2020 SEASON REPORT

Ryevitalise Landscape Partnership – Citizen Science Bat Survey

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Summary

Ryevitalise Landscape Partnership – Citizen Science Bat Survey

Keywords

Bats; Chiroptera; Survey methods; Bat activity; Species distribution; Automated acoustic monitoring

Background

The North York Moors National Park has developed a Heritage Lottery Fund (HLF) Landscape Partnership Scheme called Ryevitalise which is all about conserving, protecting and interpreting the cultural and natural landscape of the River Rye. This followed a development phase, during which surveys of a number of species groups were commissioned to establish base line data. This included work that was led by the BTO to design and implement survey work in 2018 to provide large-scale data on bat distribution and activity in the Ryevitalise Landscape Partnership area, and to scope out an innovative citizen science approach for the collection of data from static detectors (Newson & Berthinussen 2018).

Aims

This new project aims to provide the web and cloud infrastructure required to support a landscape-scale bat Citizen Science project to run over four survey seasons. This will result in the production of a robust dataset, which will increase knowledge and understanding of key bat population distribution and activity within the Ryevitalise scheme area, including the rare and newly discovered Alcathoe bat.

Objectives

The proposed work has the following objectives:

Interactive online reservation system

- To set up an online grid square reservation system for volunteer survey coordination, including a ‘priority’ function to encourage widespread coverage across the operational area.
- To work with the Ryevitalise Catchment Restoration Officer to set up a suite of bat monitoring centres, and an online system for coordinating the booking out of bat detectors from these by volunteers.

Automated pipeline for data processing

- Volunteers taking part in the survey will be provided with individual user accounts, and a desktop client (for Windows or MacOS) through which they will be able to upload recordings directly to our cloud server for processing.

Process recordings

- Recordings will be processed, and volunteers will be notified automatically by email once the results are ready to access. Results will include small mammals and bush-crickets where these are recorded as by-catch at no additional cost.

Manual validation of species identification

- Additional manual verification of the results will be carried out at the end of each survey season, and survey results updated. This will be done through the manual checking of spectrograms using software SonoBat, to provide an independent check of species identities assigned by the classifier.

Reporting

- A brief two-side summary report will be produced at the end of each field season. This will include any recommendations for the subsequent field season to maximise the benefits of data collected and efficiency of data collection.
- At the end of the project, a full report will be produced in the form of a scientific paper, which will provide (a) a detailed analysis of the data collected over each season, (b) discussion of the distribution and status of bats in the Ryevitalise scheme area, (c) recommendations for the future direction of the project to provide long standing legacy.

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Acknowledgements

I am extremely grateful to Sam Lewsey, James Caldwell and Alex Cripps for setting up the project, and in coordinating the fieldwork to deploy static bat detectors. Stuart Newson designed the methodology; Stuart Newson analysed the data and wrote the report.

1. METHODS

1.1. Bat survey protocol

The project focusses on the Ryevitalise Landscape Partnership Scheme area, a survey area of about 413 km^2. Volunteers were asked to survey 'priority squares', where land access permission had been arranged in advance.

Bat detectors were left out to record for a minimum of four consecutive nights at each location. This 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. 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 project used Wildlife Acoustics SM4Bat FS detectors, which have been purchased previously by the National Park. These detectors record in full-spectrum and automatically trigger by calls of passing bats. The BTO liaised with the national park to ensure that the most optimum bat detector settings are used for this project.

Volunteers were directed to an online square sign-up tool (see https://app.bto.org/batmap/squares/ryevitalise), showing survey coverage (available 1-km squares), through which they will sign-up and reserve a square or squares for survey (see Fig. 1). After reserving a 1-km square for the survey, the volunteer will be automatically emailed a web link through which they can reserve out a bat detector from the most convenient "Bat Monitoring Centre" (Fig. 2). In 2020, one centre, Sutton Bank National Park Centre, hosted six bat detectors. Access was provided to an online management system, through which the Ryevitalise Catchment Restoration Officer was able to accept, decline or cancel survey squares and bat detector bookings as needed.

The bat detectors will be set 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 be set to continue until no trigger is detected for a two second period. Detectors were typically deployed before 6pm and left to record until the following morning. Microphones will be mounted on 3m poles to avoid ground noise and reduce recordings of reflected calls. Guidance was provided, to avoid surveying bats in persistent heavy rain, strong wind or if the nightly temperature is predicted to fall well below 7^{o}C, and on the placement of microphones which should be deployed at least 1.5 meters in any direction from vegetation, water or other obstructions. A GPS unit was used to save the recording location with the recordings for later analysis.

In the original proposal, the plan was for the recordings along with associated information on where recording was carried out would be uploaded to the BTOs Acoustic Pipeline for processing. Due to delays exacerbated by covid, the launch of the pipeline was delayed, so a decision was made to process the recordings outside the pipeline to save time for 2020, but the system will be in place for testing ahead of the 2021 survey season.

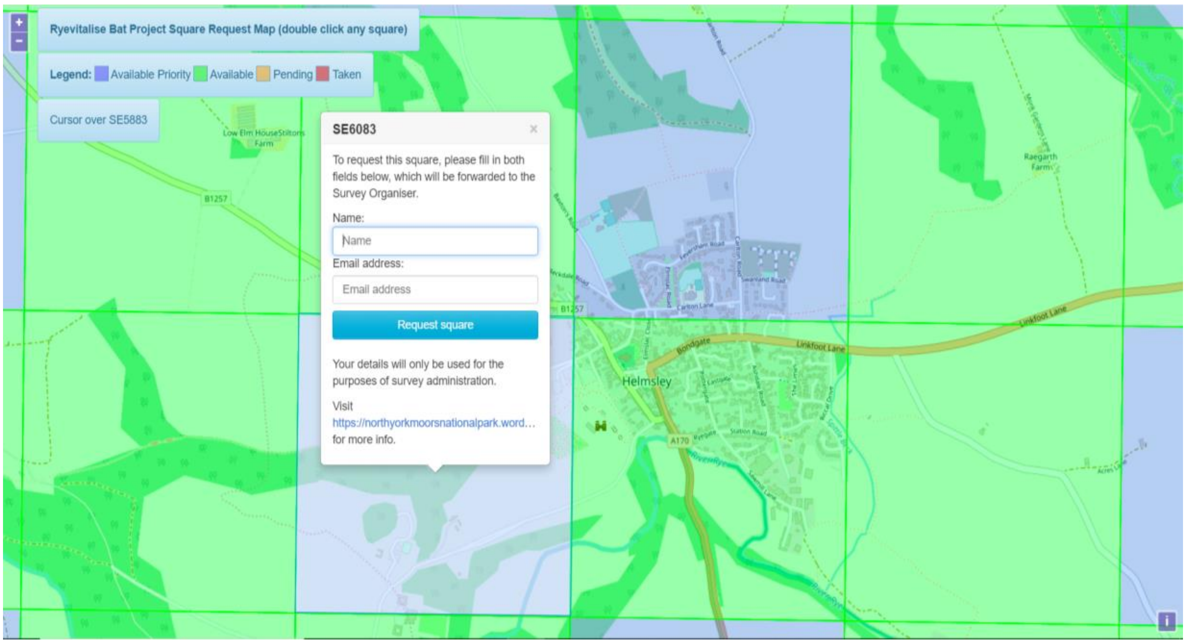

Figure 1. *Online sign-up map.*

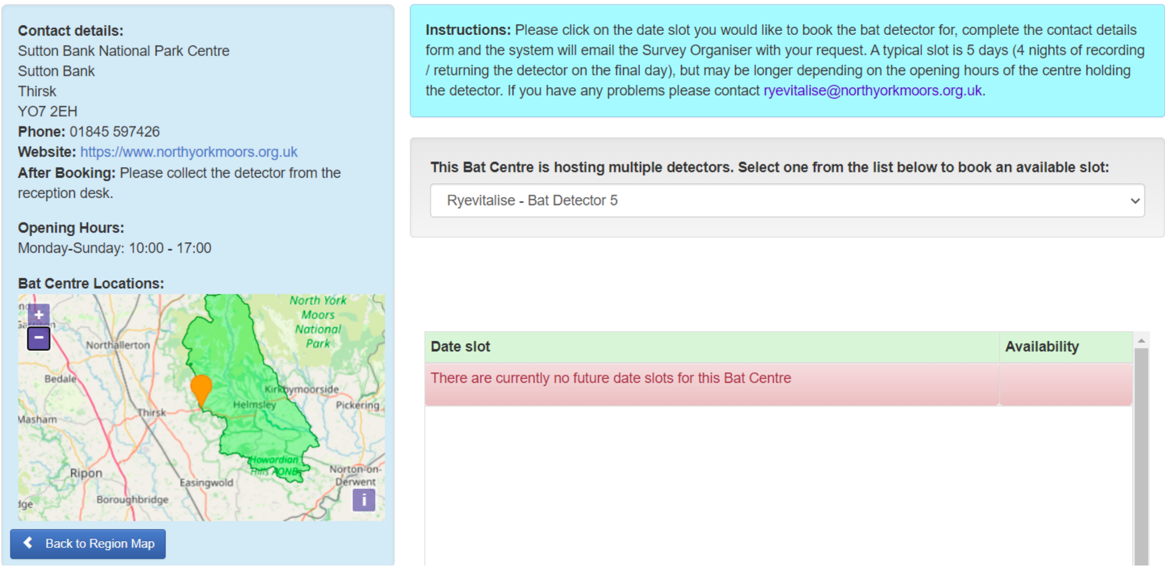

Figure 2. *Online booking system for members of the public to request a detector for a few days.*

1.2 Semi-automated acoustic identification of bats

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. All detected sound events were analysed using an acoustic classifier that we have built using the open-source software Tadarida (Bas *et al*., 2017, Step 1). The data for each bat pass consists of location, date, time, species identity and an identification confidence score (continuous value, 0–1) after Barre *et al*., 2019.

Manual checking (Step 2) of spectrograms using software SonoBat (http://sonobat.com/) was used as an independent check of the original species identities assigned by the classifier. Using the output from Step 1, manual checks were carried out on a random sample of recordings of common and soprano pipistrelle, to verify that classifier identification of these species was accurate. For the other species, all recordings were inspected with SonoBat regardless of the associated probability of correct classification. Species identities were checked (and re-classified if necessary).

Once species identities had been checked by looking at individual recordings in isolation, calls assigned to species whose calls had the most potential to be confused with those of other species (e.g. bats in the genus *Myotis* and *Nyctalus*) were re-examined in SonoBat, comparing them to other recordings potentially of the same bat made from the same location on the same night at neighbouring points in time (Step 3). All subsequent analyses used final identities upon completion of the above inspection and (where necessary) correction steps. For a summary of the main identification characters for each species see Annex 1 and 2.

It is important to note that the criteria for distinguishing whiskered and Brandt's bat are very subtle and currently poorly defined. We provide separate results for these two species, but with a big caveat that work on the sound identification of these two cryptic species is in development. We provide the separate species results to give an indication of the likely presence of each species. We think that the classifiers for distinguishing these two species perform reasonably well, but more ground-truthing and testing of the classifier for these species is needed. In the last report (Newson & Berthinussen, 2019), these two species were considered as a species pair i.e. whiskered / Brandt's bat.

2. RESULTS

2.1. Fieldwork survey coverage

Data from 10 different locations were surveyed for bats and sent back to the BTO for processing. This sample comprised 50 complete nights of recording. 110,388 recordings were collected which, following analyses and validation, were found to include 16,650 bat recordings and 1 small mammal recording (Table 1). Maps of activity showing the number of recordings of each species per night are presented in Annex 3. Manual checking of recording was carried out for all species and recordings, except for common and soprano pipistrelle for which 500 randomly selected recordings each were checked. Of these, no recordings were assigned to the wrong species.

Table 1. Bat species detected, number of recordings of each species following validation and a summary of the scale of recording.

Species group	Species	No. of recordings following validation	No. of different locations (% of total)
Bats	Daubenton's bat, *Myotis daubentonii*	4,351	6 (60%)
	whiskered bat, *M. mystacinus*	598	8 (80%)
	Brandt's bat, *M. brandtii*	1,208	9 (90%)
	Natterer's bat, *Myotis nattereri*	300	9 (90%)
	noctule, *Nyctalus noctule*	273	8 (80%)
	common pipistrelle, *Pipistrellus pipistrellus*	7,785	10 (100%)
	soprano pipistrelle, *Pipistrellus pygmaeus*	1,816	9 (90%)
	brown long-eared bat, *Plecotus auratus*	318	10 (100%)
Small Mammals	common shrew, *Sorex araneus*	1	1 (10%)

3. DISCUSSION

The current dataset of over 16,650 bat recordings has already been valuable in adding to our understanding of patterns of bat occurrence and activity with the 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 and Brandt's 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 in the region of about 100-m, compared with a detection distance of brown long-eared bat in closed woodland which is about 5-m (Barataud 2015).

Perhaps most notable from this season, is that we 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. As discussed previously, Brandt's bat is extremely similar acoustically to whiskered bat, so this is presented with the caveat that ideally additional ground-truthing would need be carried out to confirm this. Further collection of independent recordings for testing of classifier performance for whiskered and Brandt's bat is planned for 2021, but we believe that the current classifier that we have built is at the cutting edge for distinguishing these cryptic species. Of *Myotis* species, we believe that Natterer's bat (and Alcathoe bat which wasn't recorded in 2020) are probably the most range restricted.

In relation to other species groups recorded as 'by-catch' during bat surveys, there was just one recording of common shrew. For further information on the sound identification of terrestrial small mammals in Britain see Newson *et al*. (2020).

We do not have any specific recommendations for the 2021 survey season, but we plan to liaise with the North York Moors NP over the winter to find out what has worked, and what could be improved on for the 2021 season. In addition, we have prepared some first instructions for users of the Acoustic Pipeline, which we will finalise and make available for the North York Moors NP early in 2021 to test and comment on ahead of the 2021 survey season.

4. REFERENCES

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ANNEX 1. VALIDATION OF BAT RECORDINGS

Important call parameters used in Step 3 of the recording validation process to manually check species identity based on call parameters in Russ (2012) and Barataud (2015) and adapted from Newson et al. (2015). For some species (e.g. brown long-eared bat) identification is more straightforward, whilst for other species, (e.g. the Myotis bats), there is more overlap.

Species	Species code	Main confusion species	Most important call parameters for species identification[1]
Daubenton's bat, *Myotis daubentonii*	Mdau	Mmys /Mbra (and Mnat)	Calls often sigmoidal in shape Start frequency (rarely) >100 kHz End frequency (typically) about 25 kHz Often slight kink or bend at heel of call at about 40 kHz
whiskered / Brandt's bats, *Myotis mystacinus / M. brandtii*	Mmys/Mbra	Mdau (and Mnat)	Start frequency (commonly) >100 kHz End frequency (typically) > 30 kHz Sometimes slight kink at knee of call at >35 kHz In open areas calls can be similar to Mdau
Natterer's bat, *Myotis nattereri*	Mnat	Other *Myotis* bats	Most distinctive Myotis in study area Very high bandwidth End frequency (often) <20 kHz Short duration calls – (often) over 100 kHz change in frequency over 1 ms No kink at knee or heel of call in closed or semi-closed habitat is distinctive
noctule, *Nyctalus noctule*	Nnoc	Nlei (in clutter, although no evidence of species presence)	Two main call types: an FM / qCF[2] call and qCF call. FM / qCF call peak frequency of about 24 kHz, call duration about 14 ms qCF call peak frequency of about 19 kHz, call duration about 22 ms Call types (often) produced alternatively
brown long-eared bat, *Plecotus auritus*	Paur	None	Normally distinctive with two harmonics, the first starts around 55 kHz and ends about 24 kHz and second starts around 73 kHz and ends about 33 kHz

[1] See Russ (2012) and Barataud (2015) for a more detailed description and comparison of call parameters.
[2] FM = frequency modulated, qCF quasi-constant frequency (see Russ 2012, section 2.3.3 for a full description of call types)

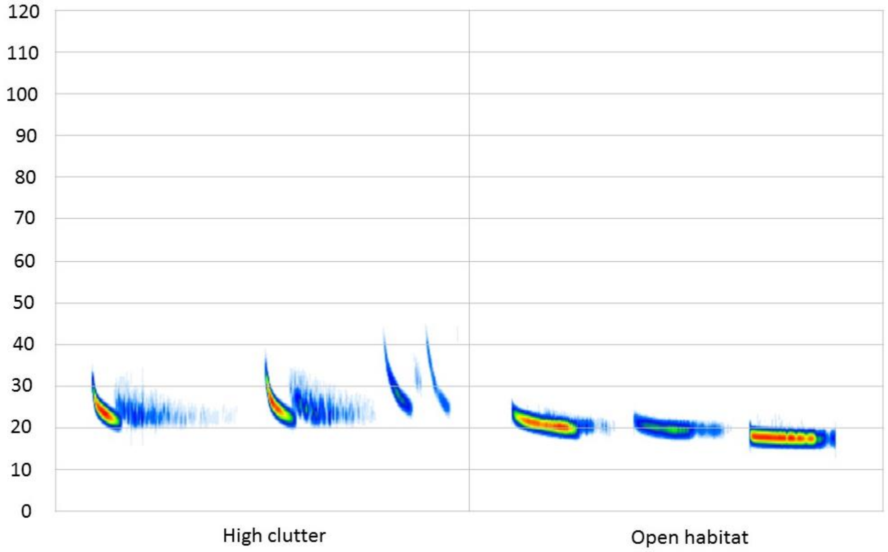
ANNEX 2. SOUND IDENTIFICATION OF BATS

Adapted from Toms and Newson (in prep). Animals of the Brecks.
FM = frequency modulated, qCF quasi-constant frequency (see Russ 2012, section 2.3.3 for a full description of call types)

Noctule, *Nyctalus noctula*

Echolocation

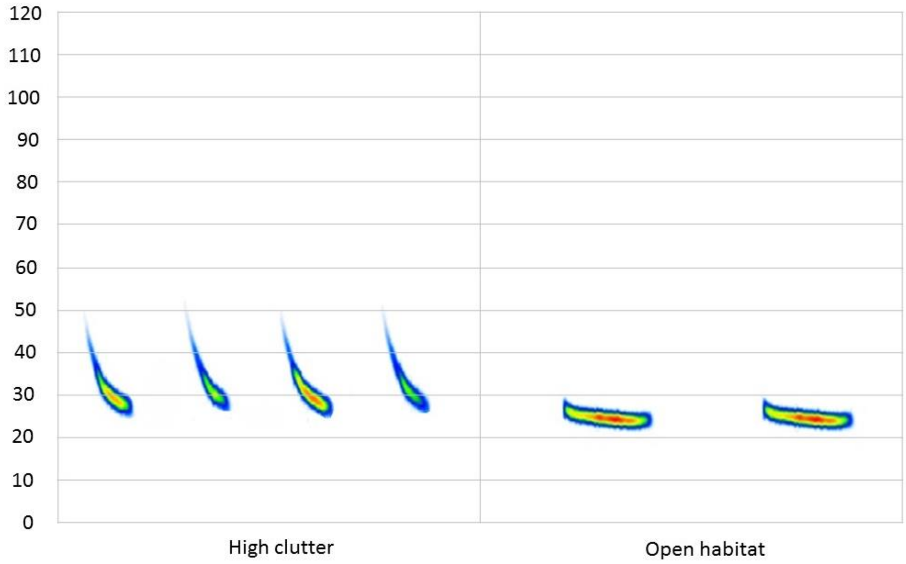
- Two main call types:
  - FM/qCF call loudest at about 24 kHz, call duration about 15 ms
  - qCF call loudest at about 19 kHz, call duration about 22 ms
- Call types (often) produced alternately
- Main confusion species: Leisler's bat (very similar in clutter)



Leisler's bat, *Nyctalus leisleri* - no evidence so far from this study that this species is present.

Echolocation

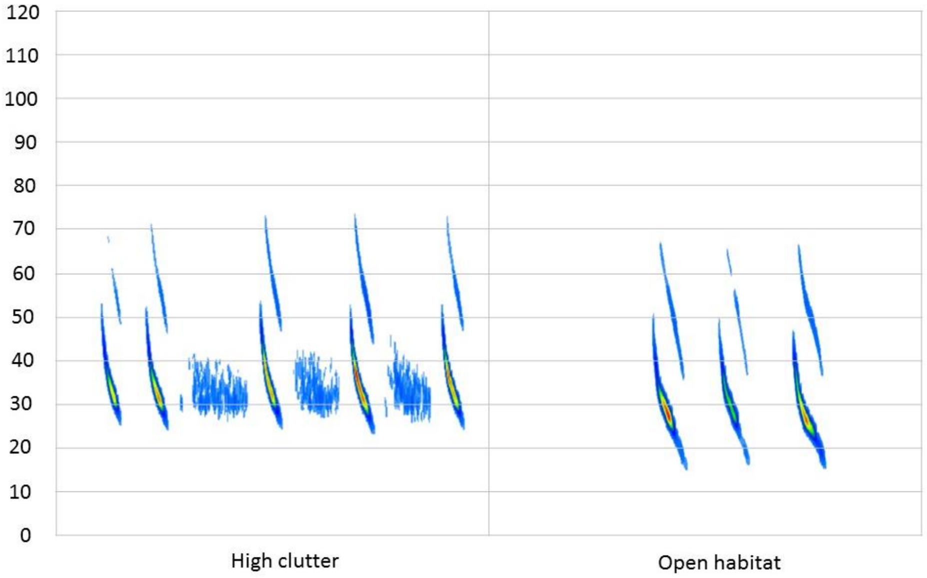
- Two main call types:
  - FM / qCF call loudest at about 27 kHz, call duration about 8 ms
  - qCF call loudest at about 23 kHz, call duration about 17 ms
- Calls types (often) produced alternatively
- Can show sharp frequency change (> 2kHz) more often than Serotine
- Main confusion species: Noctule (very similar in high clutter), but note Brown rat can produce visually similar CF calls at about 21 kHz



Brown long-eared bat, *Plecotus auritus*

Echolocation

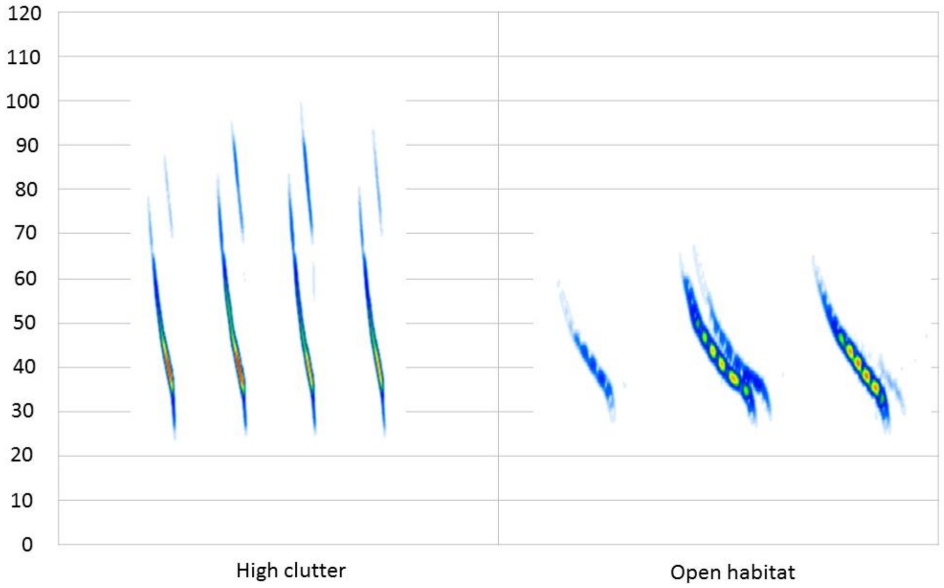
- Two harmonics:
  - first starts around 55 kHz and ends about 24 kHz
  - second weaker harmonic starts around 73 kHz, ends about 33 kHz (can be lost)
- In open habitat, call duration becomes longer and calls drop to about 20 kHz
- Main confusion species: Normally distinctive (but possible confusion with Noctule or Leisler's bat in clutter if missing second harmonic, or social calls of Common and Soprano Pipistrelle).



Daubenton's bat, *Myotis daubentonii*

Echolocation

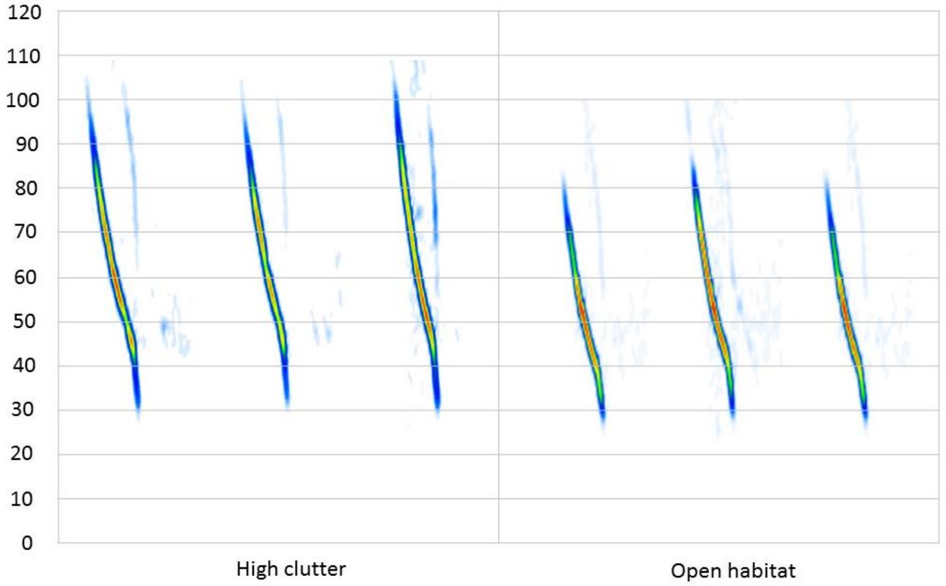
- Calls often sigmoidal in shape
- Start frequency (rarely) >100 kHz
- End frequency (typically) about 25 kHz
- Often slight kink or bend at heel of call at about 40 kHz
- Main confusion species: Whiskered, Brandt's and Natterer's bat (in open habitat)



Whiskered / Brandt's bat, *Myotis mystacinus / brandtii*

Echolocation

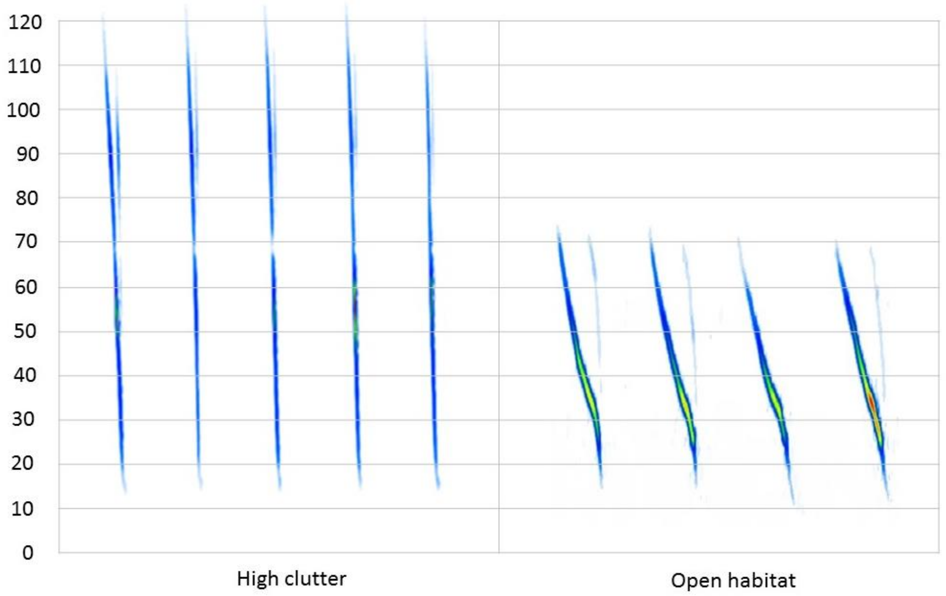
- Criteria for distinguishing these two species are subtle and currently poorly defined.
- Start frequency (commonly) >100 kHz
- End frequency (typically) > 30 kHz
- Sometimes slight kink at knee of call at >35 kHz
- In open areas calls, very similar to Daubenton's bat
- Main confusion species: Daubenton's and Natterer's bat



Natterer's bat, *Myotis nattereri*

Echolocation

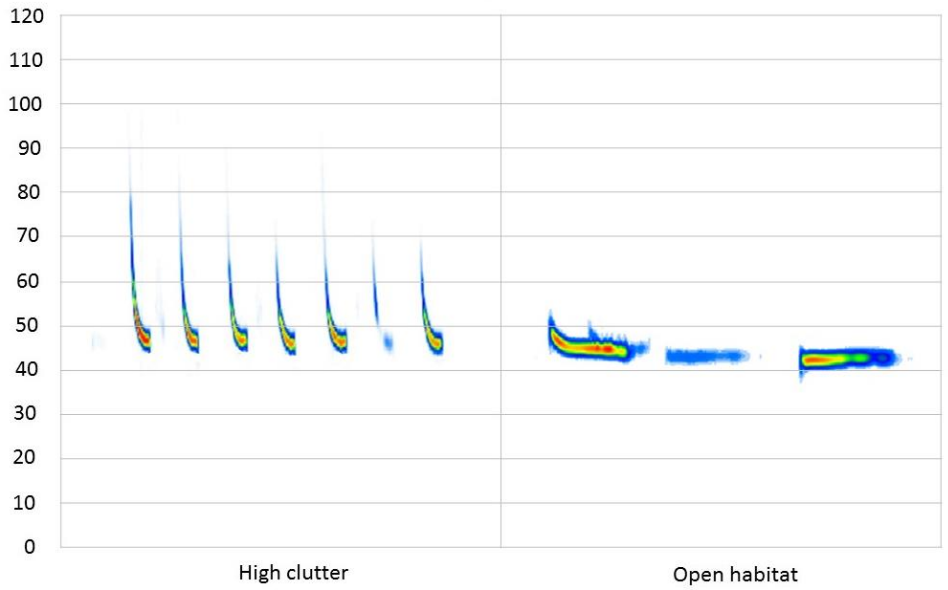
- Very high bandwidth
- End frequency (often) <20 kHz
- Short duration calls (often) over 100 kHz change in frequency over 1 ms
- No kink at knee or heel of call in clutter when calls most distinctive
- Main confusion species: Whiskered, Brandt's and Daubenton's bat



Common pipistrelle, *Pipistrellus pipistrellus*

Echolocation

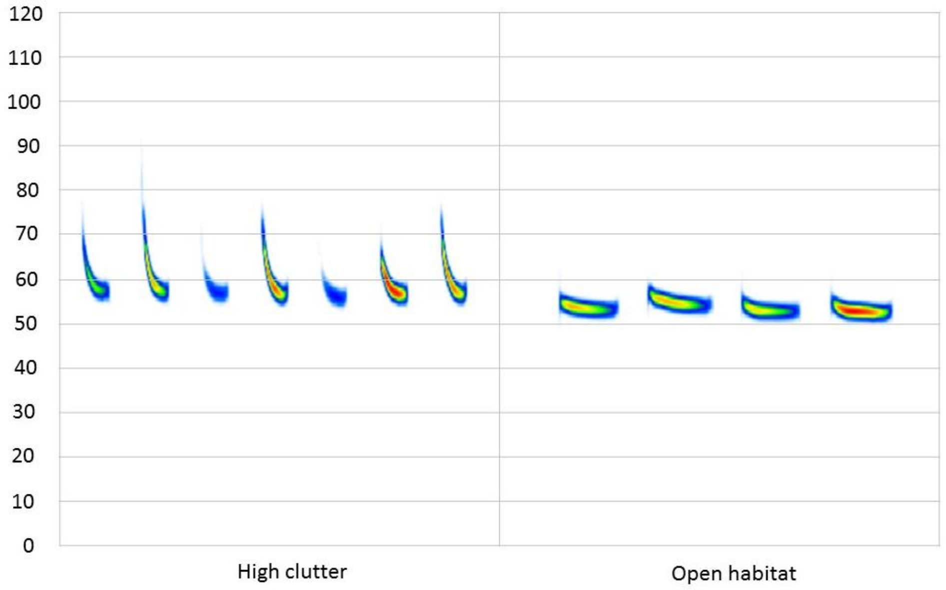
- FM/qCF calls that sweep down from about 70 kHz to about 43 kHz, calls loudest at about 46 kHz. Mean call duration about 6 ms
- In open habitat, calls become longer, calls drop to 43 kHz or lower
- In clutter, call duration longer and calls loudest at 48 kHz or more.
- Main confusion species: Soprano Pipistrelle (in clutter), Myotis (extreme clutter)



Soprano pipistrelle, *Pipistrellus pygmaeus*

Echolocation

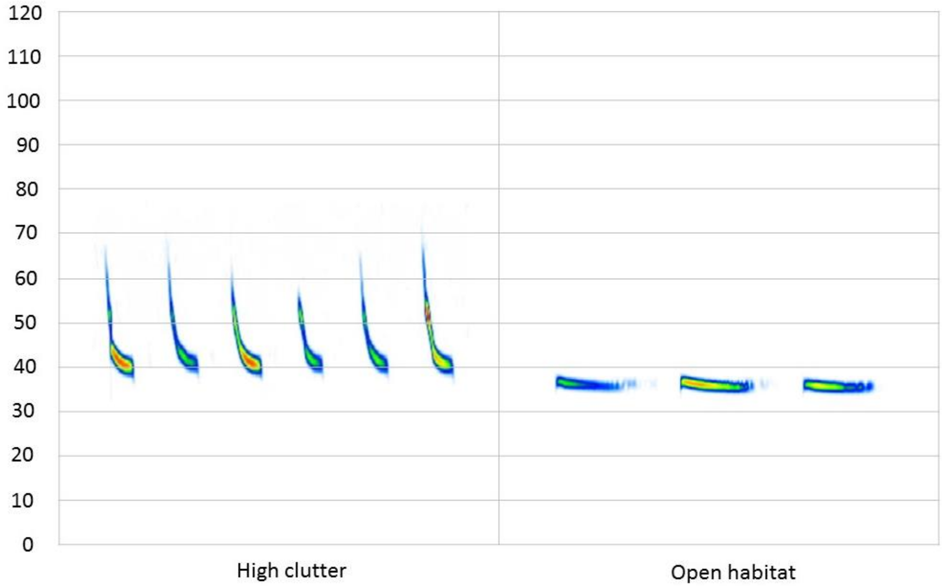
- FM/qCF calls that sweep down from about 80 kHz to about 53 kHz, calls loudest at about 55 kHz. Mean call duration about 6 ms
- In open habitat, calls become longer, calls drop to 52 kHz or lower
- In clutter, call duration longer, and calls loudest at 55 kHz or more.
- Main confusion species: Common pipistrelle (open habitat), Myotis (extreme clutter)



Nathusius' pipistrelle, *Pipistrellus nathusii* – no existing records, or evidence so far from this study that this species is present, but potential migrant.

Echolocation

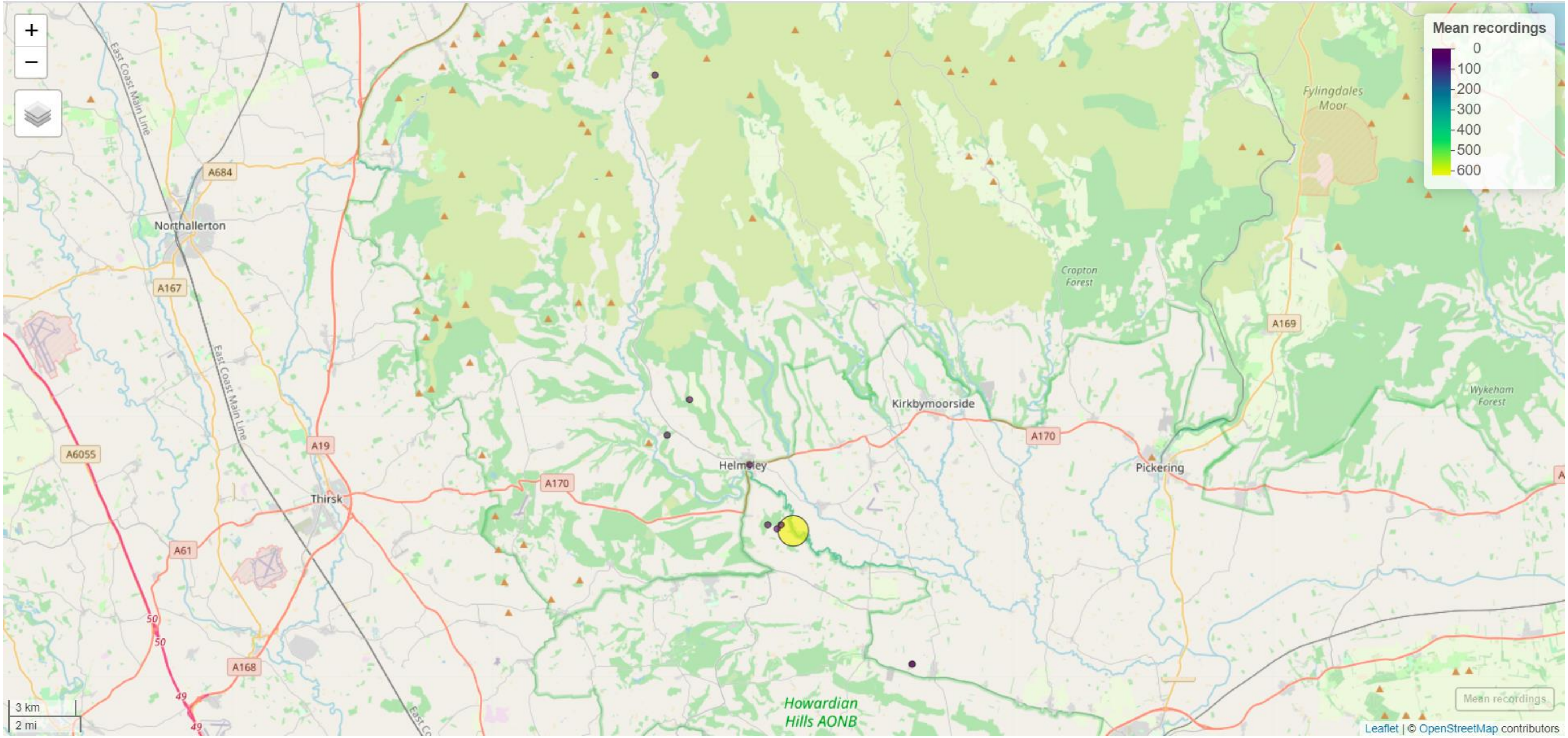
- FM/qCF calls that sweep down from about 51 kHz to about 36 kHz, calls loudest at about 39 kHz. Mean call duration about 6 ms
- In open habitat, calls become longer, calls drop to 37 kHz or lower
- In clutter, call duration shorter, and calls loudest at 39 kHz (up to about 42 kHz)
- Main confusion species: Common pipistrelle (open habitat), Myotis (extreme clutter)



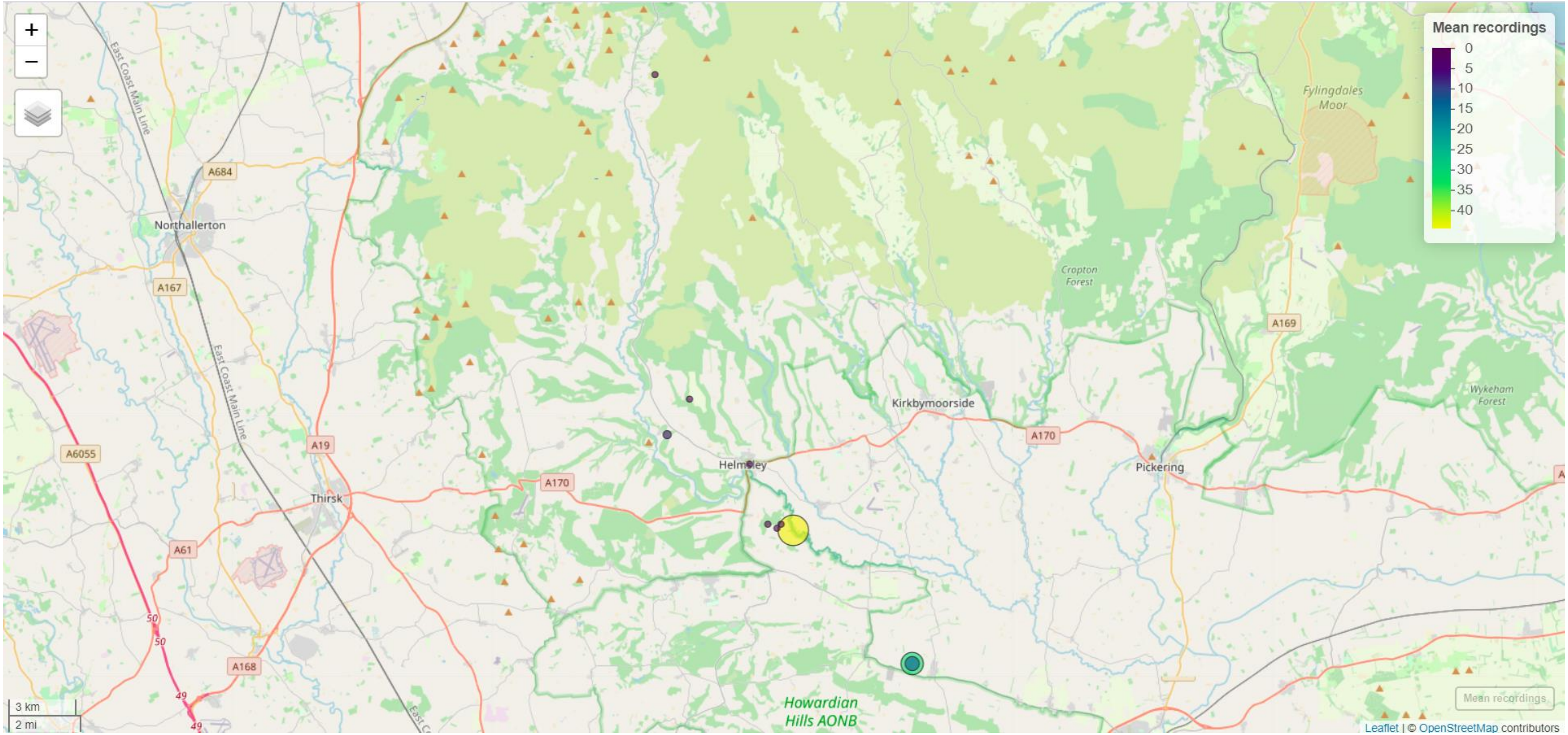
ANNEX 3. MAPS OF BAT ACTIVITY

Number of recordings / night) as a proxy for abundance. Note that these maps are also provided as interactive html maps.

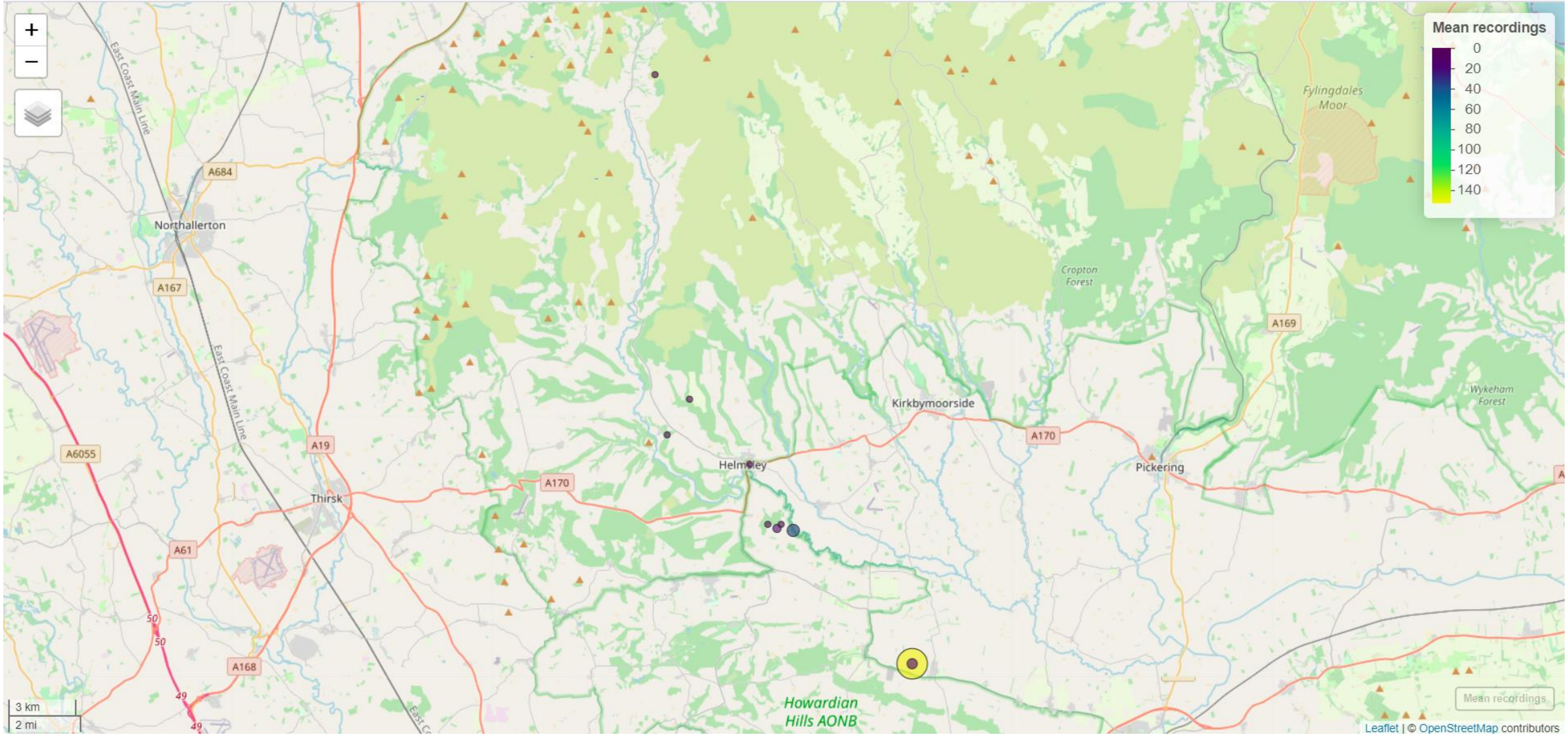
a) Daubenton's bat



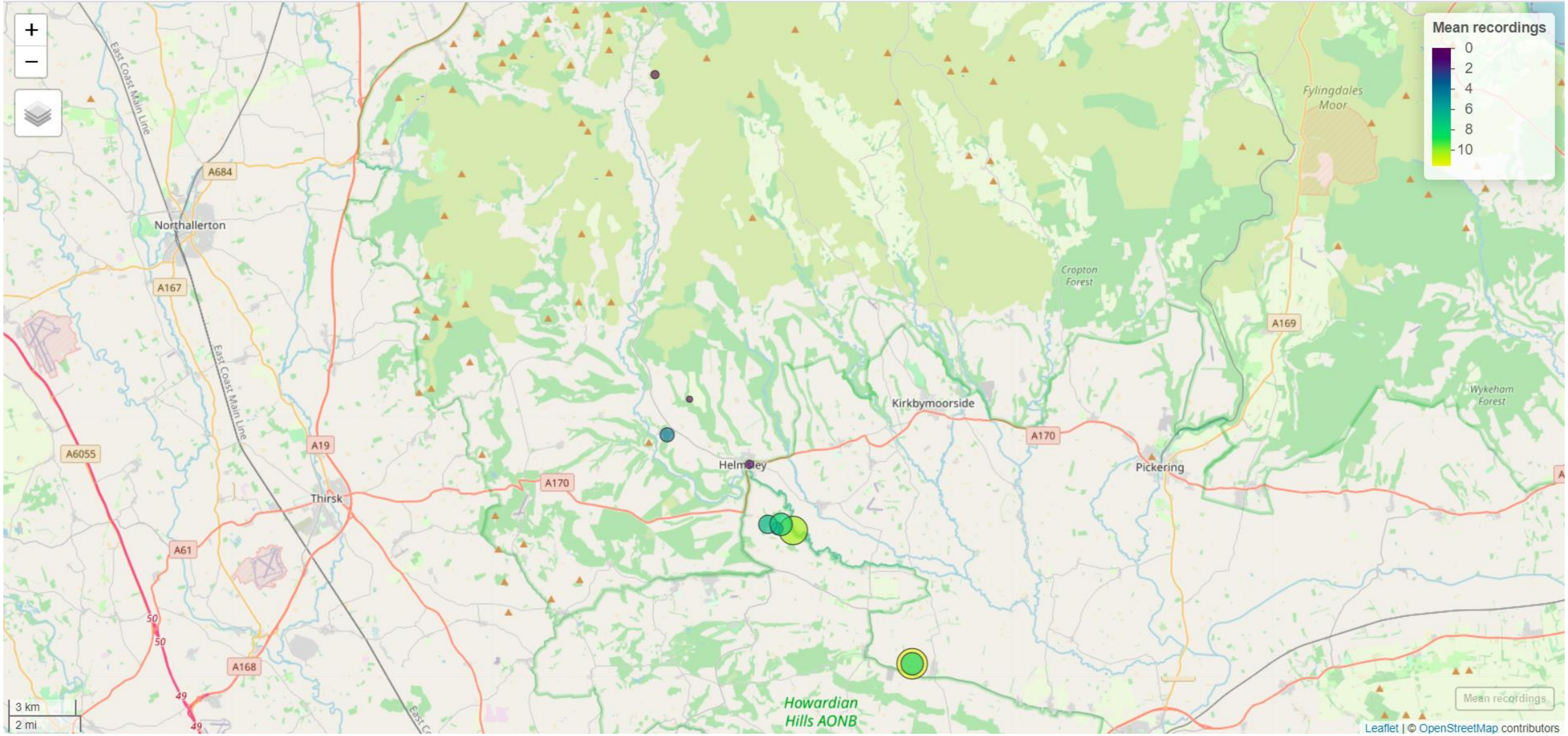
b) whiskered bat



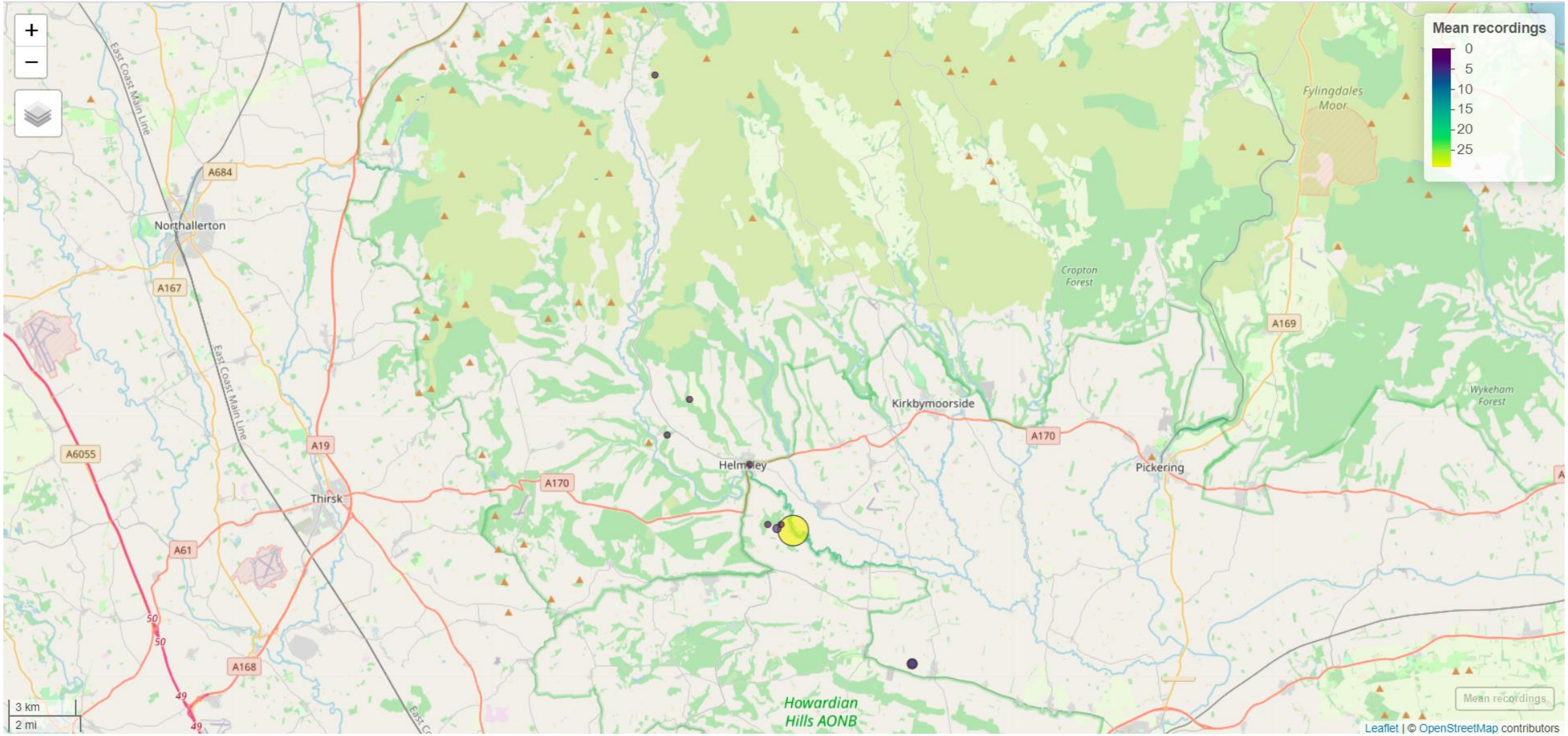
c) Brandt's bat



d) Natterer’s bat

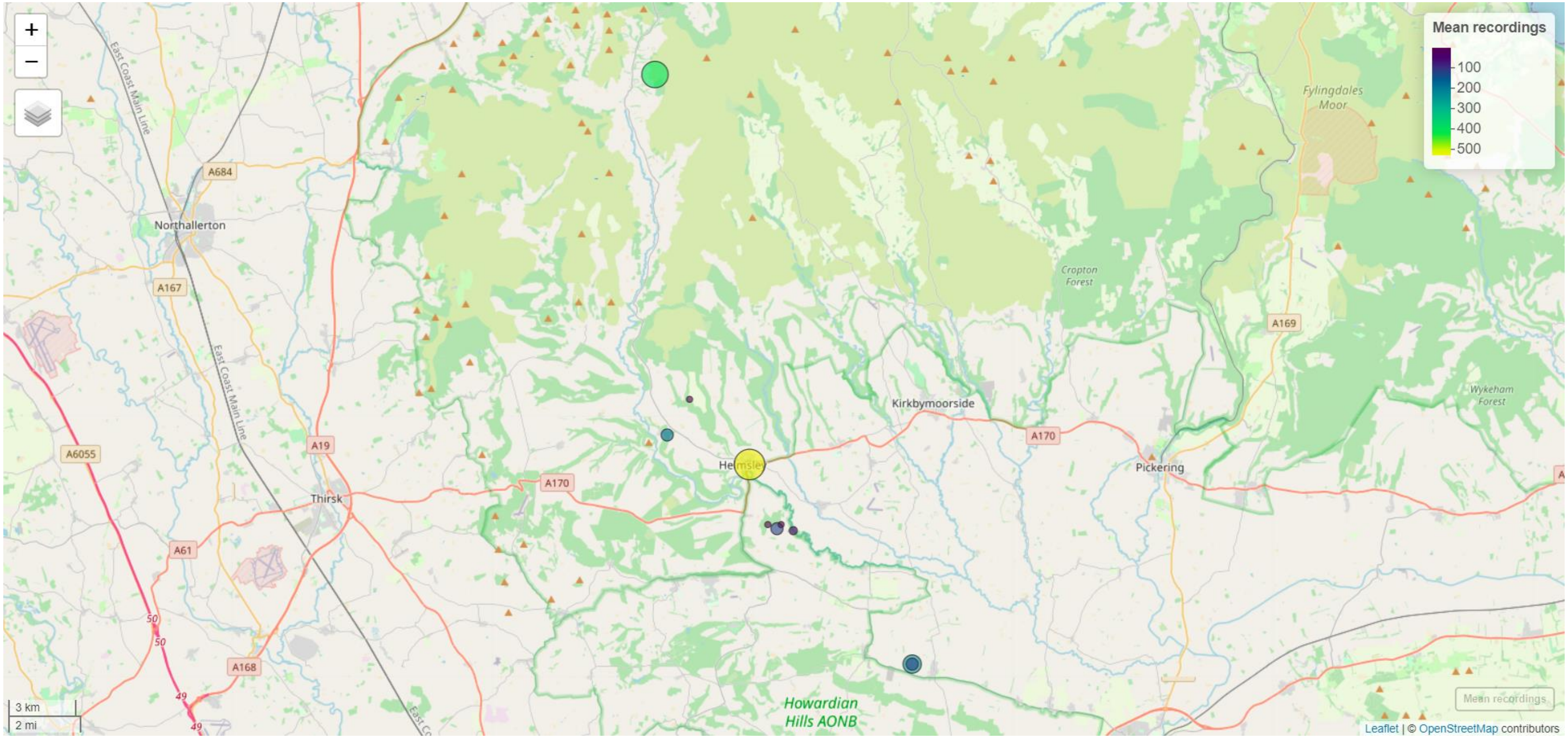


e) noctule

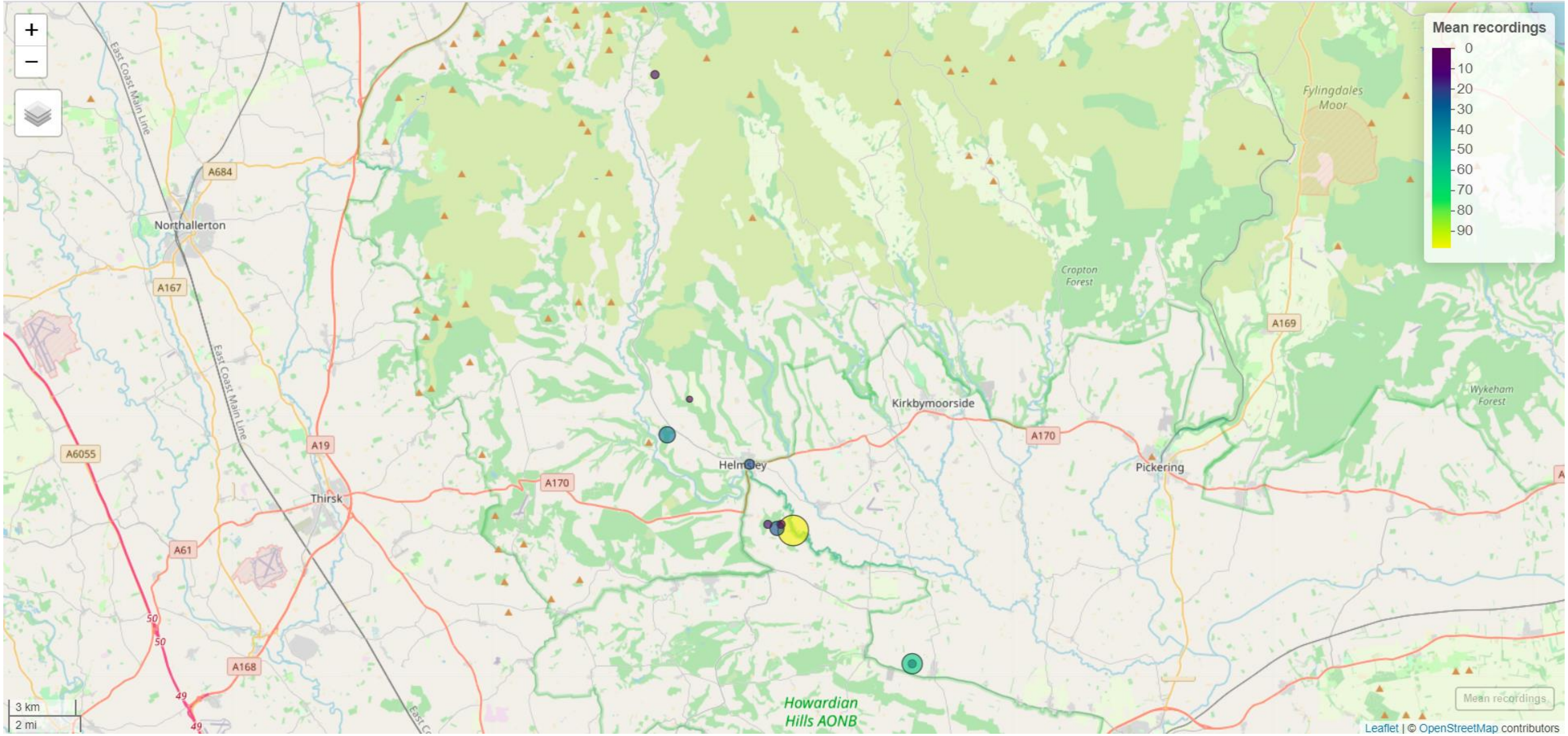


Mean recordings
0
5
10
15
20
25
Northallerton
Thirsk
Helmsley
Kirkbymoorside
Pickering
Cropton Forest
Fylingdales Moor
Wykeham Forest
Howardian Hills AONB
East Coast Main Line
A684
A167
A6055
A19
A61
A168
A170
A169
3 km
2 mi
Leaflet | © OpenStreetMap contributors

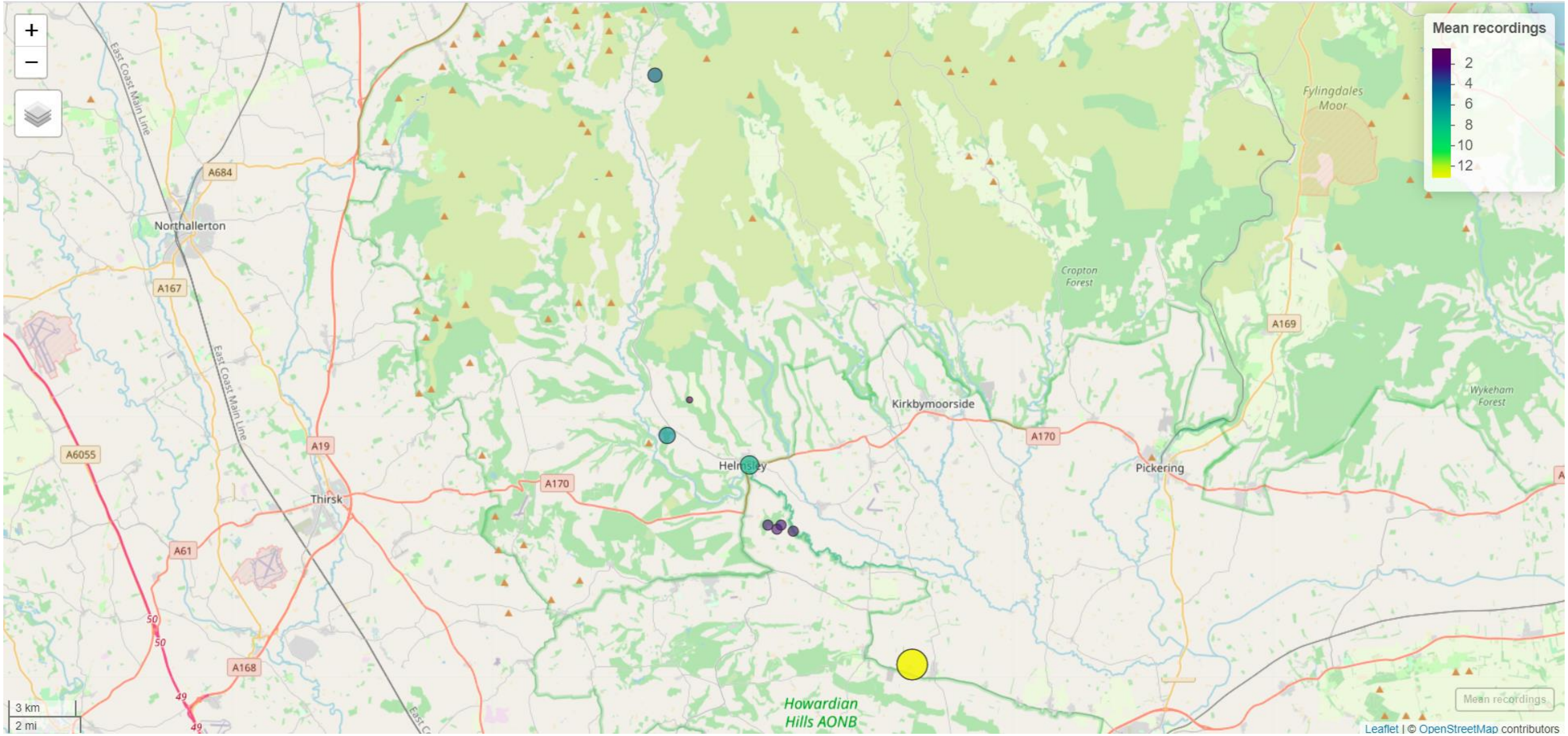
f) common pipistrelle



g) soprano pipistrelle



h) brown long-eared bat



j) common shrew