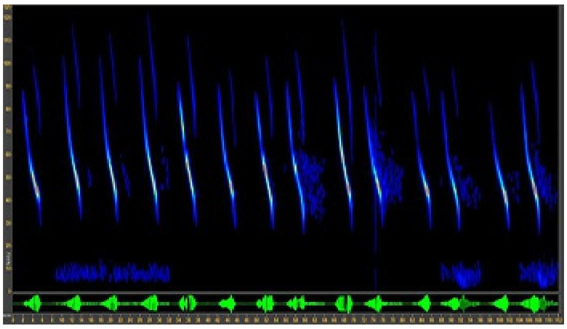

Natterer's Bat - call duration 2.8-2.9 ms

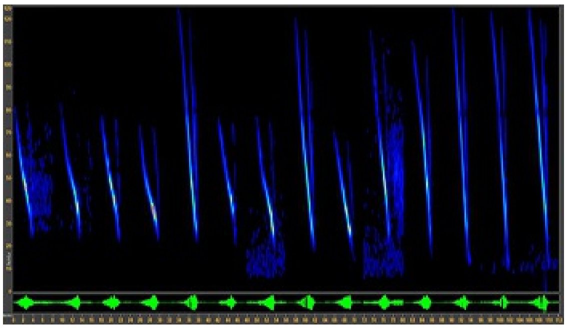

Daubenton's Bat - call duration 3.0-3.1 ms

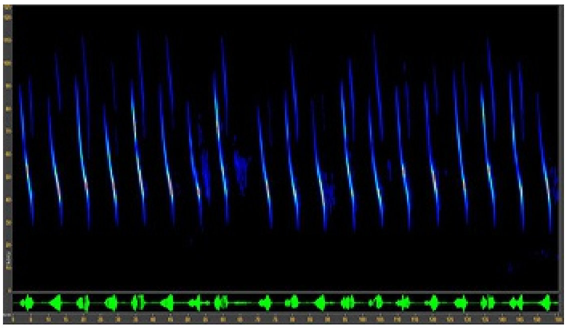

Natterer's Bat - call duration 3.0-3.1 ms

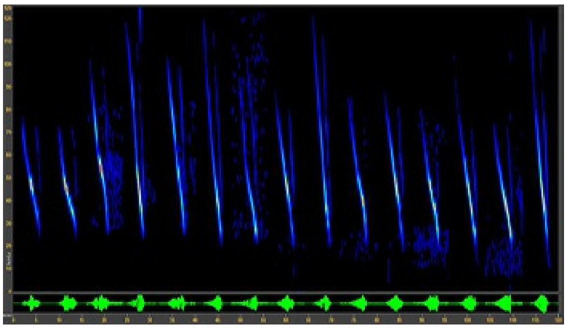

Daubenton's Bat - call duration 3.2-3.3 ms

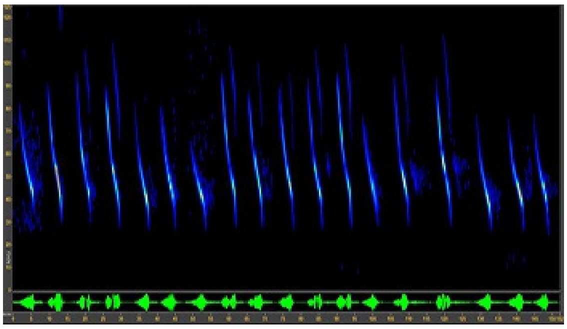

Natterer's Bat - call duration 3.2-3.3 ms

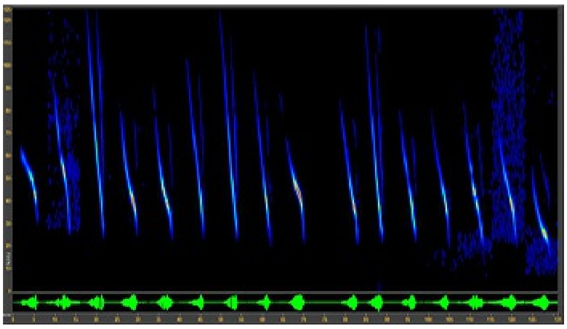

Daubenton's Bat - call duration 3.4-3.5 ms

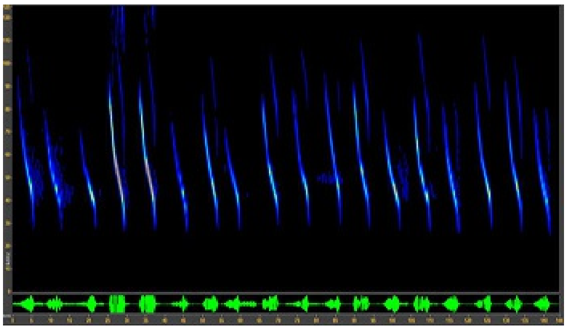

Natterer's Bat - call duration 3.4-3.5 ms

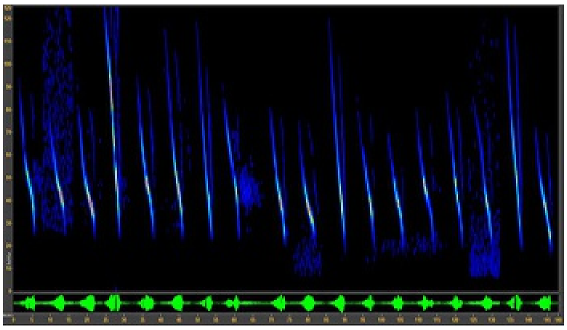

Daubenton's Bat - call duration 3.6-3.7 ms

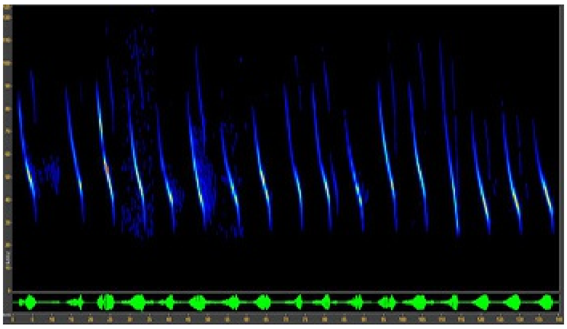

Natterer's Bat - call duration 3.6-3.7 ms

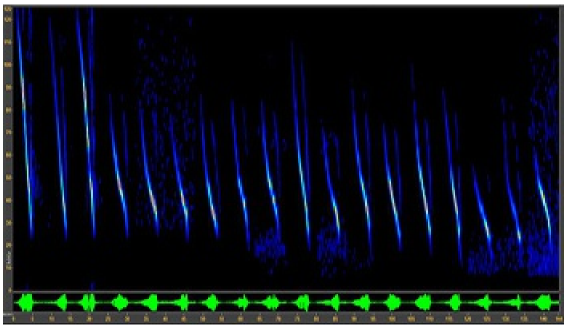

Daubenton's Bat - call duration 3.8-3.9 ms

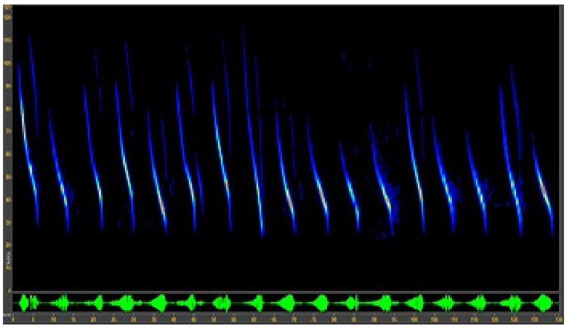

Natterer's Bat - call duration 3.8-3.9 ms

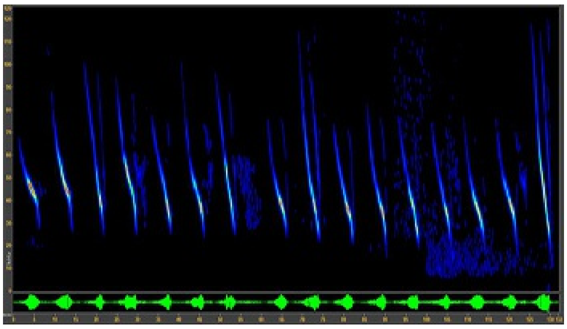

Daubenton's Bat - call duration 4.0-4.1 ms

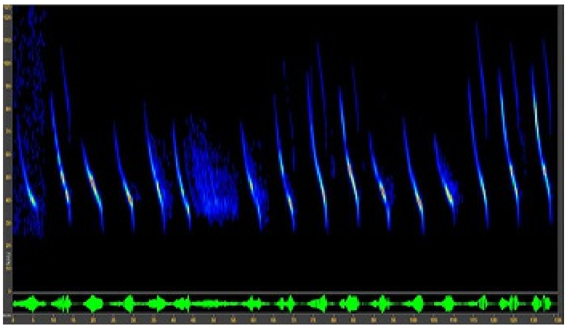

Natterer's Bat - call duration 4.0-4.1 ms

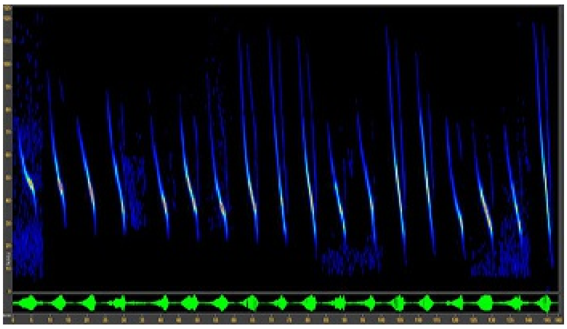

Daubenton's Bat - call duration 4.2-4.3 ms

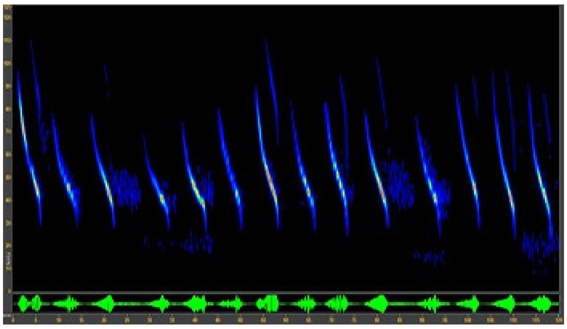

Natterer's Bat - call duration 4.2-4.3 ms

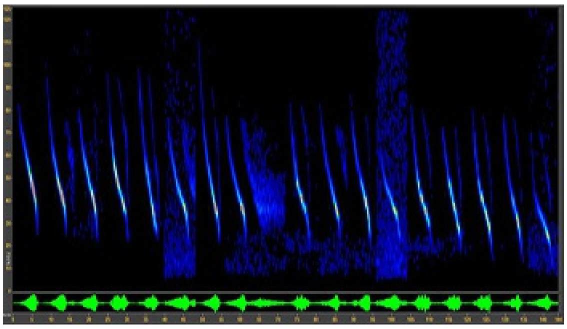

Daubenton's Bat - call duration 4.4-4.5 ms

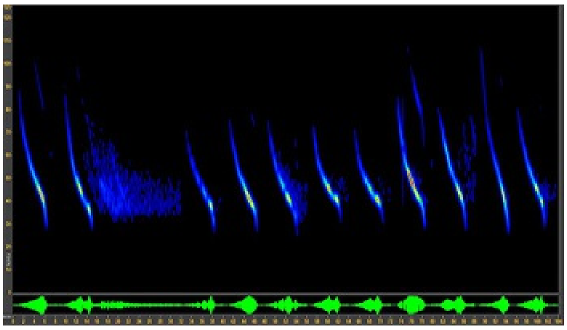

Natterer's Bat - call duration 4.4-4.5 ms

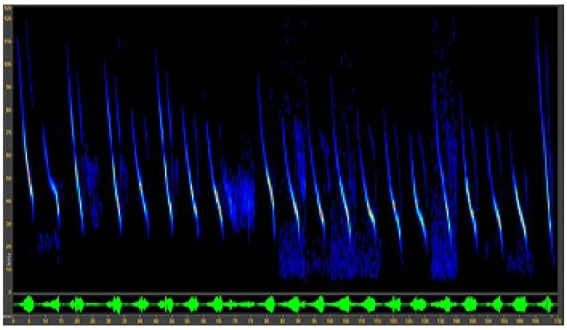

Daubenton's Bat - call duration 4.6-4.7 ms

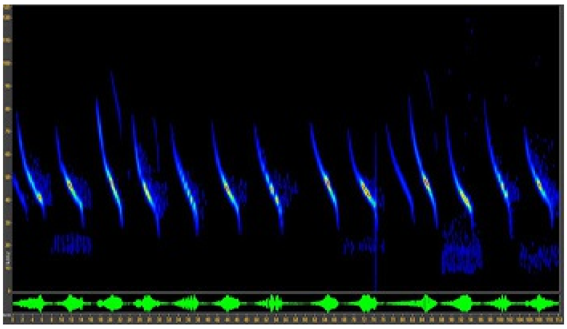

Natterer's Bat - call duration 4.6-4.7 ms

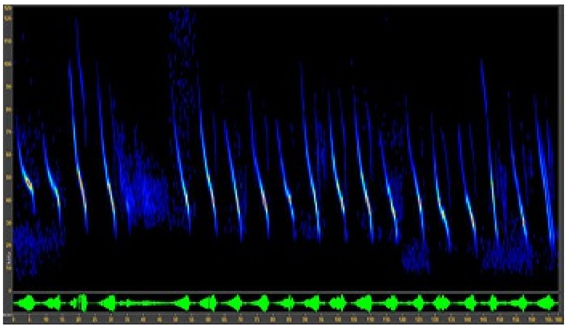

Daubenton's Bat - call duration 4.8-4.9 ms

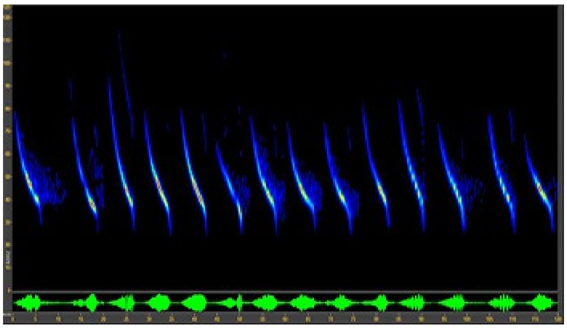

Natterer's Bat - call duration 4.8-4.9 ms

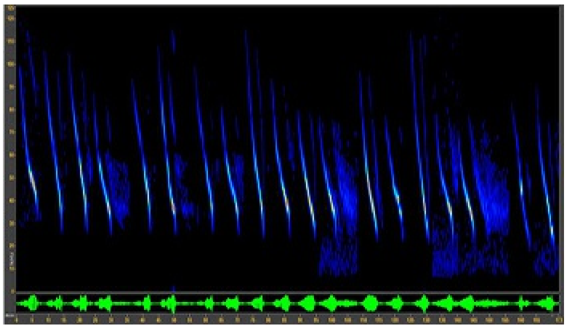

Daubenton's Bat - call duration 5.0-5.1 ms

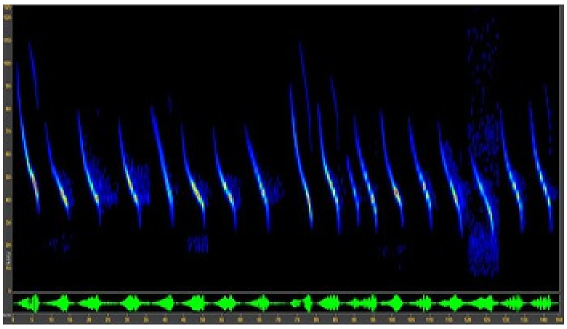

Natterer's Bat - call duration 5.0-5.1 ms

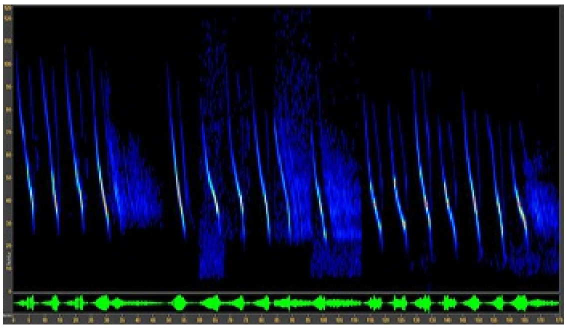

Daubenton's Bat - call duration 5.2-5.3 ms

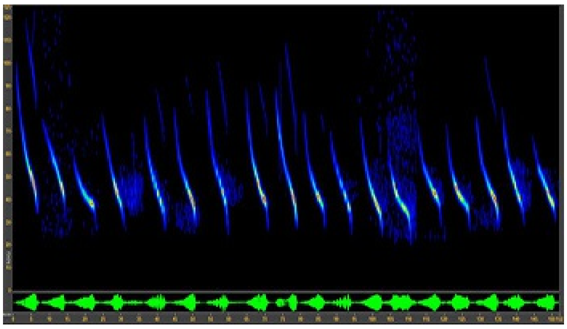

Natterer's Bat - call duration 5.2-5.3 ms

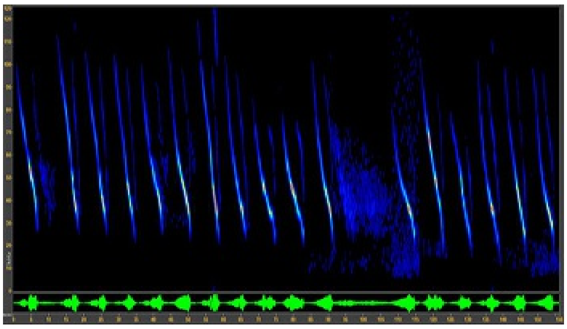

Daubenton's Bat - call duration 5.4-5.5 ms

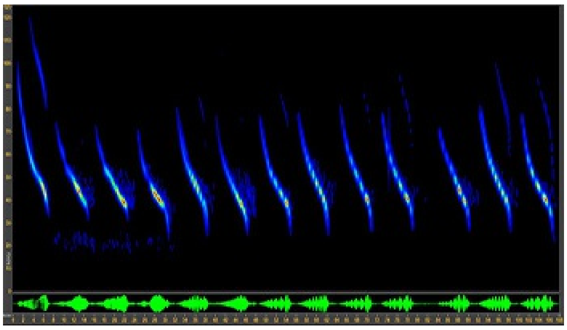

Natterer's Bat - call duration 5.4-5.5 ms

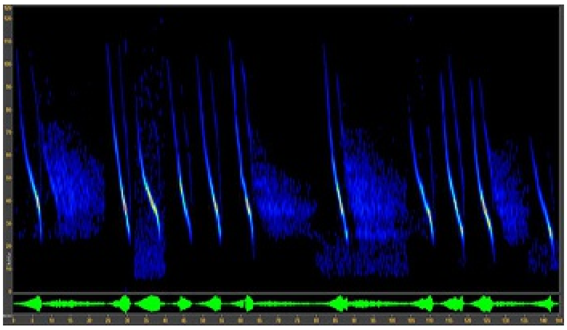

Daubenton's Bat - call duration 5.6-5.7 ms

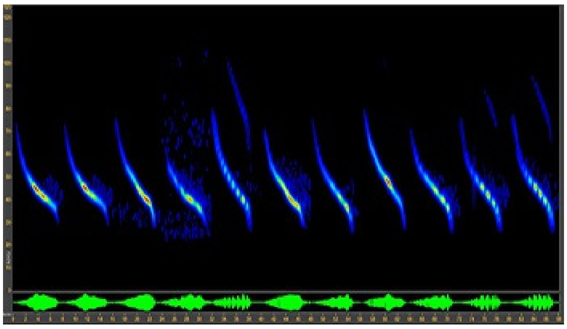

Natterer's Bat - call duration 5.6-5.7 ms

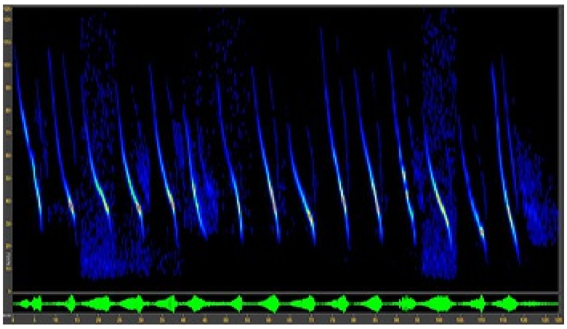

Daubenton's Bat - call duration 5.8-5.9 ms

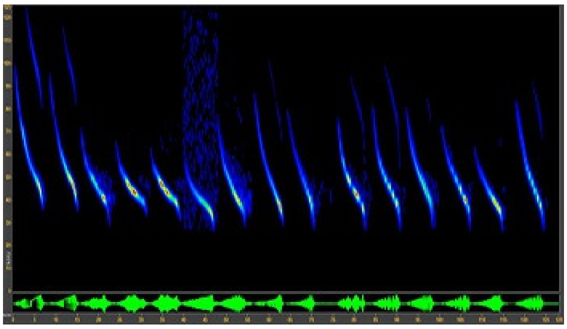

Natterer's Bat - call duration 5.8-5.9 ms

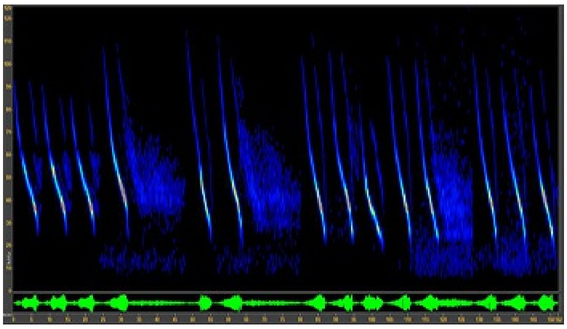

Daubenton's Bat - call duration 6.0-6.1 ms

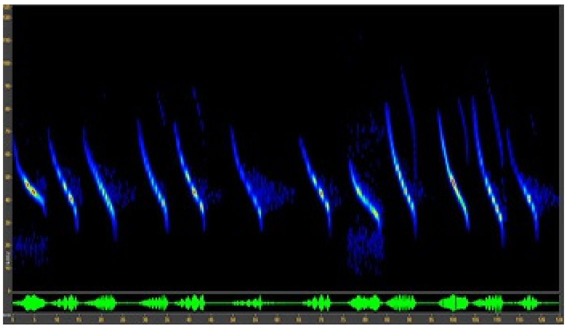

Natterer's Bat - call duration 6.0-6.1 ms


Daubenton's Bat - call duration 6.2-6.3 ms

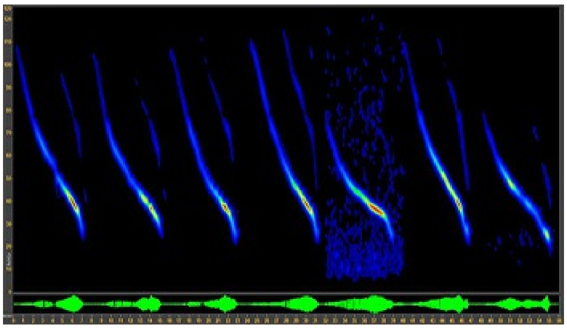

Natterer's Bat - call duration 6.2-6.3 ms


Daubenton's Bat - call duration 6.4-6.6 ms

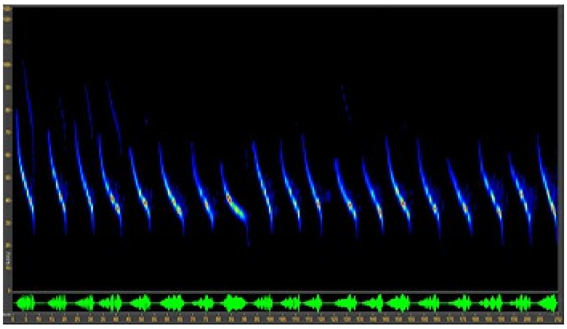

Natterer's Bat - call duration 6.4-6.6 ms



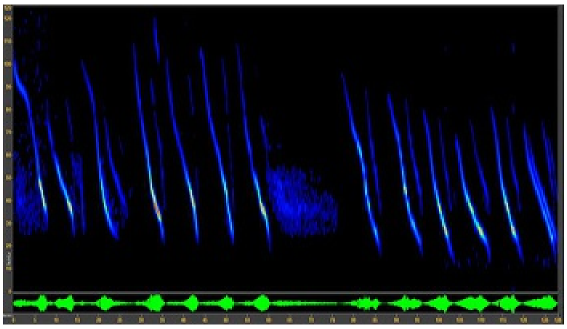
Daubenton's Bat - call duration 6.7-6.8 ms



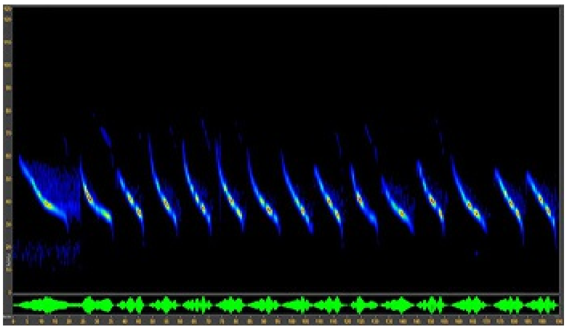
Natterer's Bat - call duration 6.7-6.8 ms



Daubenton's Bat - call duration 6.9-9.5 ms



Natterer's Bat - call duration 6.9-9.5 ms



Daubenton's Bat - call duration 9.6-17.3 ms

Natterer's Bat - call duration 9.6-17.3 ms no examples

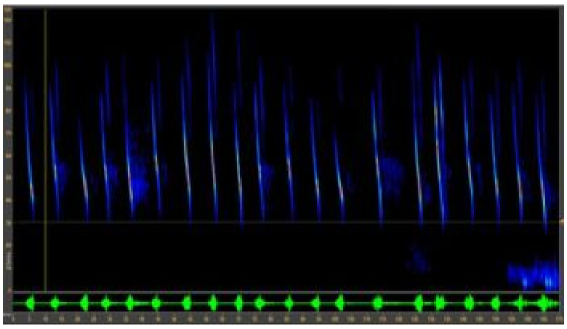
Identification appendix 3: Whiskered/Brandt's Bat *Myotis mystacinus/brandtii*

When it comes to the sound identification of bats in the genus *Myotis*, there is a common view that it is not possible to assign recordings to species, even among experienced bat workers. In the following, we would like to explain, with a recording of Whiskered Bat or Brandt's Bat, some of our thinking on how we approach an identification.

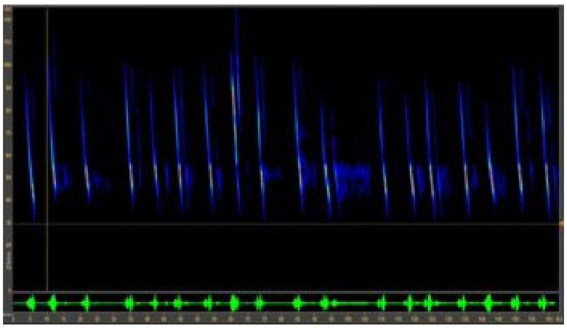
Given a *Myotis* recording, an important first consideration is the quality of the recording. Firstly, to consider whether there is significant overloading across calls that makes it difficult to determine the start and end of the calls. There is a bit of overloading in a few of the recordings of Whiskered or Brandt's Bat recordings shown in the main part of the report, but this is not extreme, and there are some good quality calls still in the sequence.

The next important consideration is to look at the ends of the calls, and to determine whether there is important attenuation of the weaker ends of the calls - in other words, whether you are missing the ends of the calls. Where there is attenuation of the calls, the apparent ends of the calls may appear to be higher in frequency than is really the case, and the start of the calls lower in frequency than is really the case. If there is important attenuation of the calls, it is often necessary to stop at this point and to not go further with an identification.

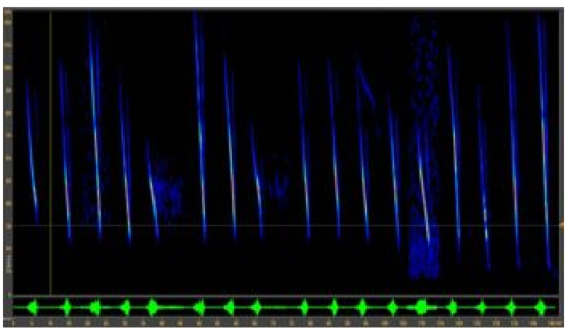
If the quality of the recordings and calls is good, we would normally expect to have a good idea of what species produced it, but it is helpful next to consider what you would expect calls of that species, given that call duration to look like, and to consider how this compares with other similar species. Just to illustrate, in the below I compare one good call from a recording of Whiskered Bat or Brandt's Bat (call shown left of the yellow vertical line in all the spectrograms below), with known calls for other *Myotis* species (compiled recordings made from known species recordings using the Sonobat Reference Compiler). Taking this approach for the recordings above, it is straightforward to see that the recordings above are well outside what you would expect for Natterer's Bat and Alcathoe bat. The difference between short duration calls of Daubenton's Bat and the presumed Whiskered / Brandt's Bat is more subtle. In Whiskered / Brandt's Bat for calls of this duration there tends to be a long and steep neck to calls and kink in the calls towards the bottom. This can be seen in Daubenton's Bat, but it is not so typical for this species, and would be usual for such calls to present across a sequence of calls without some additional clues to the real identification. The chance of seeing atypical calls is less likely again, where there is more than one recording at almost the same time of what is likely to be the same bat as seen here.



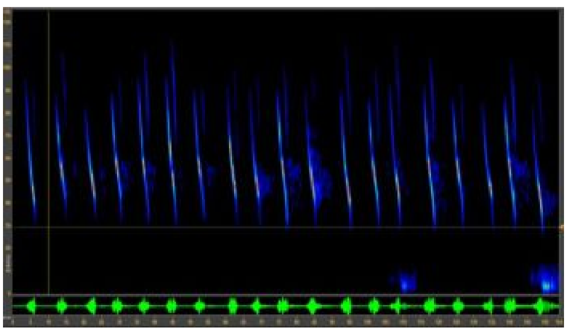
Whiskered or Brandt's Bat call (left), against known Whiskered calls (right)



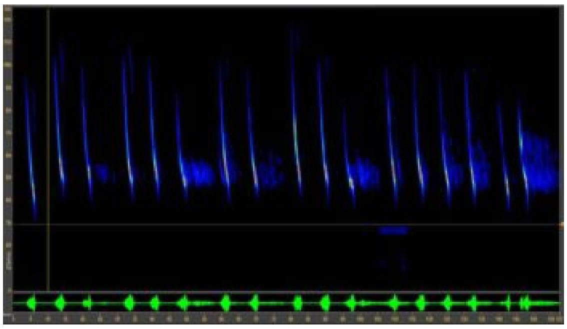
Whiskered or Brandt's Bat call (left), against known Brandt's Bat calls (right)



Whiskered or Brandt's Bat call (left), against Natterer's Bat calls (right)



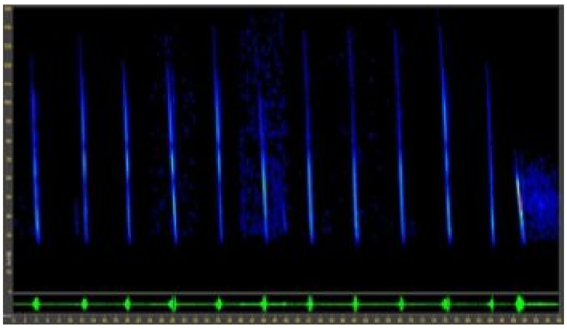
Whiskered or Brandt's Bat call (left), against known Daubenton's Bat calls (right)



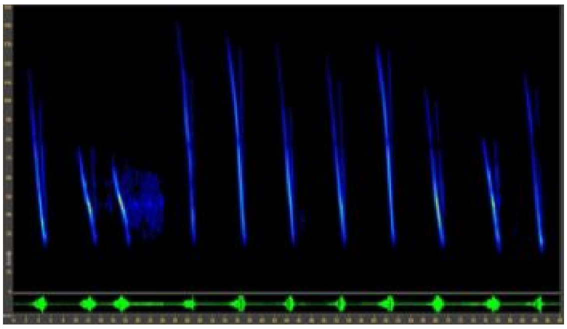
Whiskered or Brandt's Bat call (left), against known Alcathoe Bat calls (right)

Identification appendix 4: Natterer's Bat *Myotis nattereri*

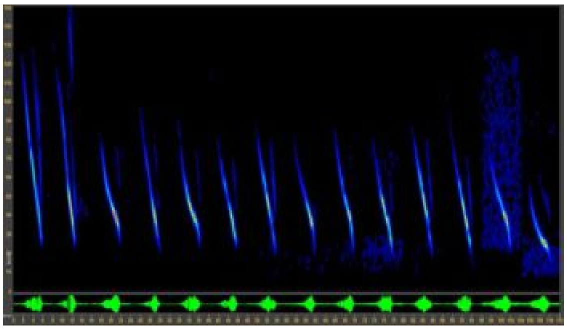
As with Whiskered and Brandt's Bat, the first consideration when looking at recordings is the quality of the recording, to consider whether the quality is good enough to try to assign the recording to species. Given a good recording, Natterer's Bat can occasionally produce atypical calls that could be mistaken for other *Myotis* species. However, such unusual calls rarely continue for long, and careful consideration of these, and in relation to neighbouring recordings where these are present to understand what is going on, should be sufficient in most cases to be able to assign these to species. In the below, we illustrate some of the range of variation in calls of Natterer's Bat from very short calls produced when flying in extreme clutter to long duration calls produced when flying in the open.



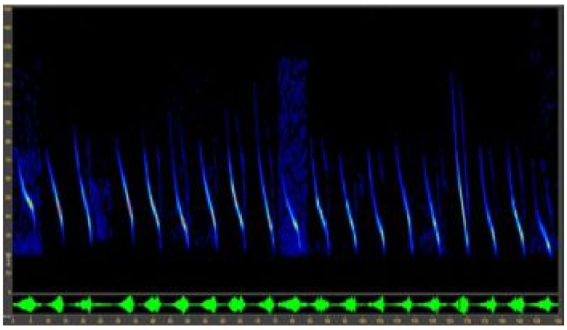
Natterer's Bat - call duration up to 1.2 ms



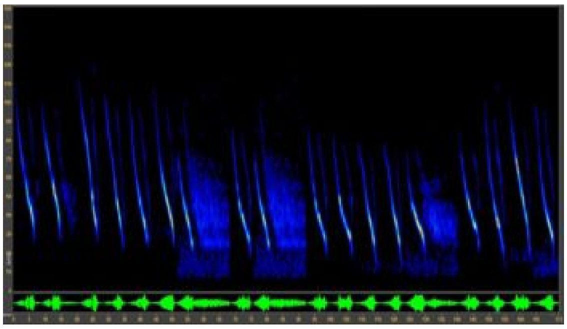
Natterer's Bat - call duration 2.7-2.8 ms



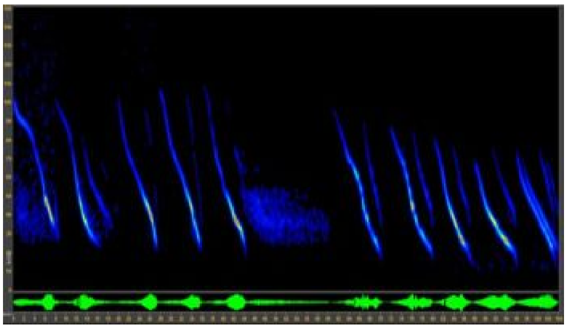
Natterer's Bat - call duration 3.9-4.0 ms



Natterer's Bat - call duration 4.9-5.0 ms

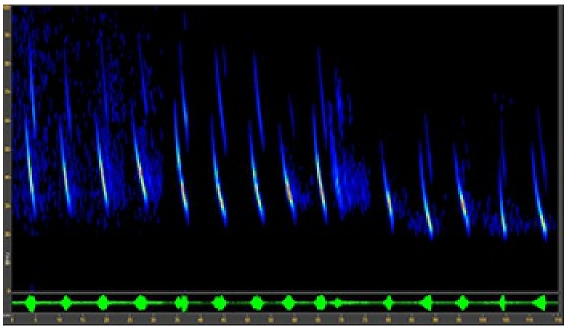


Natterer's Bat - call duration 5.9-6.0 ms

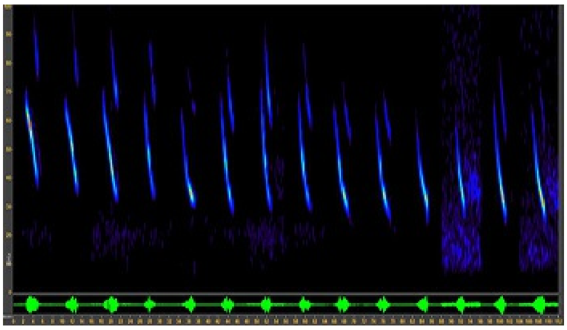


Natterer's Bat - call duration 7.1-9.4 ms

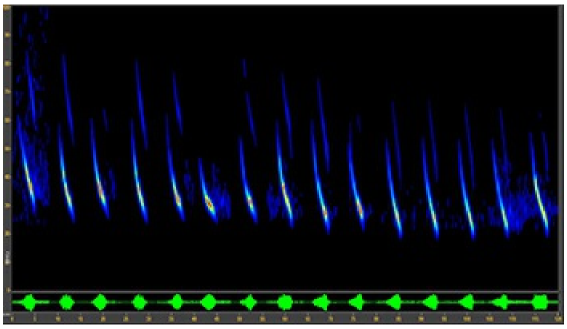
Identification appendix 5: Common Noctule *Nyctalus noctula* and Leisler's Bat *Nyctalus leisleri*



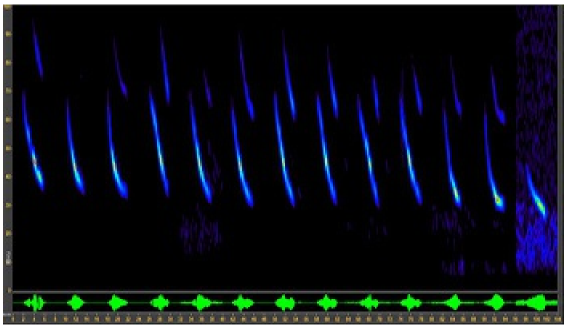
Common Noctule - call duration 1.4-3.0 ms



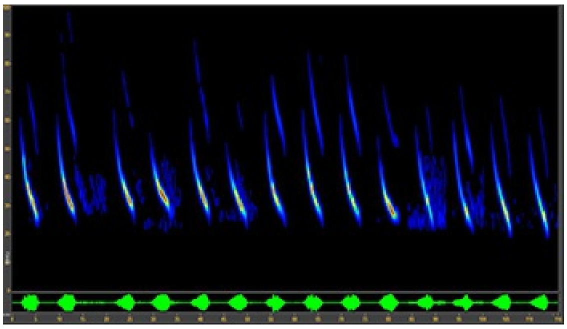
Leisler's Bat - call duration 1.4-3.0 ms



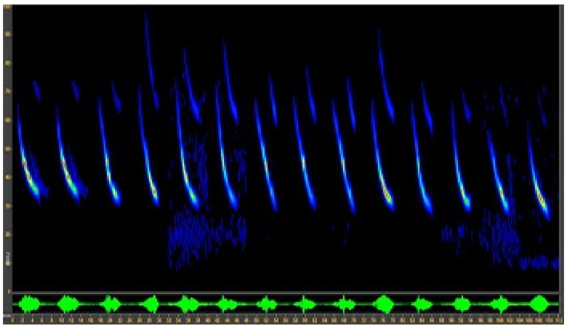
Common Noctule - call duration 3.1-3.7 ms



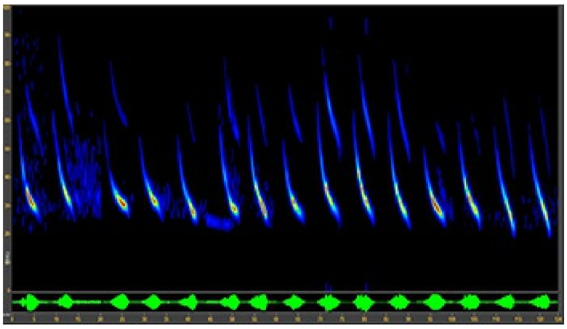
Leisler's Bat - call duration 3.1-3.7 ms



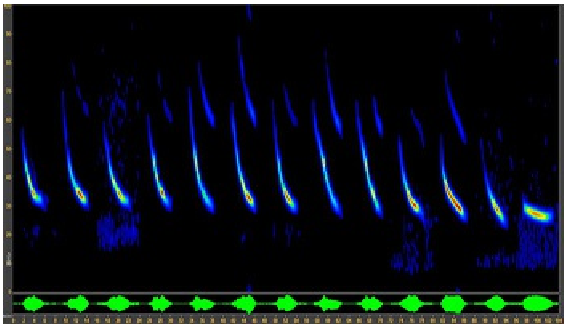
Common Noctule - call duration 3.8-4.3 ms



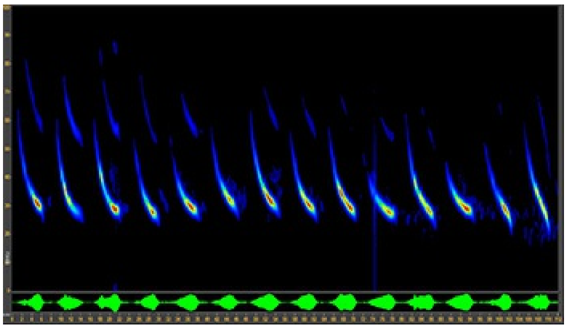
Leisler's Bat - call duration 3.8-4.3 ms

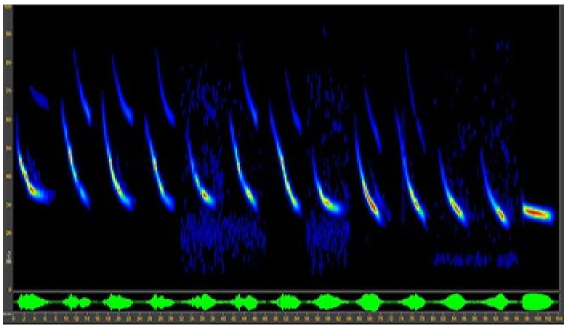


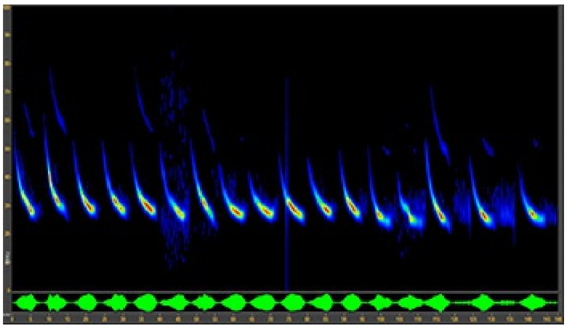
Common Noctule - call duration 4.4-4.9 ms

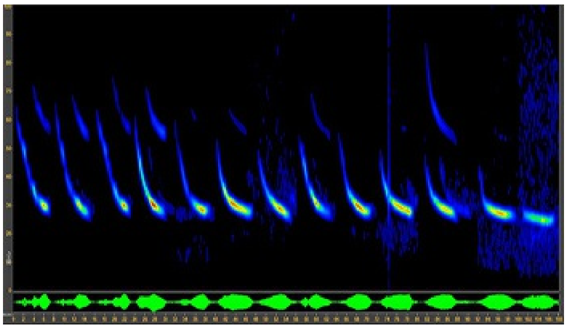


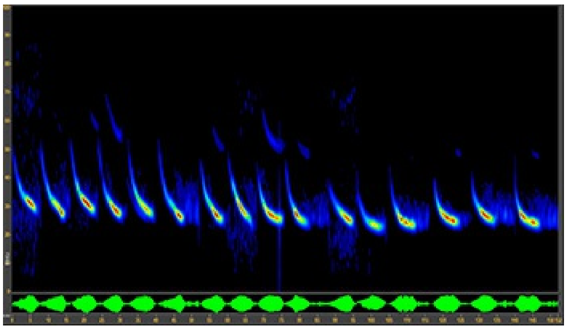
Leisler's Bat - call duration 4.4-4.9 ms

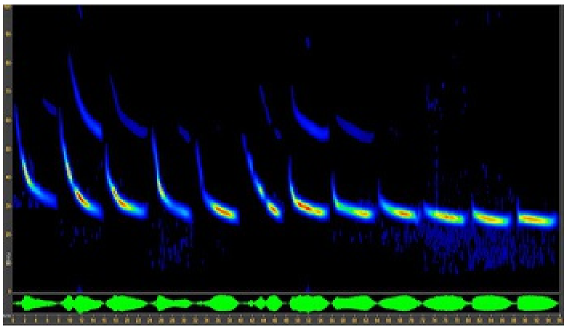

Common Noctule - call duration 5.0-5.9 ms

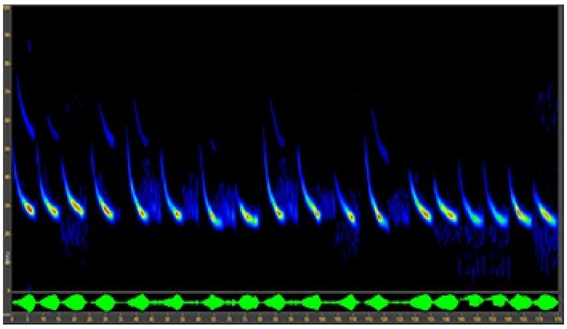

Leisler's Bat - call duration 5.0-5.9 ms

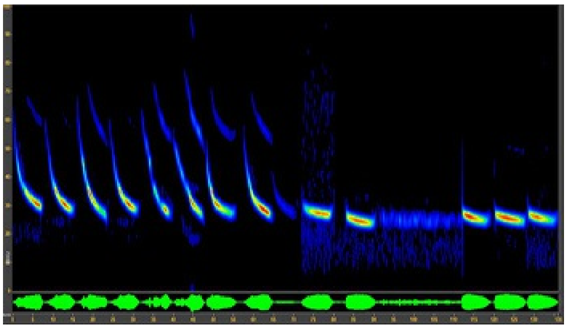

Common Noctule - call duration 6.0-6.8 ms

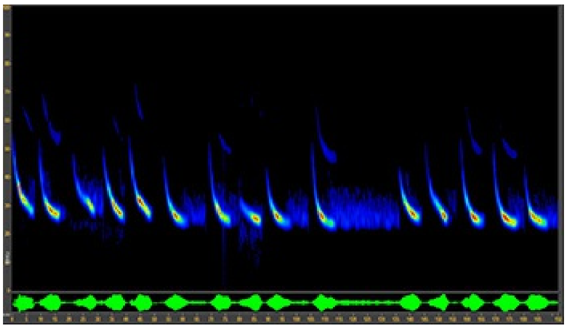

Leisler's Bat - call duration 6.0-6.8 ms

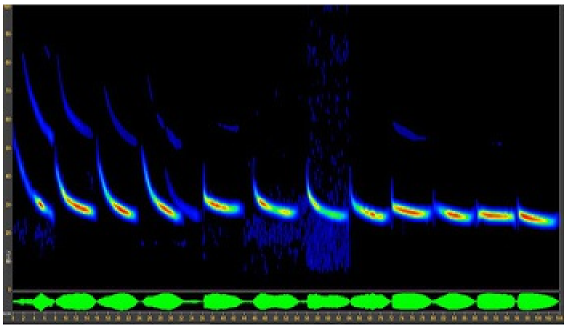

Common Noctule - call duration 6.9-7.2 ms

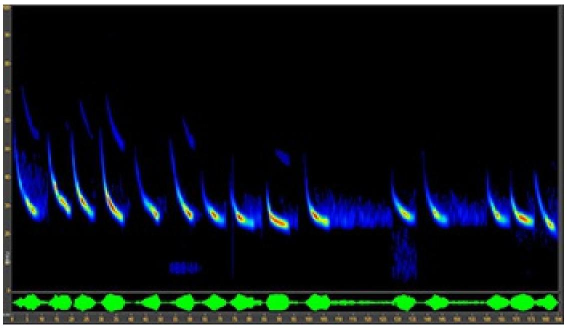

Leisler's Bat - call duration 6.9-7.2 ms

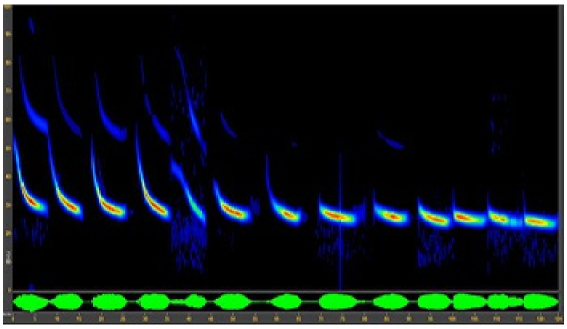

Common Noctule - call duration 7.3-7.6 ms

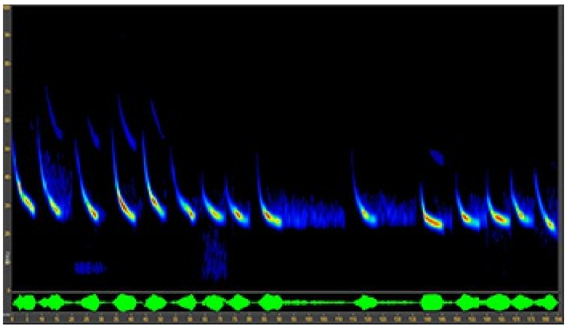

Leisler's Bat - call duration 7.3-7.6 ms

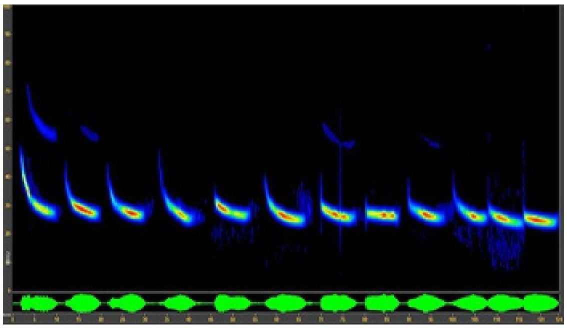

Common Noctule - call duration 7.7-7.8 ms

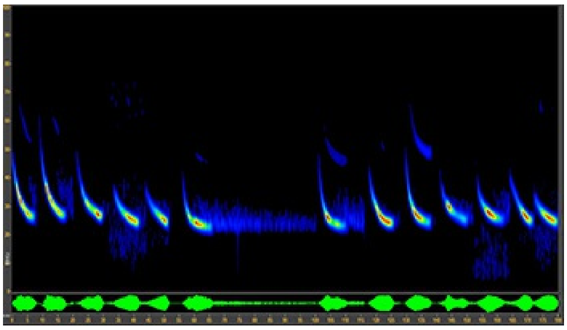

Leisler's Bat - call duration 7.7-7.8 ms

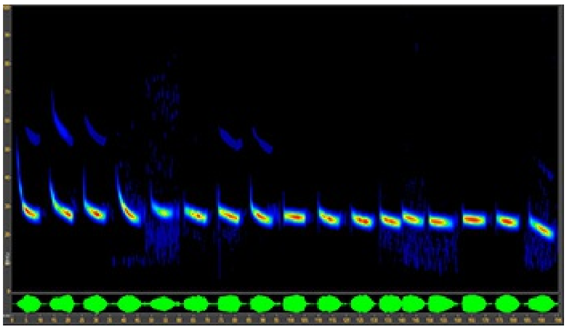

Common Noctule - call duration 7.9-8.0 ms

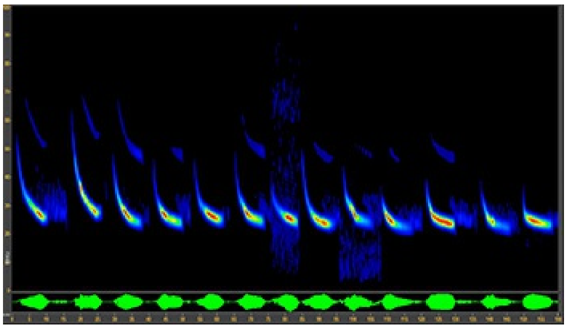

Leisler's Bat - call duration 7.9-8.0 ms

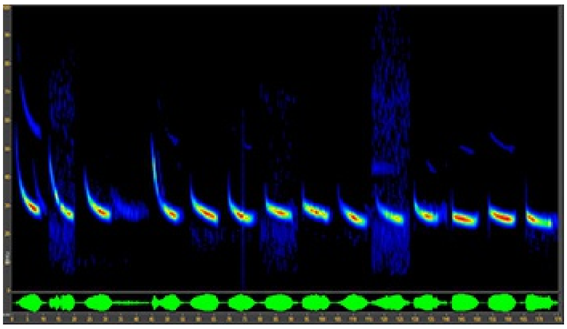

Common Noctule - call duration 8.1-8.3 ms

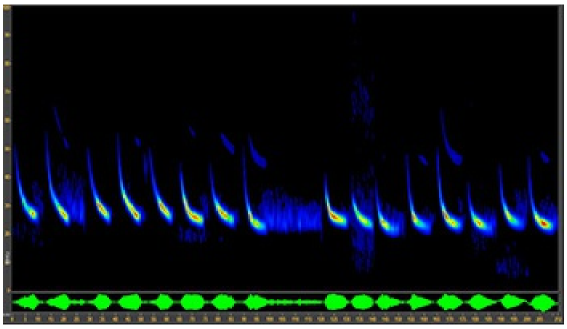

Leisler's Bat - call duration 8.1-8.3 ms

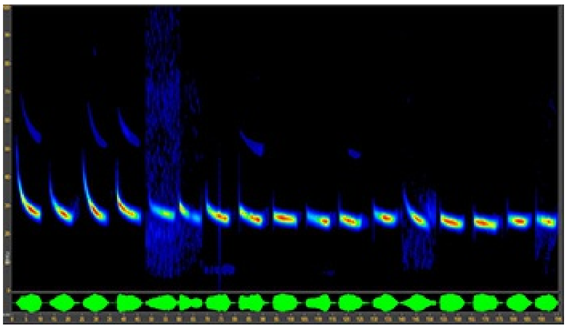

Common Noctule - call duration 8.4-8.5 ms

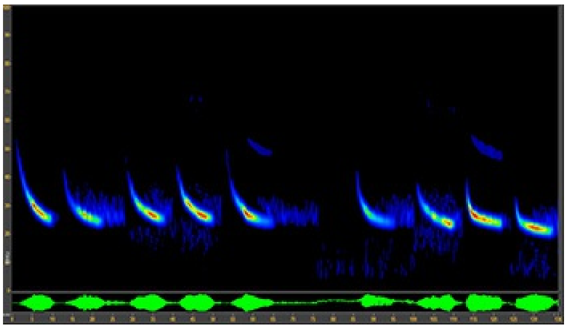

Leisler's Bat - call duration 8.4-8.5 ms

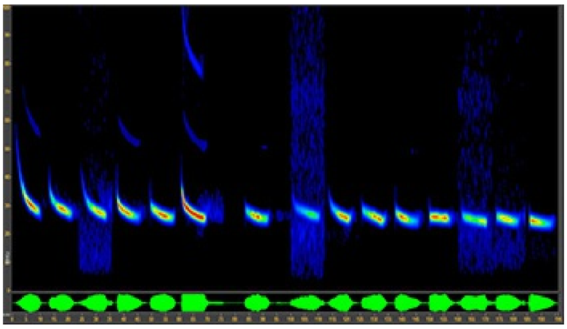

Common Noctule - call duration 8.6-8.7 ms

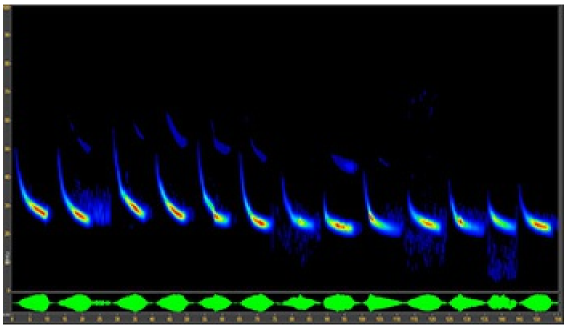

Leisler's Bat - call duration 8.6-8.7 ms

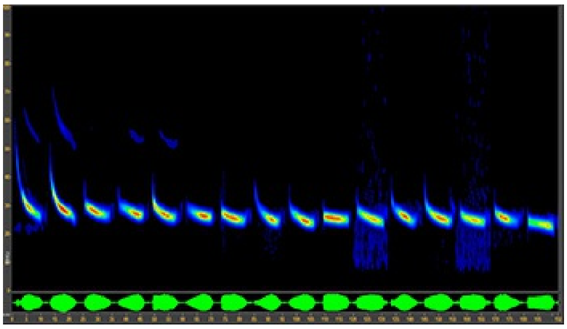

Common Noctule - call duration 8.8-8.9 ms

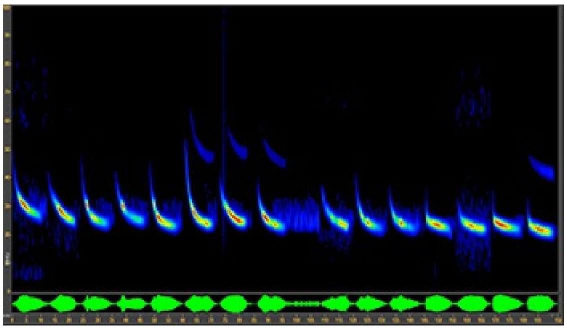

Leisler's Bat - call duration 8.8-8.9 ms

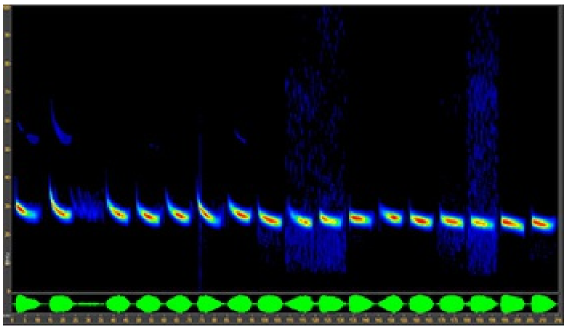

Common Noctule - call duration 9.0-9.1 ms

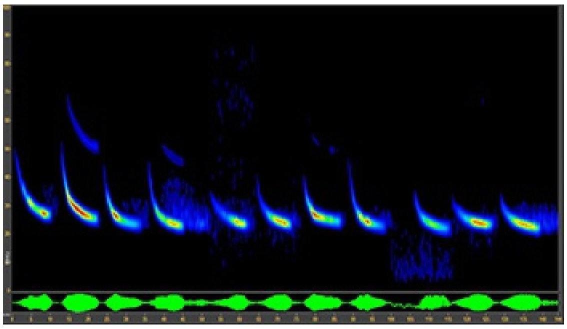

Leisler's Bat - call duration 9.0-9.1 ms

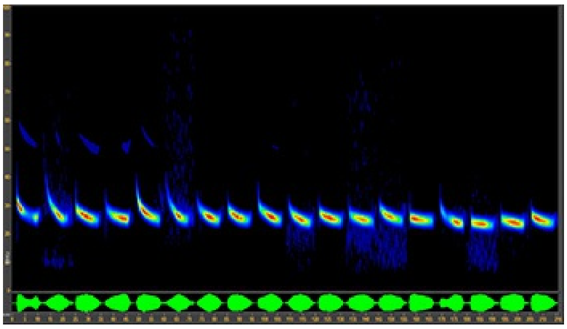

Common Noctule - call duration 9.2-9.3 ms

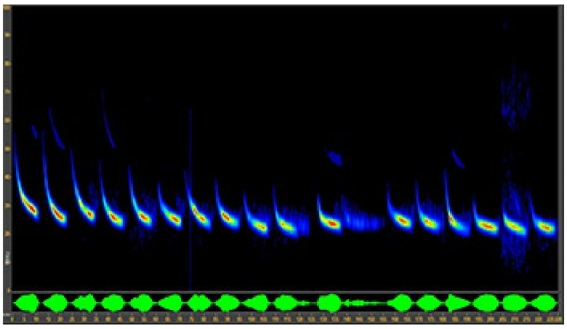

Leisler's Bat - call duration 9.2-9.3 ms

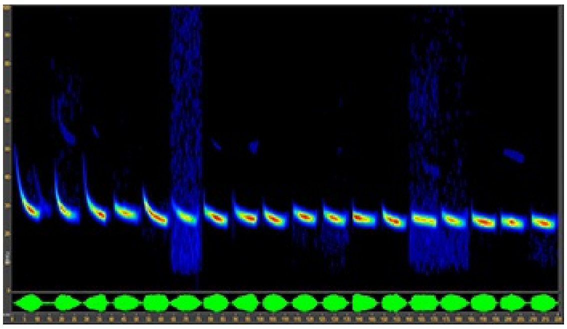

Common Noctule - call duration 9.4-9.5 ms

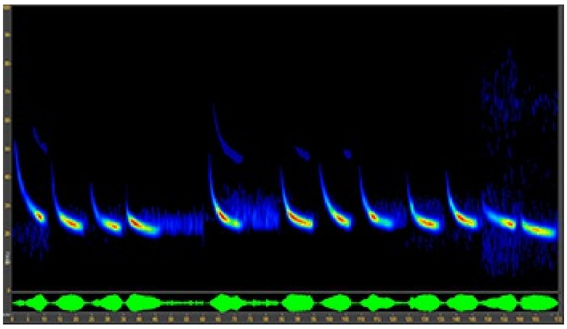

Leisler's Bat - call duration 9.4-9.5 ms


Common Noctule - call duration 9.6-9.7 ms


Leisler's Bat - call duration 9.6-9.7 ms


Common Noctule - call duration 9.8-9.9 ms


Leisler's Bat - call duration 9.8-9.9 ms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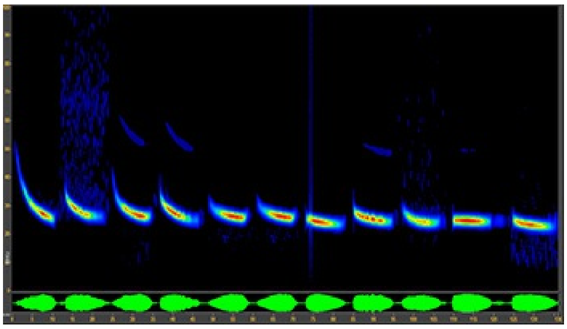
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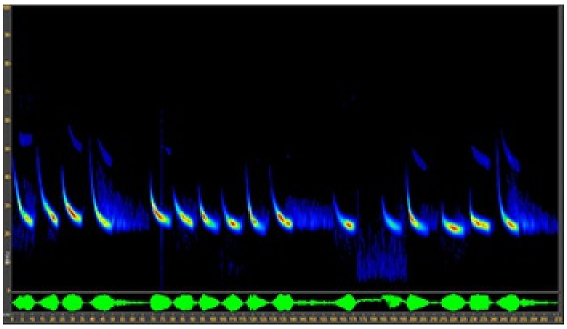
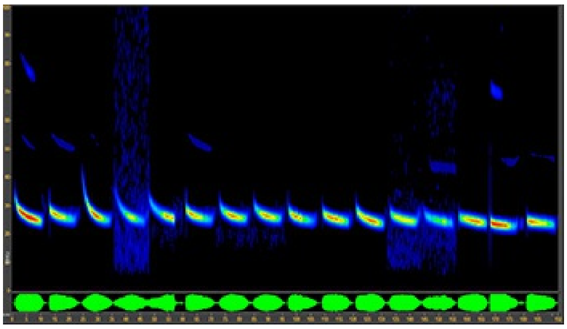
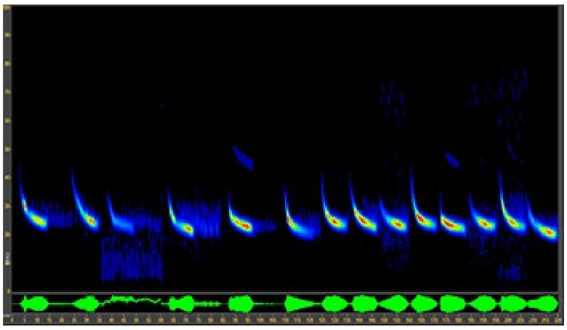
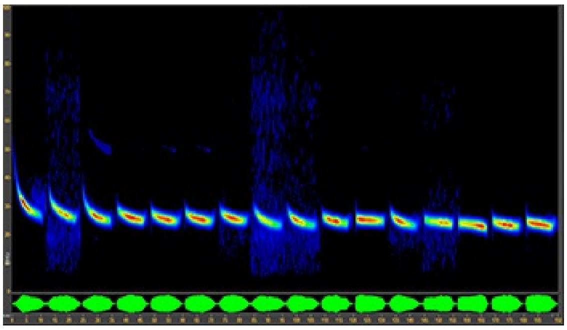
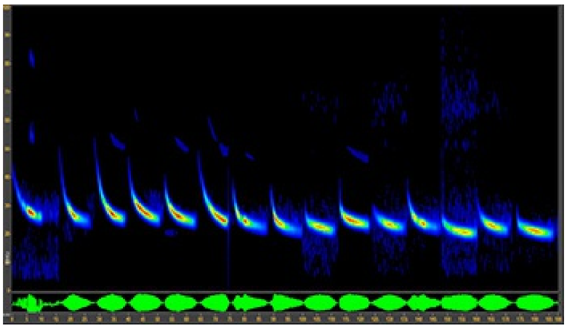

Common Noctule - call duration 10.2-10.3 ms


Leisler's Bat - call duration 10.2-10.3 ms


Common Noctule - call duration 10.4-10.5 ms


Leisler's Bat - call duration 10.4-10.5 ms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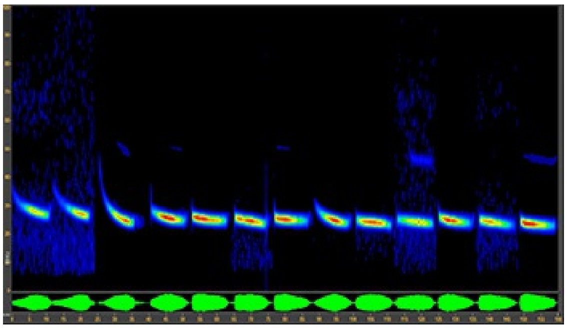
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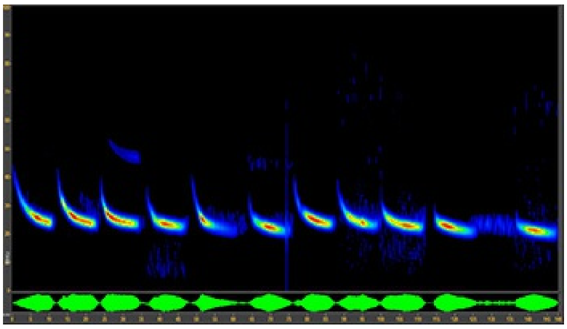
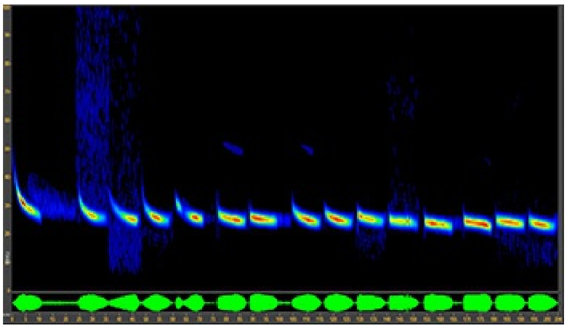

Common Noctule - call duration 10.8-10.9 ms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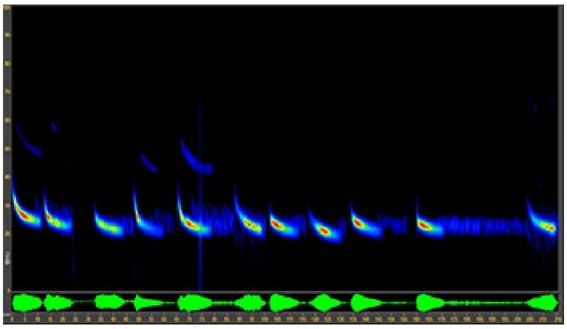
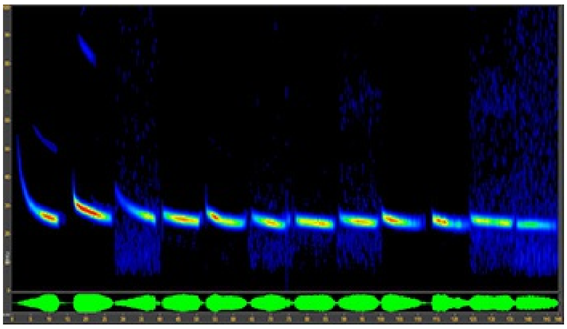

Common Noctule - call duration 11.0-11.1 ms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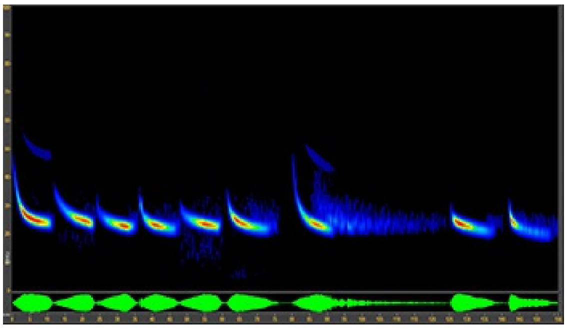
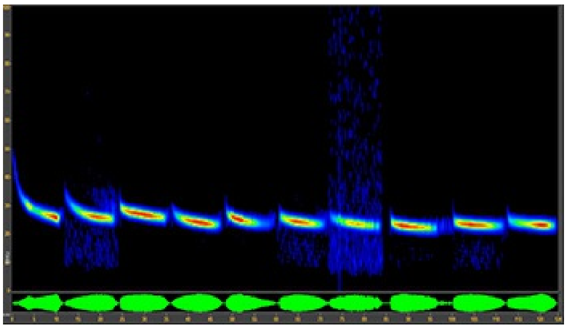
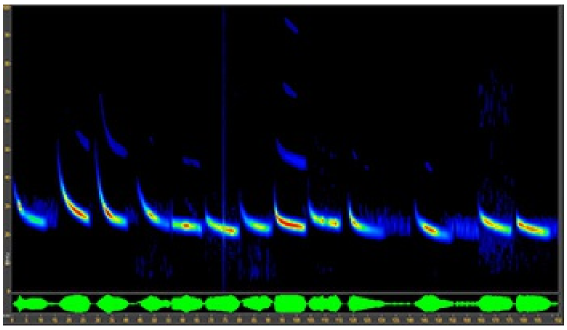

Common Noctule - call duration 11.2-11.3 ms


Leisler's Bat - call duration 11.2-11.3 ms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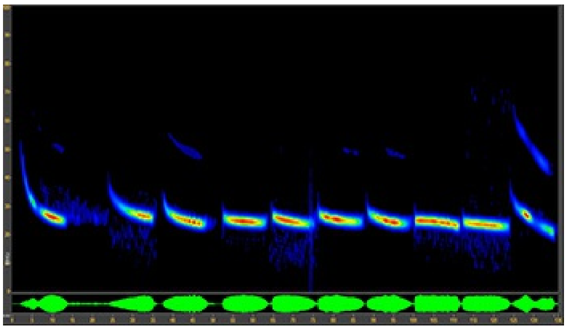
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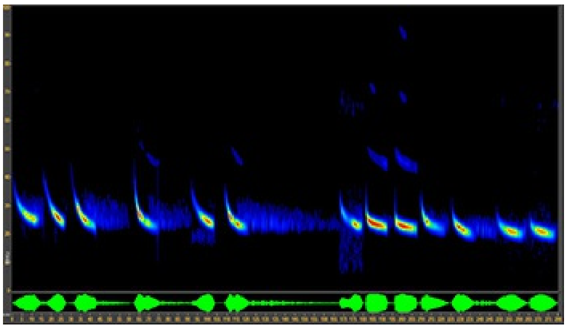
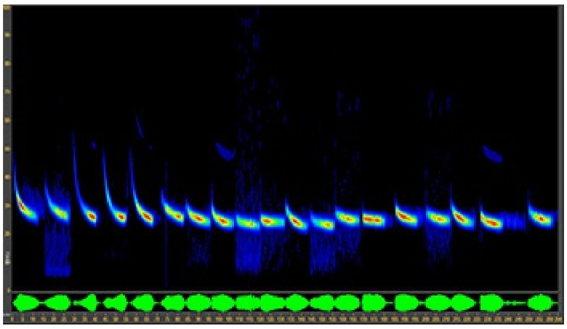

Common Noctule - call duration 11.6-11.7 ms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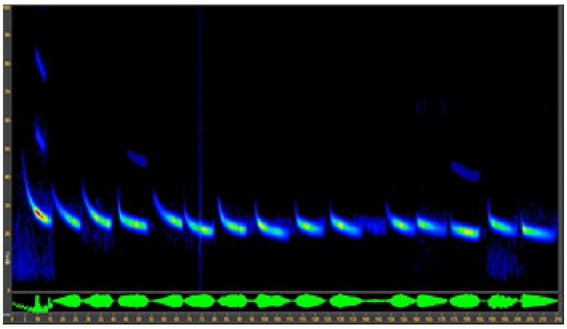
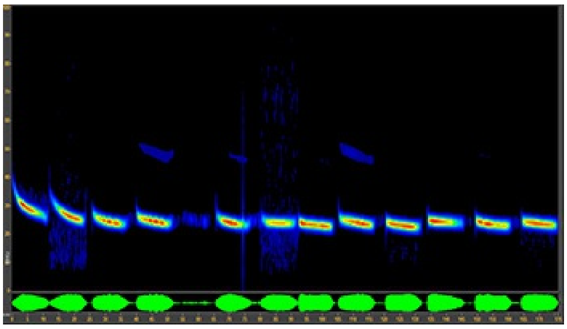

Common Noctule - call duration 11.8-11.9 ms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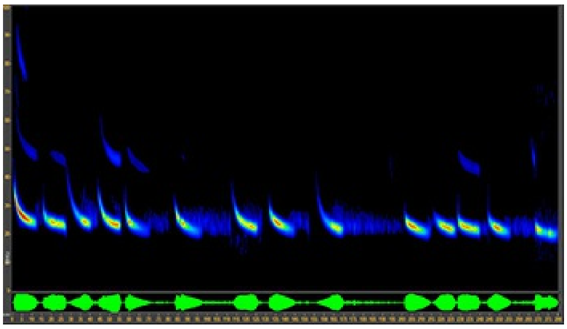
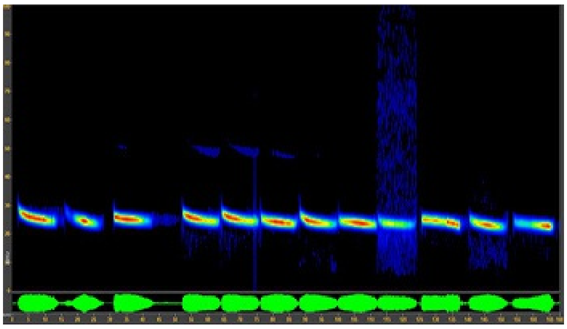

Common Noctule - call duration 12.0-12.2 ms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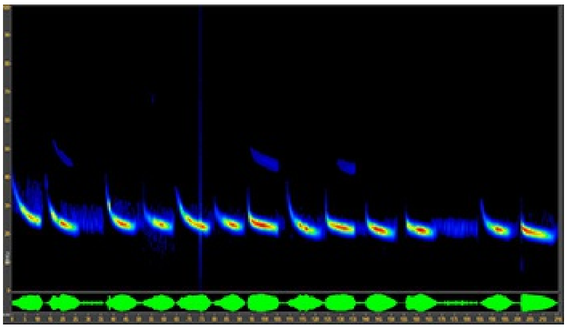
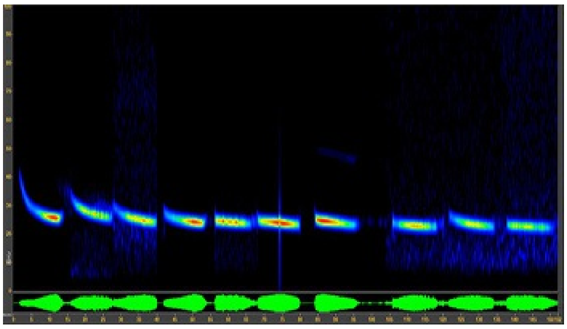
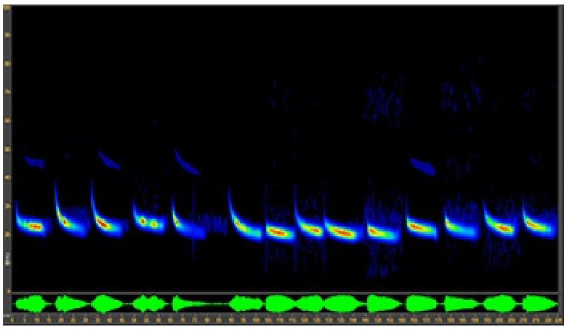
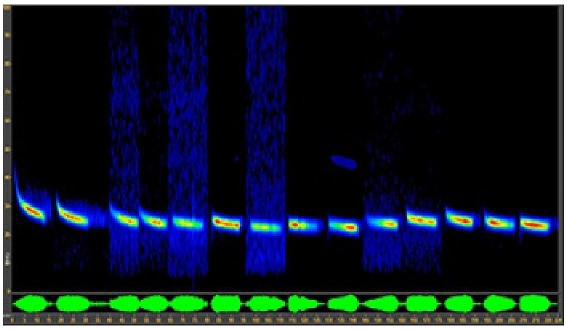
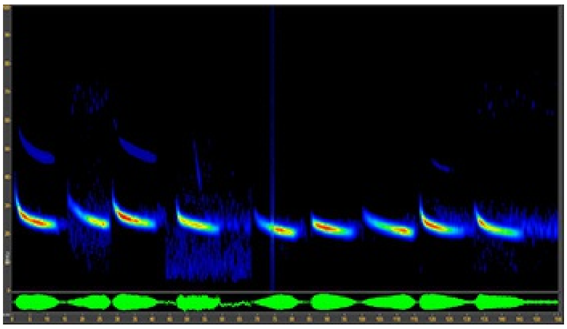

Common Noctule - call duration 12.3-12.4 ms


Leisler's Bat - call duration 12.3-12.4 ms


Common Noctule - call duration 12.5-12.7 ms


Leisler's Bat - call duration 12.5-12.7 ms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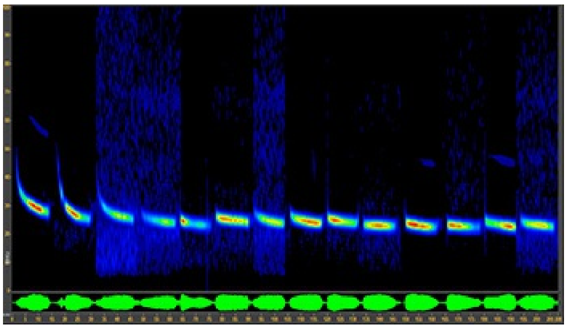
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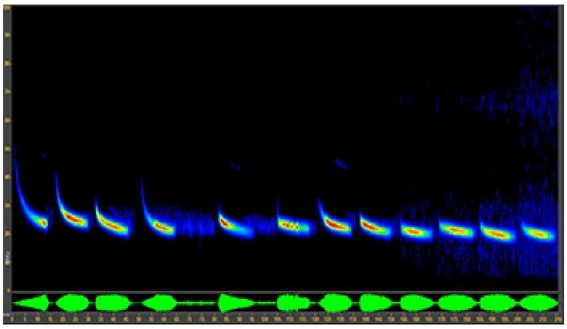
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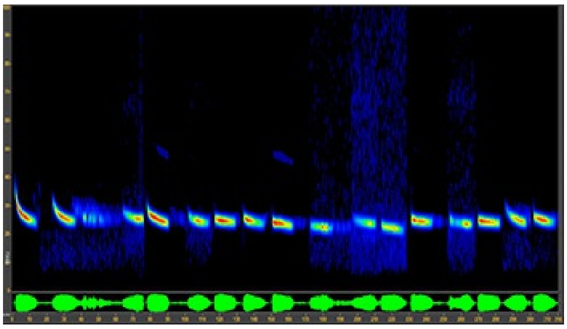
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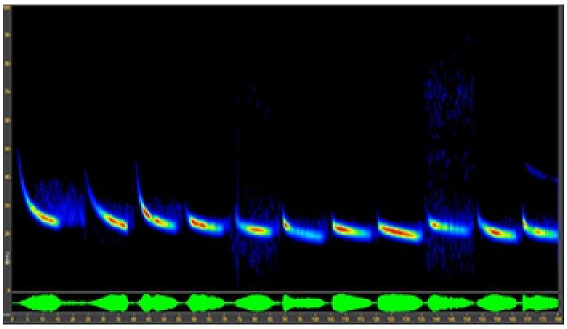
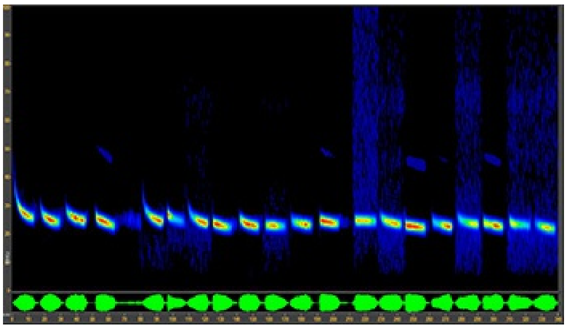
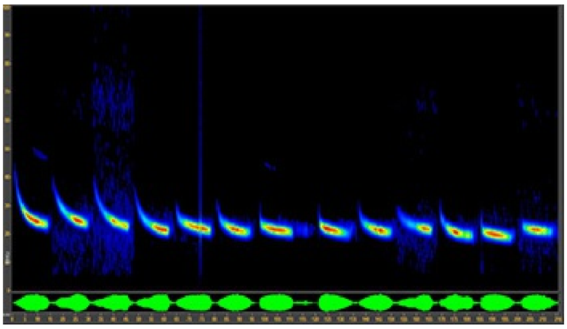
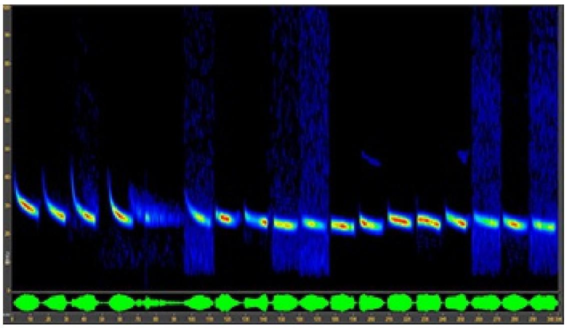
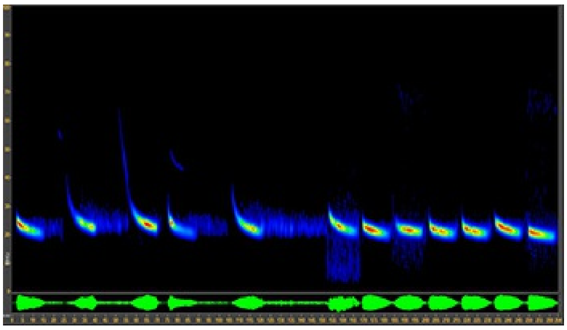
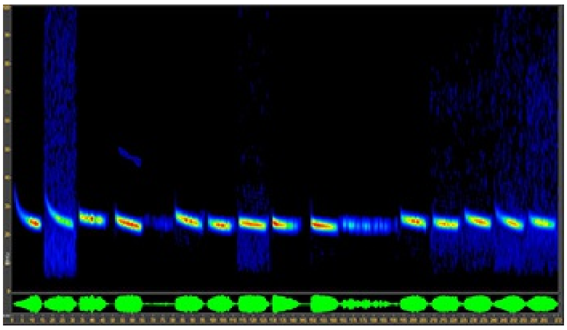

Common Noctule - call duration 13.2-13.3 ms

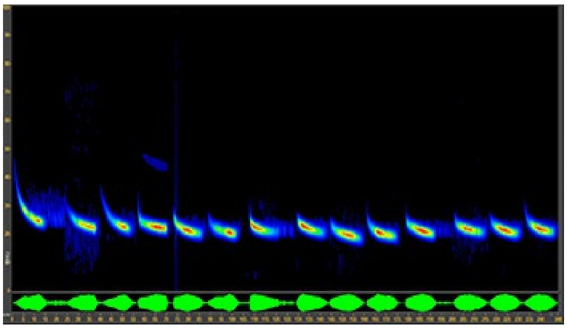

Leisler's Bat - call duration 13.2-13.3 ms

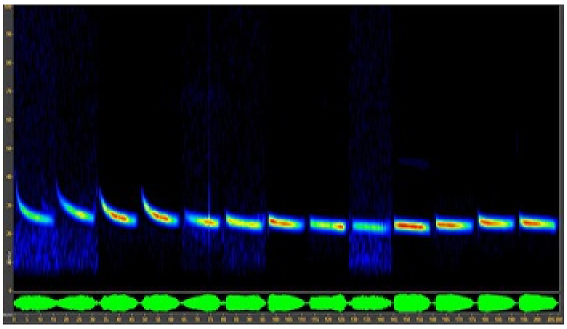

Common Noctule - call duration 13.4-13.5 ms

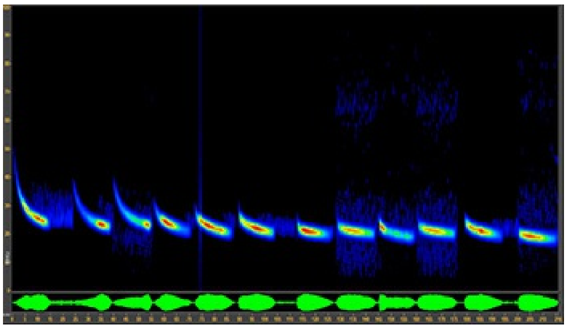

Leisler's Bat - call duration 13.4-13.5 ms

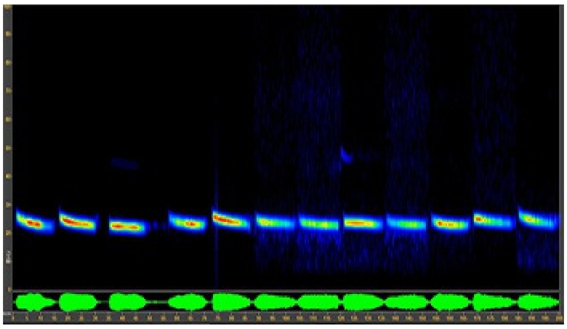

Common Noctule - call duration 13.6-13.7 ms

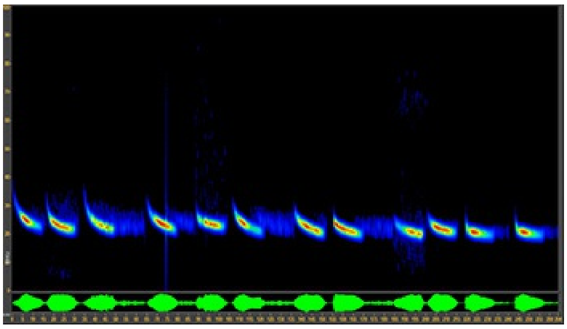

Leisler's Bat - call duration 13.6-13.7 ms


Common Noctule - call duration 13.8-14.0 ms

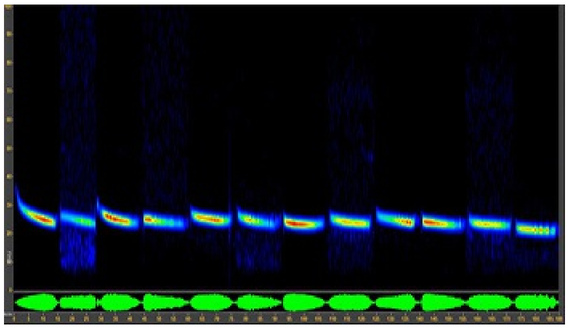

Leisler's Bat - call duration 13.8-14.0 ms


Common Noctule - call duration 14.1-14.3 ms

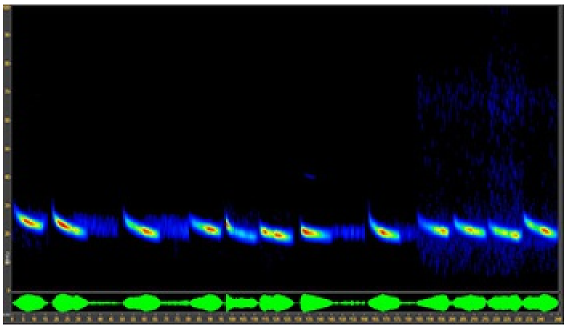

Leisler's Bat - call duration 14.1-14.3 ms



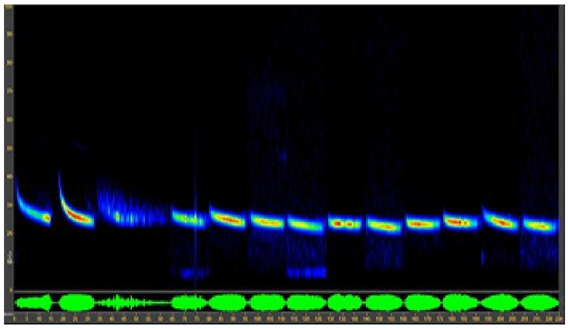
Common Noctule - call duration 14.4-14.5 ms



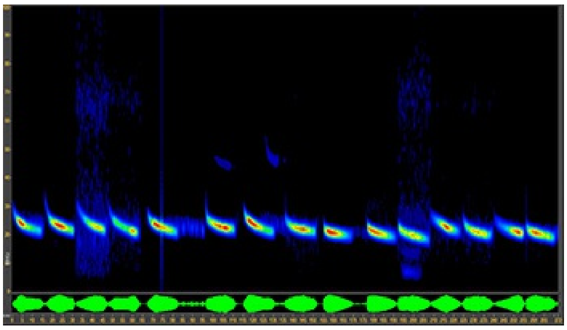
Leisler's Bat - call duration 14.4-14.5 ms



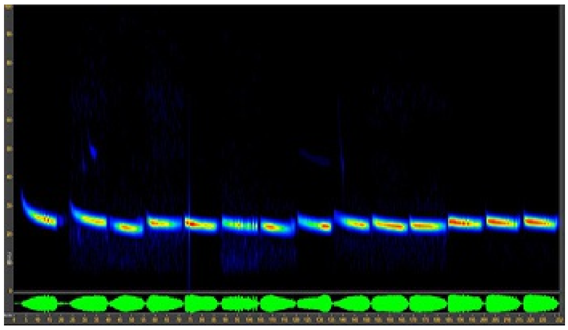
Common Noctule - call duration 14.6-14.8 ms



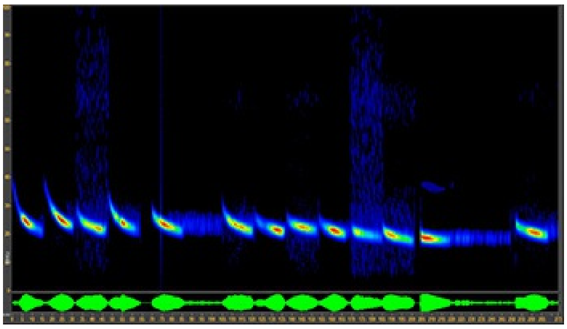
Leisler's Bat - call duration 14.6-14.8 ms



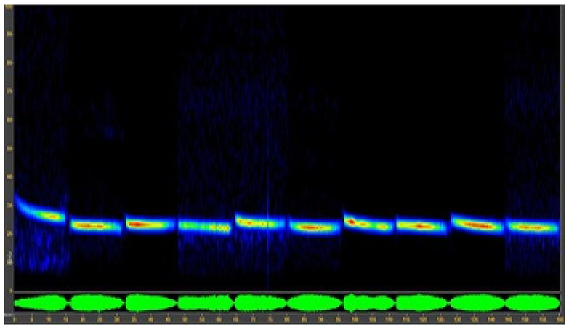
Common Noctule - call duration 14.9-15.1 ms



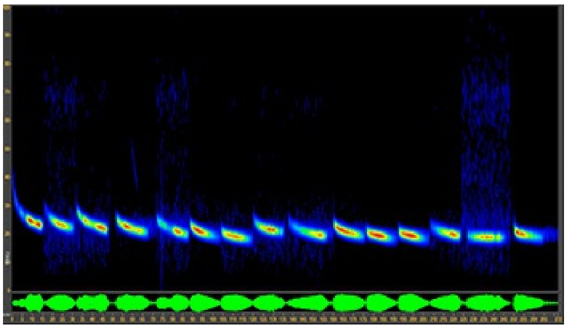
Leisler's Bat - call duration 14.9-15.1 ms



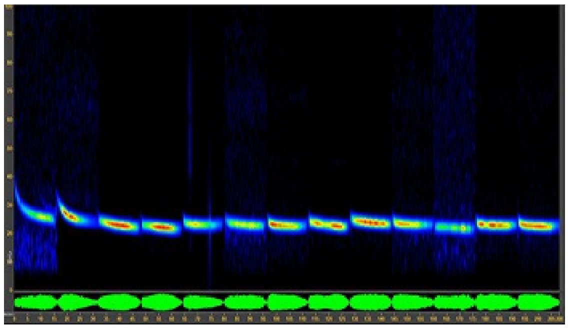
Common Noctule - call duration 15.2-15.3 ms



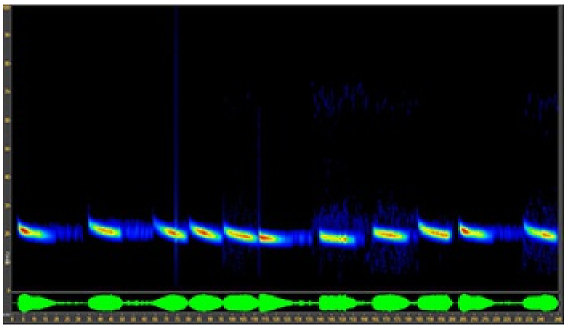
Leisler's Bat - call duration 15.2-15.3 ms

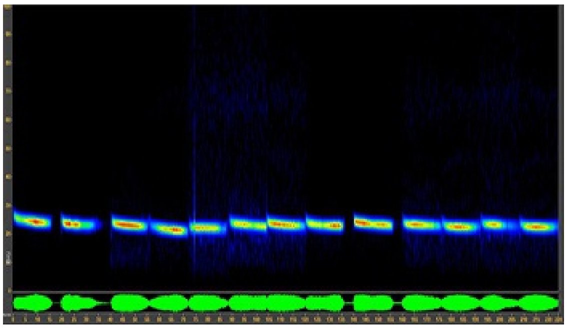


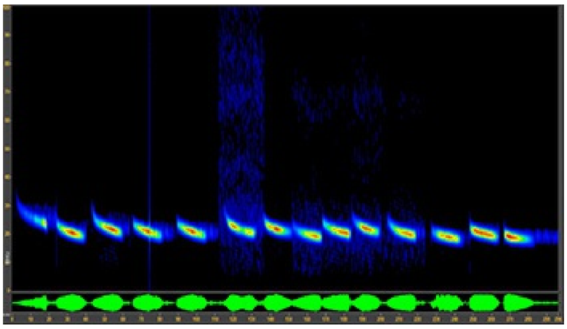
Common Noctule - call duration 15.4-15.7 ms

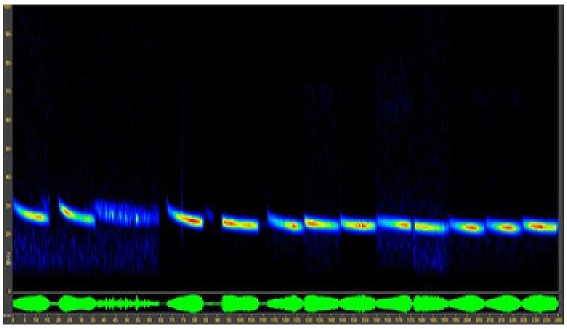


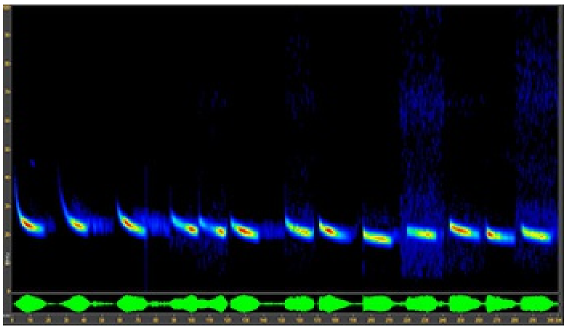
Leisler's Bat - call duration 15.4-15.7 ms

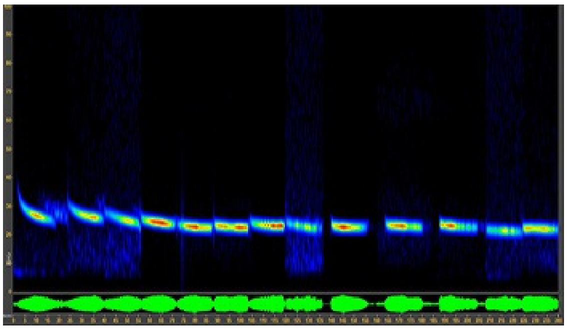

Common Noctule - call duration 15.8-16.0 ms

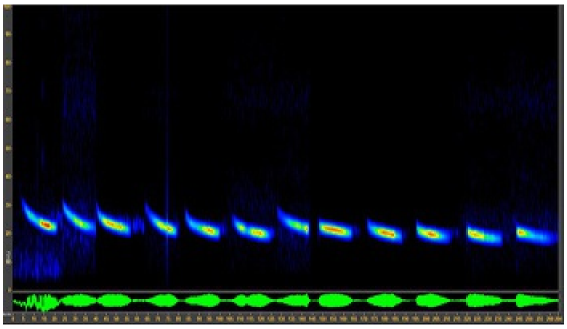

Leisler's Bat - call duration 15.8-16.0 ms

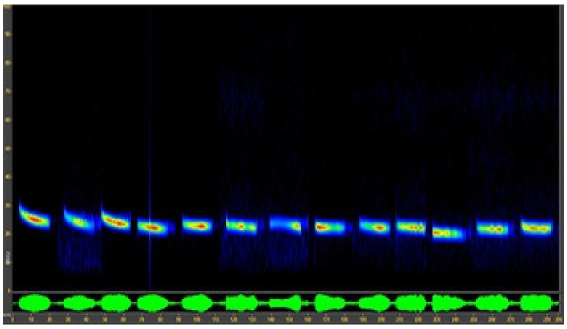

Common Noctule - call duration 16.1-16.3 ms

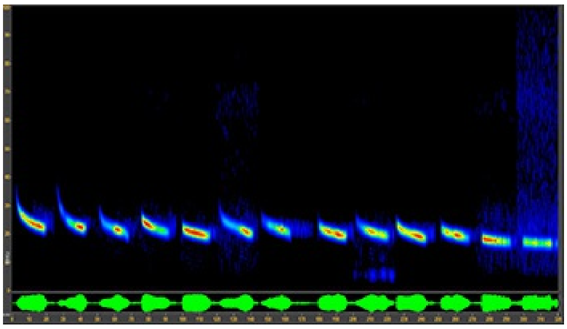

Leisler's Bat - call duration 16.1-16.3 ms

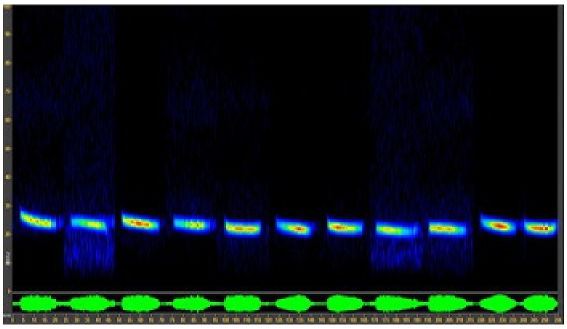

Common Noctule - call duration 16.4-16.6 ms

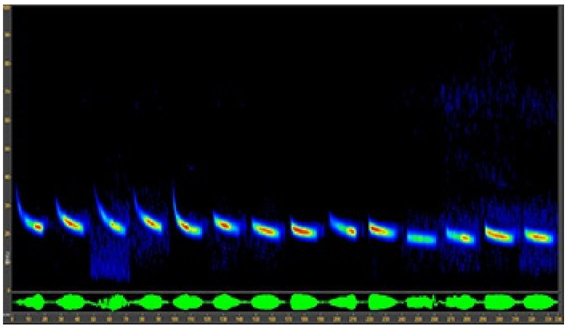

Leisler's Bat - call duration 16.4-16.6 ms

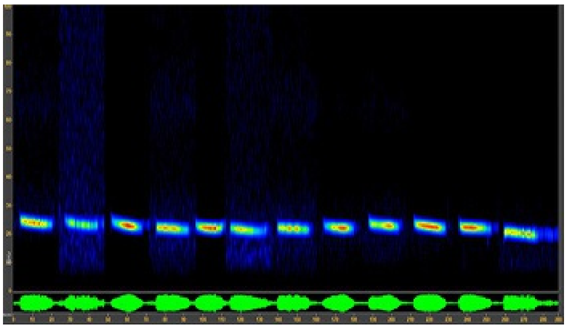

Common Noctule - call duration 16.7-17.0 ms

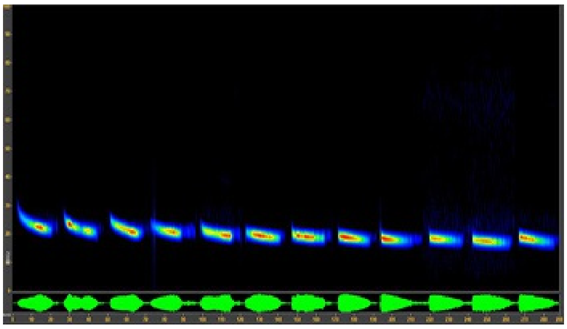

Leisler's Bat - call duration 16.7-17.0 ms

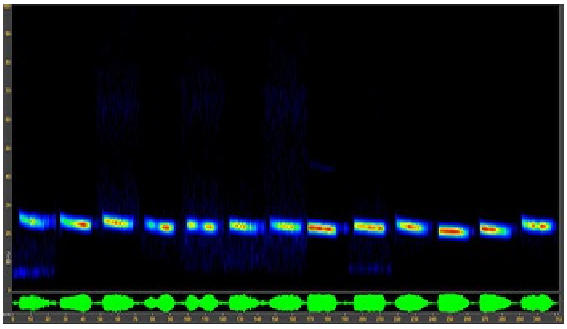

Common Noctule - call duration 17.1-17.2 ms

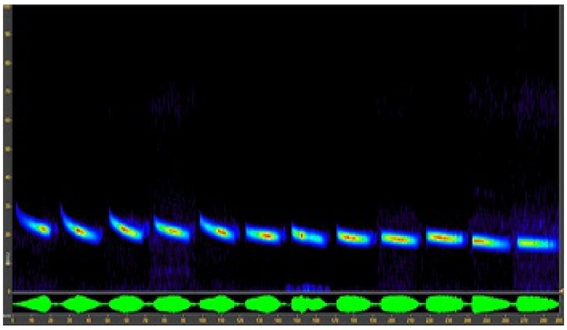

Leisler's Bat - call duration 17.1-17.2 ms

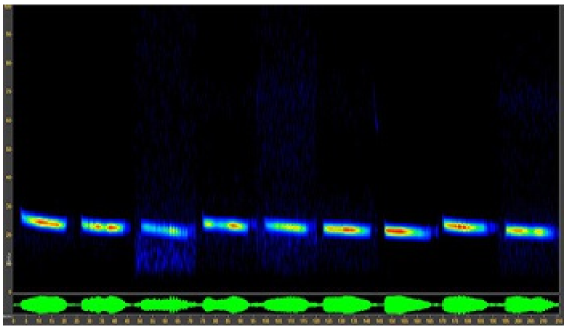

Common Noctule - call duration 17.3-17.4 ms

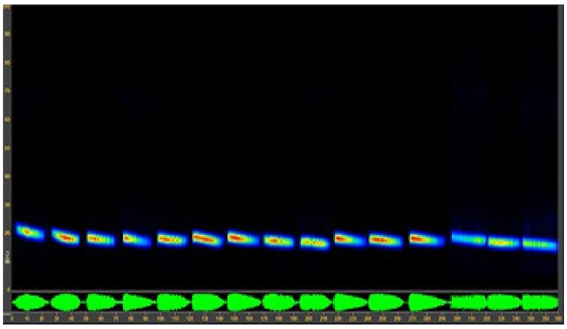

Leisler's Bat - call duration 17.3-17.4 ms

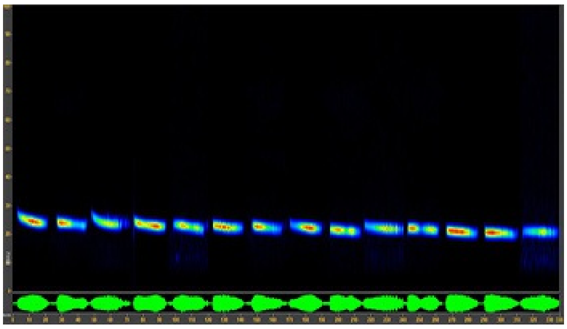

Common Noctule - call duration 17.5-18.2 ms

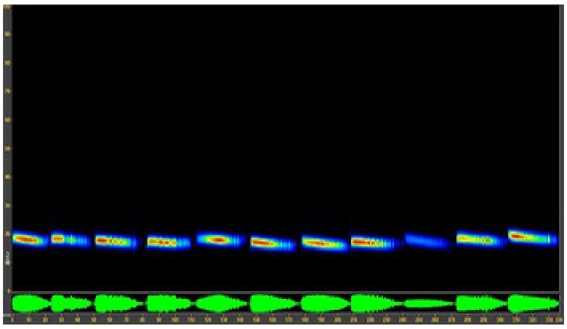

Leisler's Bat - call duration 17.5-18.2 ms


Common Noctule - call duration 18.3-18.7 ms


Leisler's Bat - call duration 18.3-18.7 ms


Common Noctule - call duration 18.8-24.0 ms


Leisler's Bat - call duration 18.8-24.0 ms


Common Noctule - call duration 24.1-31.7 ms

Leisler's Bat - no examples for this call duration

Images: Common Pipistrelle by John Black, Wood Mouse by Moss Taylor, Long-winged Cone-head by Ian thirwell, Green silver-lines by Andy Musgrove. Cover image: Guy Harris

Ryevitalise - Bats and Ancient Trees: 2022 Report

This report presents the main findings from survey work delivered using passive acoustic monitoring devices deployed across the Ryevitalise Landscape Partnership Scheme area. Through the surveys that we support we aim to improve knowledge and understanding of species distribution and activity, covering a range of taxonomic groups, including bats, small terrestrial mammals and insects. Through the approach we provide robust datasets that can be used to inform better decision-making processes.

The use of acoustic monitoring can be particularly useful for species that are rare or unexpected in the survey area, or that are traditionally regarded as too difficult to identify (such as bats in the genera Myotis or Nyctalus).
Where such species are recorded, we provide additional information to support their identification, inspiring a culture of critical thinking and the use of emerging technologies to improve the current knowledge base.

Newson, S.E., Harris, G.T. & Panter, T.L. (2022). Ryevitalise - Bats and Ancient Trees: 2022 Report.
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