

# Ryevitalise – Bats and Ancient Trees: 2023 Report

Newson, S.E. & Panter, T.L.



**RECOMMENDED CITATION:** Newson, S.E. & Panter, T.L. 2023. Ryevitalise - Bats and Ancient Trees, 2023 Report. BTO Research Report 763, BTO, Thetford.

*Graphs and mapping by S. Gillings*

*Cover design by M.P. Toms*

*Cover photo by C. Damant, Bernwood Ecology*

# SUMMARY

- Background** Working with a network of volunteers, static acoustic bat detectors were deployed over a long survey season, to provide the fourth 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 2023.
- Coverage** Over 2023, 141 different locations across the Ryevitalise Landscape Partnership Scheme area were surveyed. Recording was undertaken on a minimum of 144 different nights mainly between May and the end of September, amounting to a total of 641 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, 797,360 recordings were collected which, following analyses and validation, were found to include 390,882 bat recordings, and 135 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. 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 Roesel's Bush-cricket *Roeseliana roeselii* was recorded for the first time for the survey from four 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 three 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 fourth 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; Middleton *et al.*, 2024). In this report we present results from the fourth survey season of 2023.

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.



All maps in this report use the maptiles R package (Giraud 2023) with data copyright OpenStreetMap contributors.

## 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 end of September, 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 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 pygmaeus*, 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.

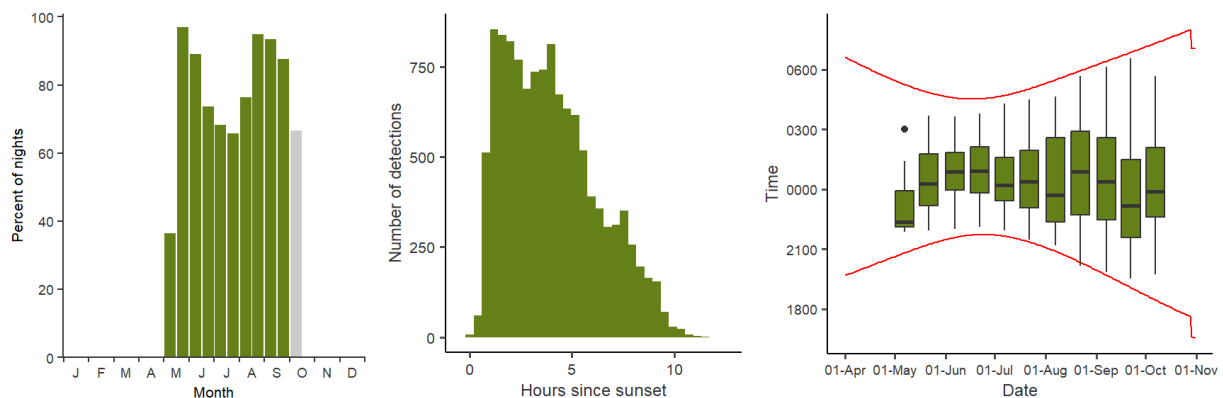
Verification of species identification was carried out through the manual checking of spectrograms using software SonoBat (<http://sonobat.com/>) which was used as an independent check of the original species identities assigned by pipeline. The spectrograms shown in this report, were also produced using 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* (Thieurmél & 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.

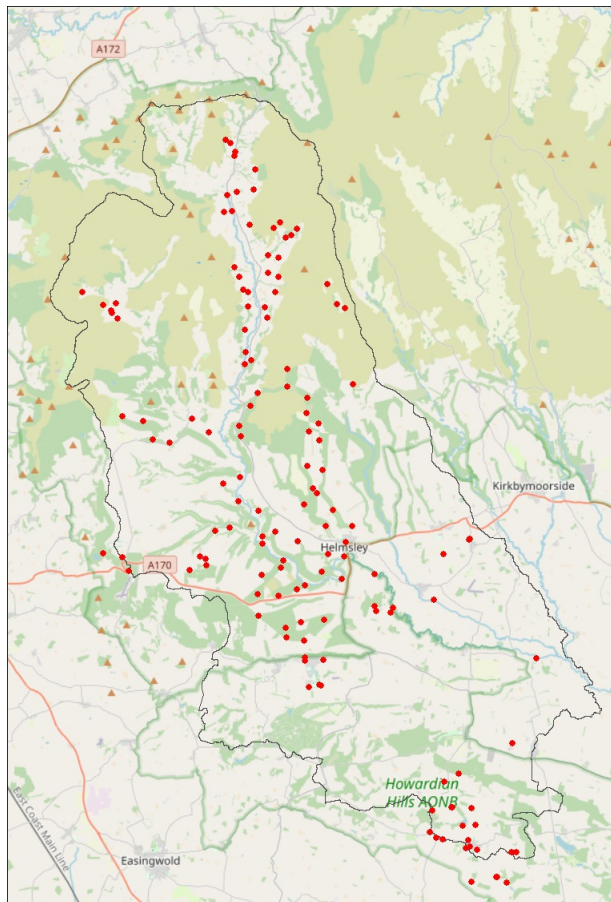


# 4. RESULTS

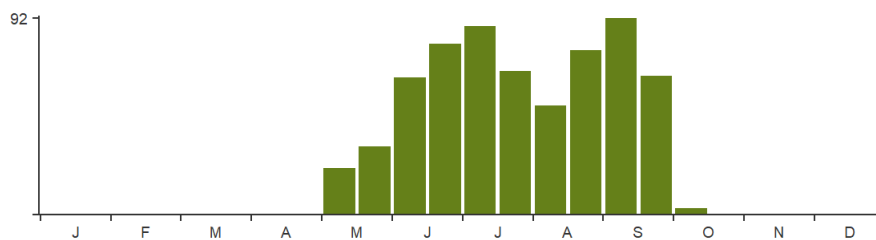
## 4.1 Survey coverage

During 2023, 141 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, 641 complete nights of recording effort was conducted. The recording effort spanned 144 different nights and 6 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 Common Pipistrelle 7 (0.5%) recordings and for Soprano Pipistrelle 5 (0.5%) recordings were assigned to the wrong species.

Map of the study area showing locations where detectors were deployed in 2023.



Number of locations surveyed.



## 4.2 General results

Overall, 797,360 recordings were collected which, following analyses and validation, were found to include 390,882 bat recordings, and 135 small terrestrial mammal recordings. In addition, two bush-cricket species and two species of audible moth species were recorded (see table below). Following validation, the presence of at least 8 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)
Daubenton's Bat, <i>Myotis daubentonii</i>	31978	135 (95.7%)
Whiskered or Brandt's Bat, <i>Myotis mystacinus</i> or <i>M. brandtii</i>	53466	139 (98.6%)
Natterer's Bat, <i>Myotis nattereri</i>	11905	134 (95%)
Common Noctule, <i>Nyctalus noctula</i>	10932	126 (89.4%)
Nathusius' Pipistrelle, <i>Pipistrellus nathusii</i>	16	3 (2.1%)
Common Pipistrelle, <i>Pipistrellus pipistrellus</i>	205157	139 (98.6%)
Soprano Pipistrelle, <i>Pipistrellus pygmaeus</i>	70523	134 (95%)
Brown Long-eared Bat, <i>Plecotus auritus</i>	6905	131 (92.9%)

### Small mammals

Species	No. of recordings following validation	No. of different locations (% of total)
Brown Rat, <i>Rattus norvegicus</i>	15	3 (2.1%)
Common Shrew, <i>Sorex araneus</i>	64	33 (23.4%)
Eurasian Pygmy Shrew, <i>Sorex minutus</i>	56	23 (16.3%)

### Bush-crickets

Species	No. of different locations (% of total)
Long-winged Bush-cricket, <i>Conocephalus fuscus</i>	2 (1.4%)
Roesel's Bush-cricket, <i>Roeseliana roeselii</i>	4 (2.8%)

### Moths

Species	No. of different locations (% of total)
Green Silver-lines, <i>Pseudoips prasinana</i>	8 (5.7%)
Bird Cherry Ermine, <i>Yponomeuta evonymella</i>	31 (22%)

## 4.3 Species and call-type results

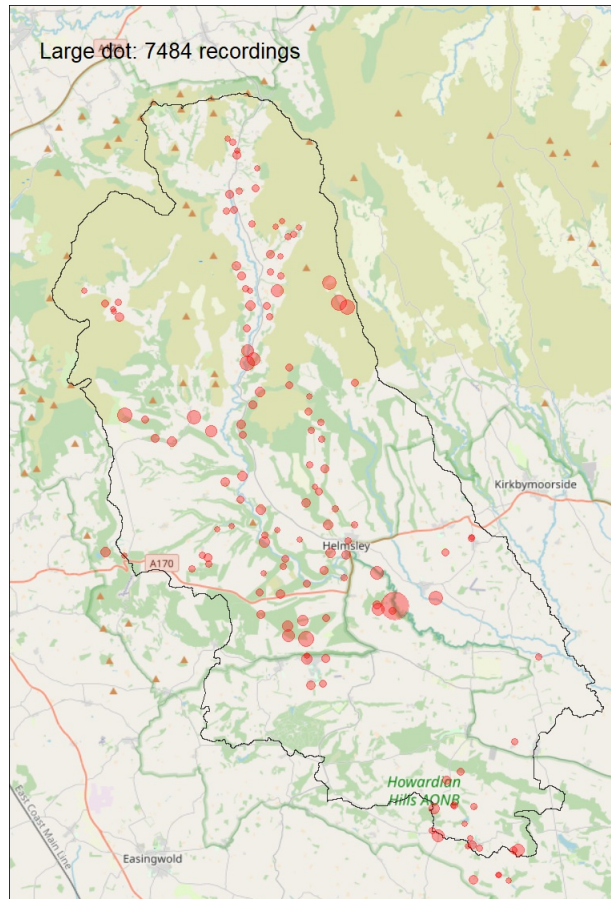
The following sections provide results for each species and/or call type.

## 4.3.1 Bat species

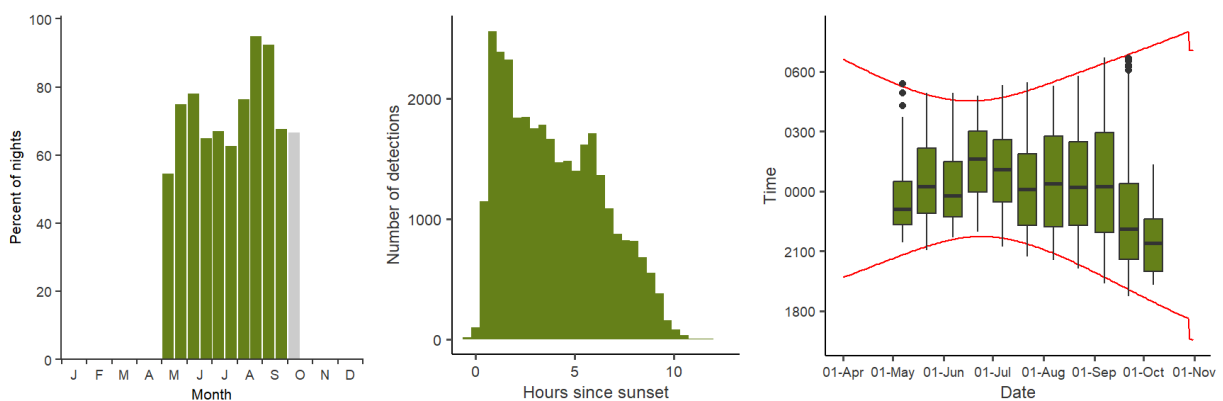
### Daubenton's Bat

Daubenton's Bat *Myotis daubentonii* was recorded on 131 nights, from 135 locations, giving a total of 31,978 recordings.

#### Spatial pattern of activity



#### Seasonal and nightly activity

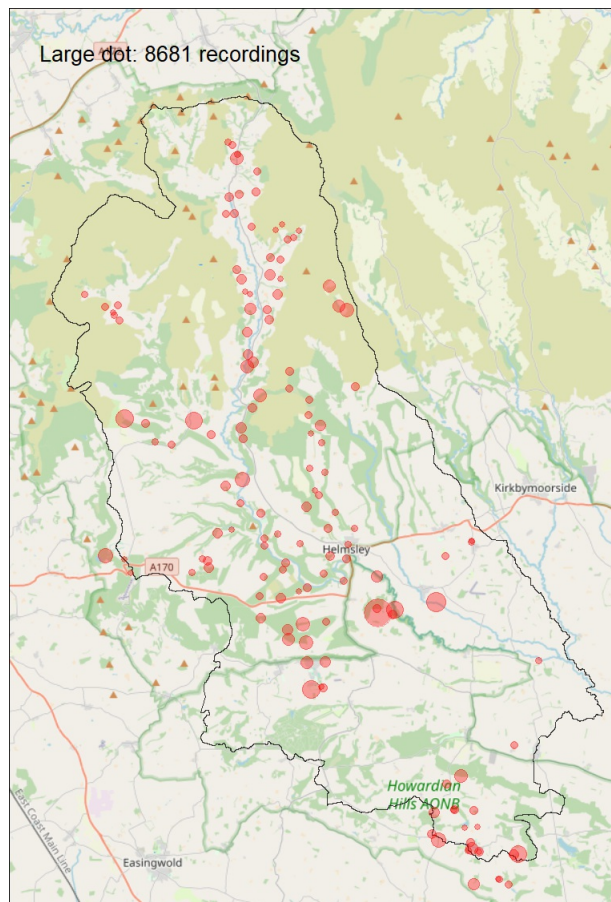


**Daubenton's Bat** was widely recorded in 2023, but with particularly high activity where detectors were left to record at locations along the Rivers Rye and Seph. There were over 2,500 Daubenton's recordings a night over three nights from a bat detector positioned along the River Rye between Nunnington and Helmsley, and 1,123 recordings from another location along the River Seph between Laskill and Fangdale Beck. See Identification appendix 1 for further information on the sound identification of Daubenton's Bat in comparison to Natterer's Bat.

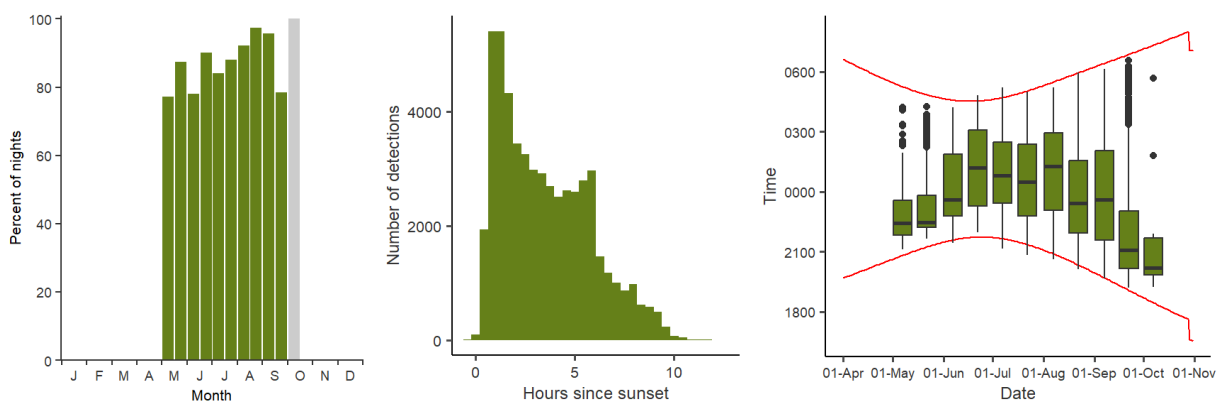
## Whiskered or Brandt's Bat

Whiskered or Brandt's Bat *Myotis mystacinus* or *M. brandtii* was recorded on 142 nights, from 139 locations, giving a total of 53,466 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity



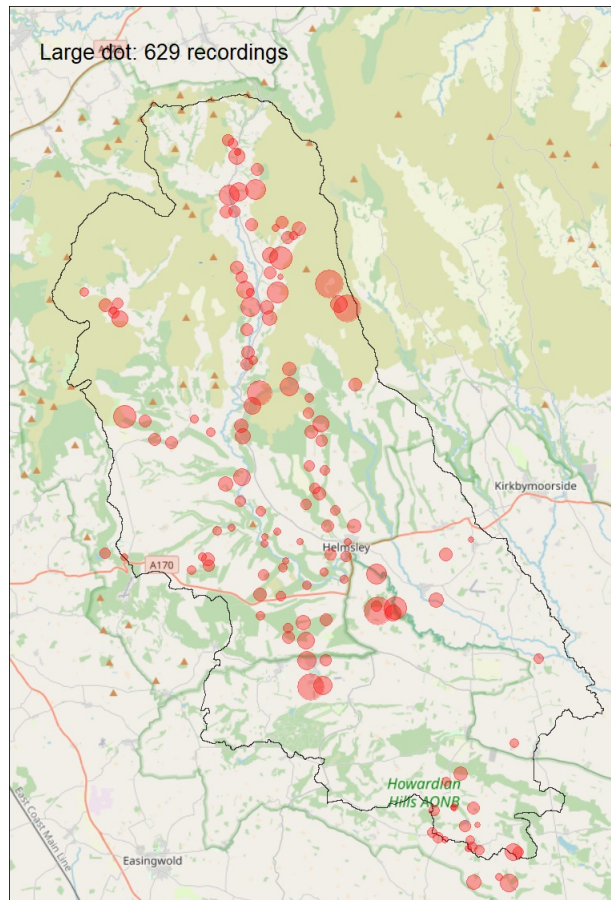
Whiskered or Brandt's Bat were very widely recorded. Different to Daubenton's Bat where the highest activity was recorded close to water, the highest activity of Whiskered or Brandt's bat was in the vicinity of woodland patches, with over 2,000 recordings a night over three nights at one location close to Sproxton in late 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 2.



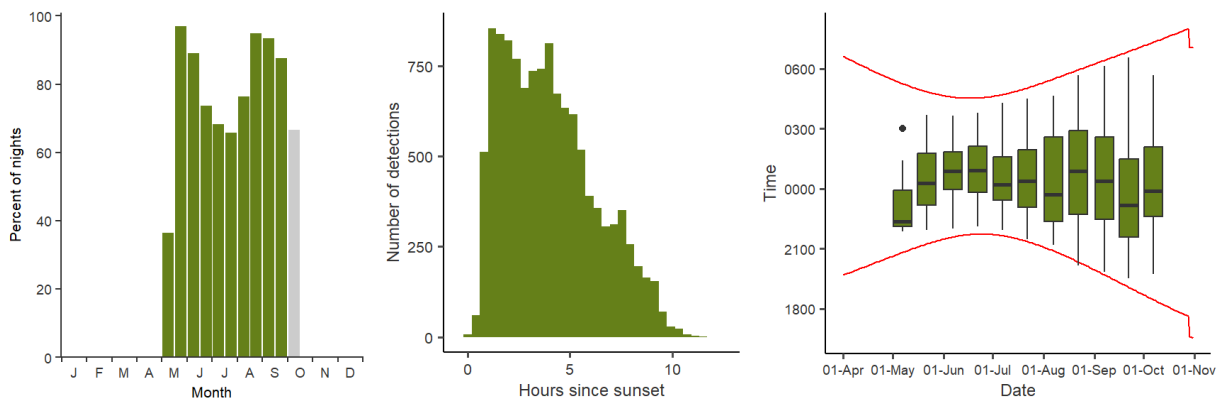
## Natterer's Bat

Natterer's Bat *Myotis nattereri* was recorded on 135 nights, from 134 locations, giving a total of 11,905 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity

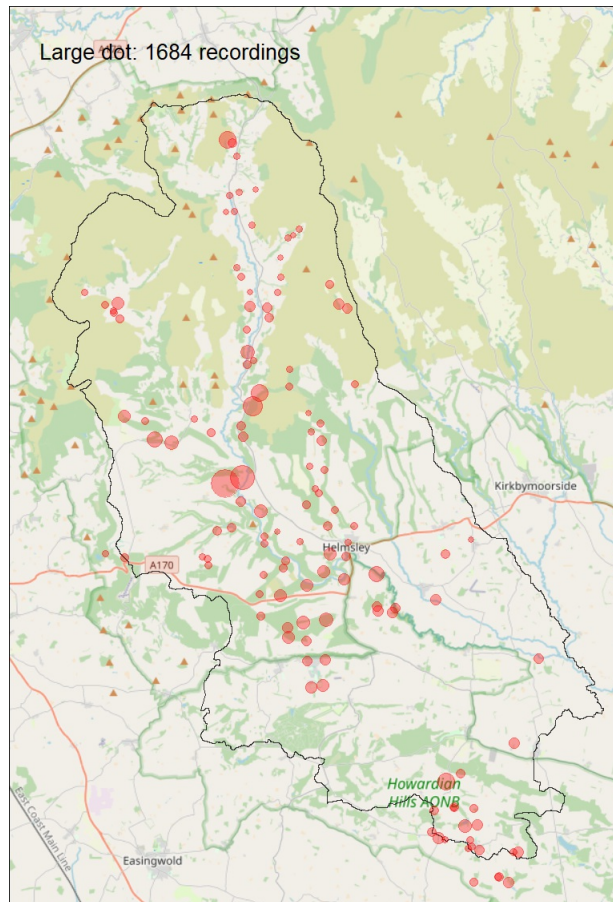


**Natterer's Bat** was widely recorded in 2023. Compared with the other *Myotis* species, the highest activity of Natterer's Bat was recorded in more open grassland and arable areas, bordering moorland, with a maximum of 363 recordings a night recorded close to Ampleforth in July. As with Whiskered and 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 3 for further information on the sound identification of Natterer's Bat.

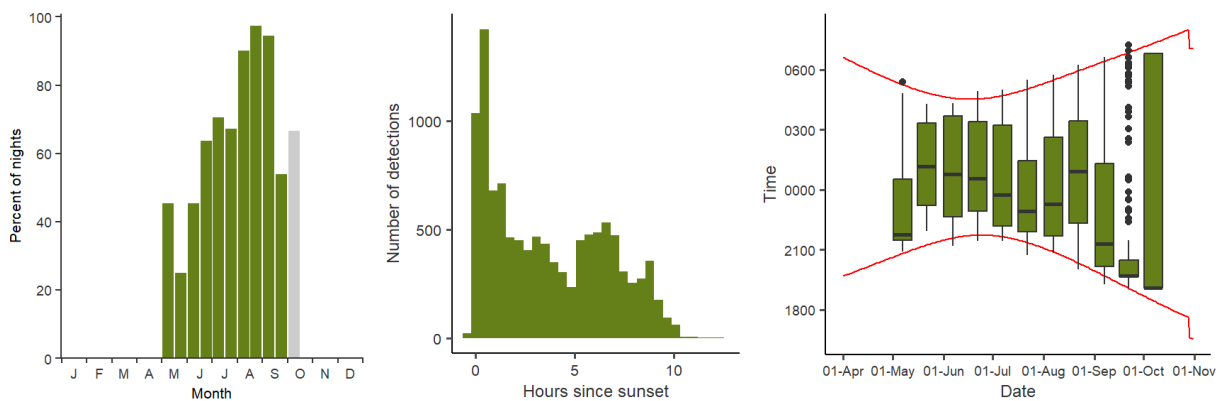
## Common Noctule

Common Noctule *Nyctalus noctula* was recorded on 133 nights, from 126 locations, giving a total of 10,932 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity

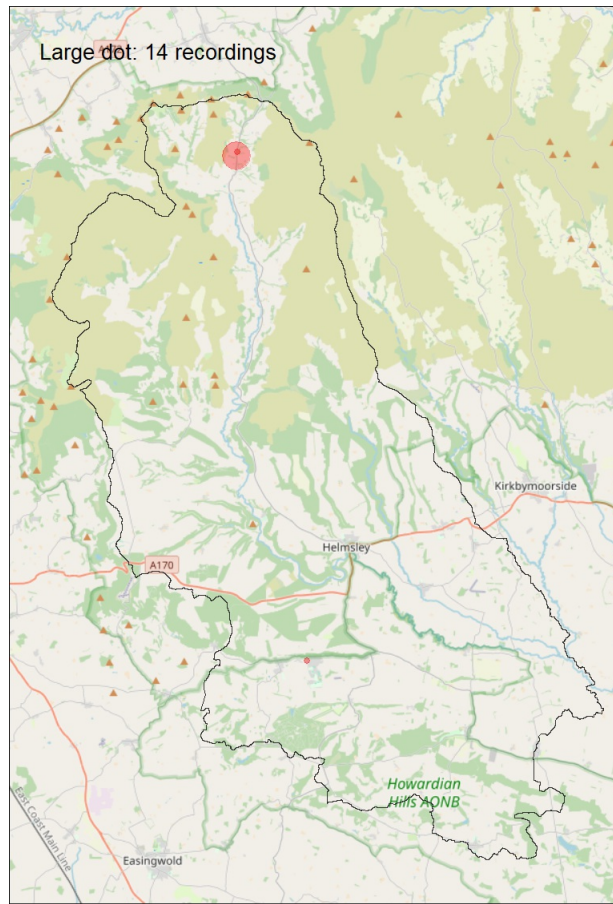


**Common Noctule** was widely recorded across the survey area, but there were a small number of locations where particularly high activity of Noctule was recorded. The maximum number of recordings of Noctule from a night was 643 recordings of Noctule from close to Rievaulx Abbey on the 21st August. See Identification appendix 4 for further information on the sound identification of Noctule and how it compares with the closely related Leisler's Bat.

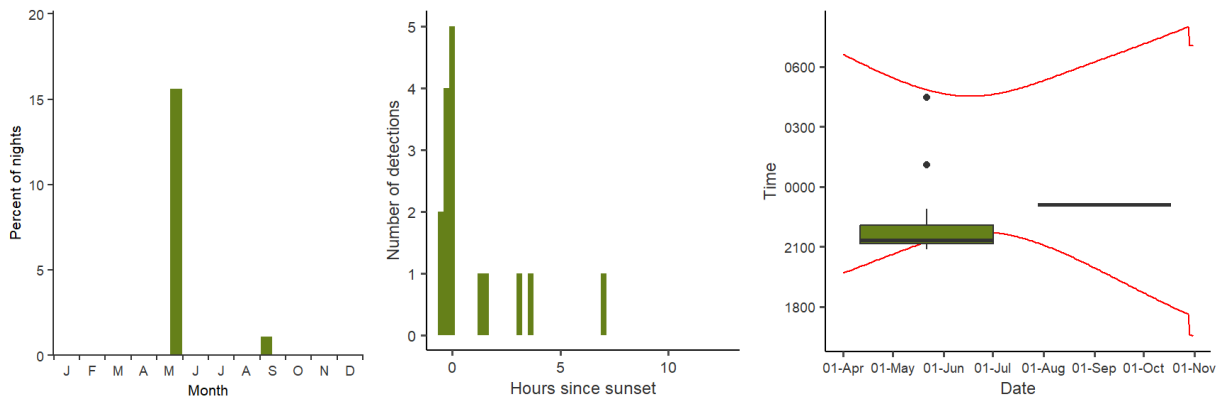
## Nathusius' Pipistrelle

Nathusius' Pipistrelle *Pipistrellus nathusii* was recorded on six nights, from three locations, giving a total of 16 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity

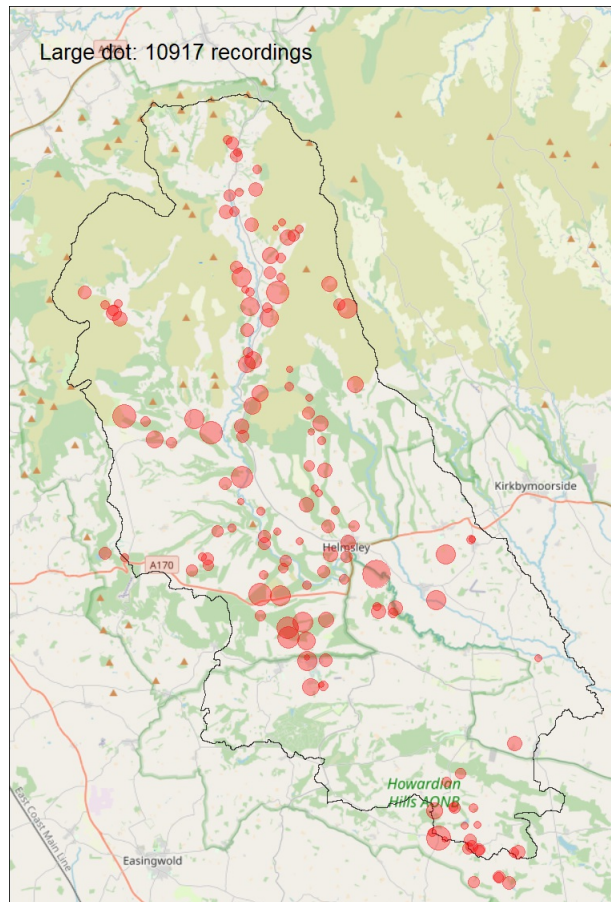


**Nathusius' Pipistrelle** For only the second of the four survey seasons, Nathusius' pipistrelle was recorded during the survey at two locations close to each other at Bilsdale Beck in May, and at a third location close to Ampleforth Abbey on one night in September. These comprised a total of 16 recordings. It is possible that these relate to migrants rather than this being a resident species.

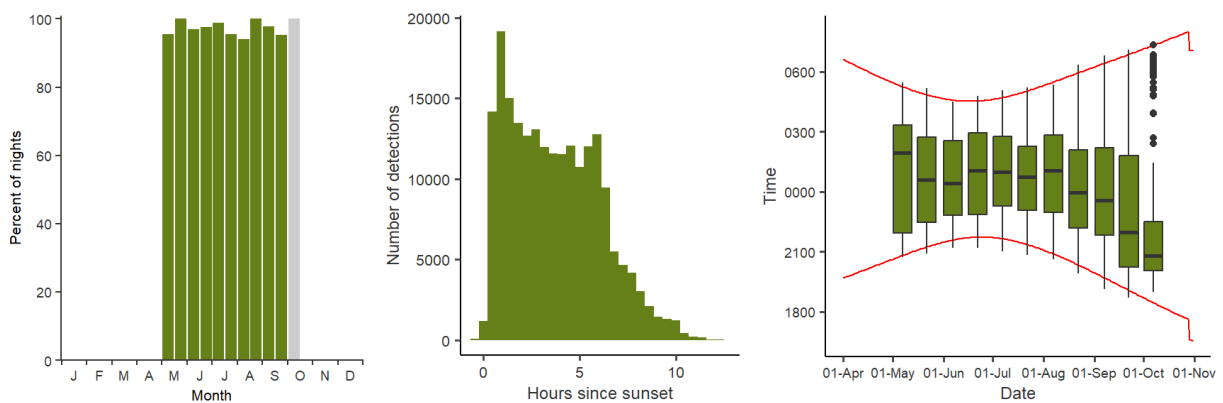
## Common Pipistrelle

Common Pipistrelle *Pipistrellus pipistrellus* was recorded on 144 nights, from 139 locations, giving a total of 205,157 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity



**Common Pipistrelle** was by far the most common and widely recorded bat species, with 200,972 recordings from 132 different locations (over 98% of survey locations).

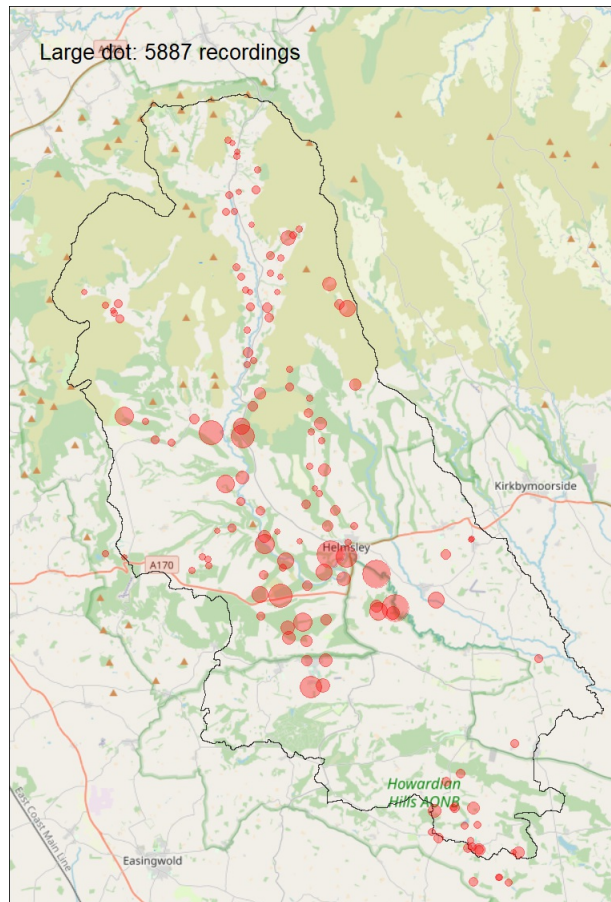
Common Pipistrelle is normally straightforward to identify acoustically, but particular care is needed given calls at the low or high frequency end of the range for this species, which could be mis-identified as Nathusius' Pipistrelle or Soprano Pipistrelle respectively. For these it is important to consider the call duration, and not just the peak or end frequency of the calls.



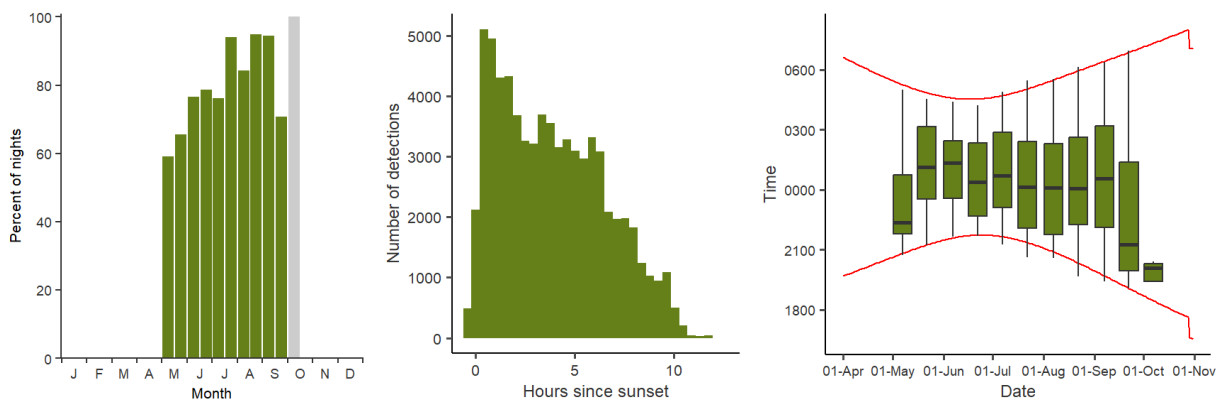
## Soprano Pipistrelle

Soprano Pipistrelle *Pipistrellus pygmaeus* was recorded on 138 nights, from 134 locations, giving a total of 70,523 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity

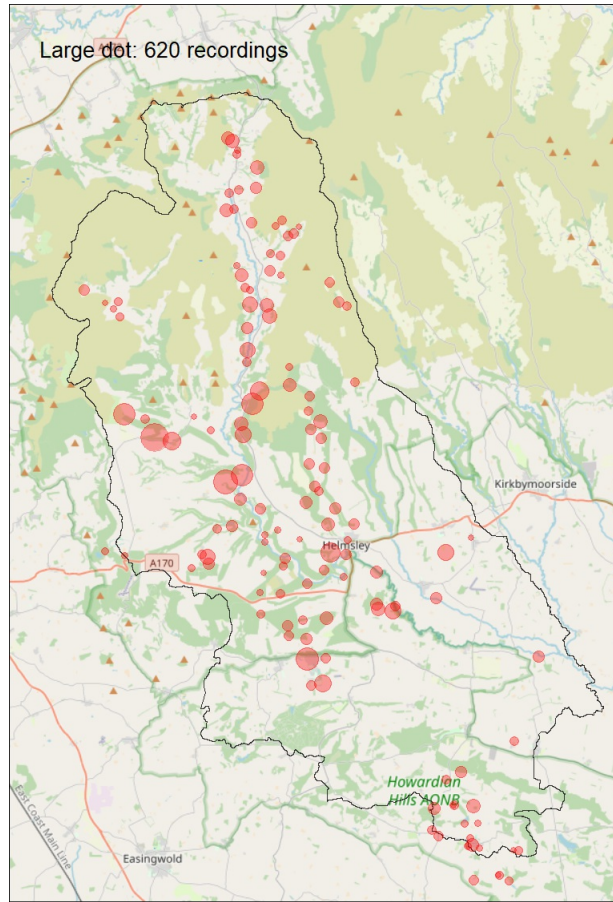


**Soprano Pipistrelle** was the second most common and widely recorded bat species, with 69,704 recordings from 127 different locations (over 94% of survey locations), but compared with Common Pipistrelle highest activity was more localised and centered around Hemsley. A maximum of 3,100 recordings of Soprano Pipistrelle were recorded from Newgate Bank on the night of the 12th September.

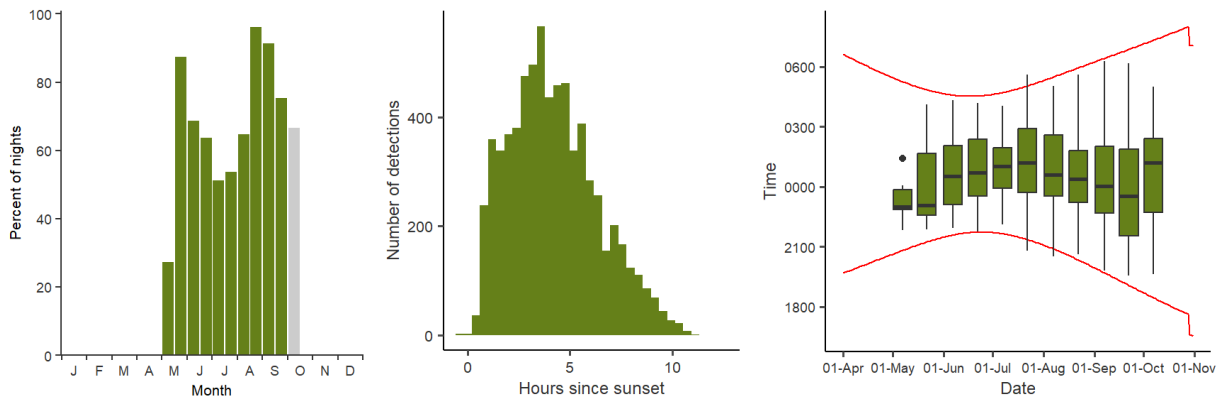
## Brown Long-eared Bat

Brown Long-eared Bat *Plecotus auritus* was recorded on 129 nights, from 131 locations, giving a total of 6,905 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity



**Brown Long-eared Bat** was widely recorded across the survey area. The maximum number of recordings a night was from a bat detector in woodland close to Hawaby on the 24th August.

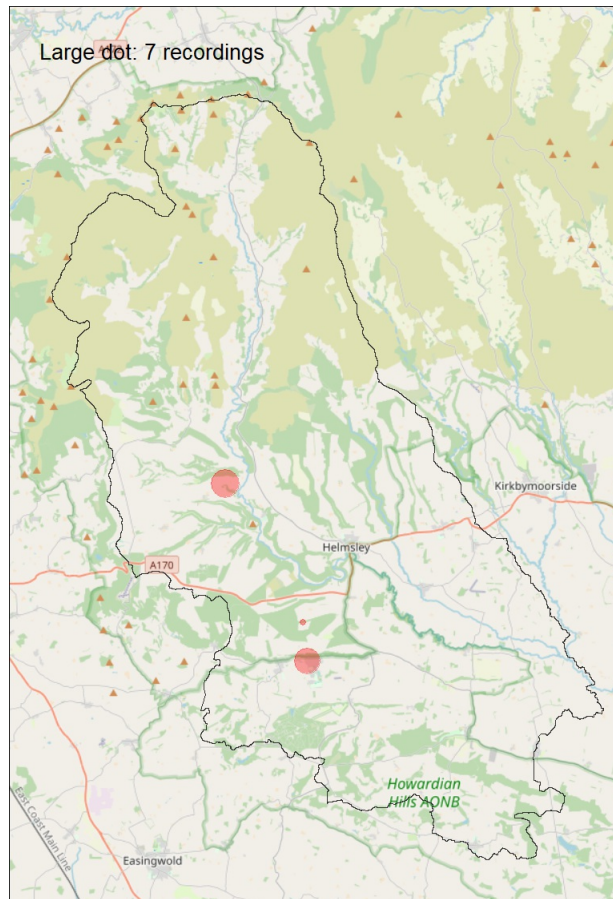
### 4.3.2 Small terrestrial mammal species

In this section we look at the recordings that we can assign to small terrestrial mammals.

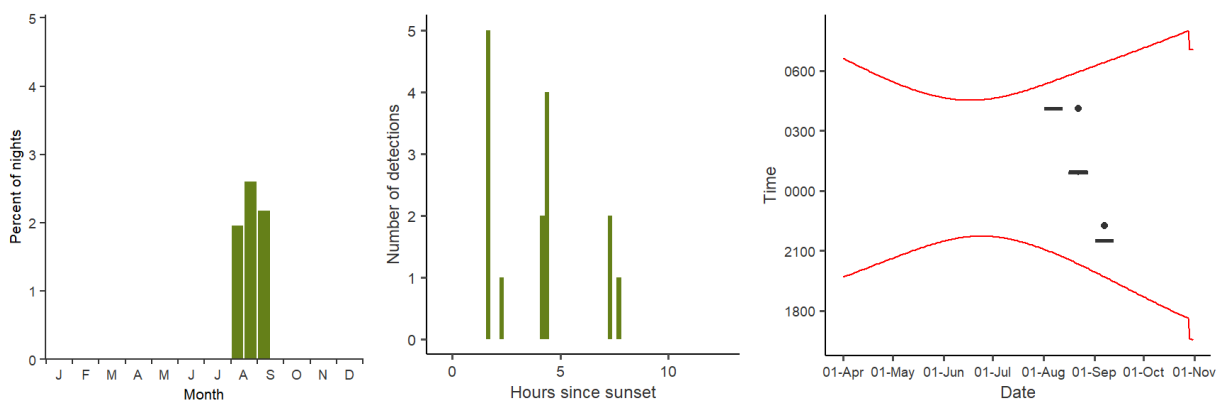
#### Brown Rat

Brown Rat *Rattus norvegicus* was recorded on five nights, from three locations, giving a total of 15 recordings.

#### Spatial pattern of activity



#### Seasonal and nightly activity

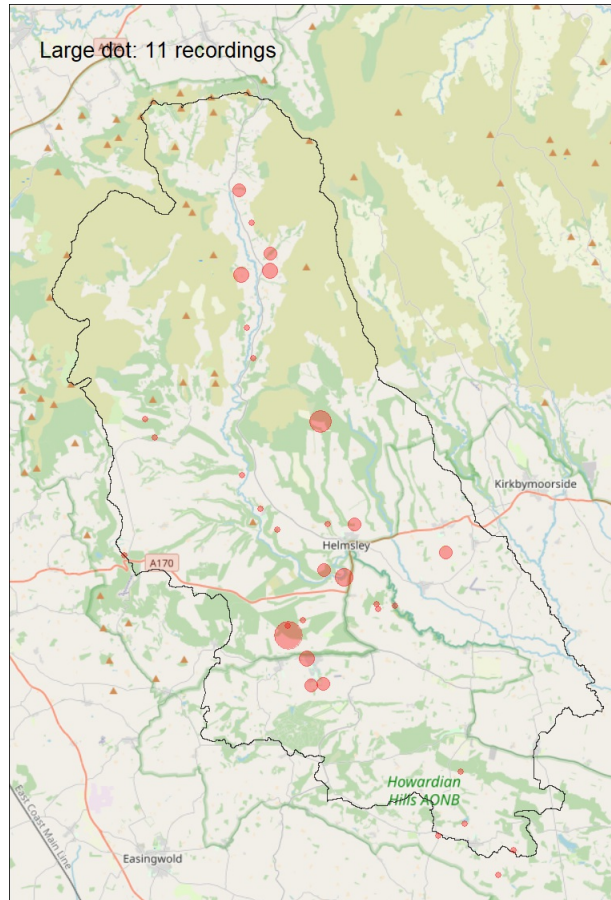


**Brown Rat** is a highly vocal species that is relative easy to detect using ultrasonic microphones and is regularly recorded incidentally during static bat detector surveys (Newson & Pearce 2022). This was only recorded from a few locations in 2023, of which the maximum number of recordings a night was 6 from a location close to Old Byland.

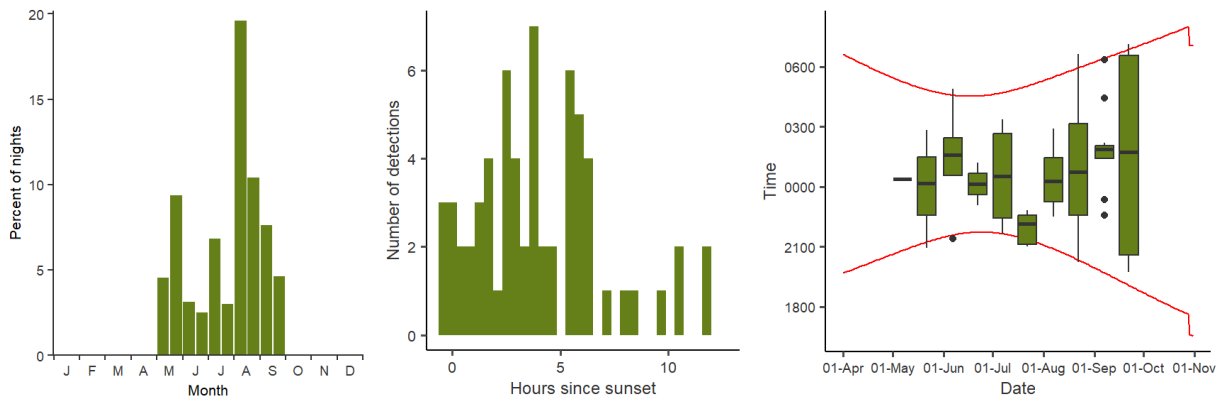
## Common Shrew

Common Shrew *Sorex araneus* was recorded on 40 nights, from 33 locations, giving a total of 64 recordings.

### Spatial pattern of activity



### Seasonal and nightly activity



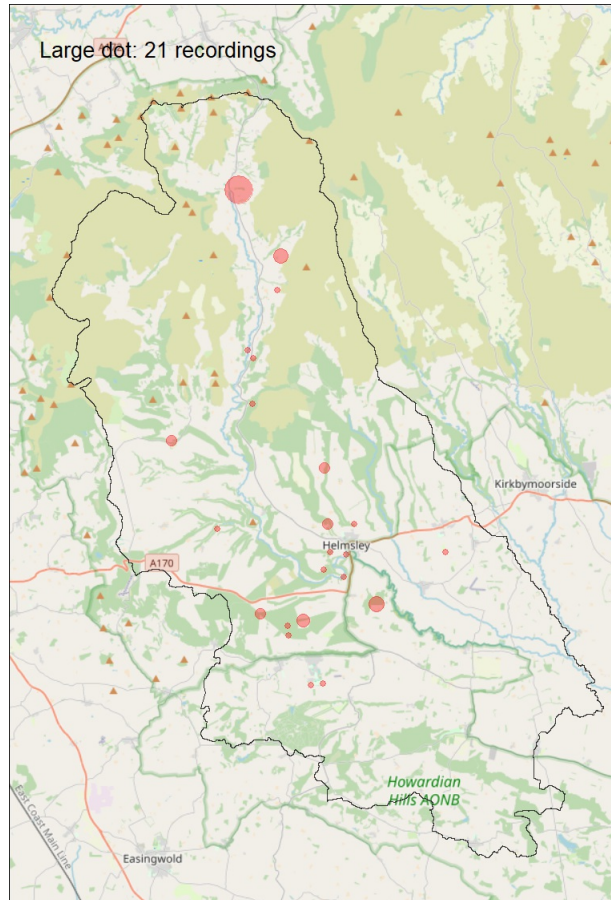
**Common Shrew** was recorded quite widely across the Ryedale Landscape Partnership Scheme area in 2023. Common and Pygmy Shrew produce calls that are notably different from those of Rodents in having multiple harmonics that when played slowed down, produces a warbling sound. In most cases it is possible 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) and Middleton *et al.*, (2024).



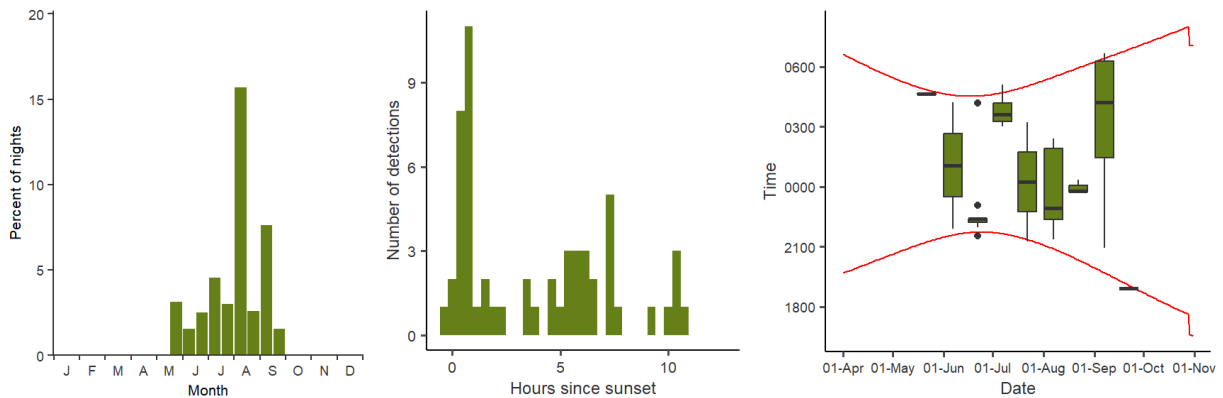
## Eurasian Pygmy Shrew

Eurasian Pygmy Shrew *Sorex minutus* was recorded on 23 nights, from 23 locations, giving a total of 56 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 Chop Gate where it was recorded every night that a detector was deployed in June, with up to a maximum of 18 recordings on one night. As discussed in the previous section (and see Newson *et al.*, 2021; Middleton *et al.* 2024), it is normally straightforward to distinguish this species acoustically from Common Shrew.

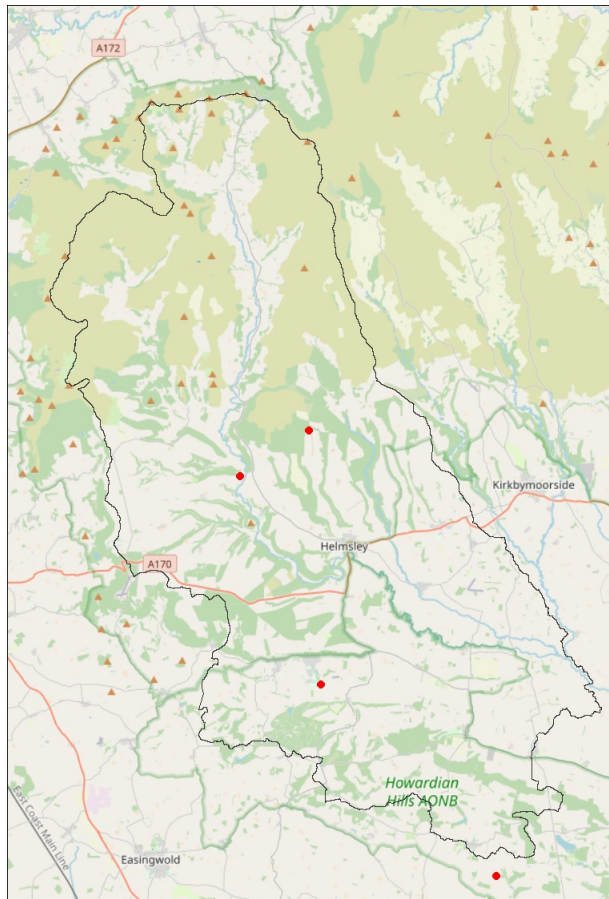
### 4.3.3 Bush-cricket

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.

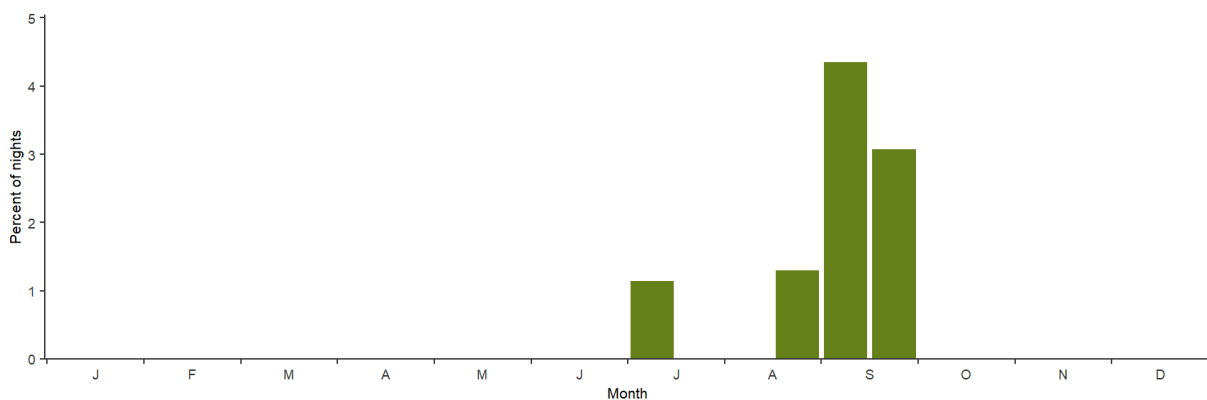
#### Roesel's Bush-cricket

Roesel's Bush-cricket *Roeseliana roeselii* was recorded on eight nights, from four locations.

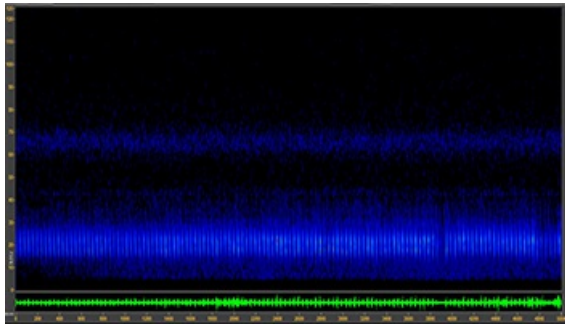
#### Spatial pattern of detections



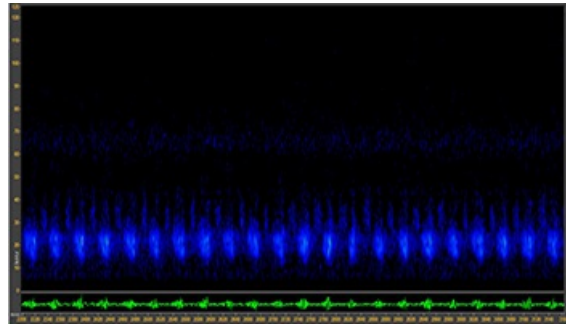
#### Seasonality



**Roesel's Bush-cricket - new species for the Ryevitalise survey area** were recorded from 4 locations between mid-July and late September. Roesel's Bush-cricket produces 'calls' with a peak frequency about 20 kHz. This species is distinctive in producing simple continuous / regular 'calls'. This species most commonly 'calls' between midday and mid-afternoon, but as here, it can be recorded during the evening and sometimes later in the night.



Roesel's Bush-cricket



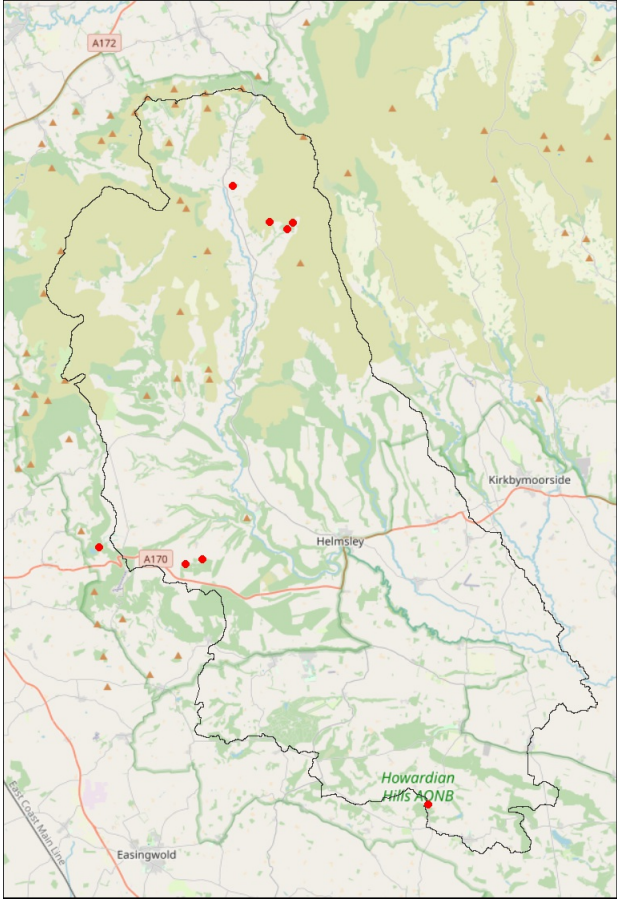
Roesel's Bush-cricket (as left, different scale)

### 4.3.4 Audible moth species

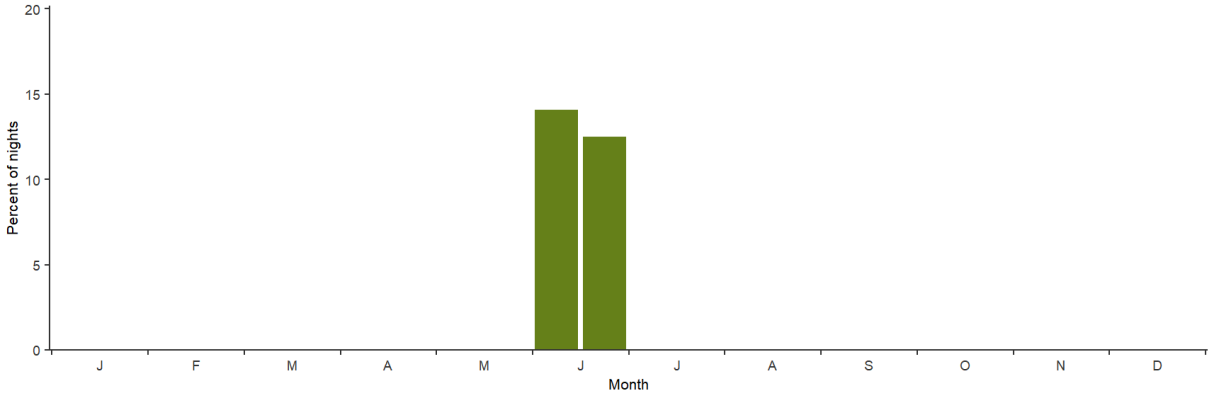
#### Green Silver-lines

Green Silver-lines *Pseudoips prasinana* was recorded on 12 nights, from eight locations.

#### Spatial pattern of detections



#### Seasonality

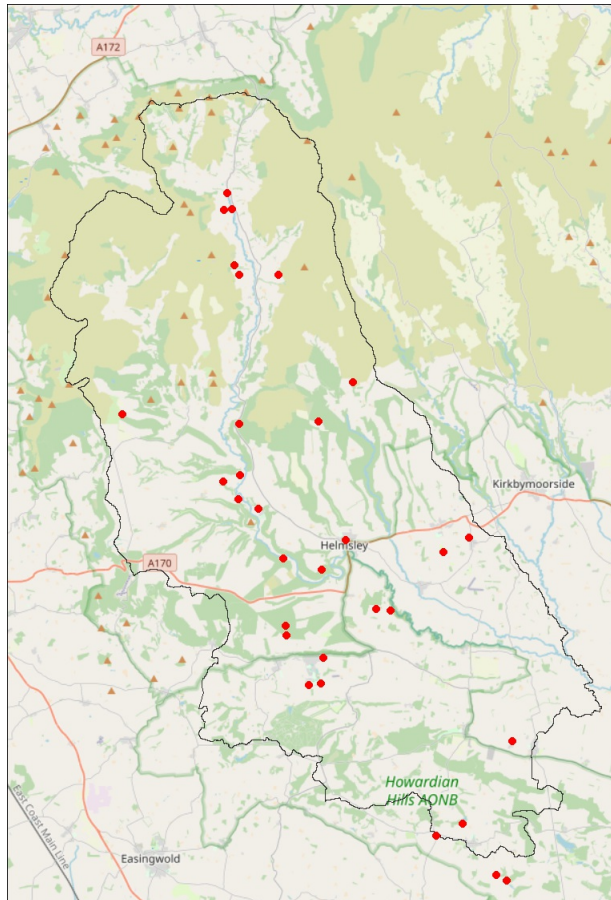


**Green Silver-lines** was recorded from 8 locations. Green Silver-lines produce 'calls' that form a very distinctive shape. See Barataud & Skals, (2018) for a description of the sound identification of Green Silver-lines.

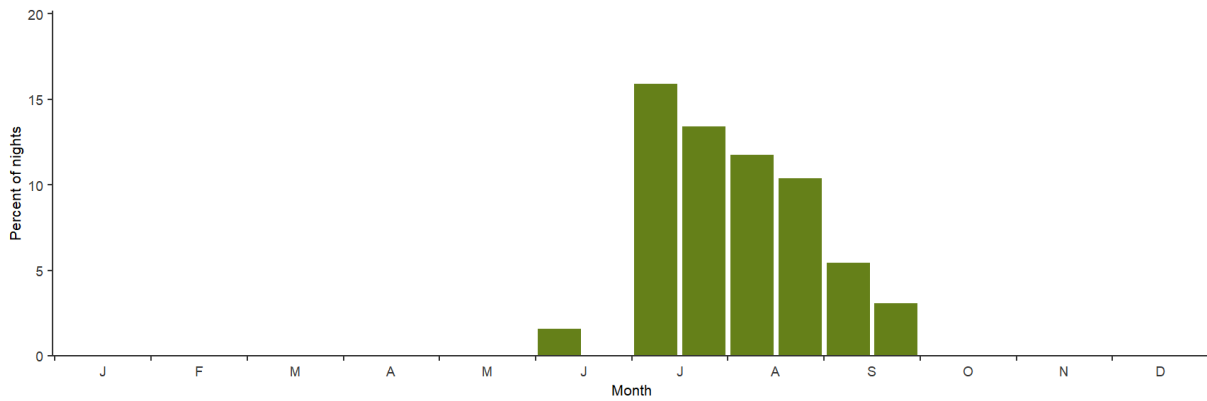
## Bird Cherry Ermine

Bird Cherry Ermine *Yponomeuta evonymella* was recorded on 29 nights, from 31 locations.

### Spatial pattern of detections



### Seasonality



**Bird Cherry Ermine** The micro-moth Bird Cherry Ermine was recorded from 31 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 2023.



## 5. DISCUSSION

The current dataset of 390,882 bat recordings from a total of 797,360 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. This is the greatest survey effort and coverage that has been achieved during a survey season over the four years of the project. The results from this season includes Roesel's Bush-cricket that had not previously been recorded in the Ryevitalise survey area.

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 Alcatheo 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 Alcatheo Bat, which was not recorded in 2023, but which has been recorded in past years is the most range restricted.

In relation to other species groups recorded as 'by-catch' during bat surveys, three small terrestrial mammal species were recorded, comprising 64 recordings of Common Shrew, 56 recordings of Pygmy Shrew and 15 recordings of Brown Rat. For further information on the sound identification of terrestrial small mammals in Britain see Newson *et al.* (2020) and Middleton *et al.* (2023). The macro-moth Green Silver-lines was recorded from 8 locations and the micro-moth Bird Cherry Ermine was also recorded from 31 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 2023, with a special mention to Joe Fryer, Grant Grieve and Jane Hanstock and to 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. Lastly we would like to thank the National Lottery Heritage Fund for funding this project.

## 7. REFERENCES

Barataud, M. 2015. *Acoustic Ecology of European Bats: Species identification, study of their habitats and foraging behaviour*. Collection Inventaires et biodiversité, Biotope Editions, Mèze et Publications scientifiques du Muséum National d'Histoire Naturelle, Paris.

Barataud, M. & Skals, N. 2018. Émissions ultrasonores de communication sociale enregistrées en canopée : attribution au lépidoptère *Pseudoips prasinana* (L.) (Noctuoidea ; Nolidae ; Chloephorinae) grâce à une analyse bibliographique. *Plume de naturalistes* 2, 11-22. [http://www.plume-de-naturalistes.fr/wp-content/uploads/2018/11/02\\_BARATAUD-M\\_05-2018\\_Emissions-ultrasonores-Pseudoips-prasinana\\_Plume2\\_11-22.pdf](http://www.plume-de-naturalistes.fr/wp-content/uploads/2018/11/02_BARATAUD-M_05-2018_Emissions-ultrasonores-Pseudoips-prasinana_Plume2_11-22.pdf)

Barré, K., Le Viol, I., Julliard, R., Pauwels, J., Newson, S.E., Julien, J.F., Fabien, C., Kerbiriou, C. & Bas, Y. 2019. Accounting for automated identification errors in acoustic surveys. *Methods in Ecology and Evolution*.

Jones, J.P.G. 2011. Monitoring species abundance and distribution at the landscape scale. *Journal of Applied Ecology*, 48, 9-13.

Thieurmél, B. & Elmarhraoui, A. 2019. suncalc: Compute Sun Position, Sunlight Phases, Moon Position and Lunar

Phase. R package version 0.5.0. <https://CRAN.R-project.org/package=suncalc>.

Middleton, N. 2020. *Is That a Bat? A Guide to Non-Bat Sounds Encountered During Bat Surveys*. Pelagic Publishing.

Middleton, N., Newson, S.E., & Pearce, H. 2024. *Sound Identification of Terrestrial Mammals of Britain & Ireland*. Pelagic Publishing.

Newson, S.E., Evans, H.E. & Gillings, S. 2015. A novel citizen approach for large-scale standardised monitoring of bat activity and distribution, evaluated in eastern England. *Biological Conservation* 191, 38-49.

Newson, S. E., Bas, Y., Murray, A. & Gillings, S. 2017b. Potential for coupling the monitoring of bush-crickets with established large-scale acoustic monitoring of bats. *Methods in Ecology and Evolution* 8, 1051-1062.

Newson, S.E., Evans, H.E., Gillings, S., Jarret, D., Raynor, R., Wilson, M.W. 2017a. Large-scale citizen science improves assessment of risk posed by wind farms to bats in southern Scotland. *Biological Conservation* 215, 61-71.

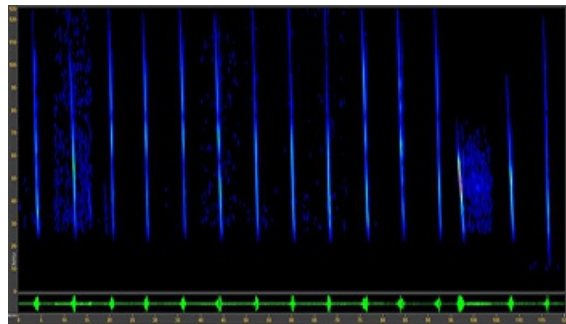
Newson, S.E., Middleton, N., & Pearce, H. 2020. The acoustic identification of small terrestrial mammals in Britain. *British Wildlife* 32, 186-194

Newson, S.E. & Pearce, H. 2022. The potential for acoustics as a conservation tool for monitoring small terrestrial mammals. *JNCC Report No. 708*. JNCC, Peterborough, ISSN 0963-8091.

Pereira, H.M. & Cooper, H.D. 2006. Towards the global monitoring of biodiversity change. *Trends Ecology and Evolution* 21, 123-129.

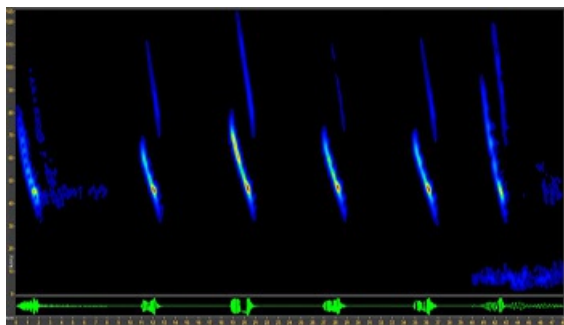
Russ, J. (ed.) 2021. *Bat calls of Britain and Europe. A guide to species identification*. Pelagic Publishing.

# Identification appendix 1: Daubenton's Bat *Myotis daubentonii* and Natterer's Bat *Myotis nattereri*

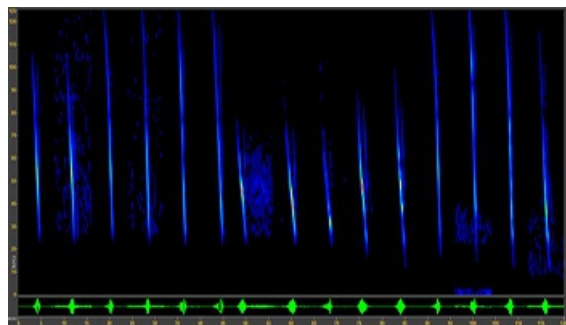


Natterer's Bat - call duration up to 1.4 ms

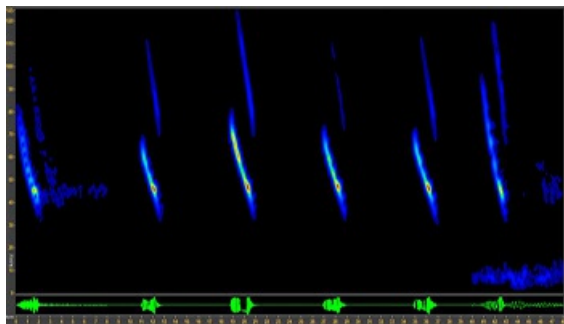
Daubenton's Bat - call duration up to 1.4 ms no examples



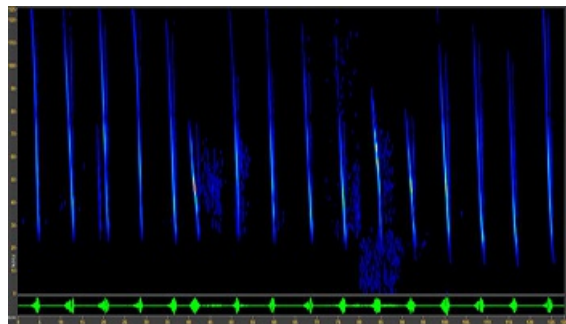
Daubenton's Bat - call duration 1.5-2.0 ms



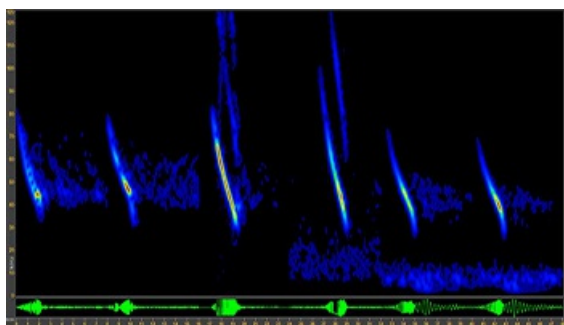
Natterer's Bat - call duration 1.5-2.0 ms



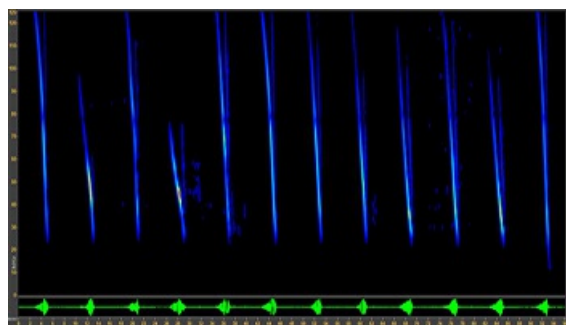
Daubenton's Bat - call duration 2.1-2.3 ms



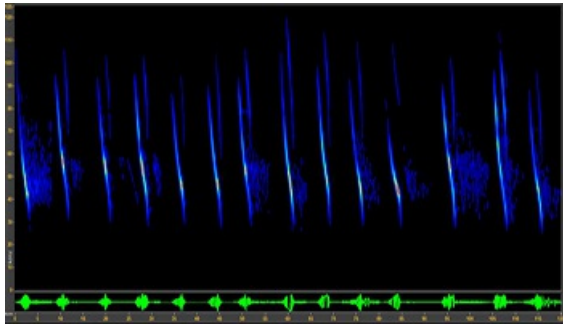
Natterer's Bat - call duration 2.1-2.3 ms



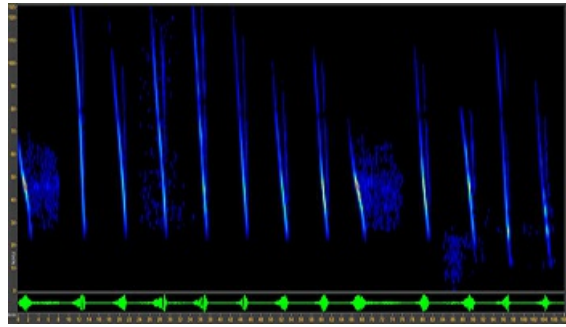
Daubenton's Bat - call duration 2.4-2.5 ms



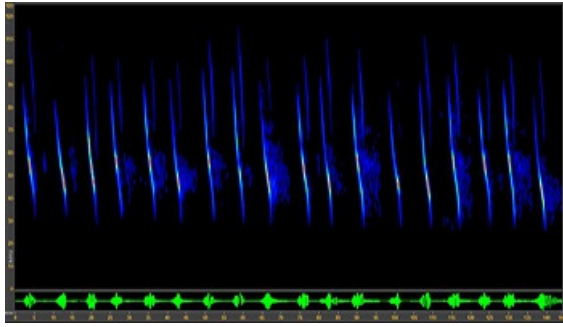
Natterer's Bat - call duration 2.4-2.5 ms



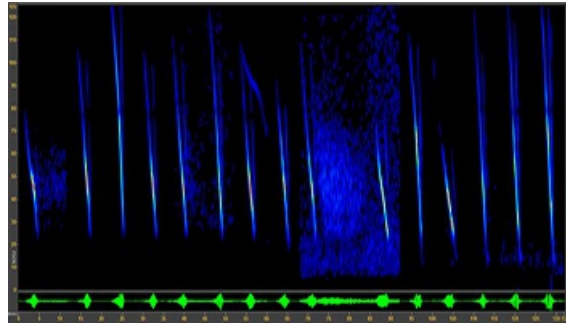
Daubenton's Bat - call duration 2.6-2.7 ms



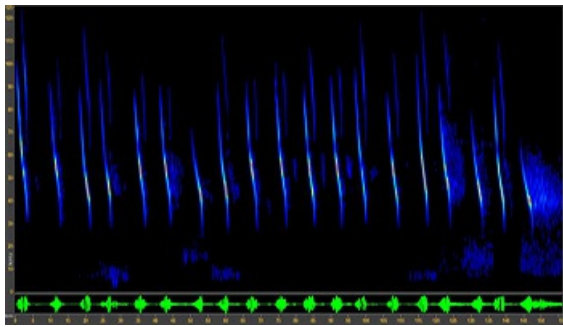
Natterer's Bat - call duration 2.6-2.7 ms



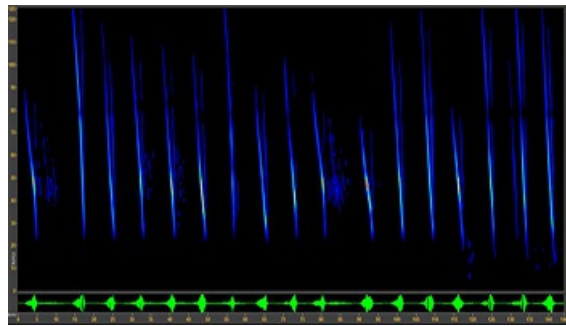
Daubenton's Bat - call duration 2.8-2.9 ms



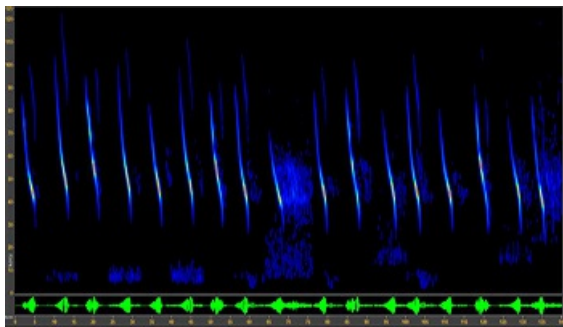
Natterer's Bat - call duration 2.8-2.9 ms



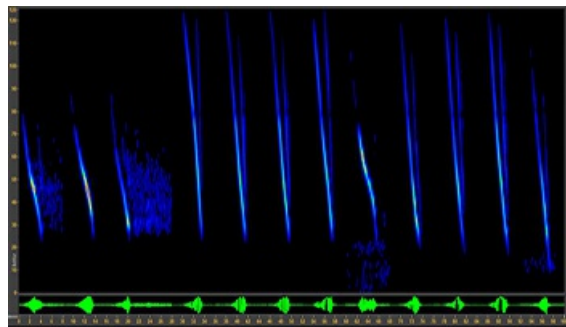
Daubenton's Bat - call duration 3.0-3.1 ms



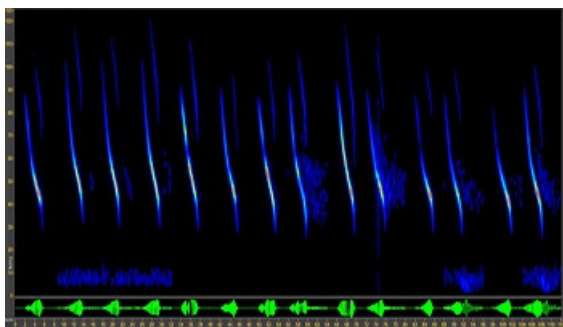
Natterer's Bat - call duration 3.0-3.1 ms



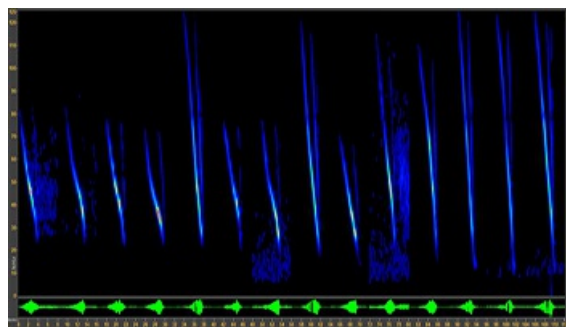
Daubenton's Bat - call duration 3.2-3.3 ms



Natterer's Bat - call duration 3.2-3.3 ms

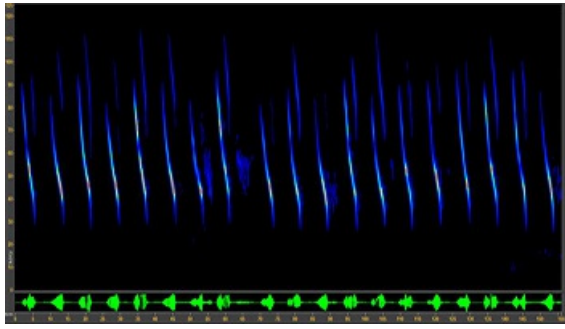


Daubenton's Bat - call duration 3.4-3.5 ms

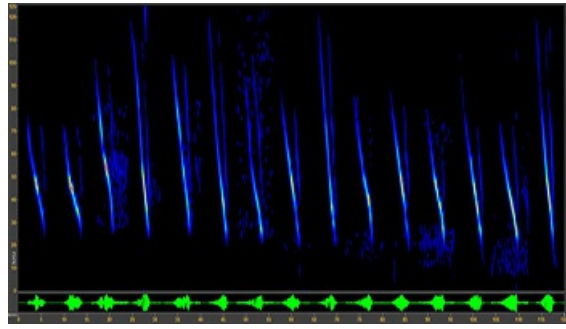


Natterer's Bat - call duration 3.4-3.5 ms

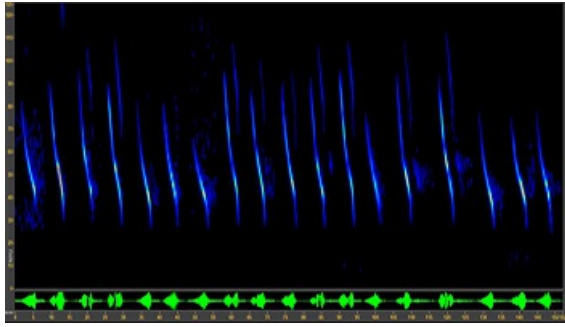




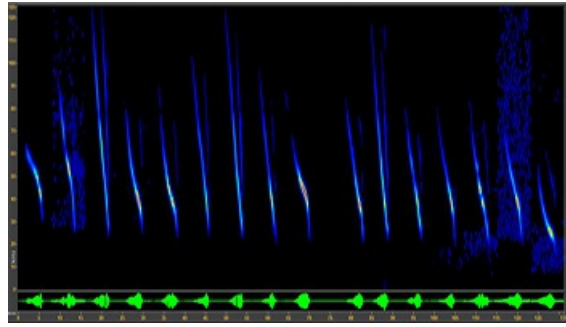
Daubenton's Bat - call duration 3.6-3.7 ms



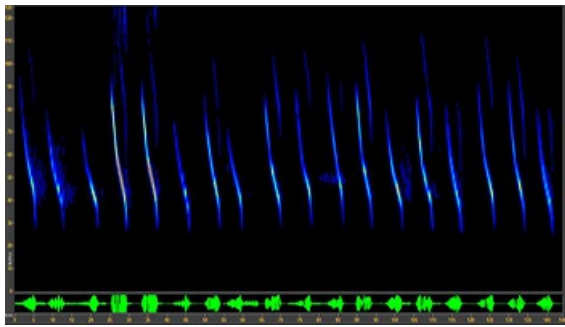
Natterer's Bat - call duration 3.6-3.7 ms



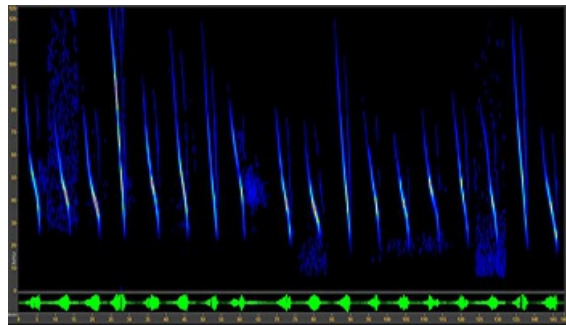
Daubenton's Bat - call duration 3.8-3.9 ms



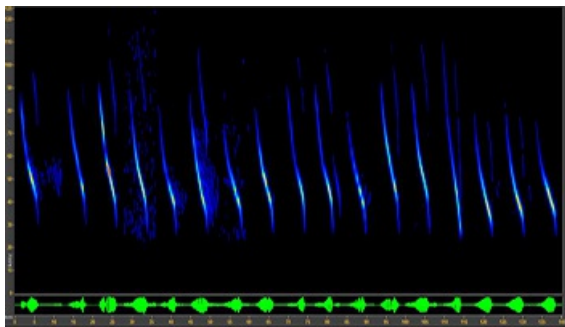
Natterer's Bat - call duration 3.8-3.9 ms



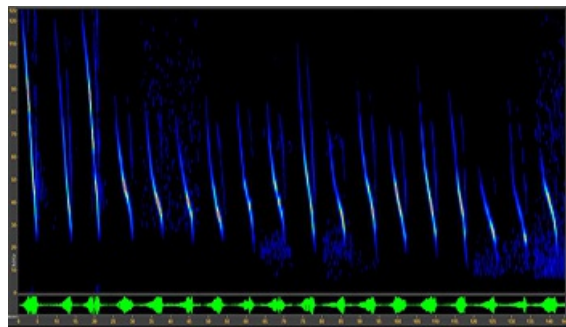
Daubenton's Bat - call duration 4.0-4.1 ms



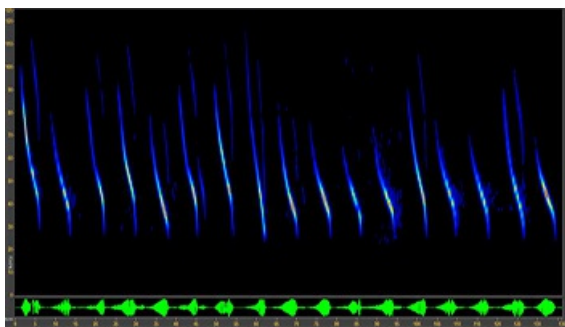
Natterer's Bat - call duration 4.0-4.1 ms



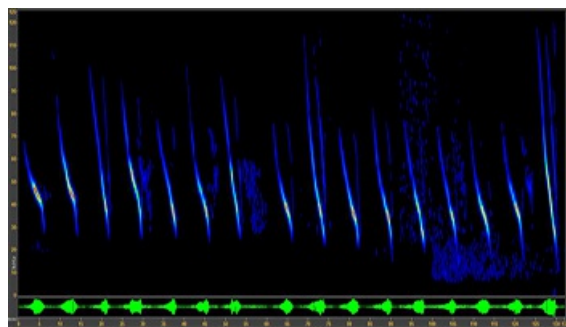
Daubenton's Bat - call duration 4.2-4.3 ms



Natterer's Bat - call duration 4.2-4.3 ms

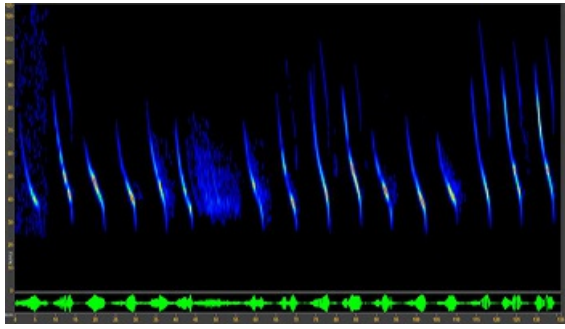


Daubenton's Bat - call duration 4.4-4.5 ms

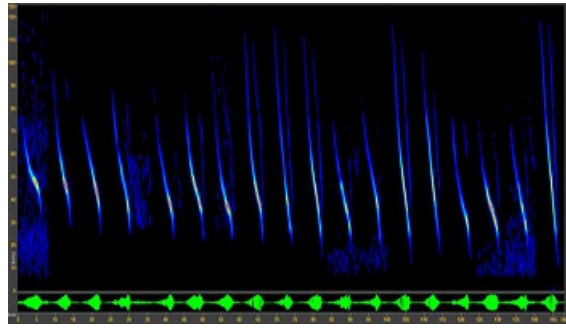


Natterer's Bat - call duration 4.4-4.5 ms

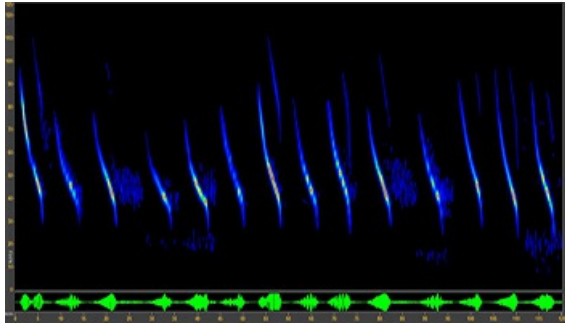




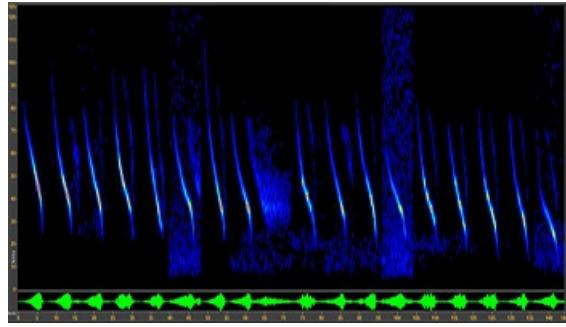
Daubenton's Bat - call duration 4.6-4.7 ms



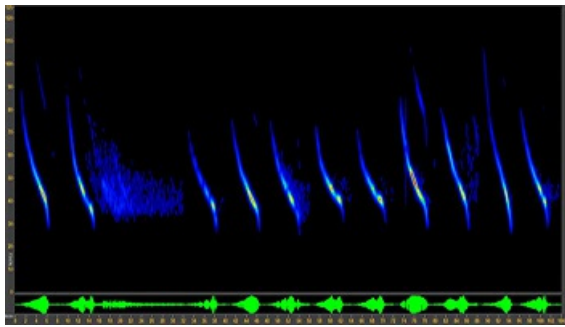
Natterer's Bat - call duration 4.6-4.7 ms



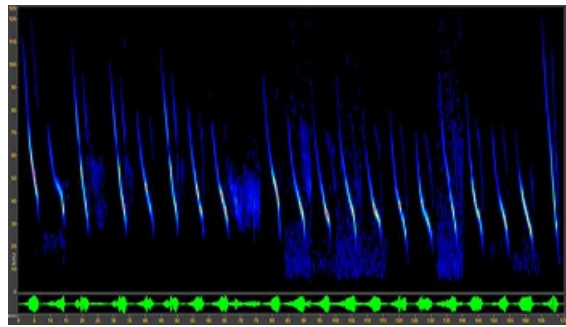
Daubenton's Bat - call duration 4.8-4.9 ms



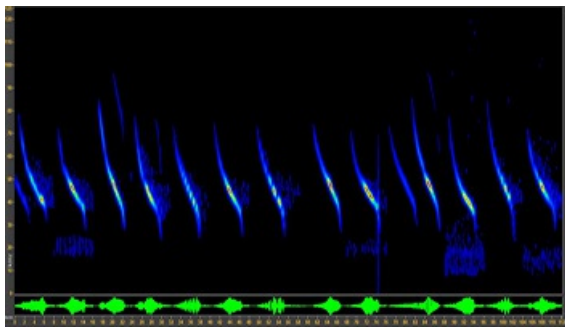
Natterer's Bat - call duration 4.8-4.9 ms



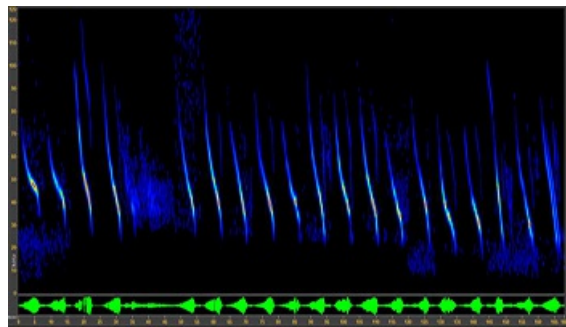
Daubenton's Bat - call duration 5.0-5.1 ms



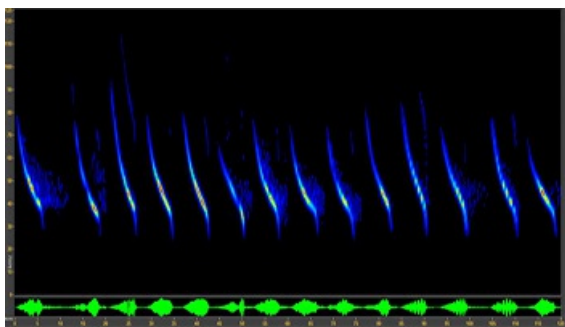
Natterer's Bat - call duration 5.0-5.1 ms



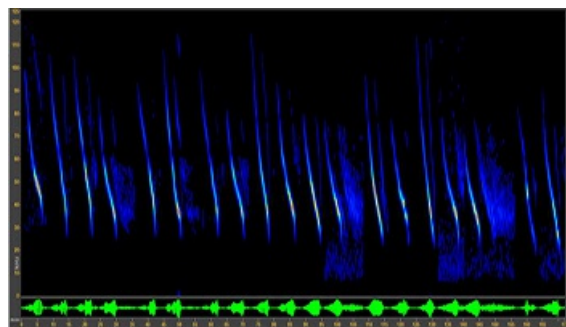
Daubenton's Bat - call duration 5.2-5.3 ms



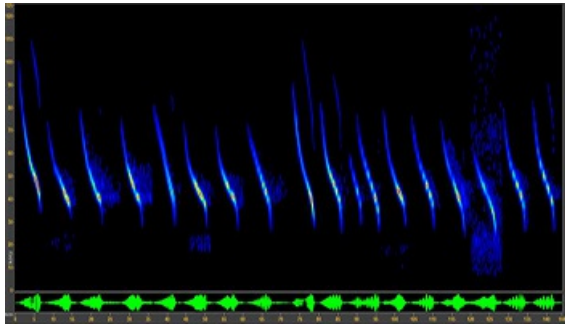
Natterer's Bat - call duration 5.2-5.3 ms



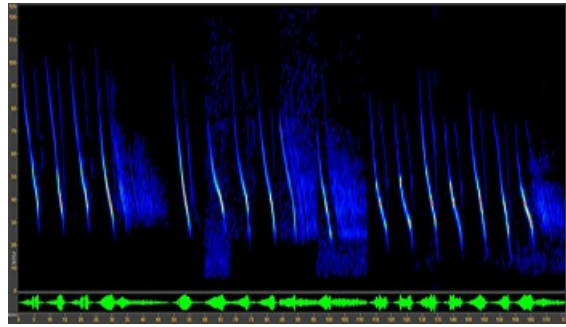
Daubenton's Bat - call duration 5.4-5.5 ms



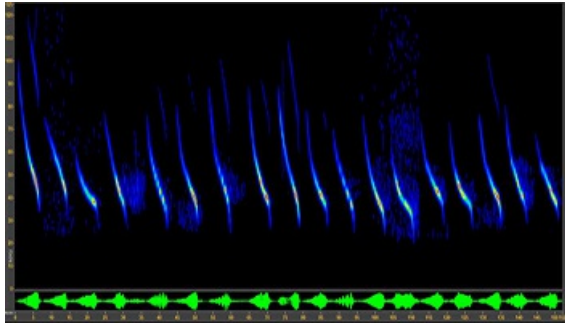
Natterer's Bat - call duration 5.4-5.5 ms



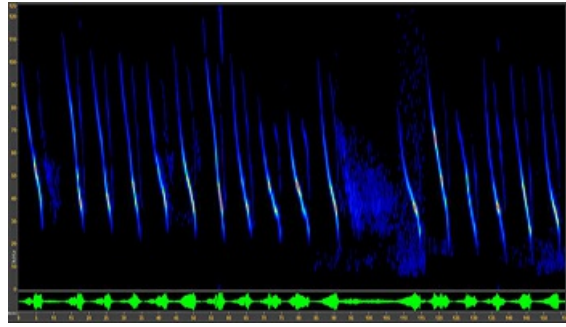
Daubenton's Bat - call duration 5.6-5.7 ms



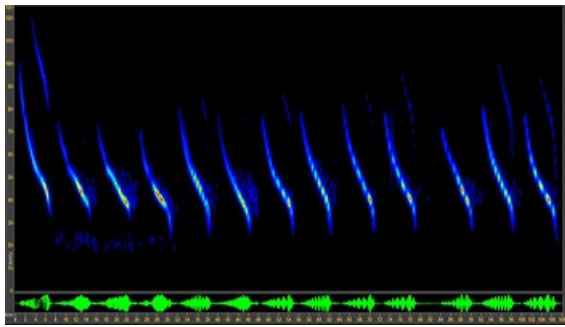
Natterer's Bat - call duration 5.6-5.7 ms



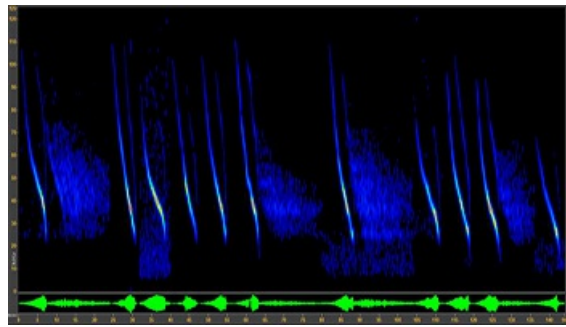
Daubenton's Bat - call duration 5.8-5.9 ms



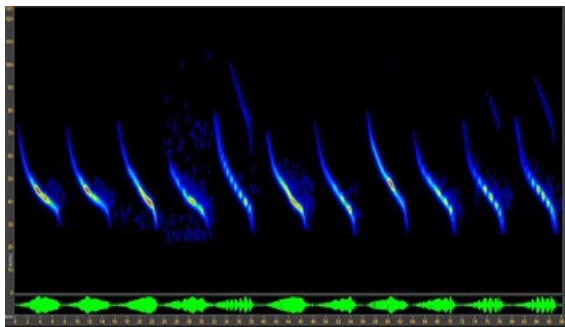
Natterer's Bat - call duration 5.8-5.9 ms



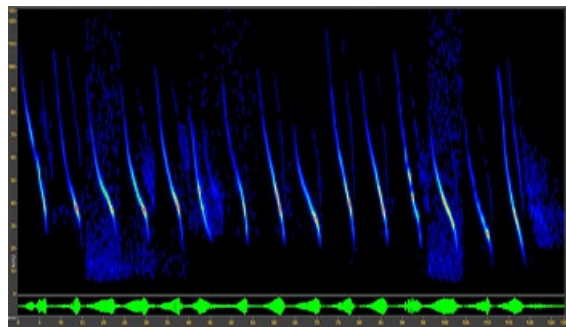
Daubenton's Bat - call duration 6.0-6.1 ms



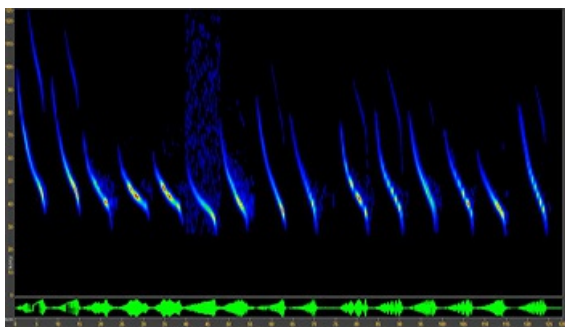
Natterer's Bat - call duration 6.0-6.1 ms



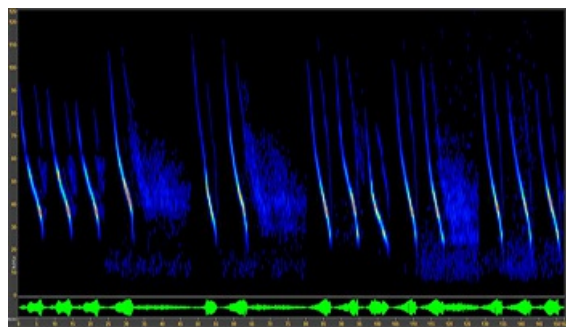
Daubenton's Bat - call duration 6.2-6.3 ms



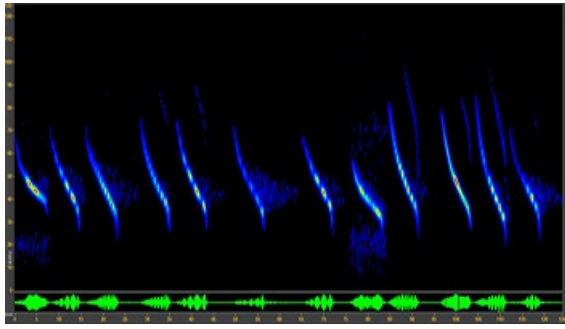
Natterer's Bat - call duration 6.2-6.3 ms



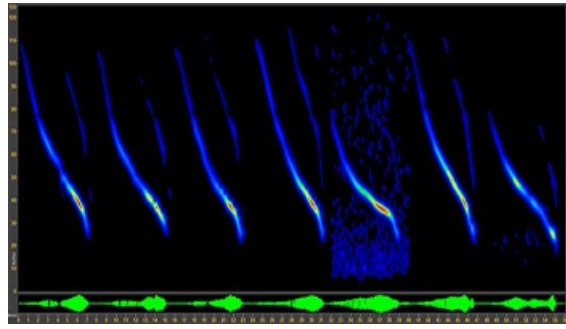
Daubenton's Bat - call duration 6.4-6.6 ms



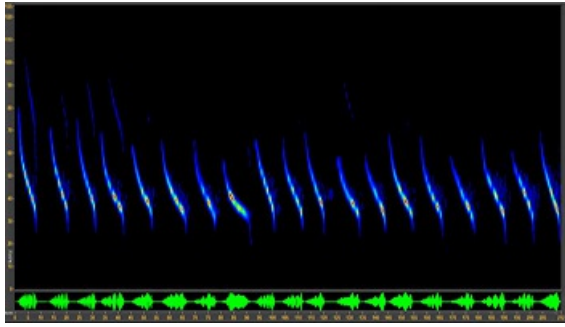
Natterer's Bat - call duration 6.4-6.6 ms



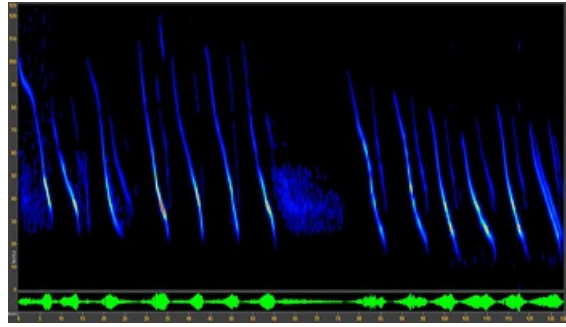
Daubenton's Bat - call duration 6.7-6.8 ms



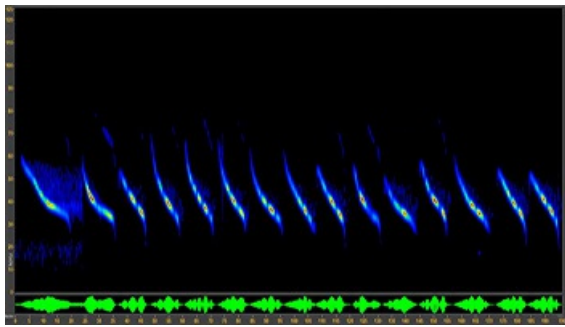
Natterer's Bat - call duration 6.7-6.8 ms



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



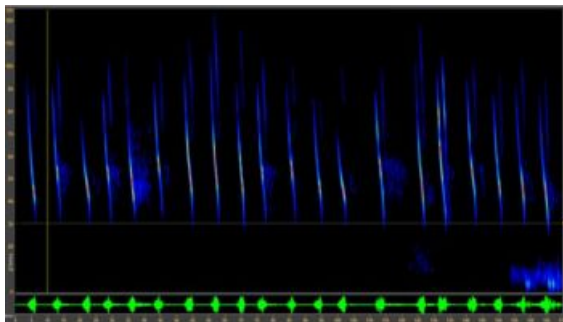
## Identification appendix 2: Whiskered/Brandt's Bat *Myotis mystacinus/brandtii*

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.

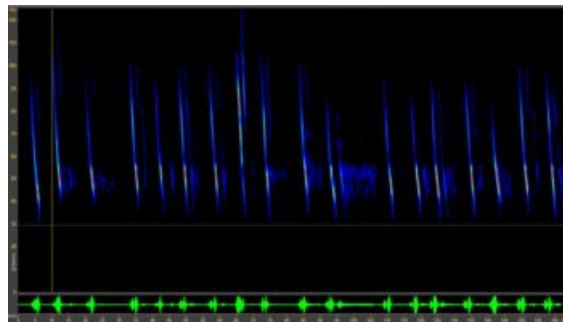
Given a *Myotis* recording, an important first consideration is the quality of the recording. Firstly, to consider whether there is significant overloading across calls that makes it difficult to determine the start and end of the calls. There is a bit of overloading in a few of the recordings of Whiskered 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.

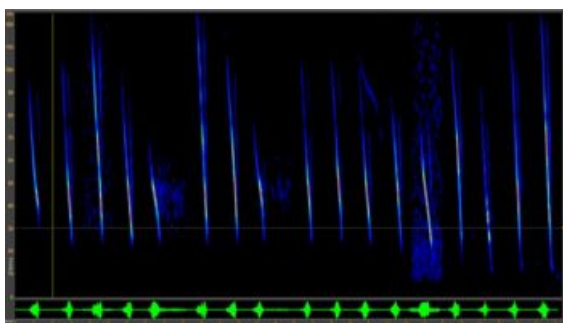
If the quality of the recordings and calls is good, we would normally expect to have a good idea of what species produced it, but it is helpful next to consider what you would expect calls of that species, given that call duration to look like, and to consider how this compares with other similar species. 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 Alcatheo 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.



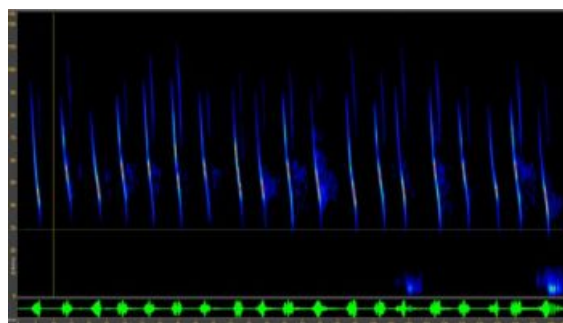
Whiskered or Brandt's Bat call (left), against known Whiskered calls (right)



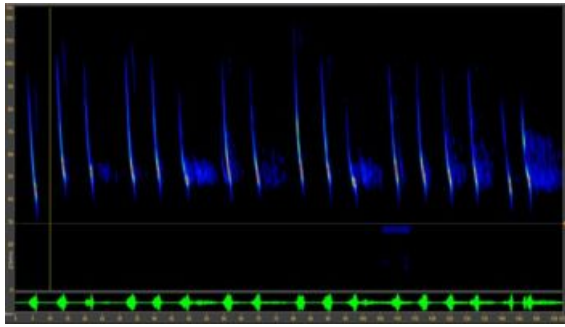
Whiskered or Brandt's Bat call (left), against known Brandt's Bat calls (right)



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)

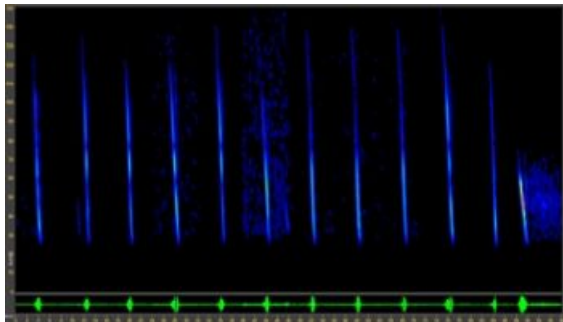


Whiskered or Brandt's Bat call (left), against known Alcatraz Bat calls (right)

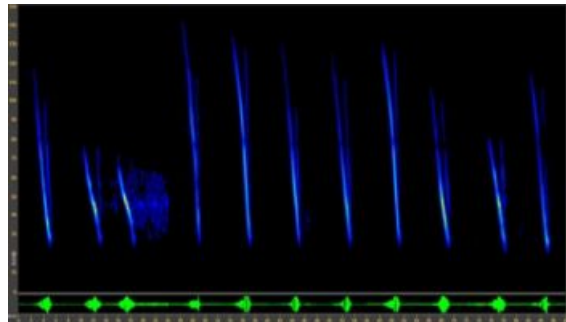


## Identification appendix 3: Natterer's Bat *Myotis nattereri*

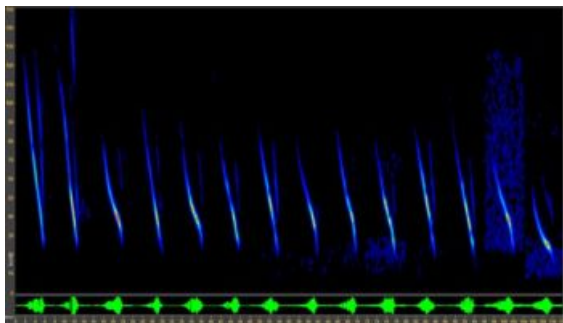
As with Whiskered and Brandt's Bat, the first consideration when looking at recordings is the quality of the recording, to consider whether the quality is good enough to try to assign the recording to species. Given a good recording, Natterer's Bat can occasionally produce atypical calls that could be 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.



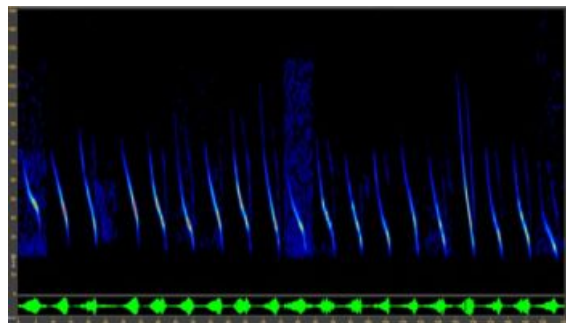
Natterer's Bat - call duration up to 1.2 ms



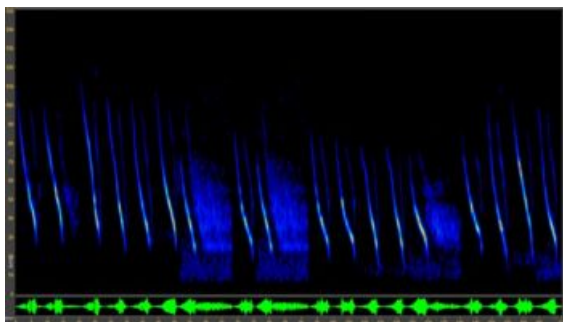
Natterer's Bat - call duration 2.7-2.8 ms



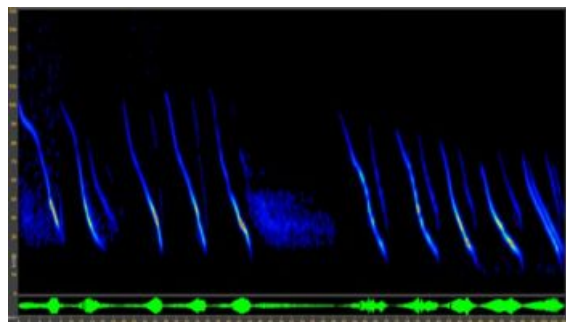
Natterer's Bat - call duration 3.9-4.0 ms



Natterer's Bat - call duration 4.9-5.0 ms

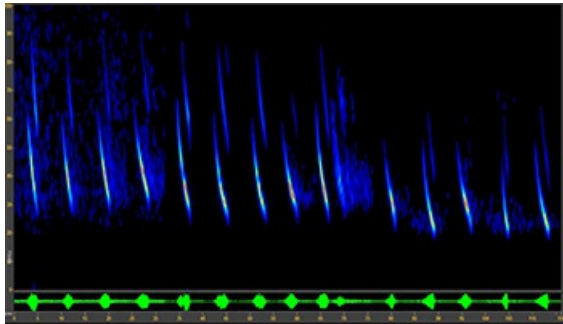


Natterer's Bat - call duration 5.9-6.0 ms

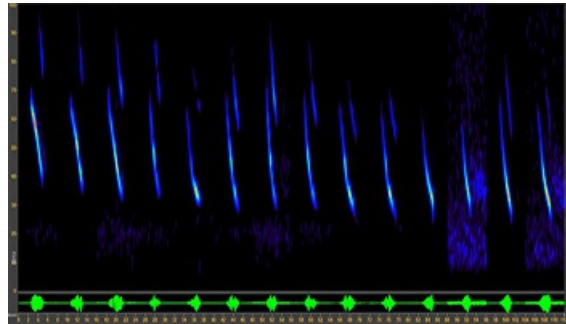


Natterer's Bat - call duration 7.1-9.4 ms

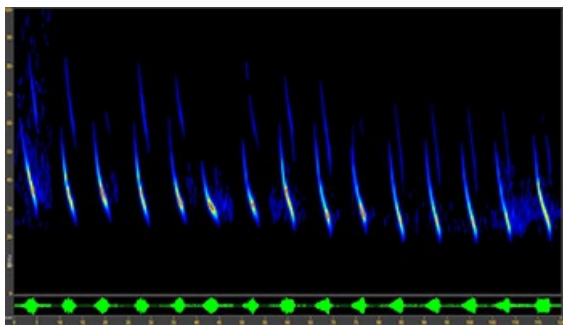
## Identification appendix 4: Common Noctule *Nyctalus noctula* and Leisler's Bat *Nyctalus leisleri*



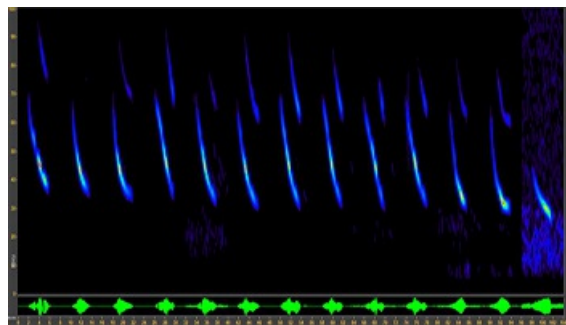
Common Noctule - call duration 1.4-3.0 ms



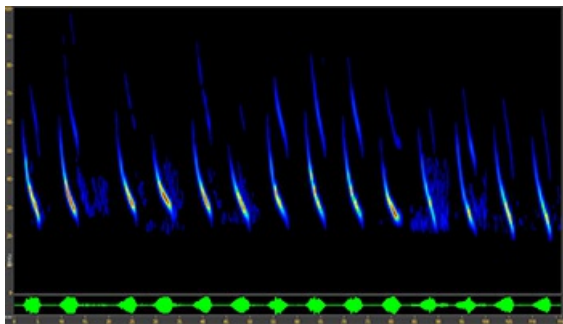
Leisler's Bat - call duration 1.4-3.0 ms



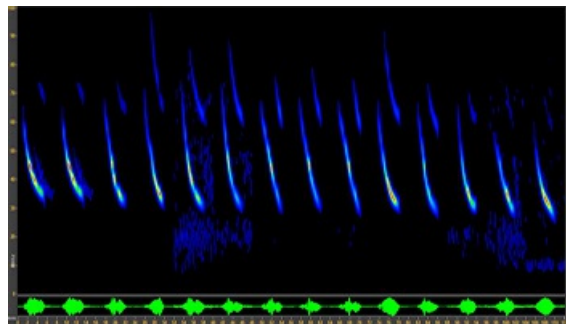
Common Noctule - call duration 3.1-3.7 ms



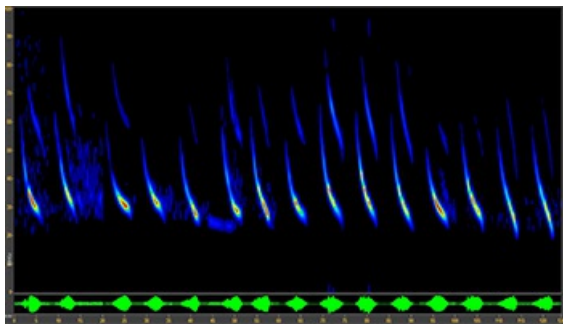
Leisler's Bat - call duration 3.1-3.7 ms



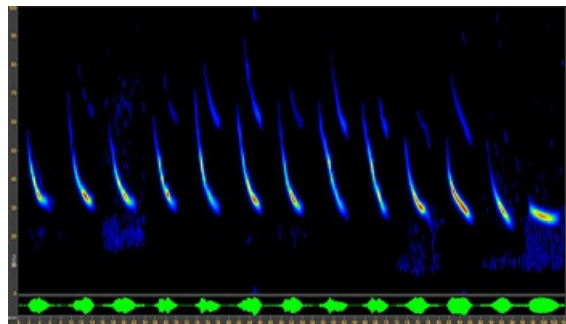
Common Noctule - call duration 3.8-4.3 ms



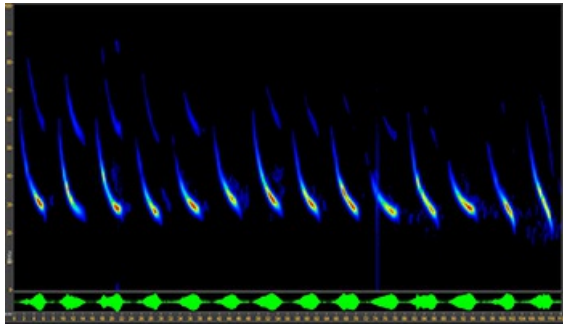
Leisler's Bat - call duration 3.8-4.3 ms



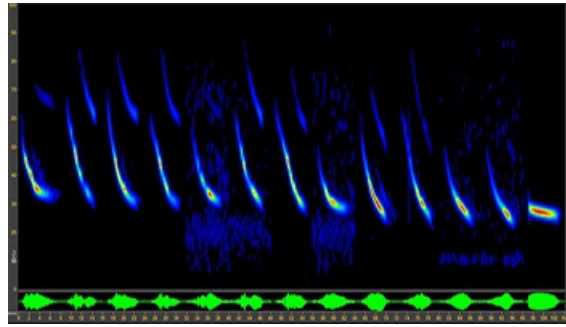
Common Noctule - call duration 4.4-4.9 ms



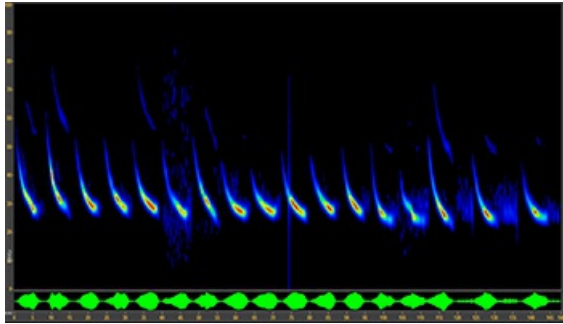
Leisler's Bat - call duration 4.4-4.9 ms



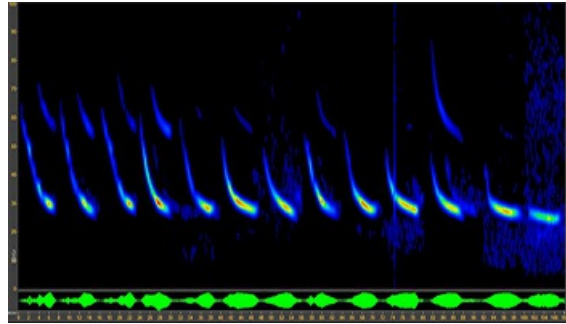
Common Noctule - call duration 5.0-5.9 ms



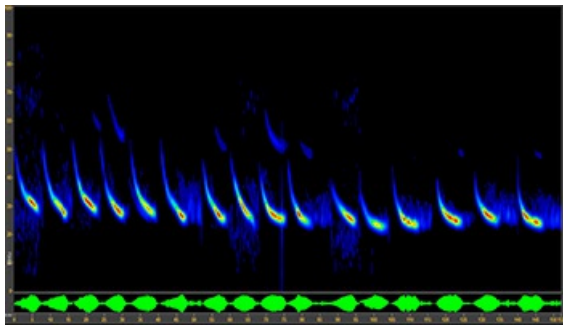
Leisler's Bat - call duration 5.0-5.9 ms



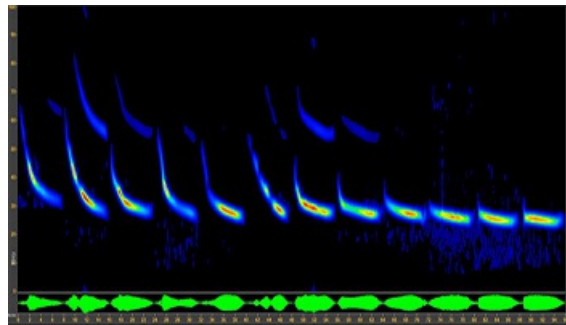
Common Noctule - call duration 6.0-6.8 ms



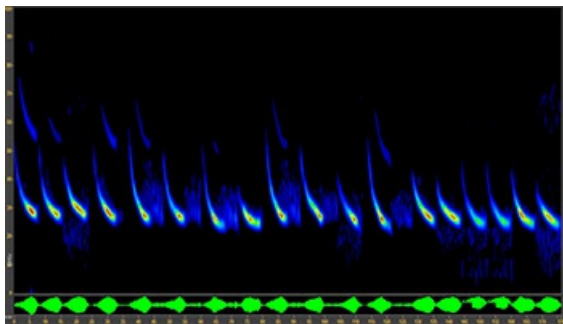
Leisler's Bat - call duration 6.0-6.8 ms



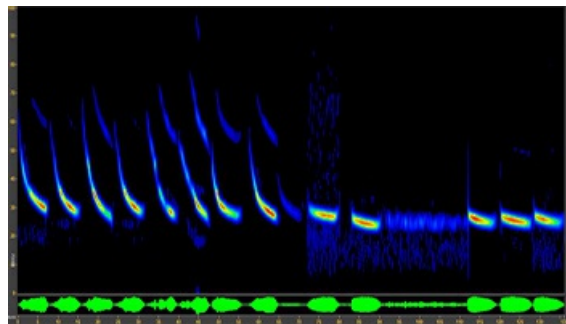
Common Noctule - call duration 6.9-7.2 ms



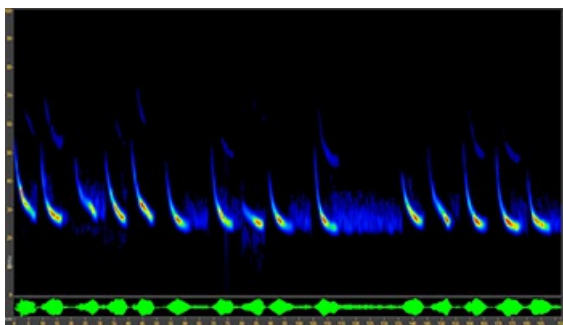
Leisler's Bat - call duration 6.9-7.2 ms



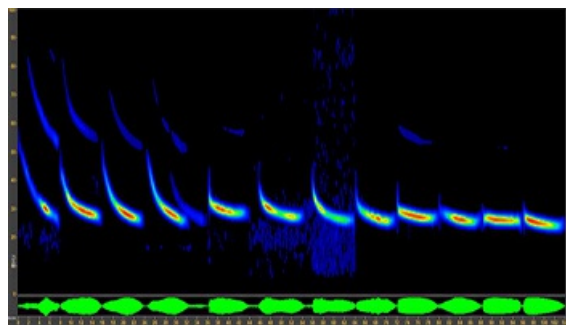
Common Noctule - call duration 7.3-7.6 ms



Leisler's Bat - call duration 7.3-7.6 ms

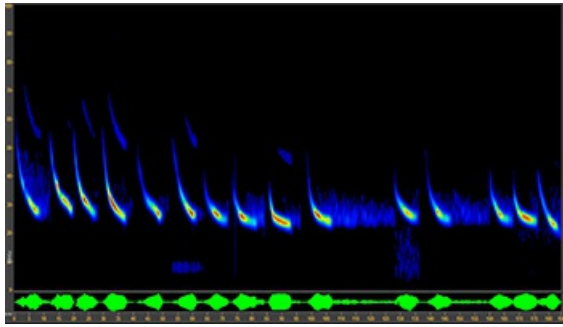


Common Noctule - call duration 7.7-7.8 ms

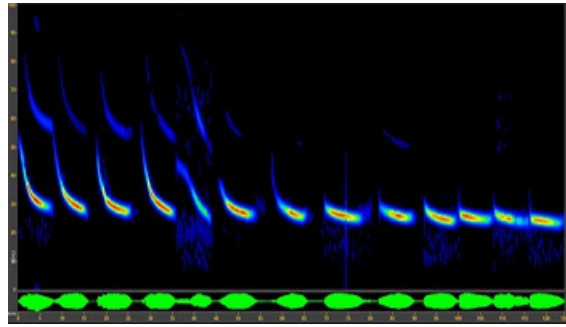


Leisler's Bat - call duration 7.7-7.8 ms

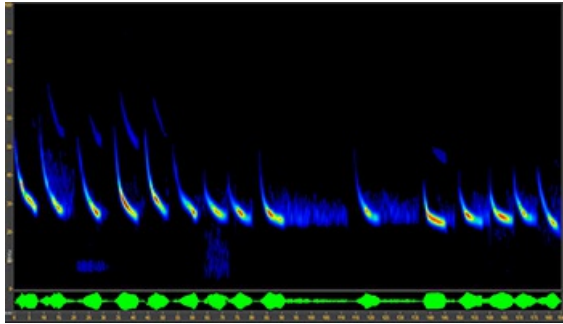




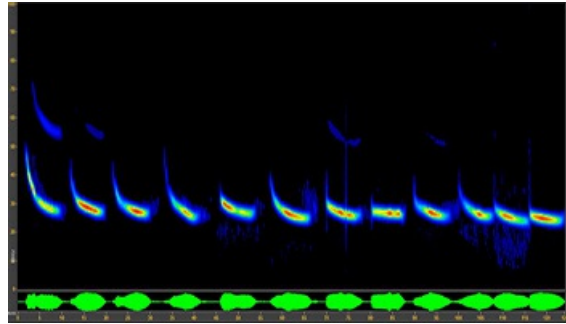
Common Noctule - call duration 7.9-8.0 ms



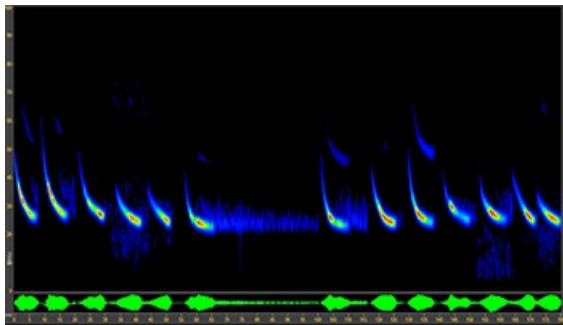
Leisler's Bat - call duration 7.9-8.0 ms



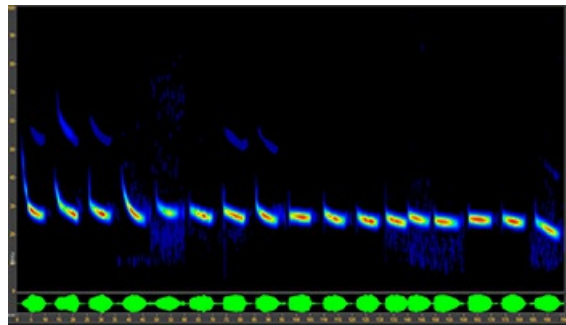
Common Noctule - call duration 8.1-8.3 ms



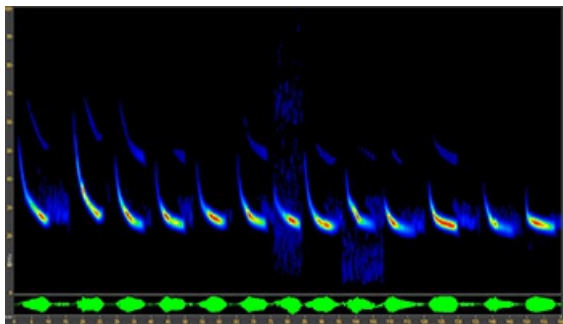
Leisler's Bat - call duration 8.1-8.3 ms



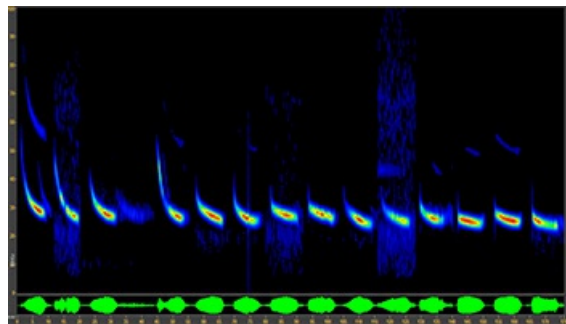
Common Noctule - call duration 8.4-8.5 ms



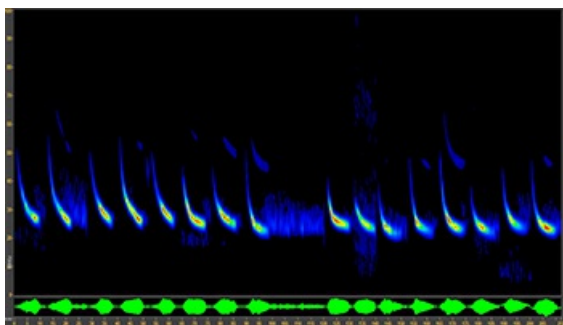
Leisler's Bat - call duration 8.4-8.5 ms



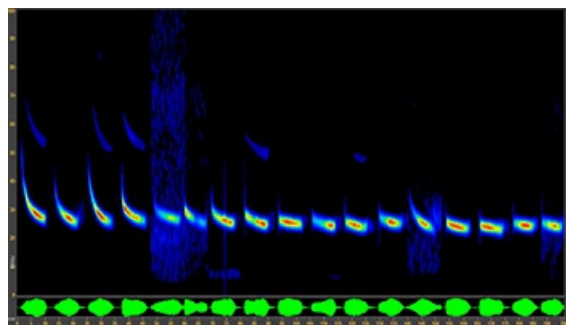
Common Noctule - call duration 8.6-8.7 ms



Leisler's Bat - call duration 8.6-8.7 ms

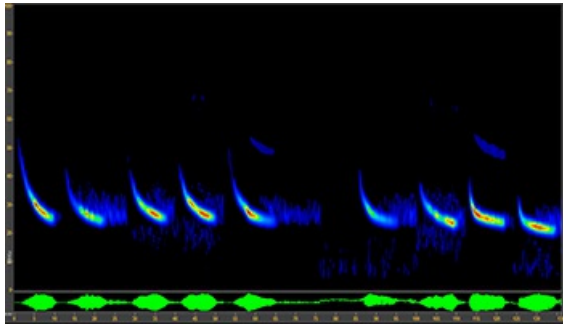


Common Noctule - call duration 8.8-8.9 ms

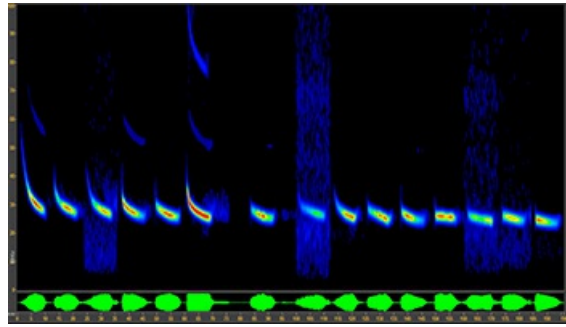


Leisler's Bat - call duration 8.8-8.9 ms

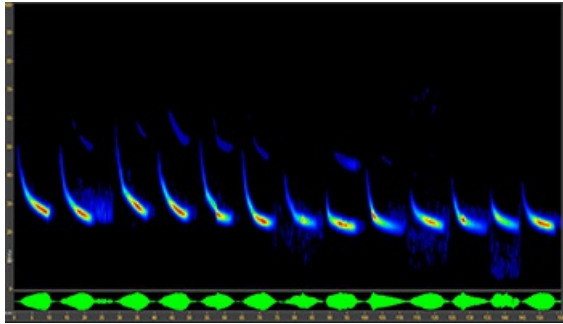




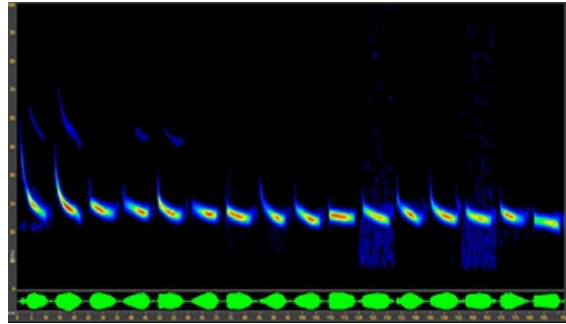
Common Noctule - call duration 9.0-9.1 ms



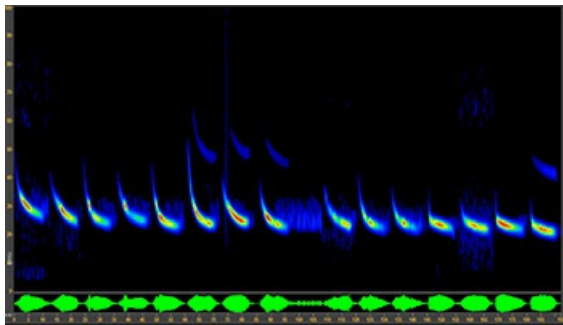
Leisler's Bat - call duration 9.0-9.1 ms



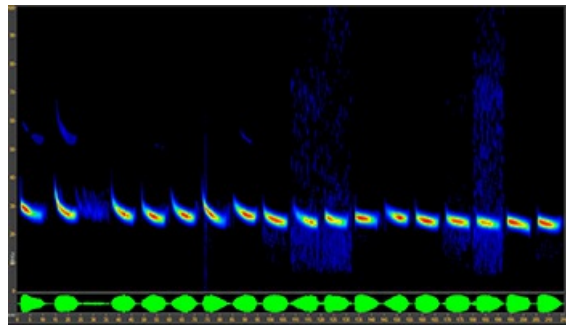
Common Noctule - call duration 9.2-9.3 ms



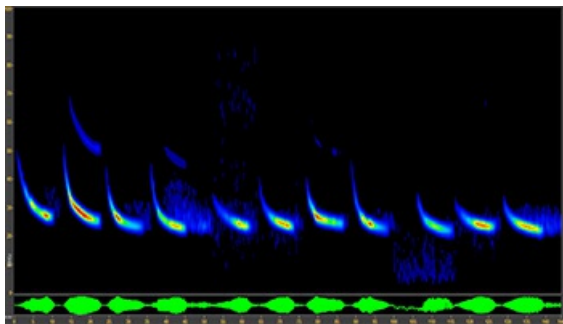
Leisler's Bat - call duration 9.2-9.3 ms



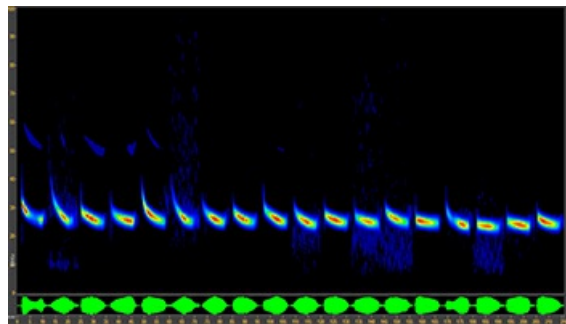
Common Noctule - call duration 9.4-9.5 ms



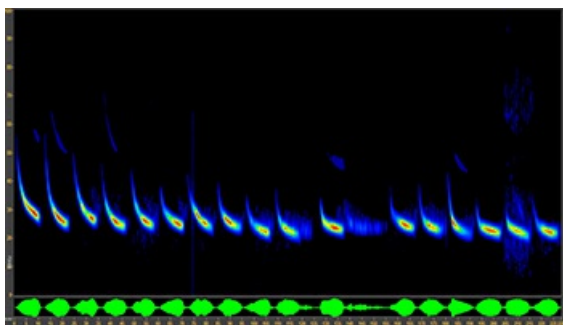
Leisler's Bat - call duration 9.4-9.5 ms



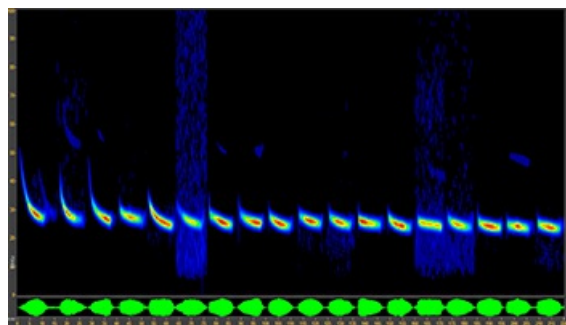
Common Noctule - call duration 9.6-9.7 ms



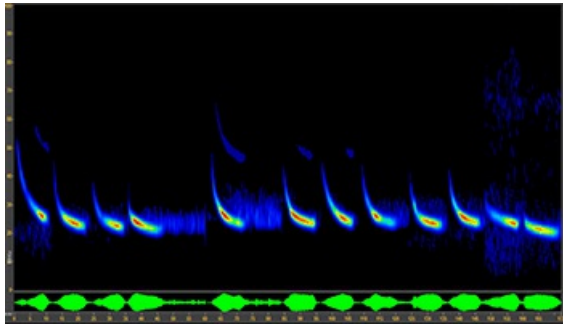
Leisler's Bat - call duration 9.6-9.7 ms



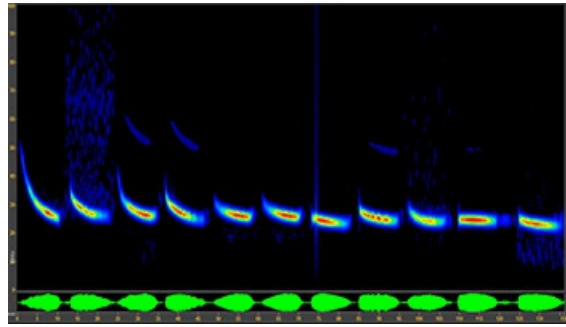
Common Noctule - call duration 9.8-9.9 ms



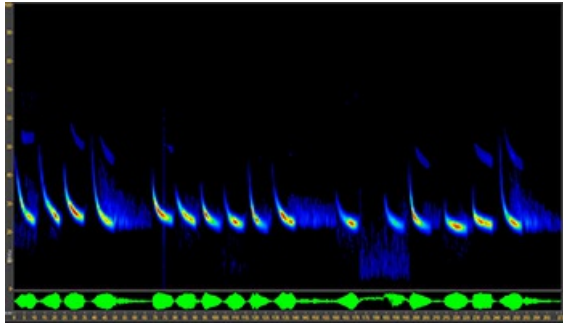
Leisler's Bat - call duration 9.8-9.9 ms



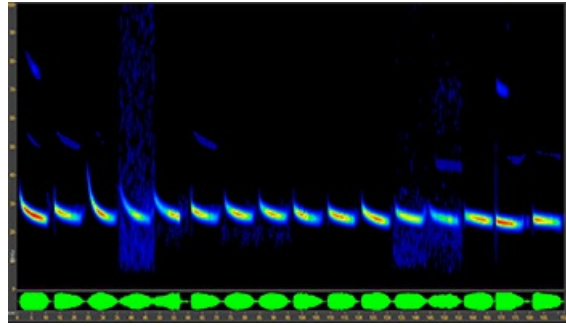
Common Noctule - call duration 10.0-10.1 ms



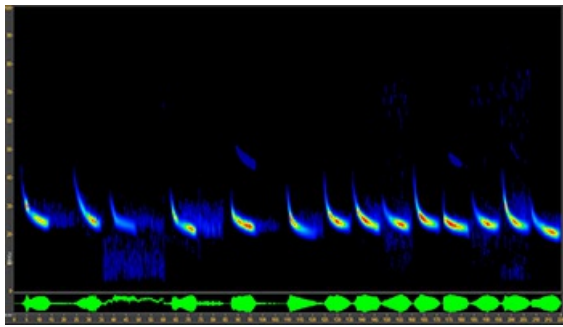
Leisler's Bat - call duration 10.0-10.1 ms



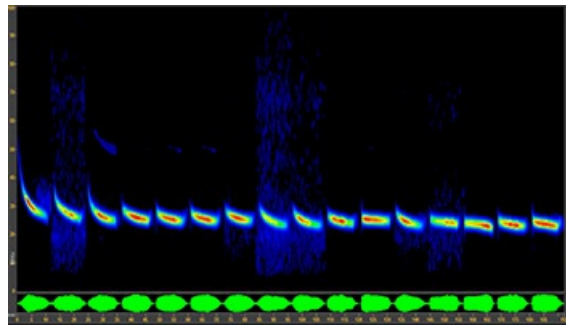
Common Noctule - call duration 10.2-10.3 ms



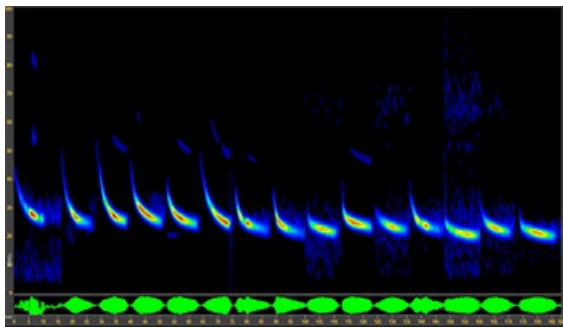
Leisler's Bat - call duration 10.2-10.3 ms



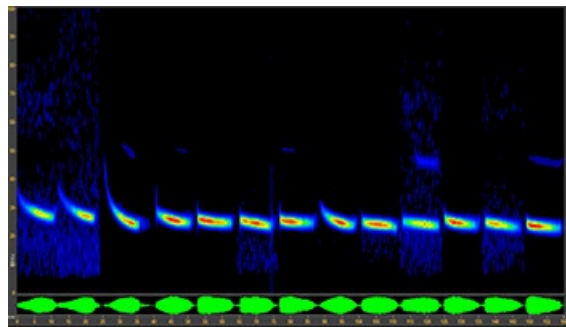
Common Noctule - call duration 10.4-10.5 ms



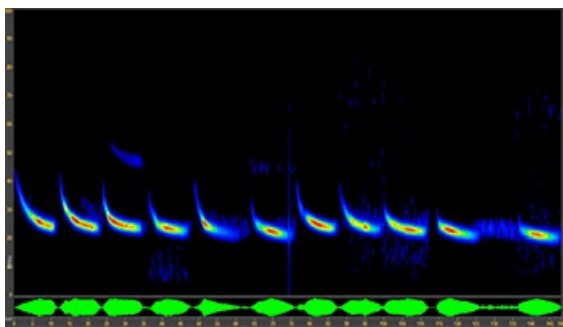
Leisler's Bat - call duration 10.4-10.5 ms



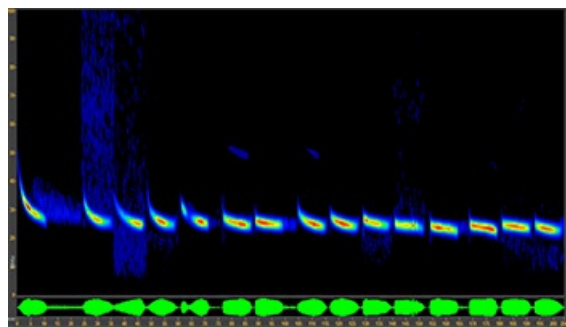
Common Noctule - call duration 10.6-10.7 ms



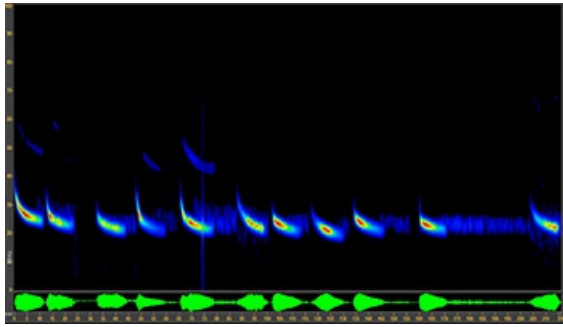
Leisler's Bat - call duration 10.6-10.7 ms



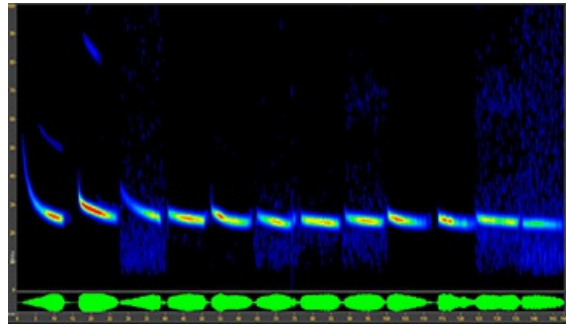
Common Noctule - call duration 10.8-10.9 ms



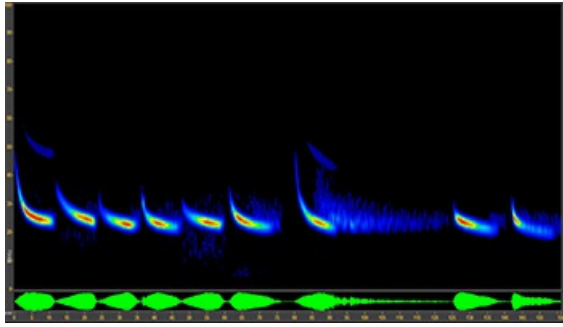
Leisler's Bat - call duration 10.8-10.9 ms



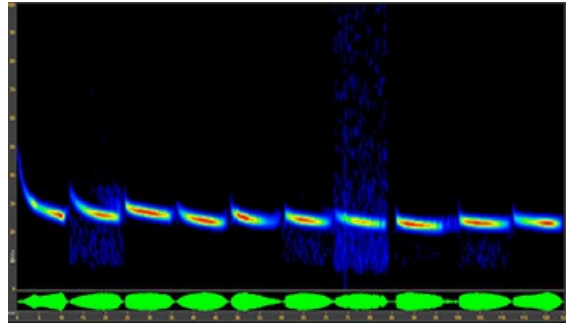
Common Noctule - call duration 11.0-11.1 ms



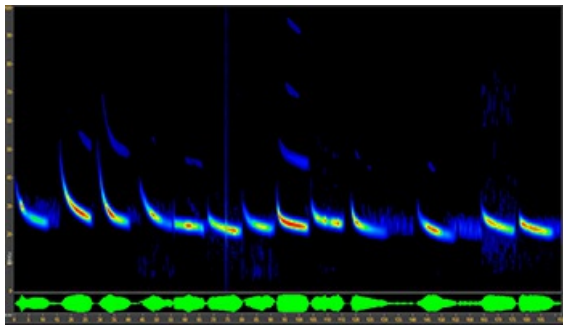
Leisler's Bat - call duration 11.0-11.1 ms



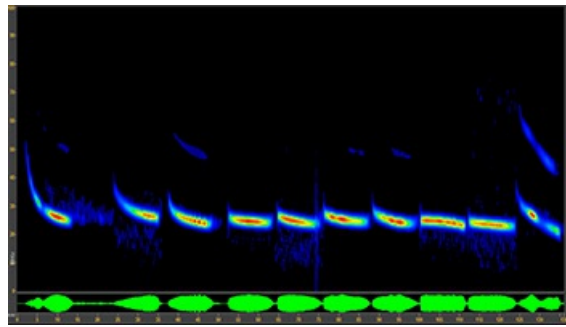
Common Noctule - call duration 11.2-11.3 ms



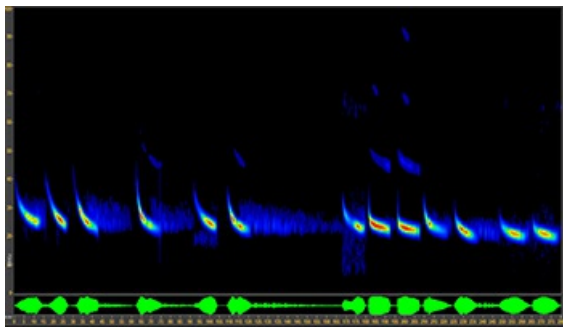
Leisler's Bat - call duration 11.2-11.3 ms



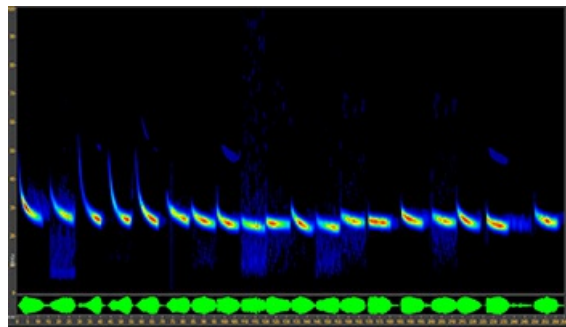
Common Noctule - call duration 11.4-11.5 ms



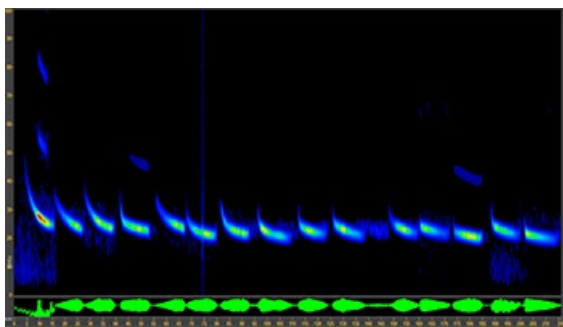
Leisler's Bat - call duration 11.4-11.5 ms



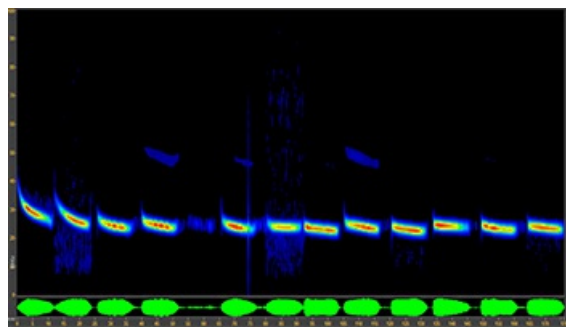
Common Noctule - call duration 11.6-11.7 ms



Leisler's Bat - call duration 11.6-11.7 ms

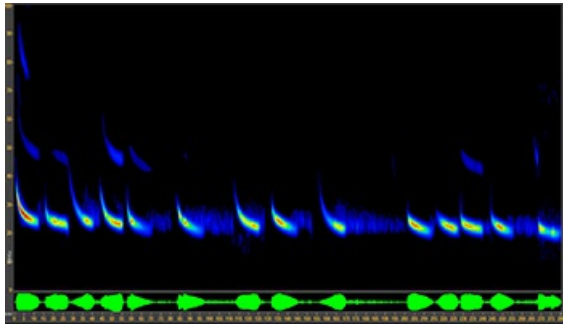


Common Noctule - call duration 11.8-11.9 ms

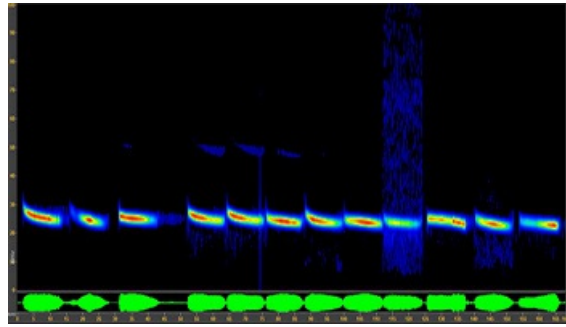


Leisler's Bat - call duration 11.8-11.9 ms

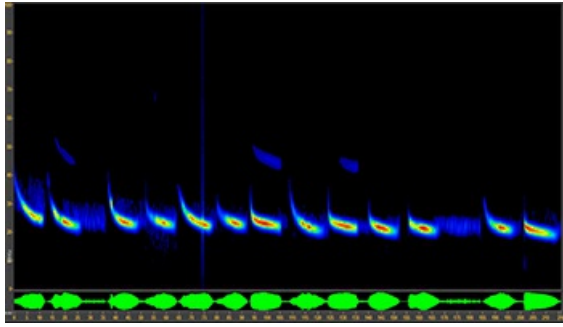




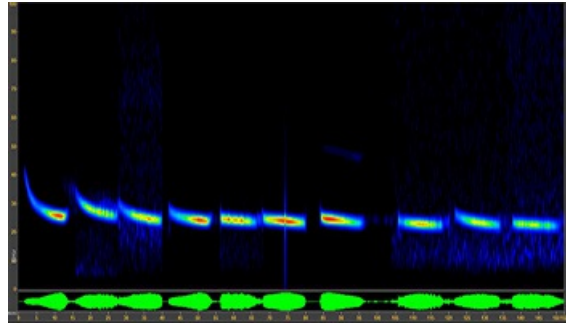
Common Noctule - call duration 12.0-12.2 ms



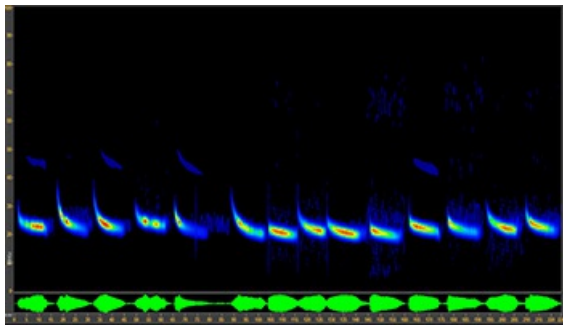
Leisler's Bat - call duration 12.0-12.2 ms



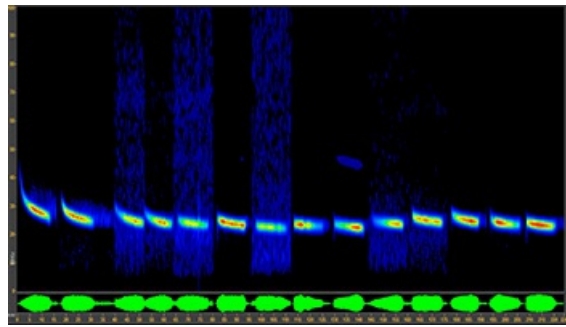
Common Noctule - call duration 12.3-12.4 ms



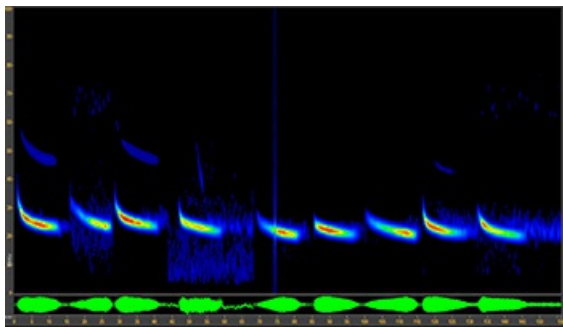
Leisler's Bat - call duration 12.3-12.4 ms



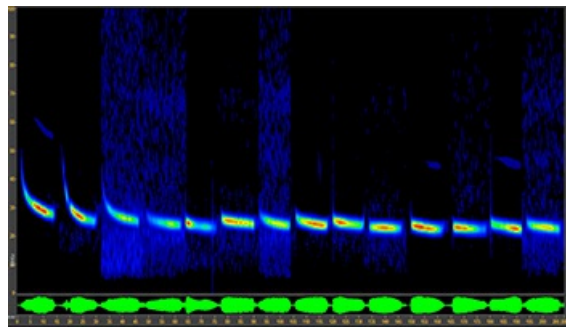
Common Noctule - call duration 12.5-12.7 ms



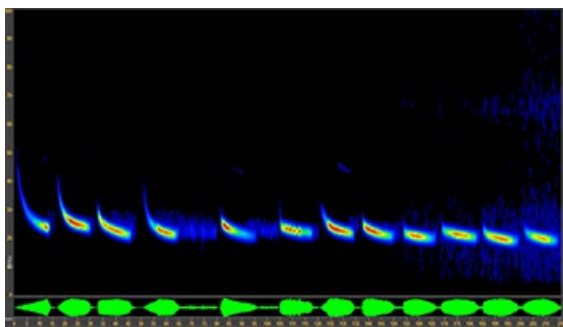
Leisler's Bat - call duration 12.5-12.7 ms



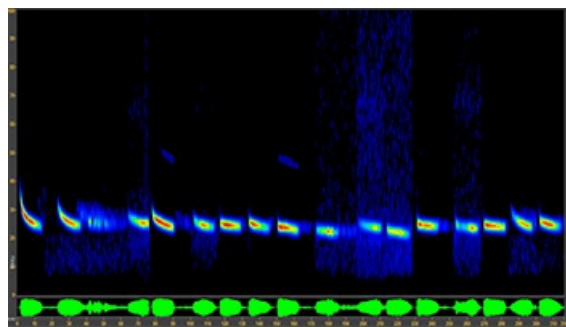
Common Noctule - call duration 12.8-12.9 ms



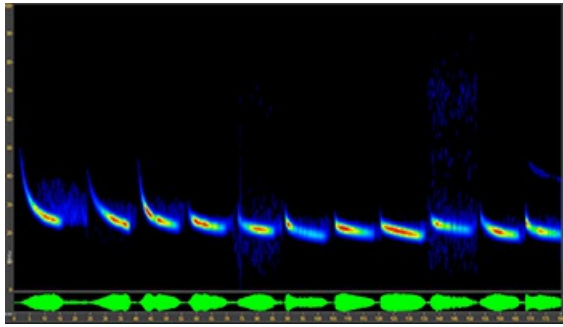
Leisler's Bat - call duration 12.8-12.9 ms



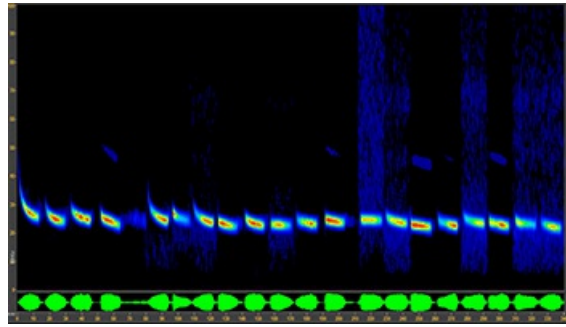
Common Noctule - call duration 13.0-13.1 ms



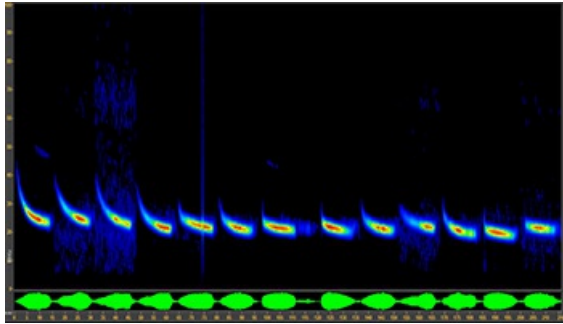
Leisler's Bat - call duration 13.0-13.1 ms



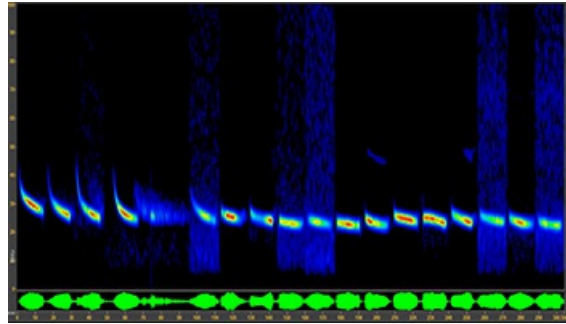
Common Noctule - call duration 13.2-13.3 ms



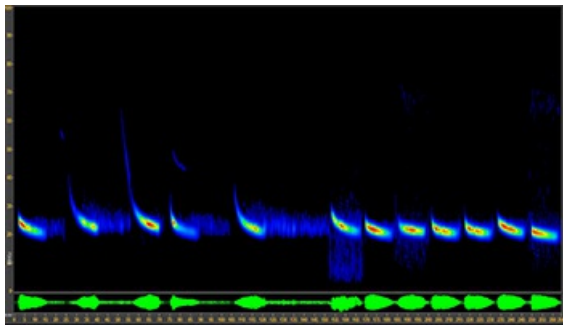
Leisler's Bat - call duration 13.2-13.3 ms



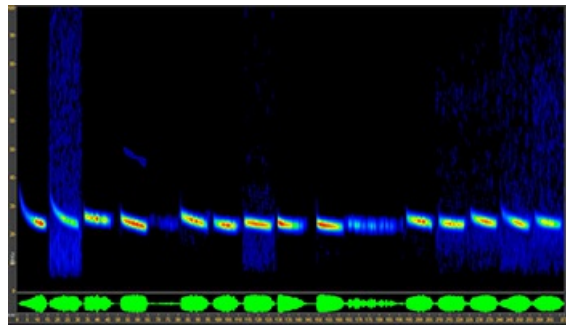
Common Noctule - call duration 13.4-13.5 ms



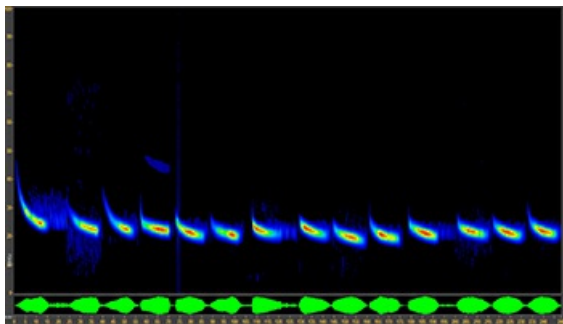
Leisler's Bat - call duration 13.4-13.5 ms



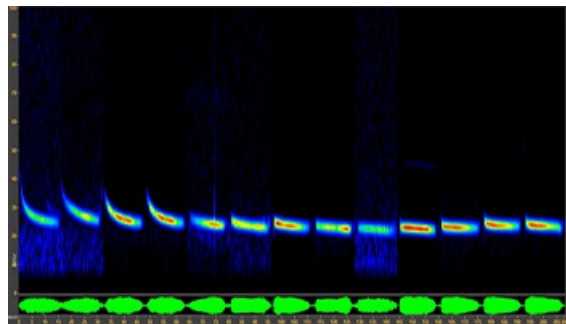
Common Noctule - call duration 13.6-13.7 ms



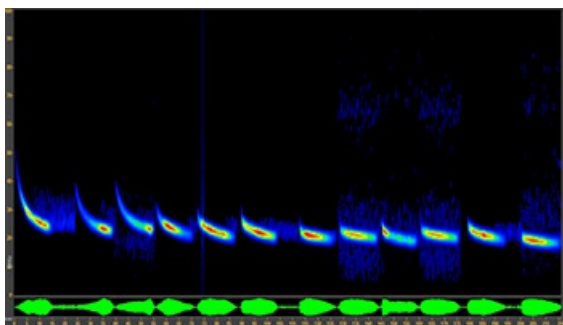
Leisler's Bat - call duration 13.6-13.7 ms



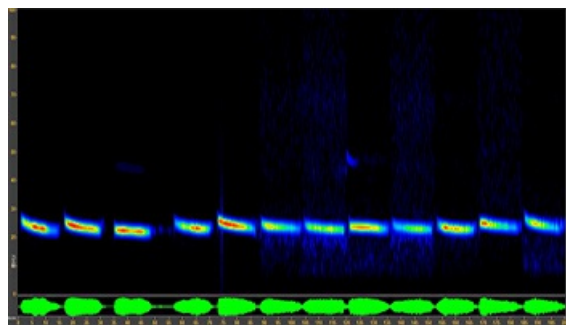
Common Noctule - call duration 13.8-14.0 ms



Leisler's Bat - call duration 13.8-14.0 ms

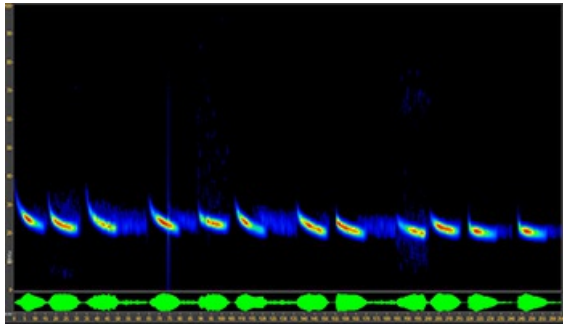


Common Noctule - call duration 14.1-14.3 ms

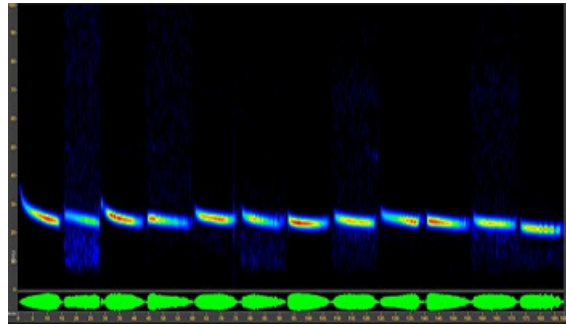


Leisler's Bat - call duration 14.1-14.3 ms

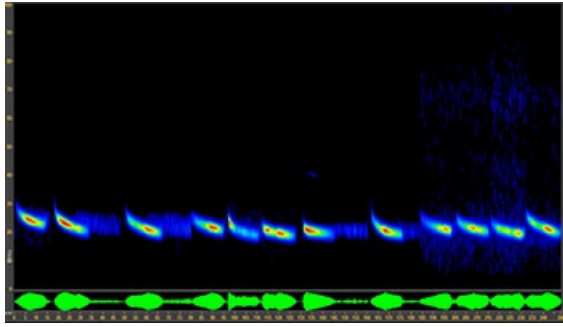




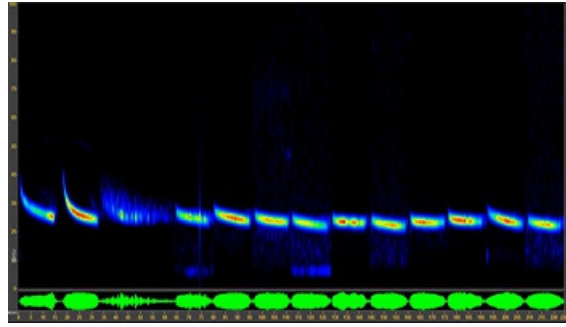
Common Noctule - call duration 14.4-14.5 ms



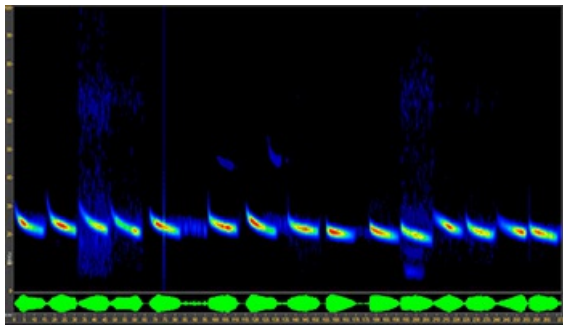
Leisler's Bat - call duration 14.4-14.5 ms



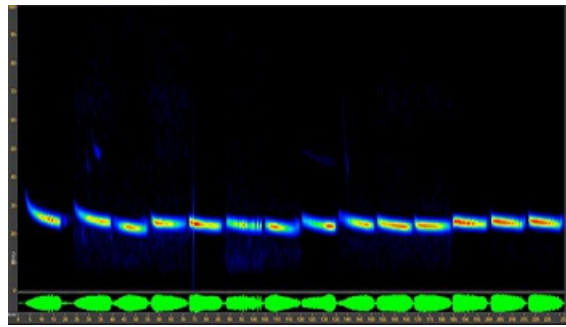
Common Noctule - call duration 14.6-14.8 ms



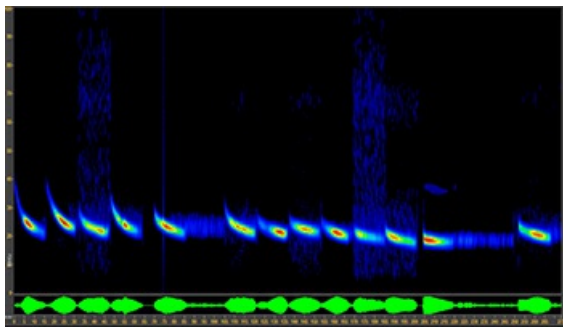
Leisler's Bat - call duration 14.6-14.8 ms



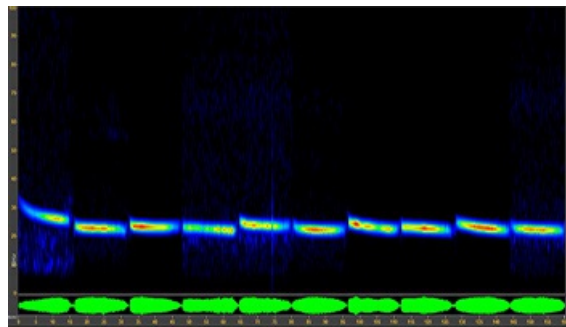
Common Noctule - call duration 14.9-15.1 ms



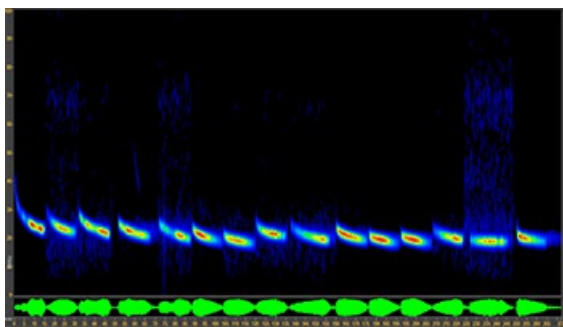
Leisler's Bat - call duration 14.9-15.1 ms



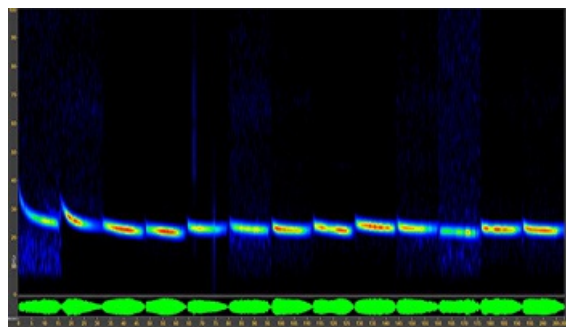
Common Noctule - call duration 15.2-15.3 ms



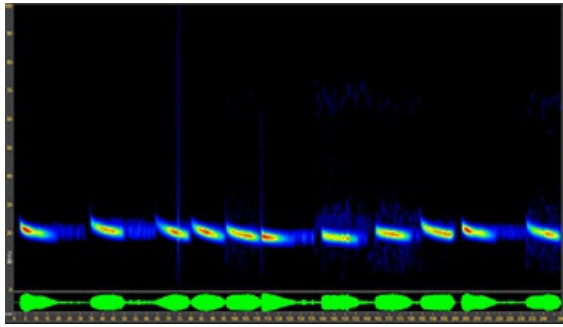
Leisler's Bat - call duration 15.2-15.3 ms



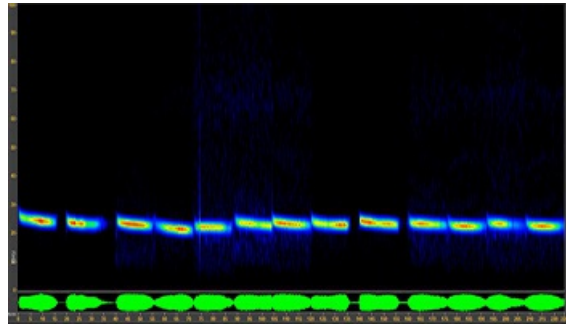
Common Noctule - call duration 15.4-15.7 ms



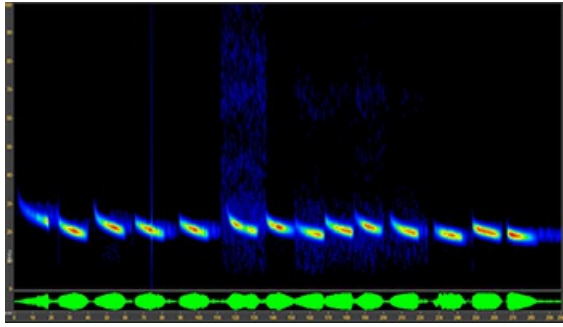
Leisler's Bat - call duration 15.4-15.7 ms



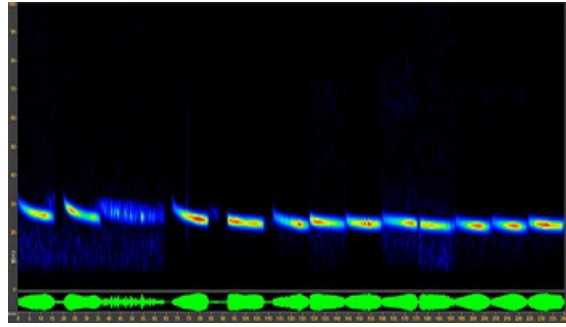
Common Noctule - call duration 15.8-16.0 ms



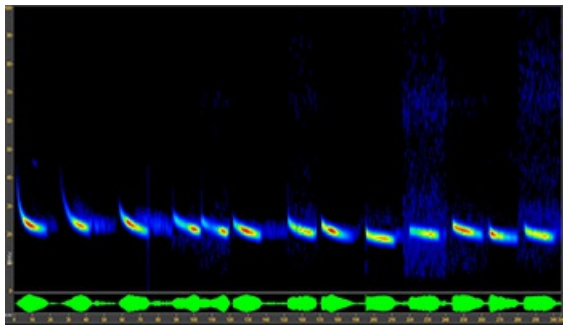
Leisler's Bat - call duration 15.8-16.0 ms



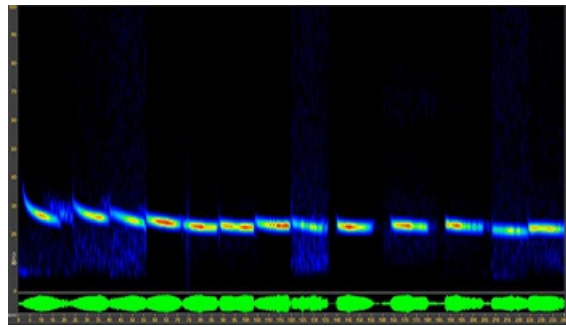
Common Noctule - call duration 16.1-16.3 ms



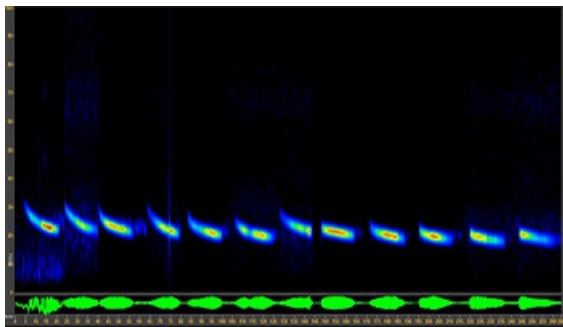
Leisler's Bat - call duration 16.1-16.3 ms



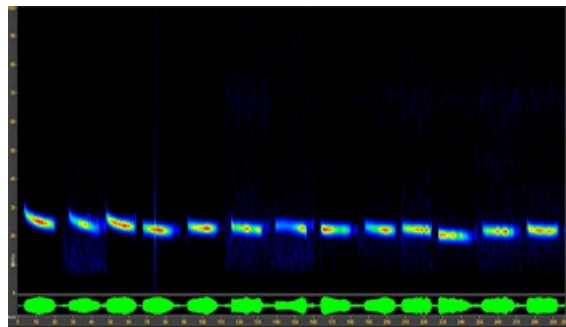
Common Noctule - call duration 16.4-16.6 ms



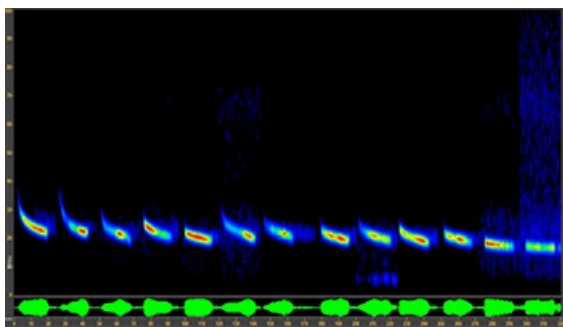
Leisler's Bat - call duration 16.4-16.6 ms



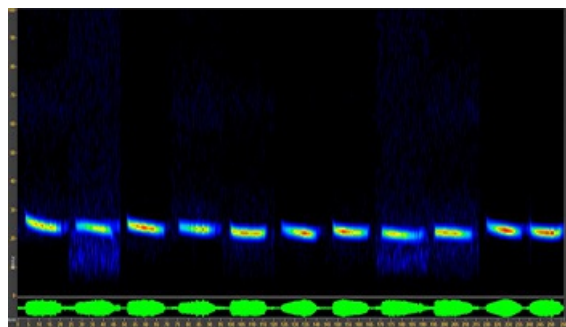
Common Noctule - call duration 16.7-17.0 ms



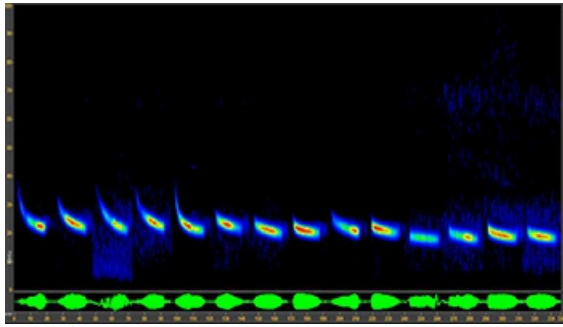
Leisler's Bat - call duration 16.7-17.0 ms



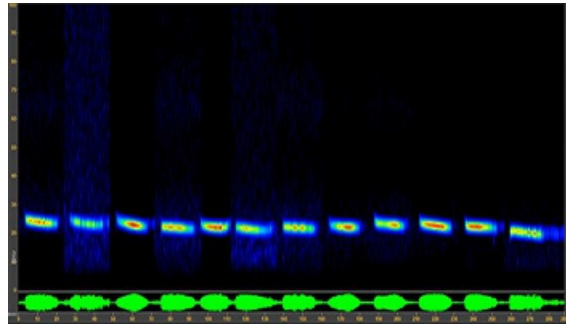
Common Noctule - call duration 17.1-17.2 ms



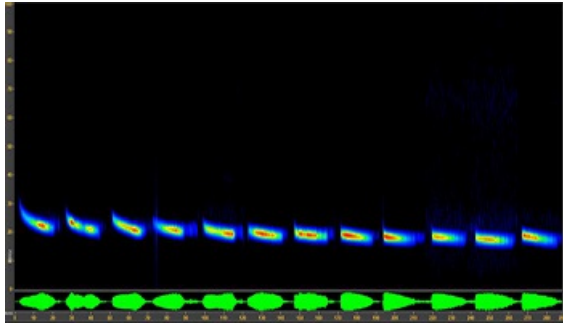
Leisler's Bat - call duration 17.1-17.2 ms



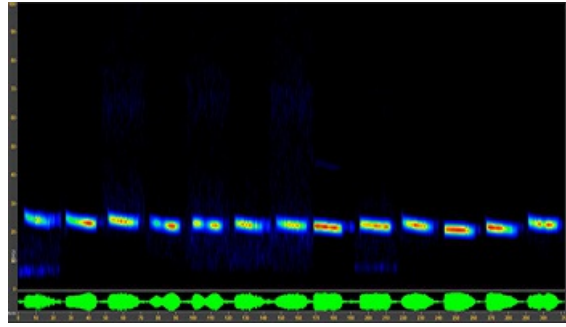
Common Noctule - call duration 17.3-17.4 ms



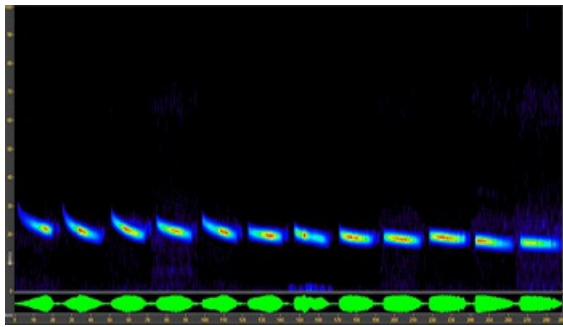
Leisler's Bat - call duration 17.3-17.4 ms



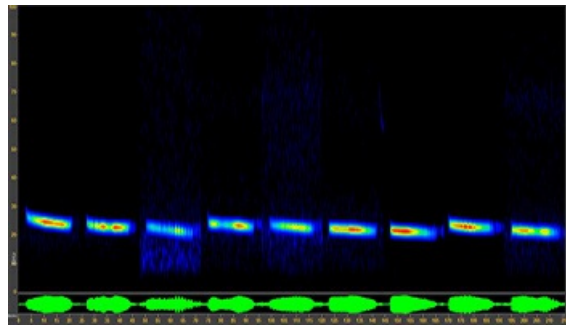
Common Noctule - call duration 17.5-18.2 ms



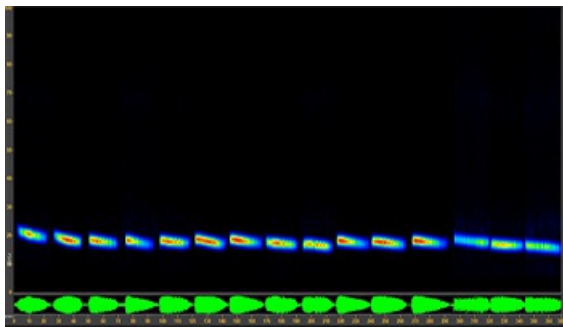
Leisler's Bat - call duration 17.5-18.2 ms



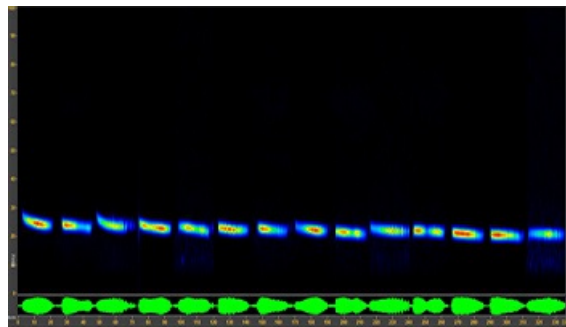
Common Noctule - call duration 18.3-18.7 ms



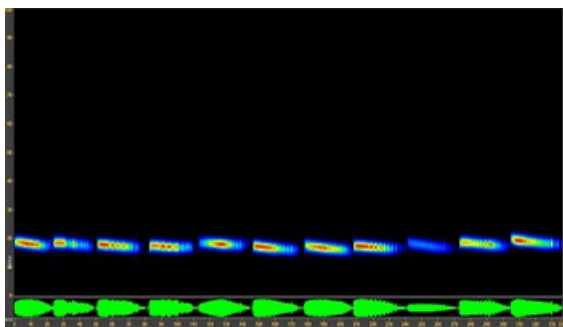
Leisler's Bat - call duration 18.3-18.7 ms



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: C. Damant, Bernwood Ecology

## Ryevitalise - Bats and Ancient Trees: 2023 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. & Panter, T.L. (2023). Ryevitalise - Bats and Ancient Trees: 2023 Report. *BTO Research Report 763*, BTO, Thetford, UK.

ISBN 978-1-912642-59-5



9 781912 642595 >



North York Moors  
National Park



Birds  
Science  
People