BTO RESEARCH REPORT 785

Connecting Constable and Gainsborough Country – using acoustics to support landscape recovery

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BTO Birds Science People

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SUMMARY

Background Static acoustic recorders were deployed between May and September 2024, to provide extensive acoustic data for the Connecting Constable and Gainsborough Country Landscape Recovery Project. The priority was to look at the potential for using acoustics to detect a wide range of taxa including the presence of flagship species such as Hazel Dormouse, Nightingale and Turtle Dove. This report provides an overview of the survey coverage and main results.

Coverage Over 2024, 40 different locations across the Connecting Constable and Gainsborough Country project area were surveyed. Recording was undertaken on 41 different days May and September, amounting to a total of 570 days of recording effort across sites.

Results 1,375,296 ultrasonic recordings were collected which, following analyses and validation, were found to include 505,497 detections of at least eleven bat species, and 1,136 detections of four small terrestrial mammal species. This includes Hazel Dormouse, which was recorded from two sites. One of these sites was close to Bradfield Woods where there is a well established and long monitored population of Hazel Dormouse, and the second site was in a small patch of woodland at Stone Street, just south of Boxford. Four bush-cricket species and two audible moth species were also detected. Additionally, presence was confirmed for 54 bird species.

1. BACKGROUND

Connecting Constable and Gainsborough Country is a Landscape Recovery project, funded by DEFRA (Department for Environment, Food & Rural Affairs), that aims to restore woodlands and reconnect habitats throughout south Suffolk.

Working with the Stour Valley Farm Cluster and Wool Towns Farm Cluster, Suffolk Wildlife Trust's vision for the project is to develop the pilot scheme in which they enhance and connect wildlife habitats across farmlands in the project area - which extends through the Stour, Brett, and Box valleys.

The goal is to create a wilder environment in which wildlife can move across the landscape including an expansive network of farmland enhance for nature. This will include:

habitat corridors encompassing woodland, scrub, grassland, and ponds wildlife-friendly farmland landscapes well-managed ancient and secondary woodlands natural heritage features.

One of the key focuses of the Landscape Recovery Project is to recover, restore, and reconnect woodland sites across the valleys - habitats vital for flagship species such Nightingale, Turtle Dove, Great Crested Newt, and specialist flora. Most notably, they hope to reconnect rare populations of Hazel Dormouse which are currently restricted to only a small number of sites in south Suffolk & north Essex.

2. AIMS AND OBJECTIVES

This project aims to use passive acoustic monitoring as an effective tool for assessing the status of broad range of species groups, with the opportunity for monitoring change in species populations over time. This includes using acoustics as a novel approach to assess Hazel Dormouse presence, where owing to the long deployment that the technology allows, it potentially offers us a better chance of detecting this species than might be possible from short duration visits by human surveyors. In addition, by using recording equipment that can record at low frequency (audible) and the high frequency (ultrasonic) range, the project aims to improve understanding of the status, distribution and timing of occurrence of birds, bats, bush-crickets and small mammal species in the study region.

3. METHODS

Planning, liaison with landowners, deployment of recording equipment, collation of audio recordings and processing through the BTO Acoustic Pipeline were undertaken by SWT (LT). Acoustic identification verification, data analysis and reporting were undertaken by BTO (SEN, AW and AAB). Classifier development was undertaken by BTO (SEN).

3.1 Static recorder protocol

Our protocol enabled SWT staff to deploy passive real-time recorders which they left outside to record birds during the day, and to automatically trigger and record the calls to a memory card every time a bat passes, a mouse squeaks, or bush-cricket stridulates during the night.

Acoustic recorders (the Song Meter Mini Bat), were placed out to record over three discrete recording sessions of about seven consecutive days at each location. Multiple days of recording increase the chance of recording species if present and are likely to smooth over stochastic and weather-related variation, whilst also being easy to implement logistically (once a recorder is on site, it is easy to leave it in situ for multiple days and nights). Two recording sessions (May to June and August to September) aimed to cover the breeding season of birds and bats, and the peak period of activity for bush-crickets.

The recorders were programmed to cycle between bird recording using an acoustic microphone, and recording bats, small mammals and bush-crickets with an ultrasonic microphone. For bird recording, a sample rate of 22,050 Hz was used, with recording blocks of one minute in every fifteen minutes from sunrise to sunset. For bats, a sample rate 256,000 Hz and a high pass filter of 13,000 Hz which defined the lower threshold of the frequencies of interest for the triggering mechanism. Ultrasonic recording was set to continue until no trigger is detected for a 2 second period up to a maximum of 5 seconds and activated to trigger between sunset until sunrise the following day. The recorders were

mounted on 2 m poles to avoid ground noise and reduce recordings of reflected calls and deployed at least 1.5 m in any direction from vegetation, water or other obstructions.

3.2 Processing recordings and species identification

Monitoring on this scale with automated passive real-time recorders 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. Audible recordings and ultrasonic recordings require different methods of analysis and verification as detailed in the following sections.

3.2.1 Audible (bird) recordings

At the end of a recording session, the files recorded by the acoustic recorder (uncompressed wav format), including associated metadata, were processed as follows. All audible / bird recordings were saved onto an external hard drive for later processing by BTO. As the BTO Acoustic Pipeline http://bto.org/pipeline all bird species classifier is still in development, we also processed all recordings through BirdNet, another machine-learning based acoustic classifier developed by Cornell University. BirdNET was configured to return all detections with a confidence score of at least 0.4 and no spatial or temporal species filters were applied. Positive identifications of each species, for each site and period (early or late) of recording were then manually verified by one observer (AW). This was done by selecting 100 detections (or as many as possible if fewer detections) of each species and location with the highest confidence scores. These were checked until at least one true positive detection was found to produce a verified species list for each site and sampling period. Vocal activity of bird species (number of calls per day) was included but should be used with caution, as the accuracy (proportion of true to false positives) and detectability (proportion of true positives to false negatives) can differ considerably between species and between sites, and there was not the resources in this project to quantify these measures.

3.2.2 Ultrasonic recordings

For the ultrasonic / bat processing, the site staff 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 acoustic recorders were deployed), which are matched automatically to the 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 provisional results are provided with the caveat that additional auditing of the results and recordings must be carried out to manually confirm identifications.

The ultrasonic processing through the BTO Acoustic Pipeline applies machine learning algorithms to classify sound events in the uploaded recordings. The classifier allows up to four different “identities” to be assigned to a single recording, according to probability distributions between detected and classified sound events. From these, species identities are assigned by the classifier, along with an estimated probability of correct classification. Specifically this is the false positive rate, which is the probability that the Pipeline has assigned an identification to the wrong species. However, we scale the probability, so that the higher the probability, the lower the false positive rate. To give an example, given a species identification with a probability of 0.9, there is a 10% chance that the identification is wrong. Our recommendation, which is supported in Barré *et al.* (2019), is that identifications with a probability of less than 0.5 (50%) are discarded. However, manually auditing of a sample of recordings (wav files) that are below this threshold was carried out to be confident that we were losing very little by doing this.

For bats and small mammals where we were interested in producing a measure of activity, we manually checked all the recordings of a species. With the exception of the most common species, Common Pipistrelle *Pipistrellus pipistrellus* and Soprano pipistrelle *Pipistrellus pygmeaus*, where the error rate is close to zero (e.g. Newson & Panter 2024). For insects 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.

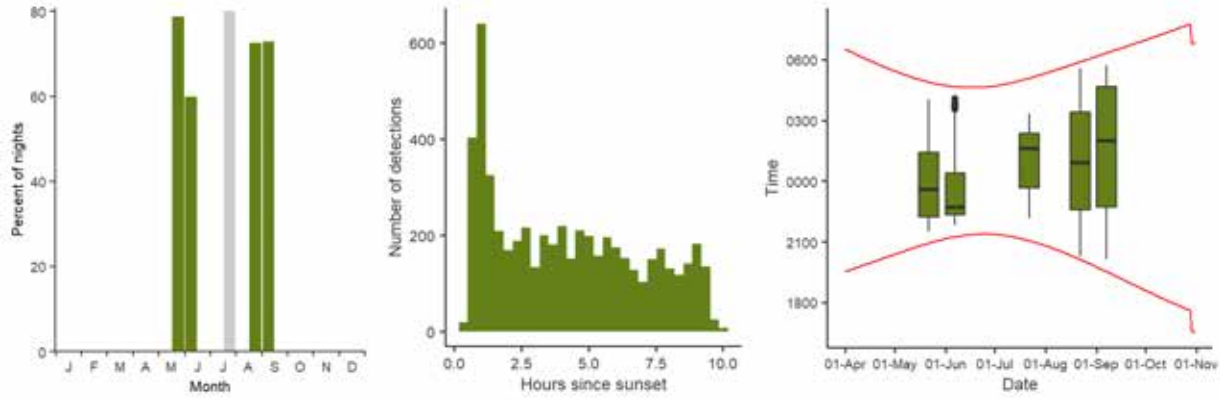
Verification of species identification was carried out by SN through the manual checking of spectrograms using

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.

3.3 Temporal patterns of activity

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

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



3.4 Spatial patterns of activity and distribution

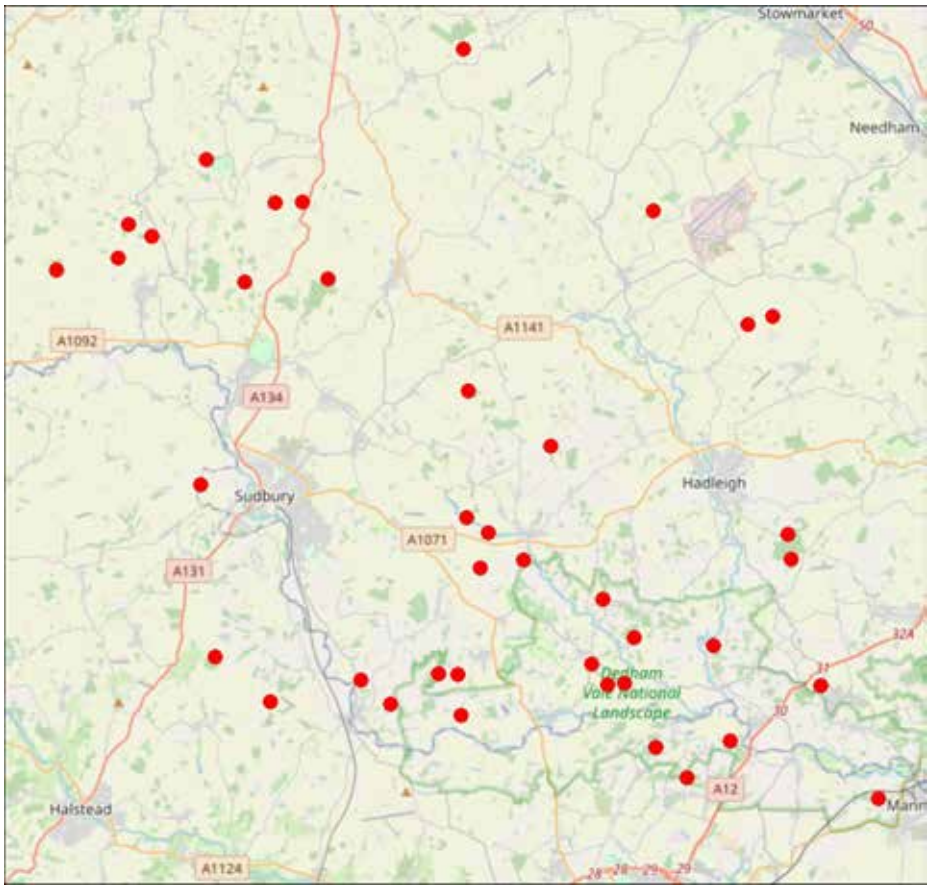
For audible moths and for birds, the results focus on species presence. For bats and small mammals, we present activity where dots are scaled according to the total number of recordings of this species at each location. Activity here represents usage of an area, which will be a combination of species abundance, and time spent in the area.

4. RESULTS

4.1 Survey coverage

During 2024, 40 different locations were surveyed for bats, small mammals and bush-crickets, with all ultrasonic recordings uploaded and processed through the BTO Acoustic Pipeline. The distribution of these are shown below. Collectively across all these sites, 570 days of recording effort was conducted. The recording effort spanned 41 different days and 5 months. Unfortunately, subsequent to field recording, some of the media storage hardware used by SWT to store audible data (bird recordings) prior to verification became corrupted and recordings from May to June were unrecoverable. For this reason there is only coverage of the second recording period from August to September for audible results.

Map of the study area showing locations where detectors were deployed in 2024.



4.2 General results

Overall, 1,375,296 ultrasonic recordings were collected which, following analyses and validation, were found to include 505,497 bat recordings, and 1,136 small terrestrial mammal recordings. This includes recording Hazel Dormouse calls from 2 sites. One of these sites was close to Bradfield Woods where there is a well established and monitored population of Hazel Dormouse, and the second site was in a small patch of woodland at Stone Street, just south of Boxford. In addition, four bush-cricket species and two species of audible moth species were recorded (see table below). Following validation, the presence of at least 11 bat species, 4 small mammal species, 4 bush-cricket species and 2 audible moth species can be confirmed. Processing of the bird data using BirdNET following manual verification of the results, resulted in the identification of 54 species during the period August to September.

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

Small mammals

Species (/call type)	No. of recordings following validation	No. of different sites (% of total)	Conservation status
Brown Rat, *Rattus norvegicus*	630	11 (27.5%)	
Common Shrew, *Sorex araneus*	281	20 (50%)	
Eurasian Pygmy Shrew, *Sorex minutus*	218	28 (70%)	
Hazel Dormouse, *Muscardinus avellanarius*	7	2 (5%)	Vulnerable

Bats

Species (/call type)	No. of recordings following validation	No. of different sites (% of total)	Conservation status
Barbastelle echolocation calls, *Barbastella barbastellus*	11,569	37 (92.5%)	Vulnerable
Barbastelle feeding buzzes, *Barbastella barbastellus*	17	9 (22.5%)	Vulnerable
Barbastelle social calls, *Barbastella barbastellus*	27	13 (32.5%)	Vulnerable
Brown Long-eared Bat echolocation calls, *Plecotus auritus*	4,972	39 (97.5%)	
Common Noctule echolocation calls, *Nyctalus noctula*	868	31 (77.5%)	
Common Noctule feeding buzzes, *Nyctalus noctula*	3	3 (7.5%)	
Common Noctule social calls, *Nyctalus noctula*	14	3 (7.5%)	
Common Pipistrelle echolocation calls, *Pipistrellus pipistrellus*	274,357	40 (100%)	
Common Pipistrelle feeding buzzes, *Pipistrellus pipistrellus*	9,461	36 (90%)	
Common Pipistrelle social calls, *Pipistrellus pipistrellus*	32,422	39 (97.5%)	
Daubenton's Bat echolocation calls, *Myotis daubentonii*	933	32 (80%)	
Daubenton's Bat feeding buzzes, *Myotis daubentonii*	16	9 (22.5%)	
Daubenton's Bat social calls, *Myotis daubentonii*	14	5 (12.5%)	
Leisler's Bat echolocation calls, *Nyctalus leisleri*	68	19 (47.5%)	Near threatened
Leisler's Bat social calls, *Nyctalus leisleri*	2	1 (2.5%)	Near threatened
Nathusius' Pipistrelle echolocation calls, *Pipistrellus nathusii*	2	2 (5%)	Near threatened
Natterer's Bat echolocation calls, *Myotis nattereri*	5,419	39 (97.5%)	
Natterer's Bat feeding buzzes, *Myotis nattereri*	58	17 (42.5%)	
Natterer's Bat social calls, *Myotis nattereri*	5	2 (5%)	
Serotine echolocation calls, *Eptesicus serotinus*	3,830	33 (82.5%)	Vulnerable
Serotine feeding buzzes, *Eptesicus serotinus*	6	3 (7.5%)	Vulnerable
Serotine social calls, *Eptesicus serotinus*	1	1 (2.5%)	Vulnerable
Soprano Pipistrelle echolocation calls, *Pipistrellus pygmaeus*	106,964	40 (100%)	
Soprano Pipistrelle feeding buzzes, *Pipistrellus pygmaeus*	8,464	37 (92.5%)	
Soprano Pipistrelle social calls, *Pipistrellus pygmaeus*	45,869	36 (90%)	
Whiskered or Brandt's Bat echolocation calls, *Myotis mystacinus or M. brandtii*	136	19 (47.5%)	Data deficient

Birds

Species	No. of different locations (% of total)	Conservation status
Black-headed Gull, *Chroicocephalus ridibundus*	1 (2.5%)	Amber
Blackbird, *Turdus merula*	16 (40%)	
Blackcap, *Sylvia atricapilla*	13 (32.5%)	
Blue Tit, *Cyanistes caeruleus*	36 (90%)	
Bullfinch, *Pyrrhula pyrrhula*	5 (12.5%)	Amber
Buzzard, *Buteo buteo*	36 (90%)	

Species	No. of different locations (% of total)	Conservation status
Canada Goose, *Branta canadensis*	1 (2.5%)	
Carrion Crow, *Corvus corone*	38 (95%)	
Chaffinch, *Fringilla coelebs*	3 (7.5%)	
Chiffchaff, *Phylloscopus collybita*	25 (62.5%)	
Coal Tit, *Periparus ater*	15 (37.5%)	
Coot, *Fulica atra*	1 (2.5%)	
Dunnock, *Prunella modularis*	21 (52.5%)	Amber
Goldcrest, *Regulus regulus*	35 (87.5%)	
Goldfinch, *Carduelis carduelis*	3 (7.5%)	
Great Spotted Woodpecker, *Dendrocopos major*	30 (75%)	
Great Tit, *Parus major*	28 (70%)	
Green Woodpecker, *Picus viridis*	33 (82.5%)	
Greenfinch, *Chloris chloris*	5 (12.5%)	Red
Grey Heron, *Ardea cinerea*	1 (2.5%)	
Grey Wagtail, *Motacilla cinerea*	2 (5%)	Amber
Greylag Goose, *Anser anser*	2 (5%)	Amber
Hawfinch, *Coccothraustes coccothraustes*	1 (2.5%)	Red
Herring Gull, *Larus argentatus*	2 (5%)	Red
Hobby, *Falco subbuteo*	7 (17.5%)	
House Martin, *Delichon urbicum*	7 (17.5%)	Red
Jackdaw, *Coloeus monedula*	35 (87.5%)	
Jay, *Garrulus glandarius*	33 (82.5%)	
Kestrel, *Falco tinnunculus*	7 (17.5%)	Amber
Kingfisher, *Alcedo atthis*	1 (2.5%)	
Linnet, *Linaria cannabina*	1 (2.5%)	Red
Long-tailed Tit, *Aegithalos caudatus*	39 (97.5%)	
Magpie, *Pica pica*	24 (60%)	
Mallard, *Anas platyrhynchos*	1 (2.5%)	Amber
Marsh Tit, *Poecile palustris*	14 (35%)	Red
Moorhen, *Gallinula chloropus*	2 (5%)	Amber
Nuthatch, *Sitta europaea*	24 (60%)	
Pheasant, *Phasianus colchicus*	29 (72.5%)	
Raven, *Corvus corax*	9 (22.5%)	
Red-legged Partridge, *Alectoris rufa*	3 (7.5%)	
Red Kite, *Milvus milvus*	4 (10%)	
Redstart, *Phoenicurus phoenicurus*	1 (2.5%)	Amber
Robin, *Erithacus rubecula*	37 (92.5%)	
Rook, *Corvus frugilegus*	28 (70%)	Amber
Siskin, *Spinus spinus*	1 (2.5%)	
Song Thrush, *Turdus philomelos*	7 (17.5%)	Amber
Spotted Flycatcher, *Muscicapa striata*	8 (20%)	Red
Stock Dove, *Columba oenas*	28 (70%)	Amber
Swallow, *Hirundo rustica*	2 (5%)	
Tawny Owl, *Strix aluco*	5 (12.5%)	Amber
Treecreeper, *Certhia familiaris*	33 (82.5%)	
Willow Warbler, *Phylloscopus trochilus*	1 (2.5%)	Amber
Woodpigeon, *Columba palumbus*	39 (97.5%)	Amber

Species	No. of different locations (% of total)	Conservation status
Wren, *Troglodytes troglodytes*	39 (97.5%)	Amber

Bush-crickets

Species	No. of different locations (% of total)	Conservation status
Dark Bush-cricket, *Pholidoptera griseoaptera*	37 (92.5%)	
Long-winged Conehead, *Conocephalus fuscus*	1 (2.5%)	
Roesel's Bush-cricket, *Roeseliana roeselii*	1 (2.5%)	
Speckled Bush-cricket, *Leptophyes punctatissima*	39 (97.5%)	

Moths

Species	No. of different locations (% of total)	Conservation status
Bird Cherry Ermine, *Yponomeuta evonymella*	13 (32.5%)	
Green Silver-lines, *Pseudoips prasinana*	2 (5%)	

Number of species recorded by species group.

	Number of species
All birds	54
Birds of Conservation Concern 5 (BOCC5) - Red-listed	7
Birds of Conservation Concern 5 (BOCC5) - Amber-listed	16
All bats	11
IUCN Red Listed Threatened Species - Near threatened	2
IUCN Red Listed Threatened Species - Vulnerable	2
All small mammals	4
All bush-crickets	4
All moths	2

4.3 Species and call-type results

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

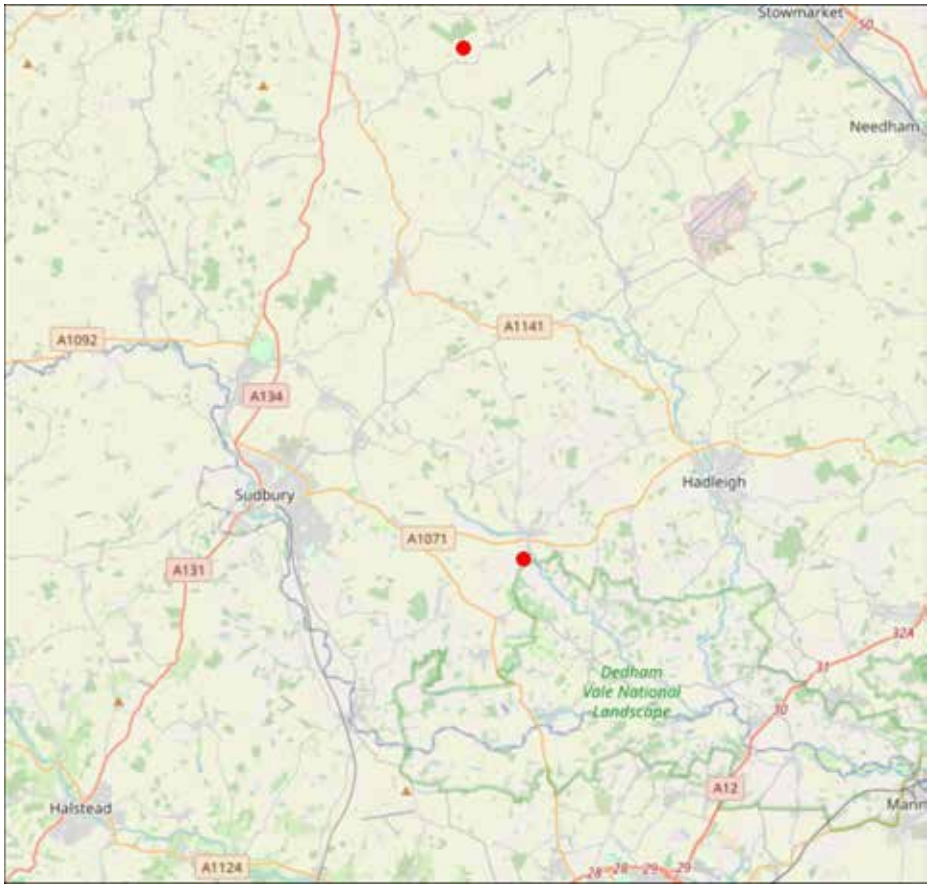
4.3.1 Hazel Dormouse

In this section we look at the recordings that we can assign to Hazel Dormouse.

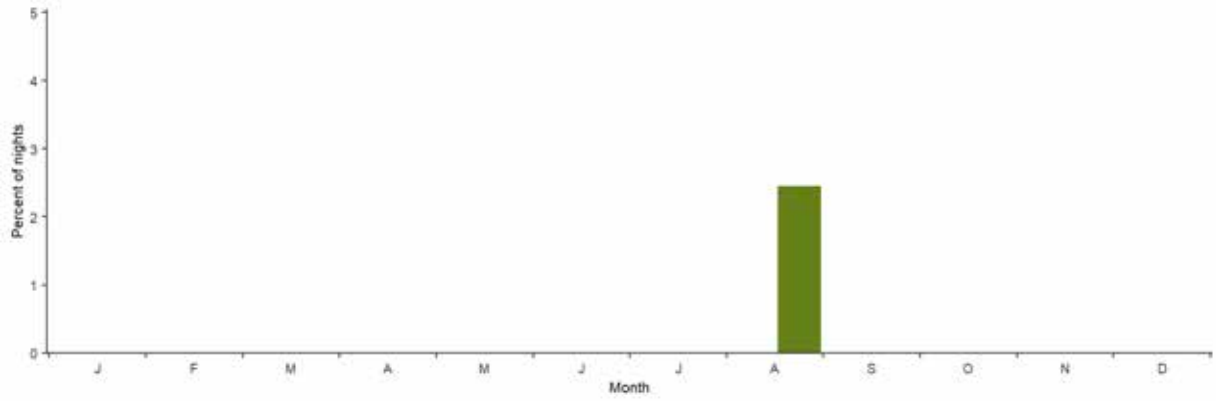
Hazel Dormouse

Hazel Dormouse *Muscardinus avellanarius* was recorded on four nights, from two locations.

Spatial pattern of detections



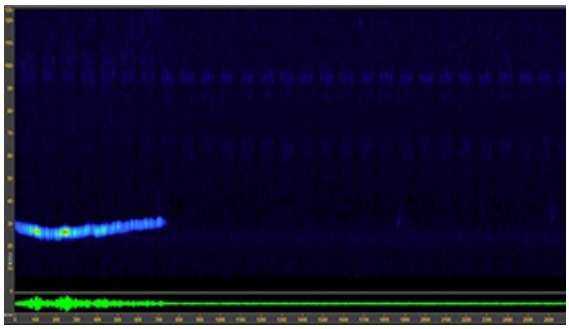
Seasonality



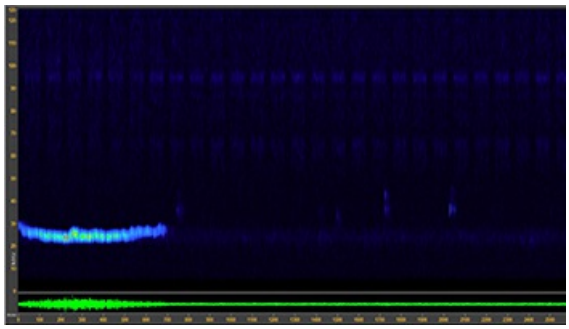
Hazel Dormouse Hazel Dormouse was recorded from two sites. This included six recordings from four different nights (20th, 21st, 23rd and 26th August) from a small patch of woodland just south of Bradford woods, where there is an established population of Hazel Dormouse. In addition there was a single recording of Hazel Dormouse from woodland south of Boxford at Stone Street.

This species can produce a range of different calls, but most common are ascending frequency modulated calls,

which is more evident in one of the spectrograms below. The most similar confusion species is Brown Rat. However, when the listening (time expansion x 10) to these calls, there is normally a clear distinction in the sound. The Brown rat call is very clean and almost electrical in sound, whereas the Hazel Dormouse call is more of a vibrato approach, as the sound quickly fluctuates, and to our ears sounds similar to a whistling kettle as it achieves boiling point. In Brown Rat calls you will quite often see that at the start of the call the frequency drops, before becoming more constant in frequency. In Hazel Dormouse, it is often the case that the frequency increases throughout the duration of the call. For more information on the sound identification of Hazel Dormouse see Newson *et al.* (2020) and Middleton *et al.* (2024).



Hazel Dormouse call



Hazel Dormouse call

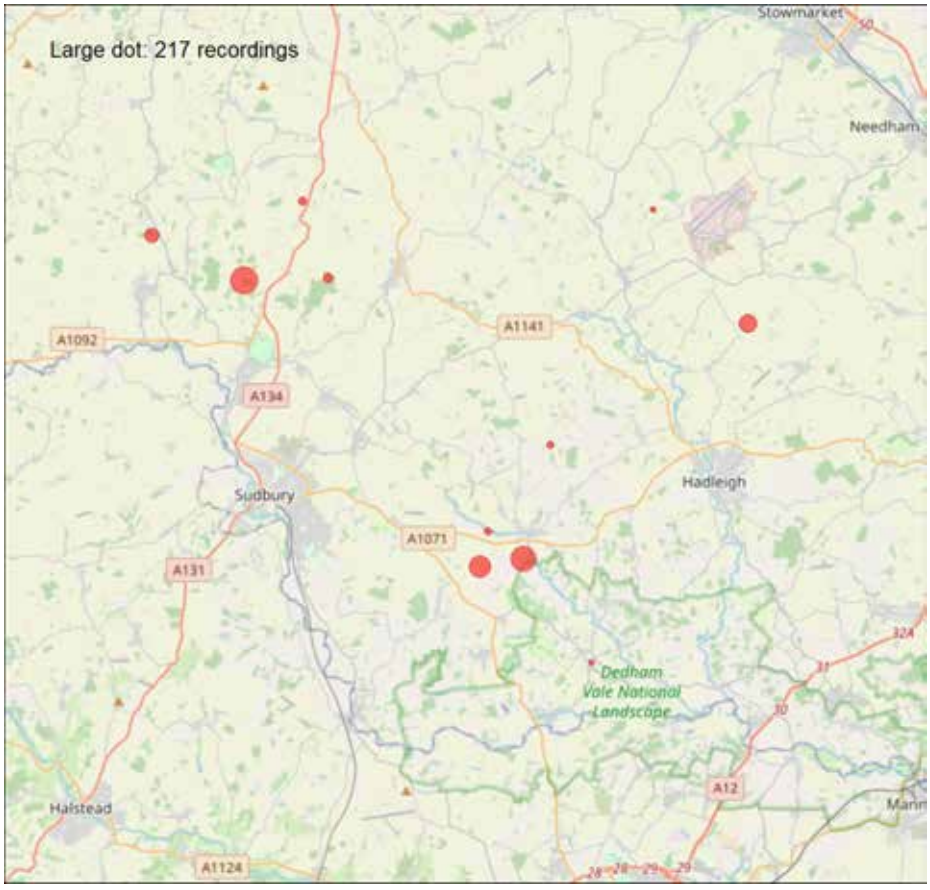
4.3.2 Other small terrestrial mammal species

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

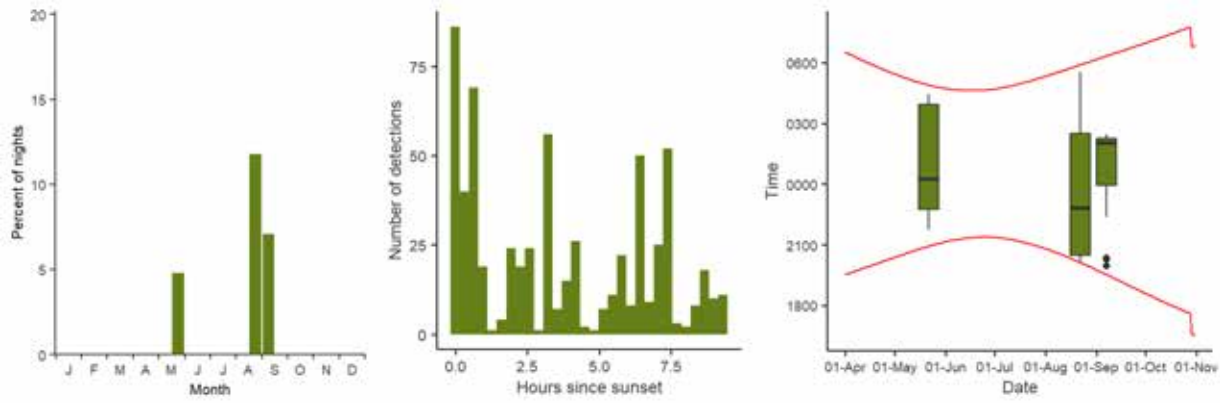
Brown Rat

Brown Rat *Rattus norvegicus* was recorded on 21 nights, from 11 locations, giving a total of 630 recordings.

Spatial pattern of activity



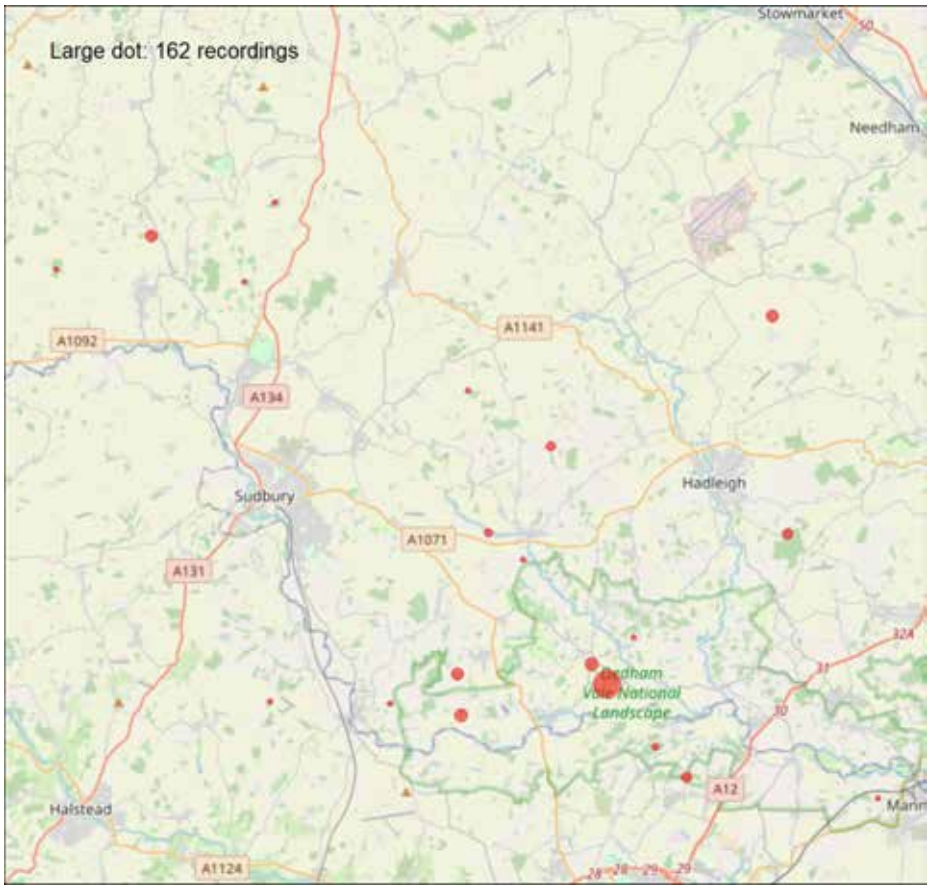
Seasonal and nightly activity



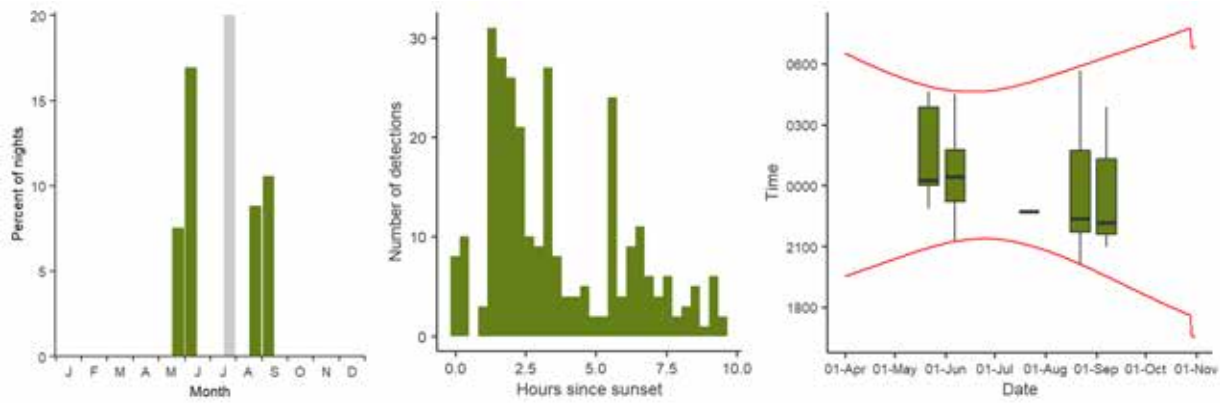
Common Shrew

Common Shrew *Sorex araneus* was recorded on 28 nights, from 20 locations, giving a total of 281 recordings.

Spatial pattern of activity



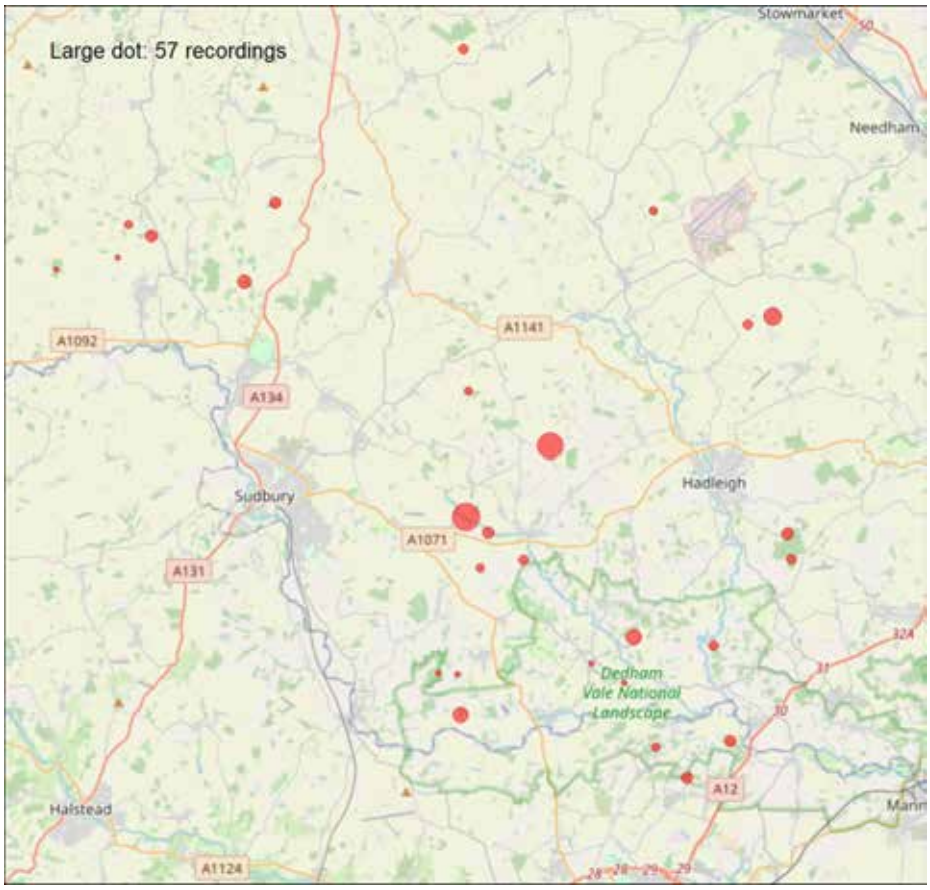
Seasonal and nightly activity



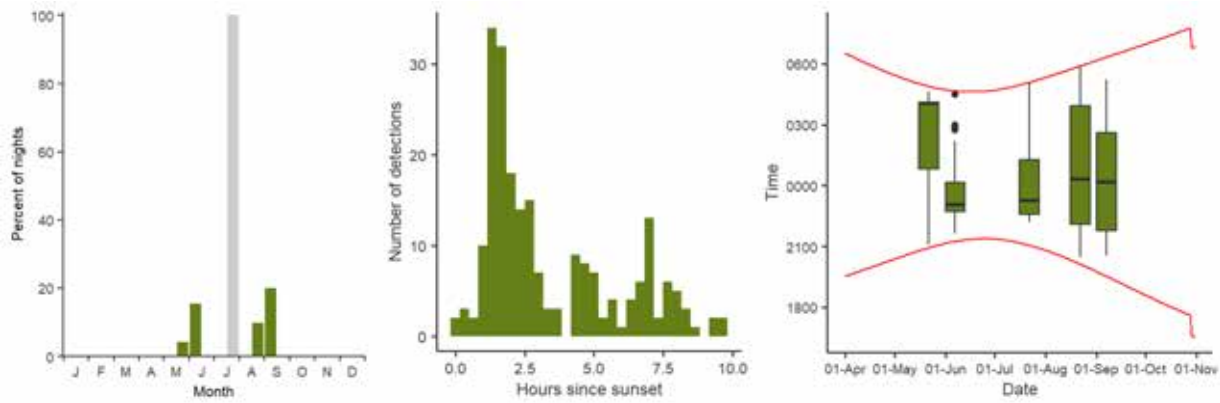
Eurasian Pygmy Shrew

Eurasian Pygmy Shrew *Sorex minutus* was recorded on 32 nights, from 28 locations, giving a total of 218 recordings.

Spatial pattern of activity



Seasonal and nightly activity

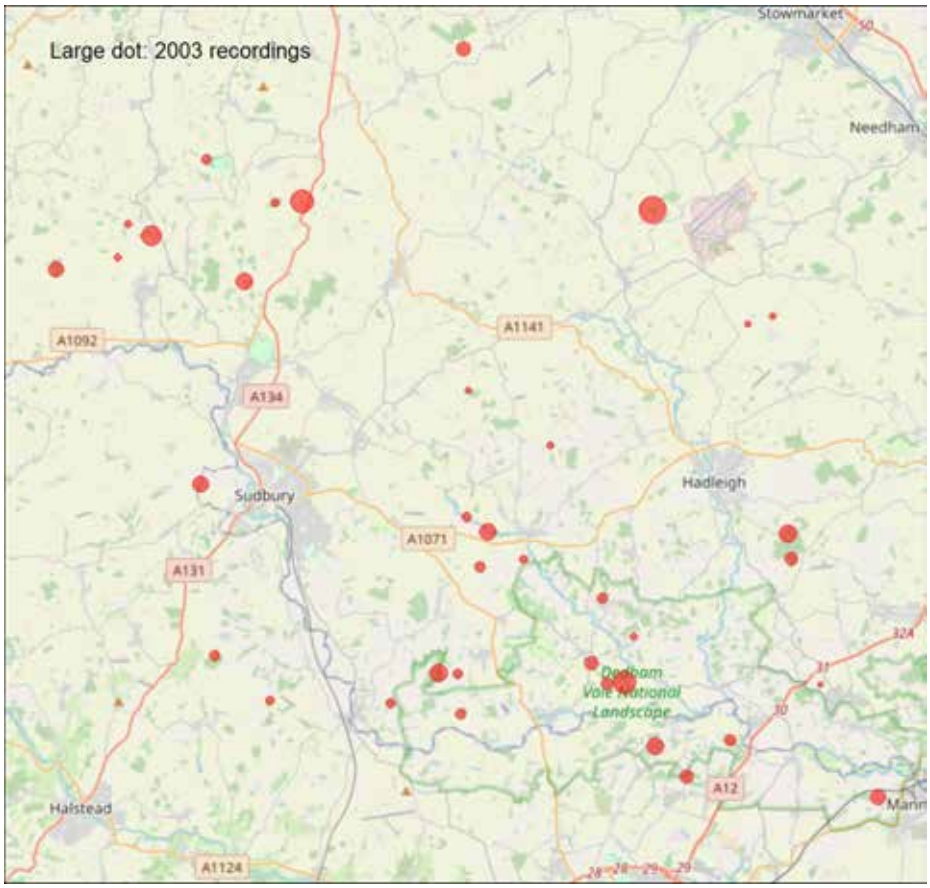


4.3.3 Bat species

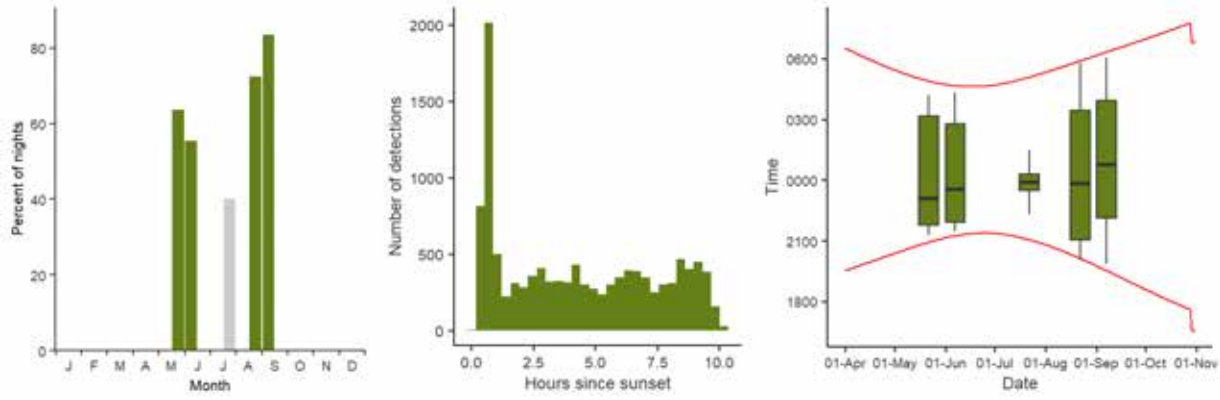
Barbastelle echolocation calls

Barbastelle echolocation calls *Barbastella barbastellus* was recorded on 37 nights, from 37 locations, giving a total of 11,569 recordings.

Spatial pattern of activity



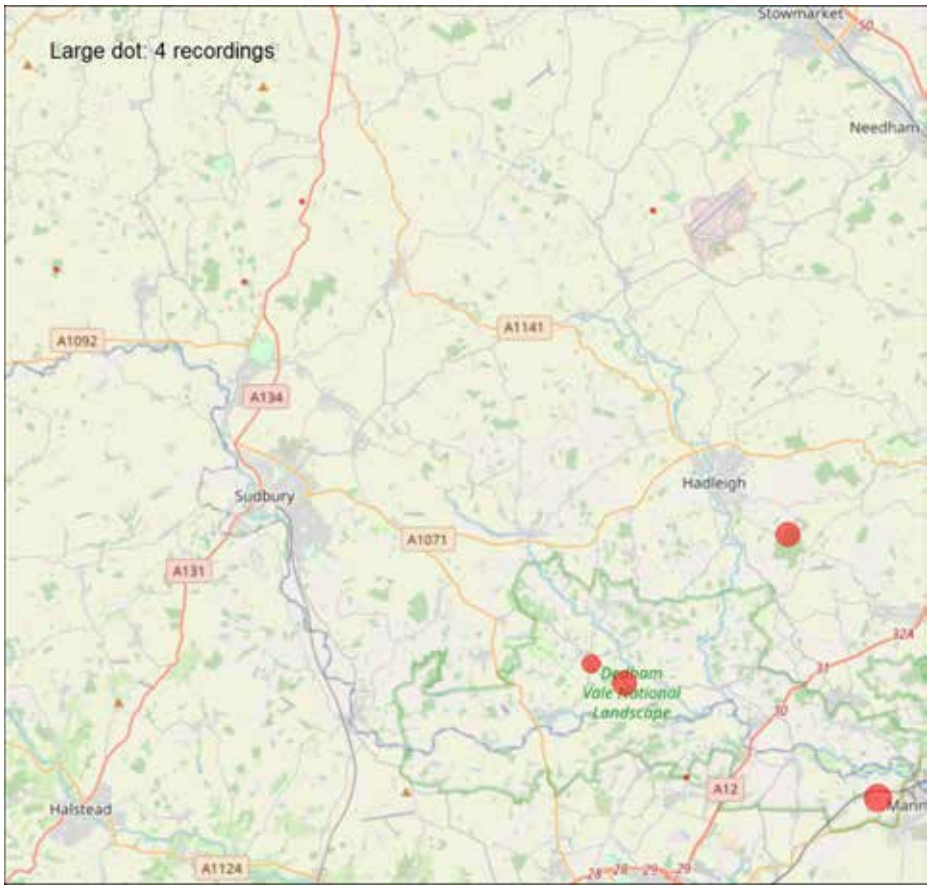
Seasonal and nightly activity



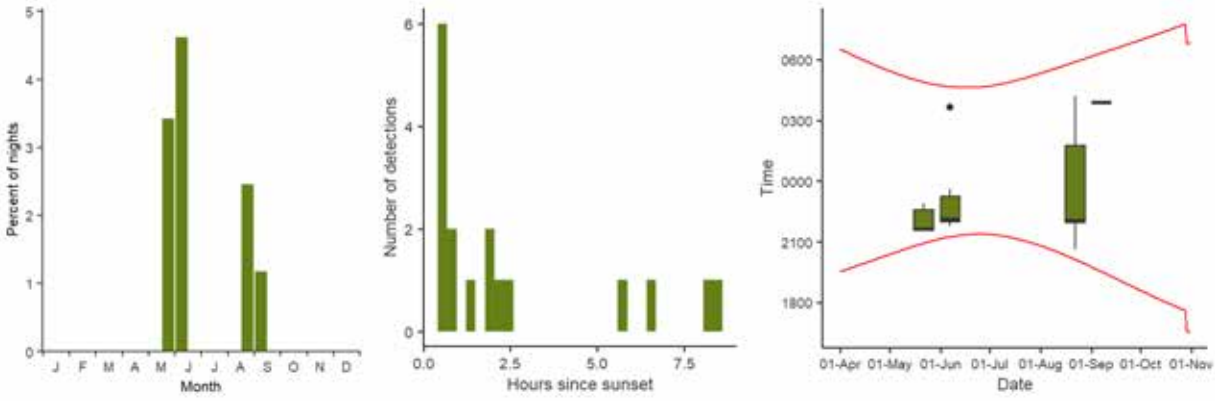
Barbastelle feeding buzzes

Barbastelle feeding buzzes *Barbastella barbastellus* were recorded on 15 nights, from 9 locations, giving a total of 17 recordings.

Spatial pattern of activity



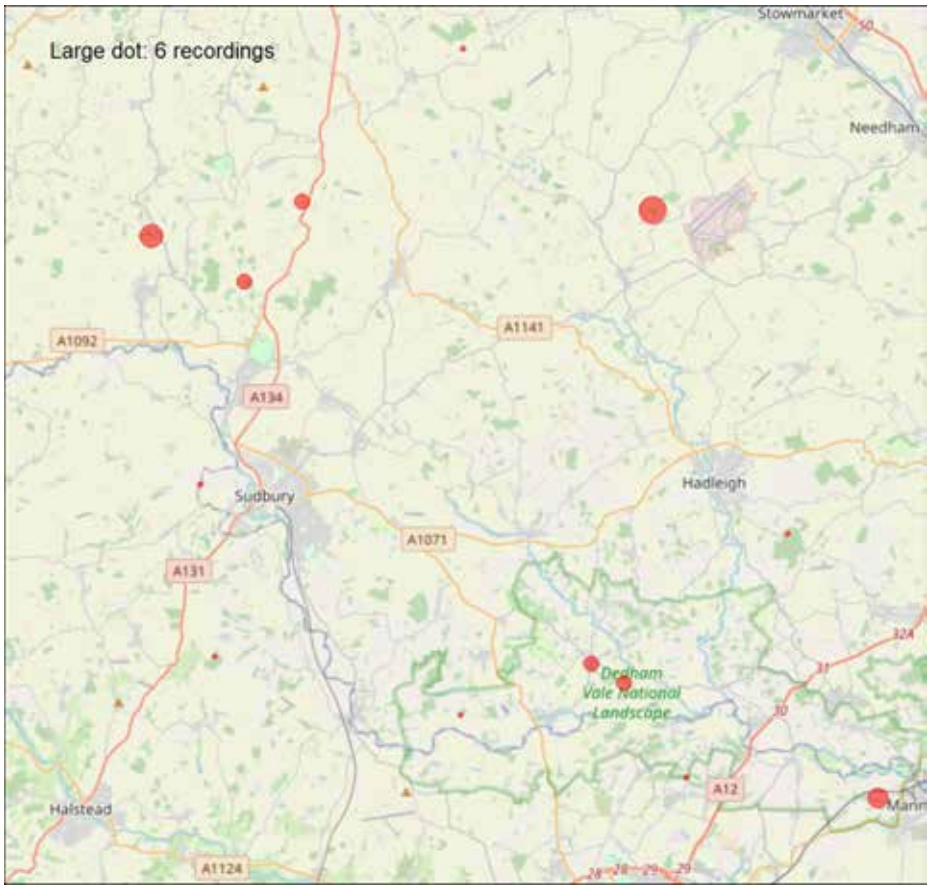
Seasonal and nightly activity



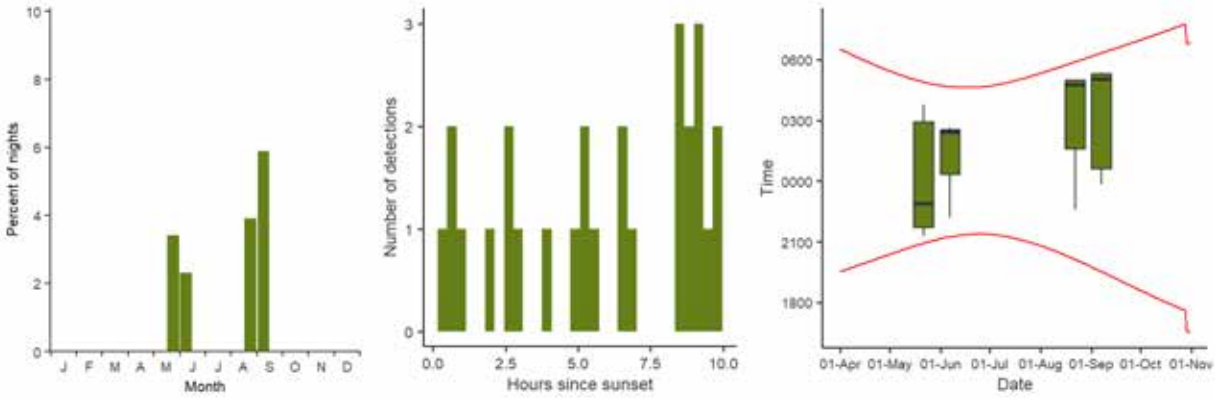
Barbastelle social calls

Barbastelle social calls *Barbastella barbastellus* were recorded on 17 nights, from 13 locations, giving a total of 27 recordings.

Spatial pattern of activity



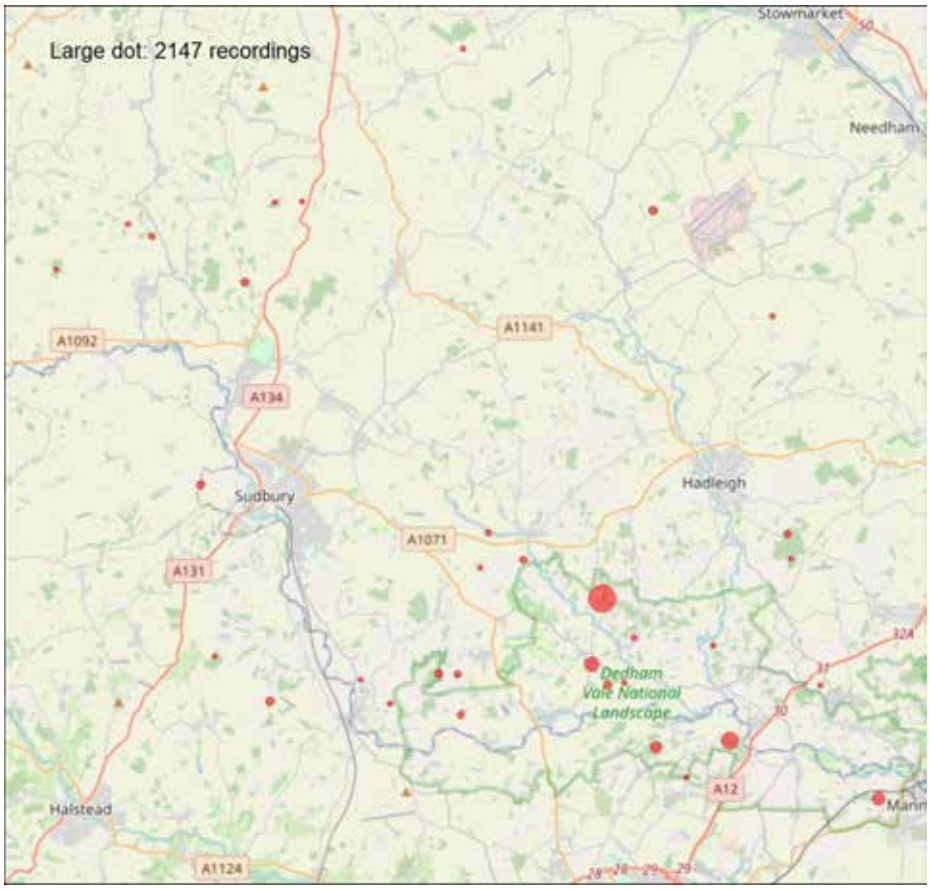
Seasonal and nightly activity



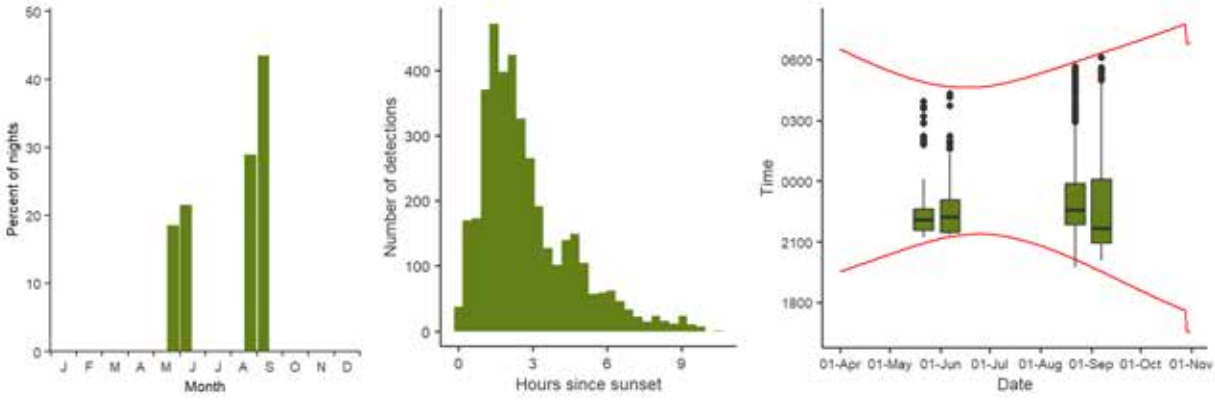
Serotine echolocation calls

Serotine echolocation calls *Eptesicus serotinus* was recorded on 31 nights, from 33 locations, giving a total of 3,830 recordings.

Spatial pattern of activity



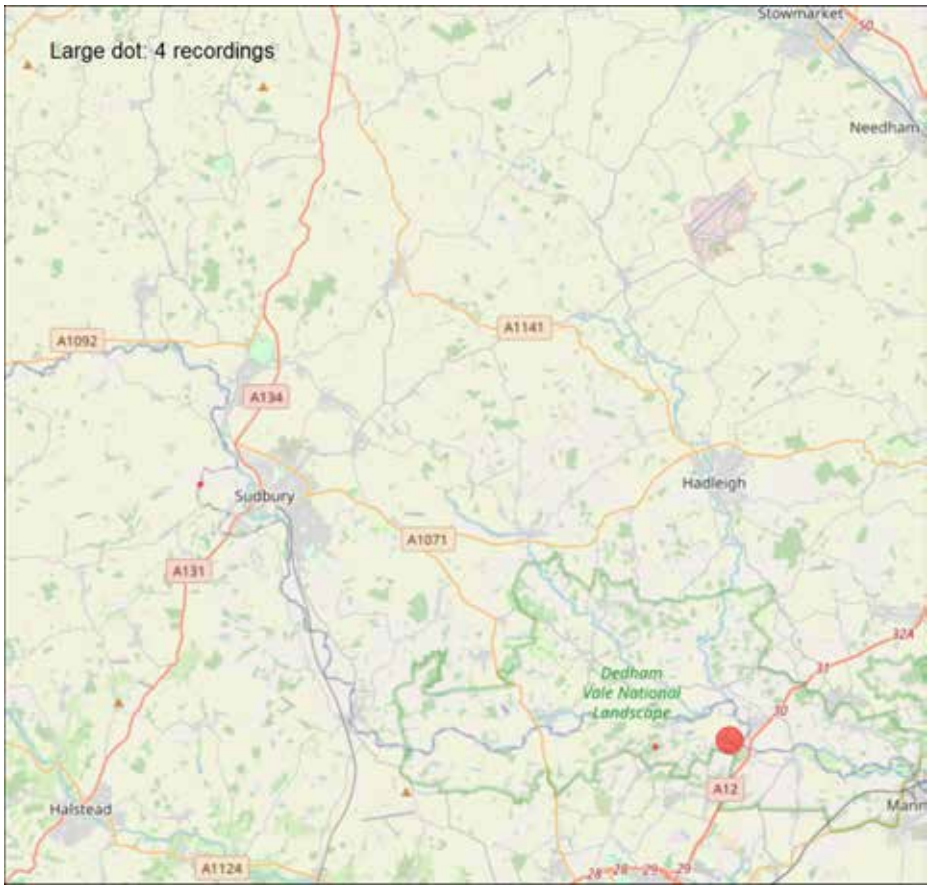
Seasonal and nightly activity



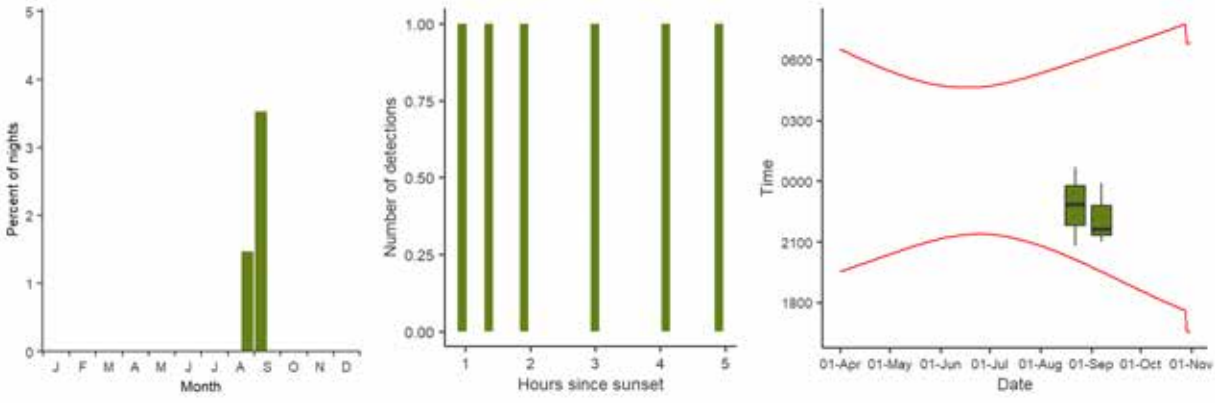
Serotine feeding buzzes

Serotine feeding buzzes *Eptesicus serotinus* were recorded on five nights, from 3 locations, giving a total of 6 recordings.

Spatial pattern of activity



Seasonal and nightly activity

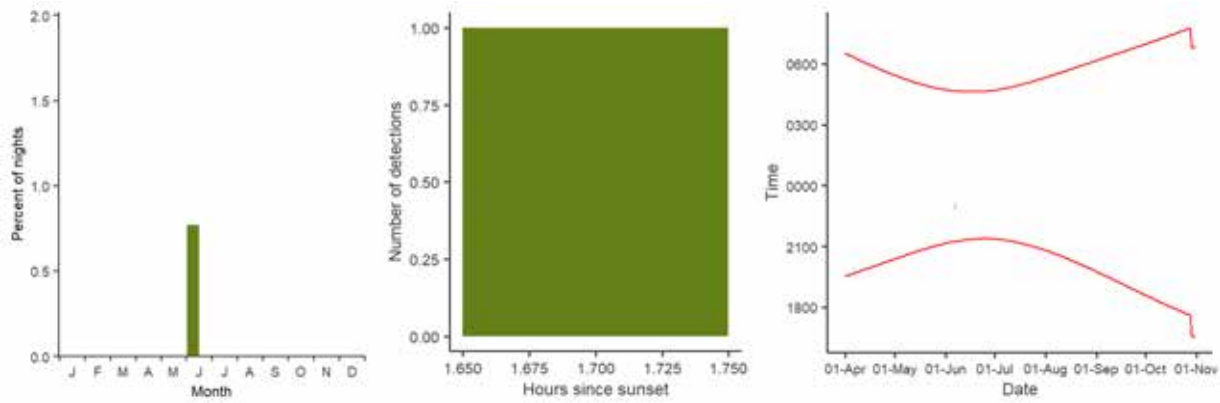


Serotine social calls

Serotine social calls *Eptesicus serotinus* were recorded on one night, from 1 location, giving a total of 1 recording.

Spatial pattern of activity

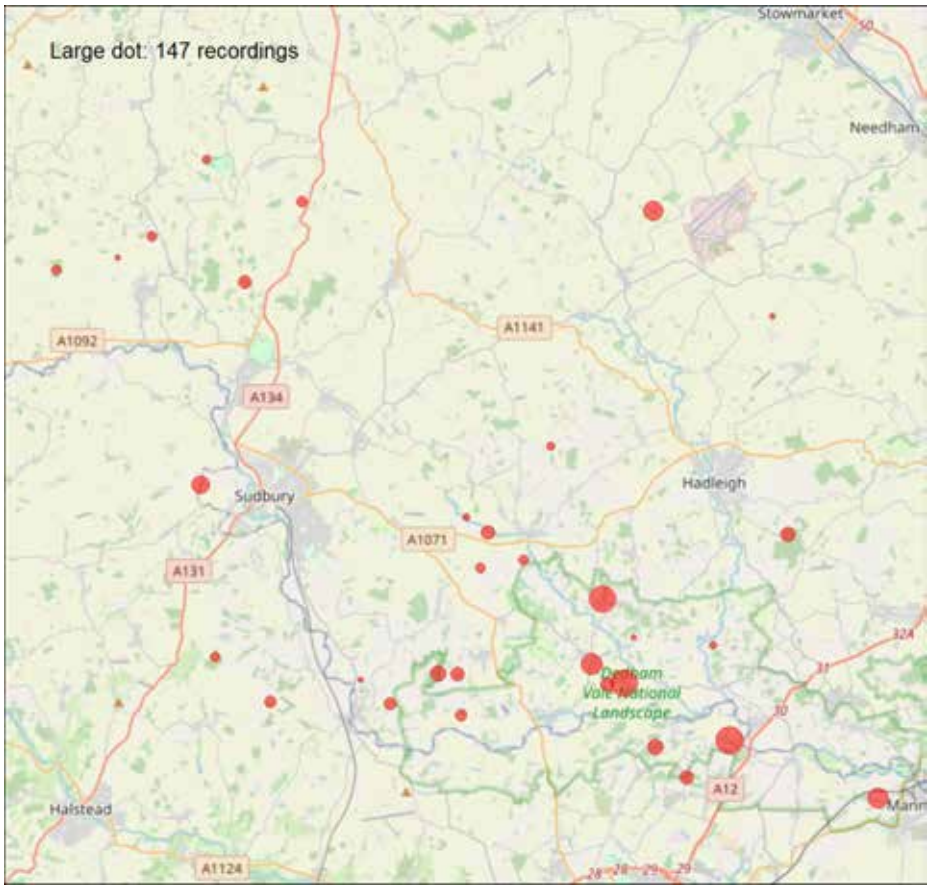
Seasonal and nightly activity



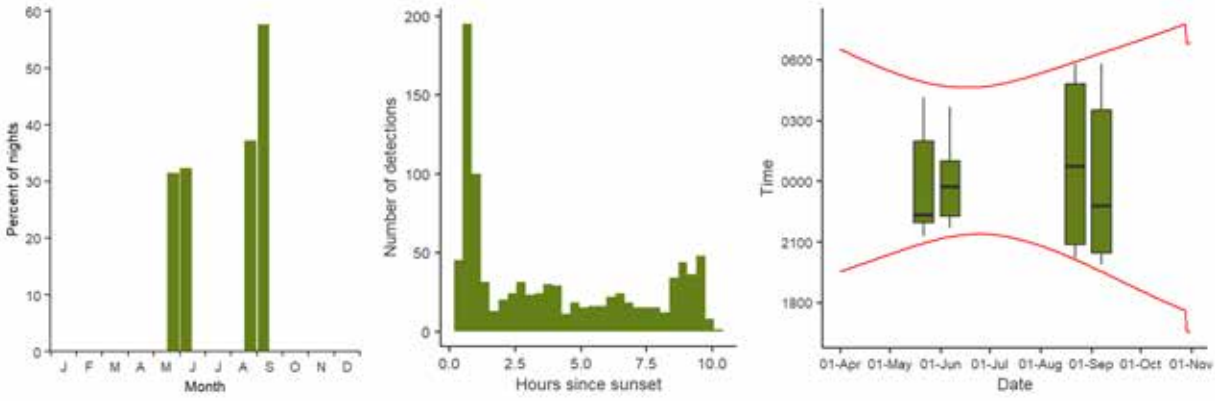
Daubenton's Bat echolocation calls

Daubenton's Bat echolocation calls *Myotis daubentonii* was recorded on 32 nights, from 32 locations, giving a total of 933 recordings.

Spatial pattern of activity



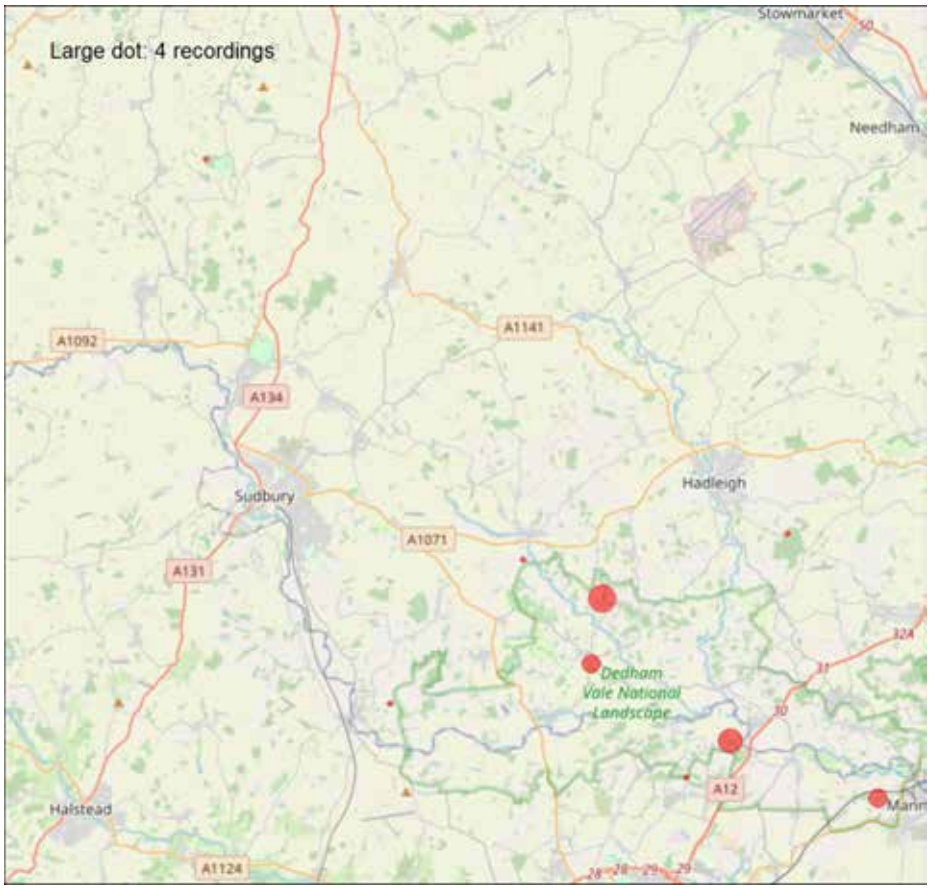
Seasonal and nightly activity



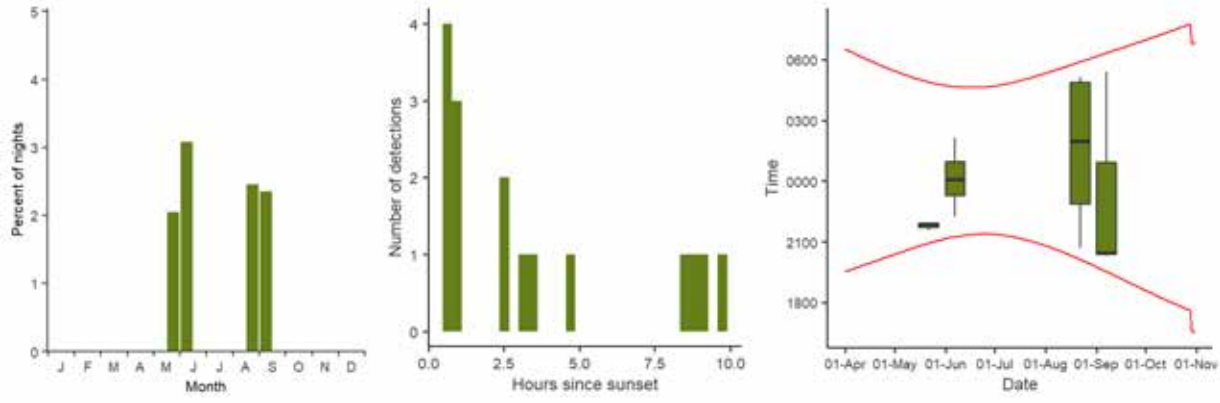
Daubenton's Bat feeding buzzes

Daubenton's Bat feeding buzzes *Myotis daubentonii* were recorded on 13 nights, from 9 locations, giving a total of 16 recordings.

Spatial pattern of activity



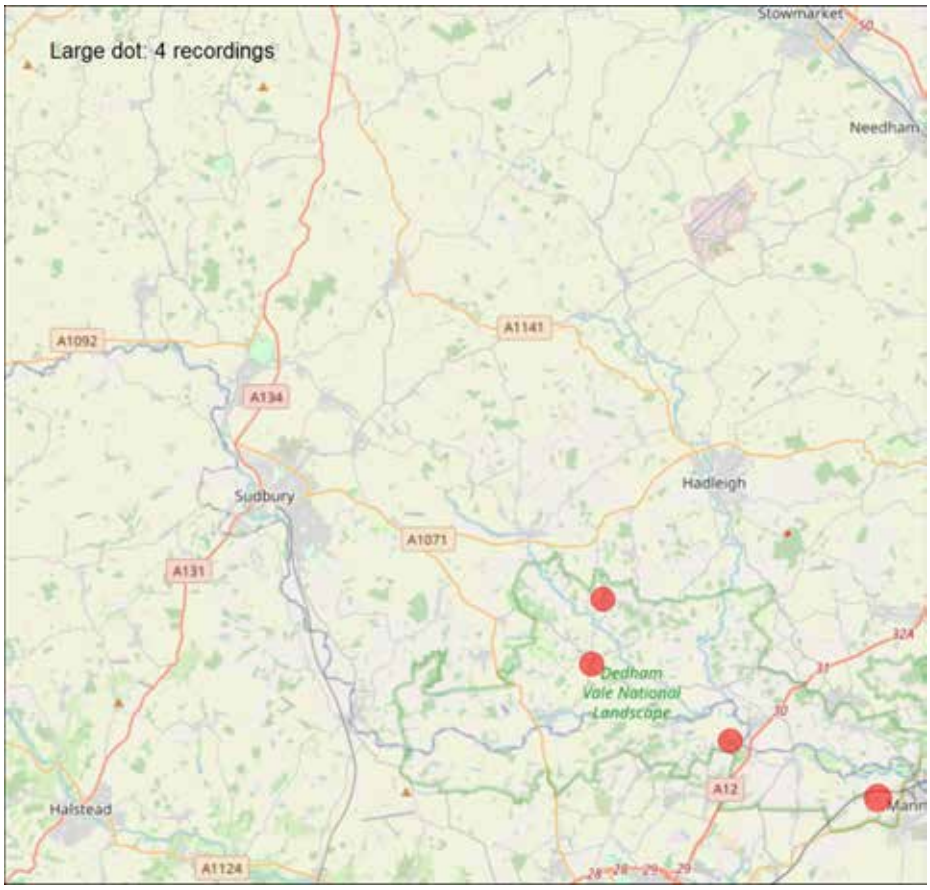
Seasonal and nightly activity



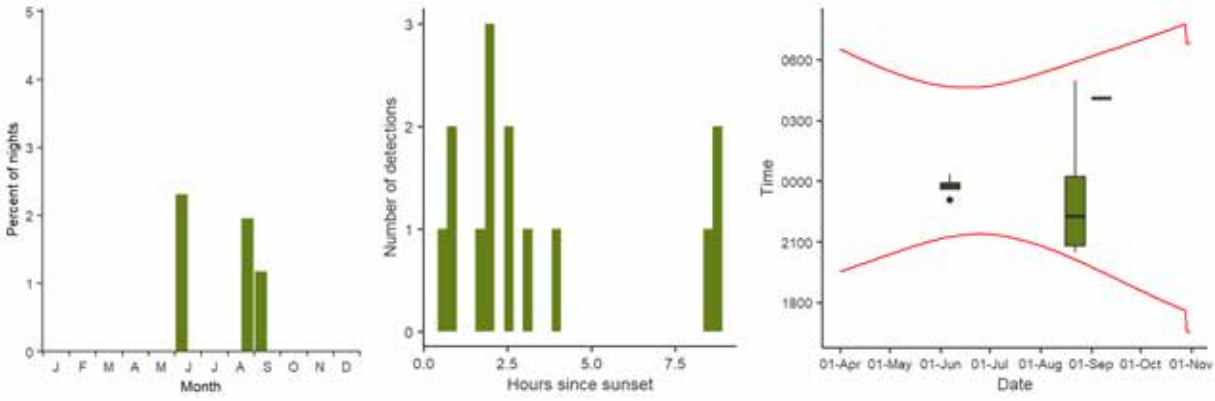
Daubenton's Bat social calls

Daubenton's Bat social calls *Myotis daubentonii* were recorded on seven nights, from 5 locations, giving a total of 14 recordings.

Spatial pattern of activity



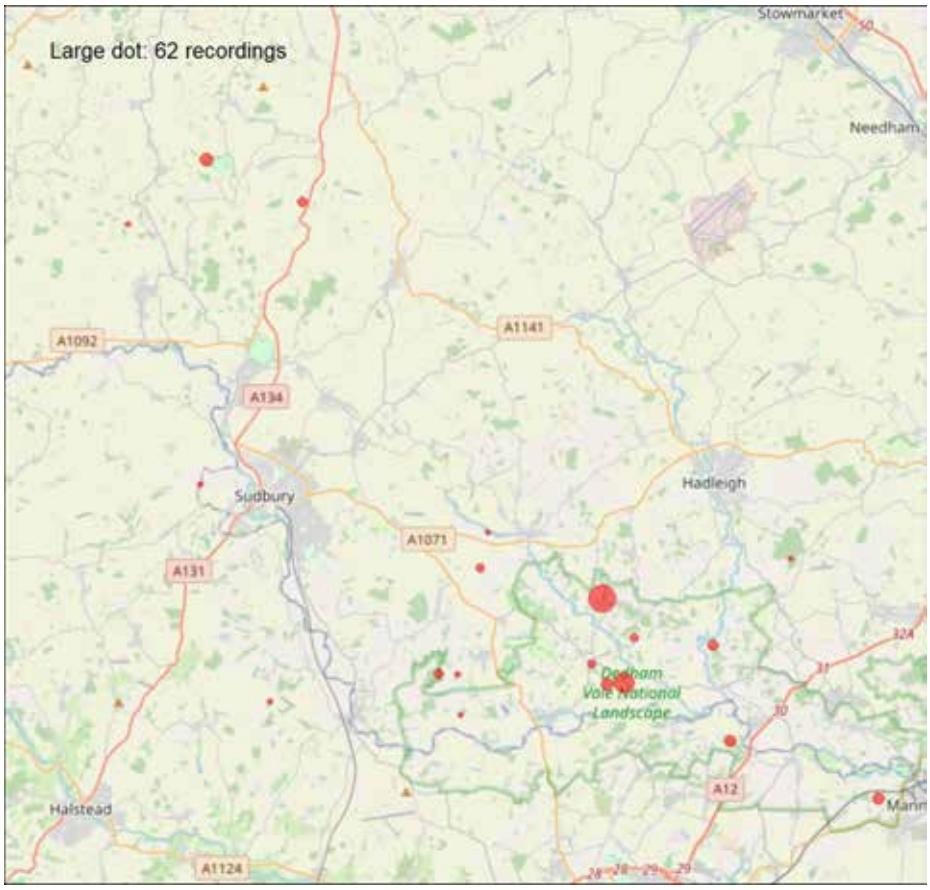
Seasonal and nightly activity



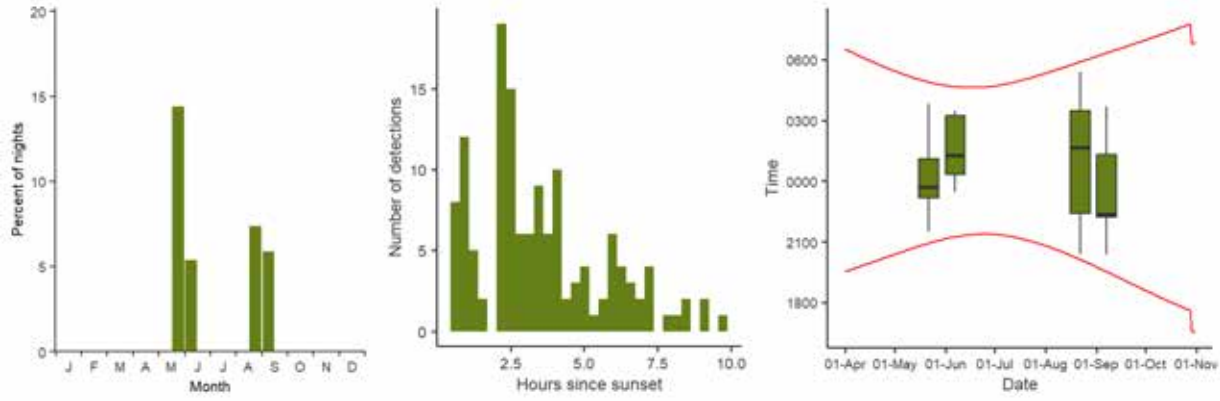
Whiskered or Brandt's Bat echolocation calls

Whiskered or Brandt's Bat echolocation calls *Myotis mystacinus or M. brandtii* was recorded on 23 nights, from 19 locations, giving a total of 136 recordings.

Spatial pattern of activity



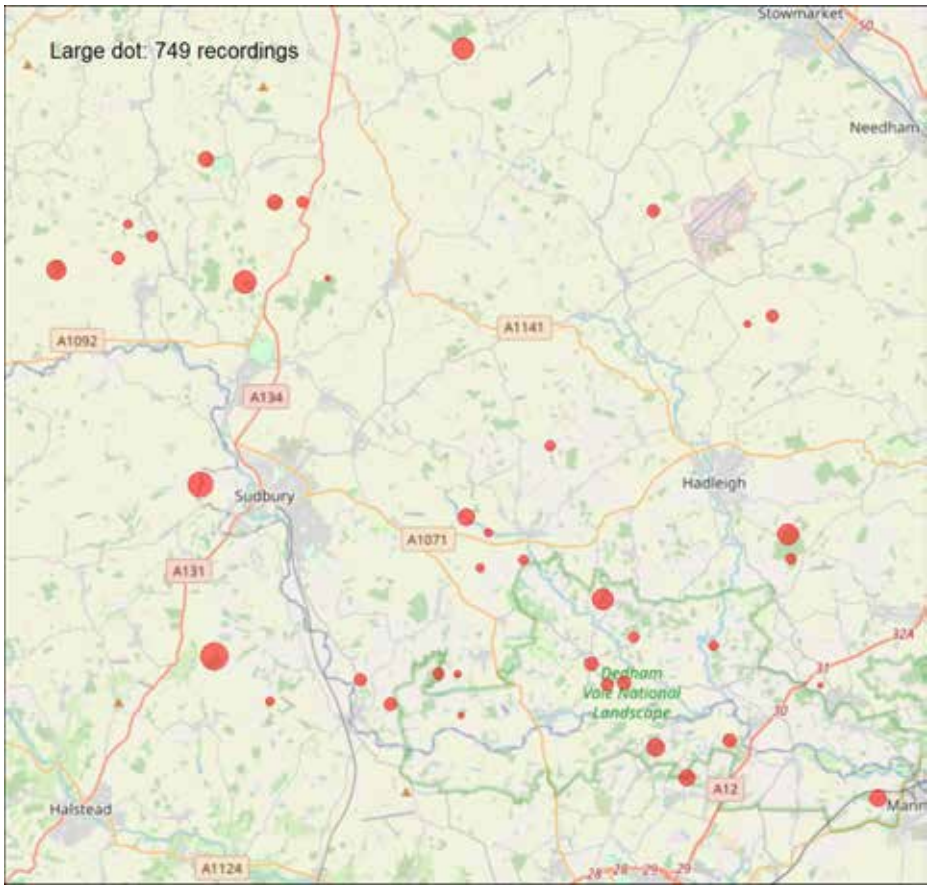
Seasonal and nightly activity



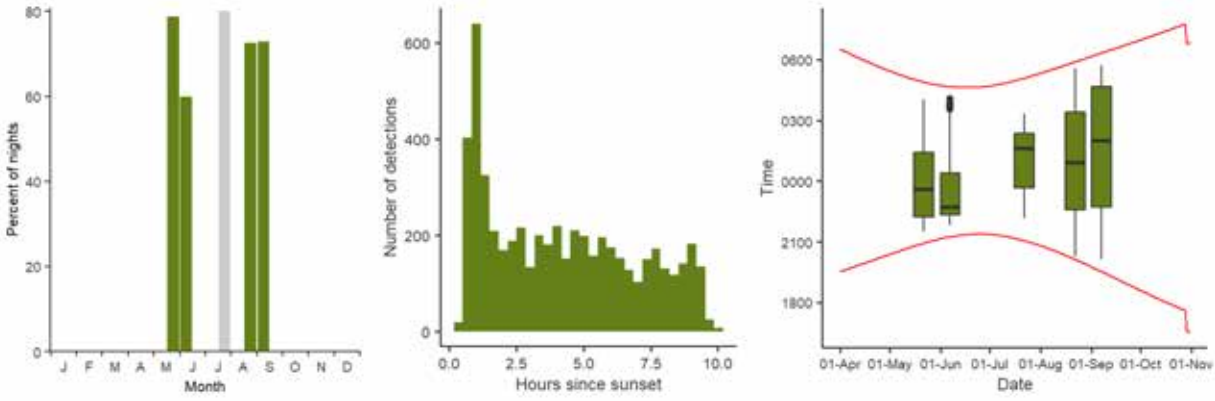
Natterer's Bat echolocation calls

Natterer's Bat echolocation calls *Myotis nattereri* was recorded on 39 nights, from 39 locations, giving a total of 5,419 recordings.

Spatial pattern of activity



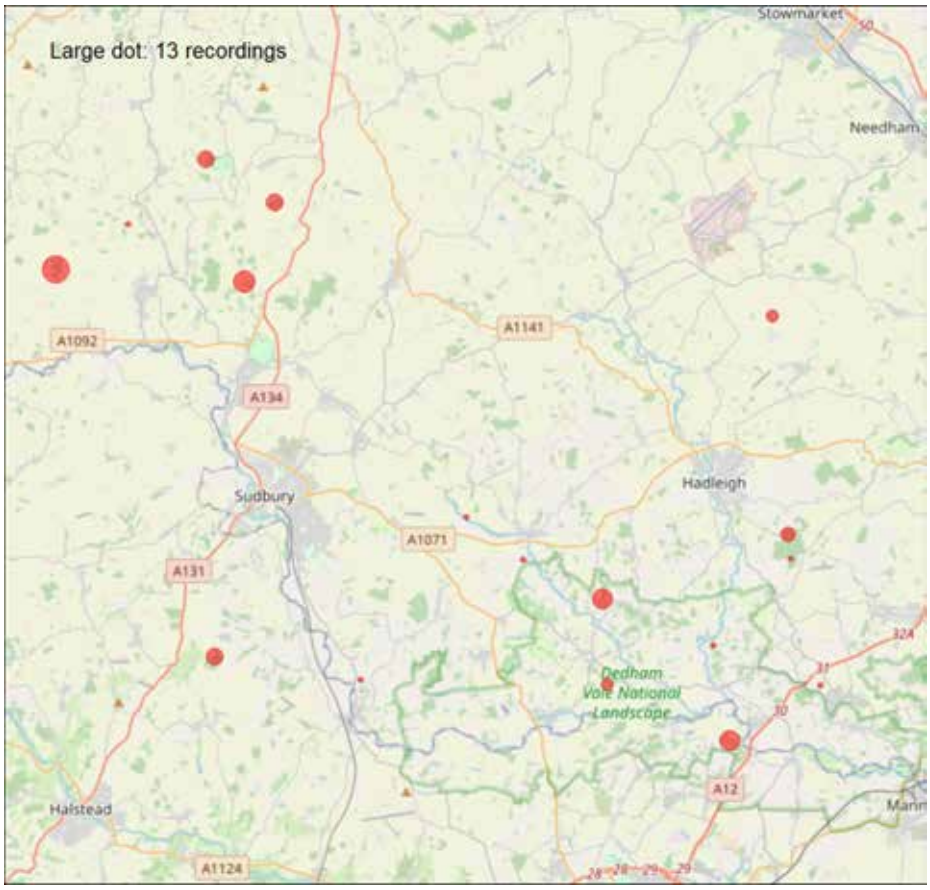
Seasonal and nightly activity



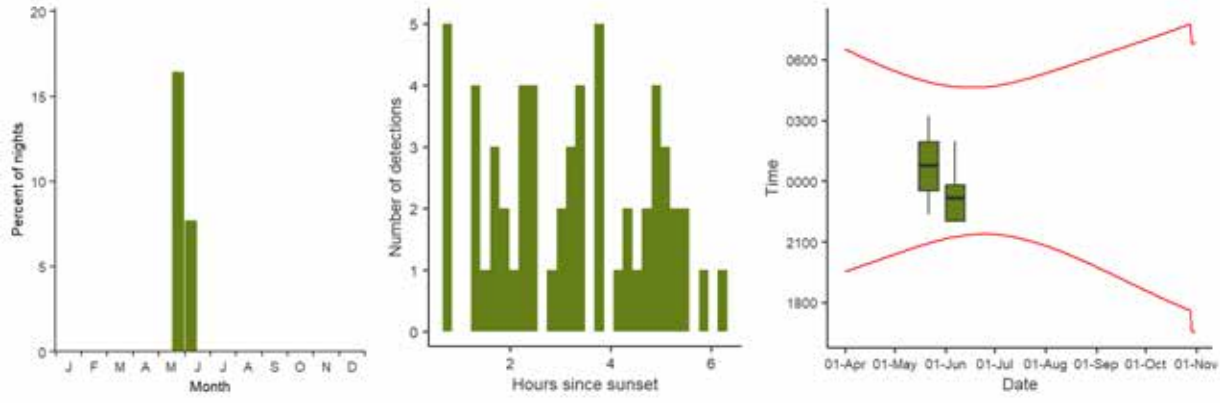
Natterer's Bat feeding buzzes

Natterer's Bat feeding buzzes *Myotis nattereri* were recorded on 17 nights, from 17 locations, giving a total of 58 recordings.

Spatial pattern of activity



Seasonal and nightly activity

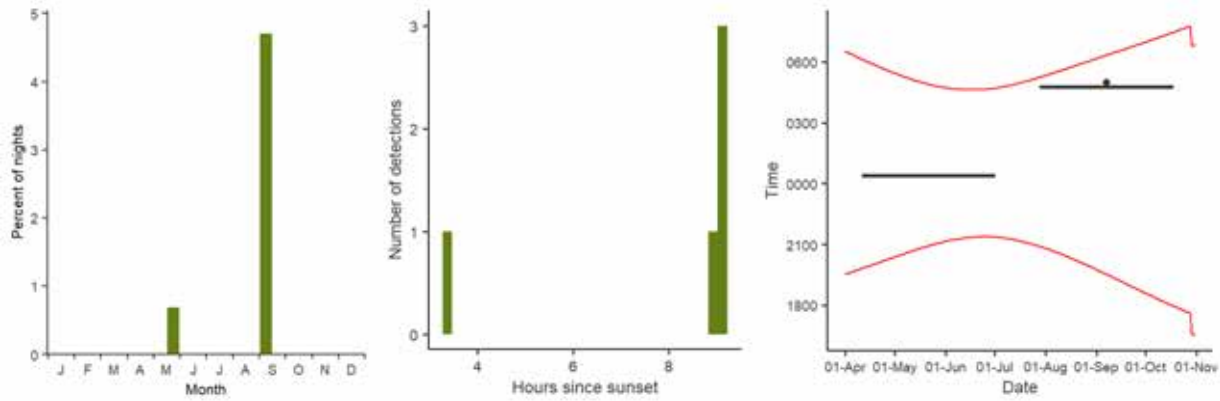


Natterer's Bat social calls

Natterer's Bat social calls *Myotis nattereri* were recorded on five nights, from 2 locations, giving a total of 5 recordings.

Spatial pattern of activity

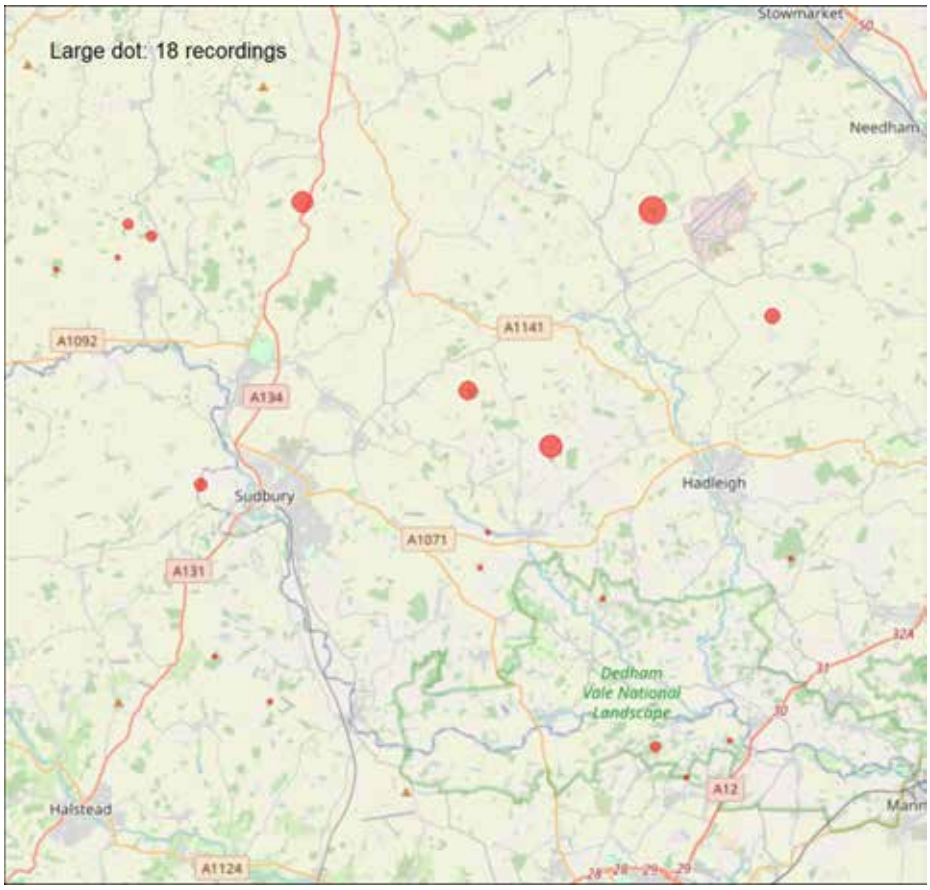
Seasonal and nightly activity



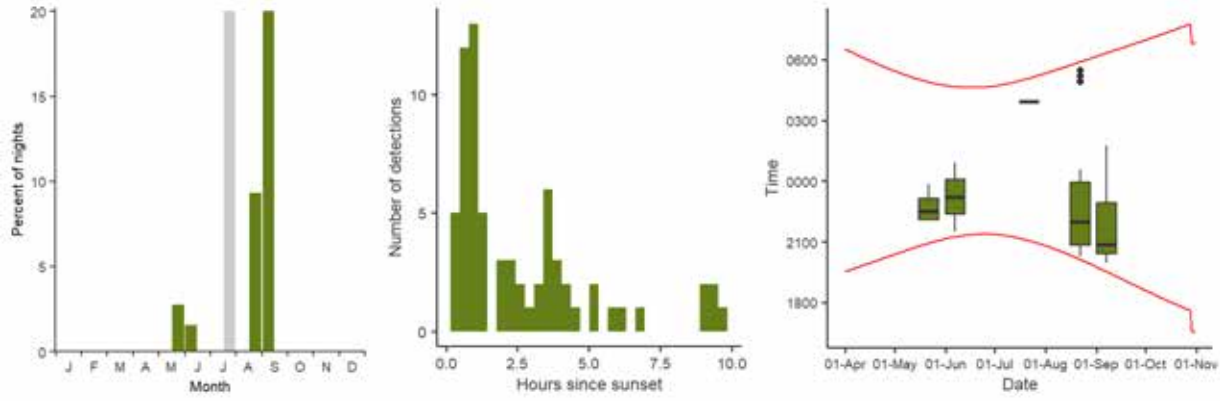
Leisler's Bat echolocation calls

Leisler's Bat echolocation calls *Nyctalus leisleri* was recorded on 21 nights, from 19 locations, giving a total of 68 recordings.

Spatial pattern of activity



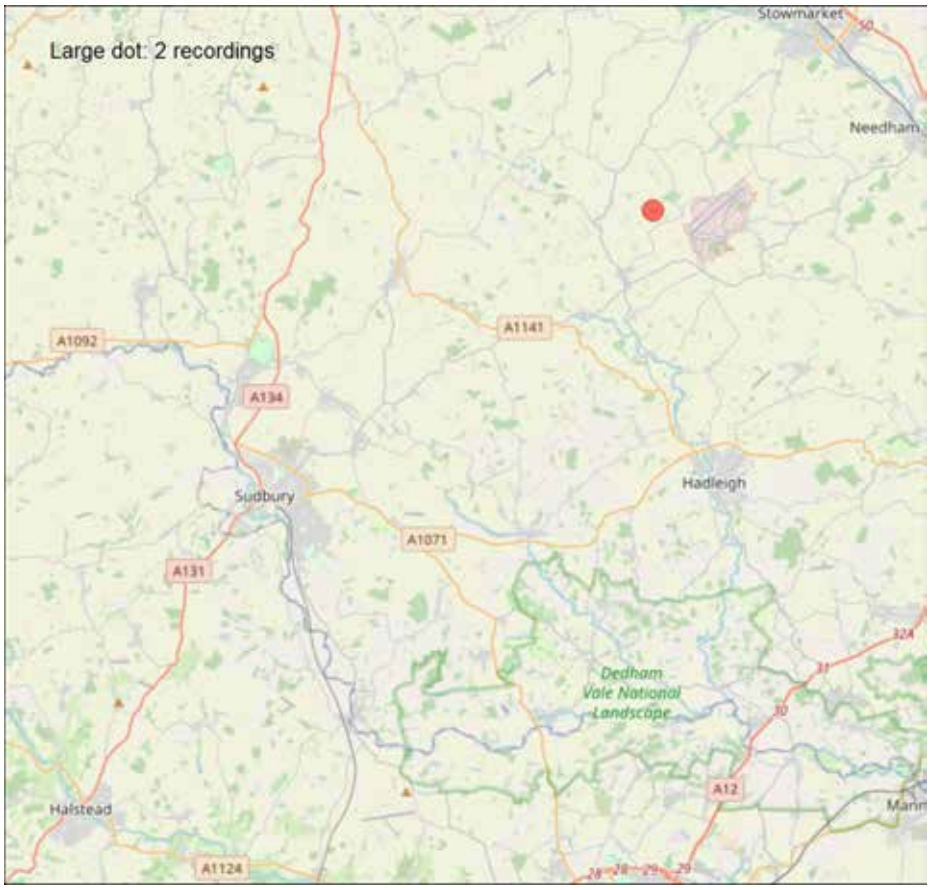
Seasonal and nightly activity



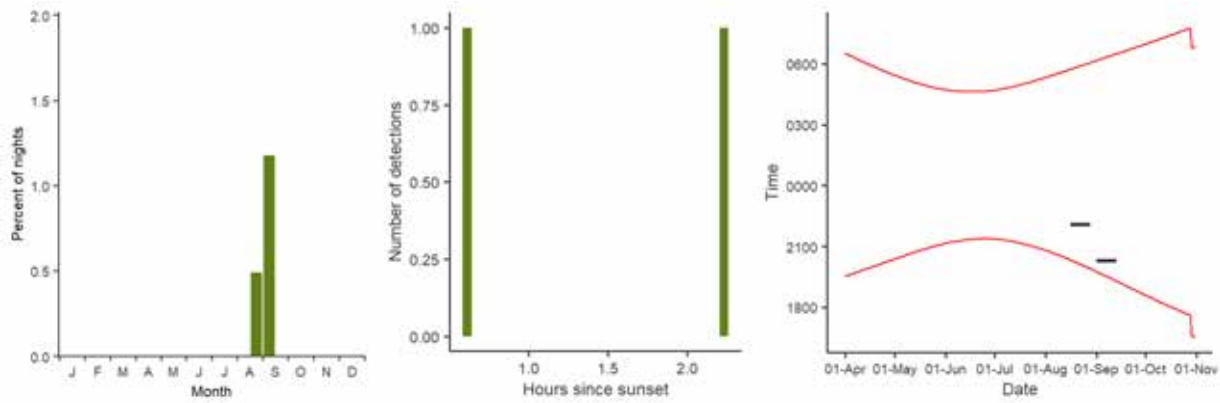
Leisler's Bat social calls

Leisler's Bat social calls *Nyctalus leisleri* were recorded on two nights, from 1 location, giving a total of 2 recordings.

Spatial pattern of activity



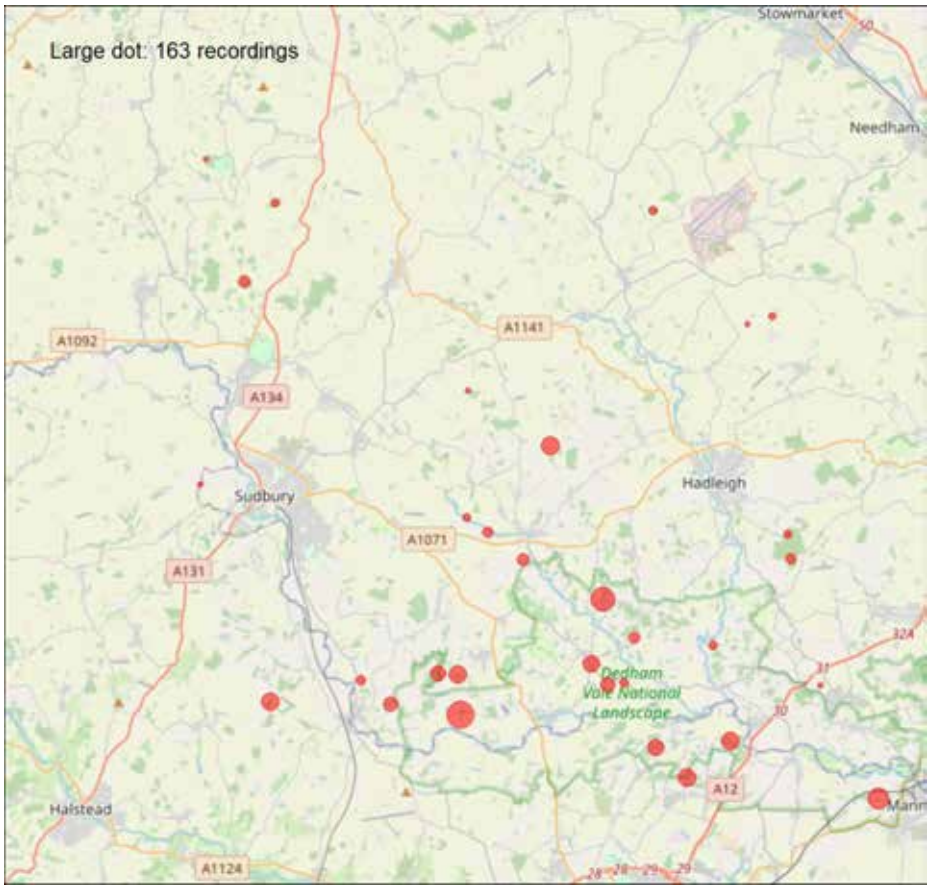
Seasonal and nightly activity



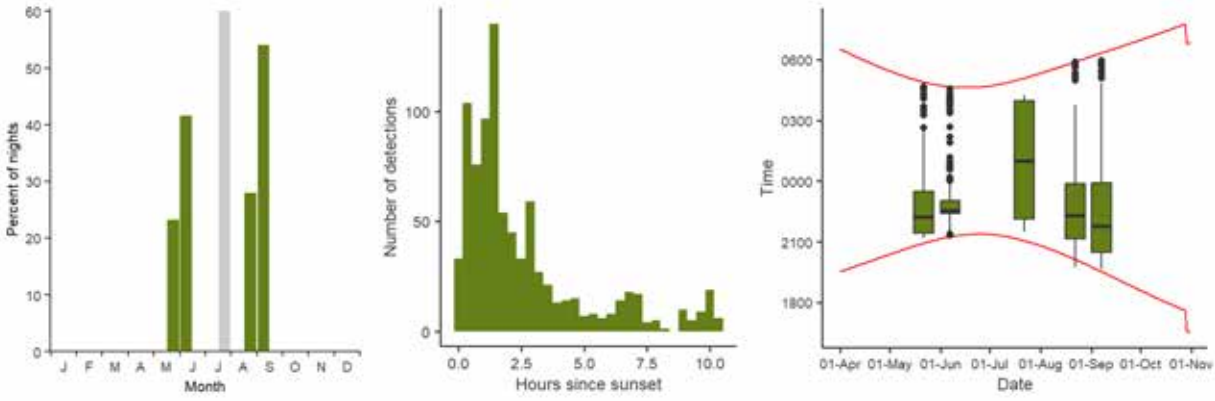
Common Noctule echolocation calls

Common Noctule echolocation calls *Nyctalus noctula* was recorded on 36 nights, from 31 locations, giving a total of 868 recordings.

Spatial pattern of activity



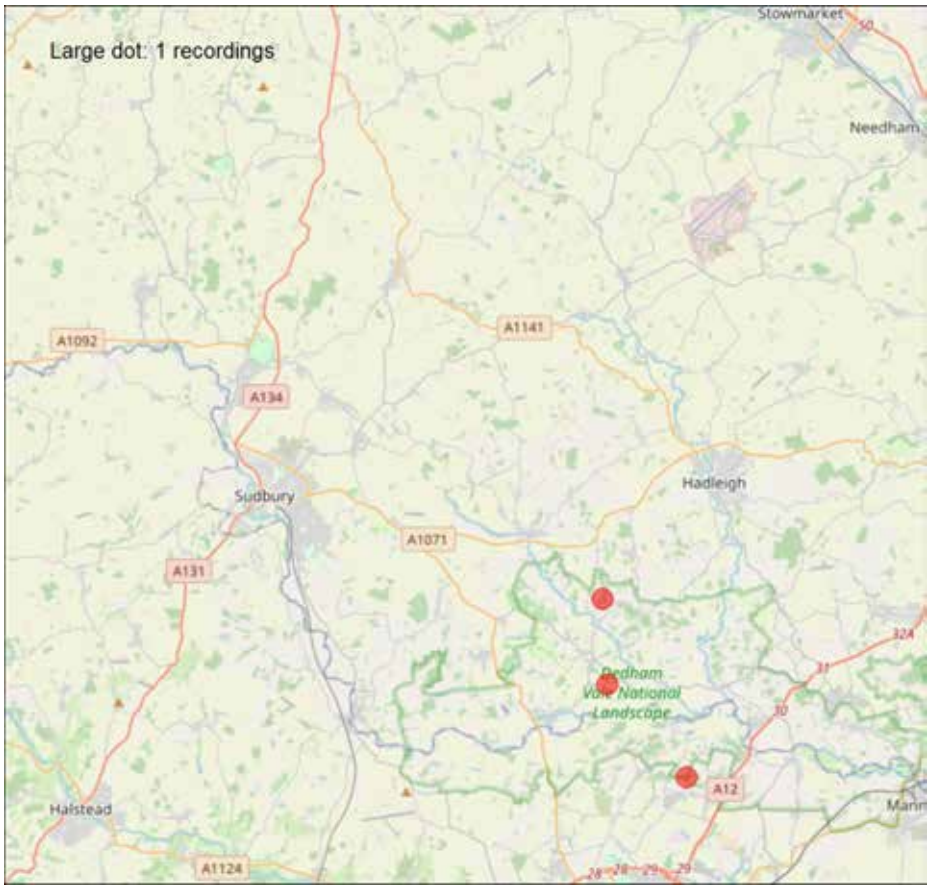
Seasonal and nightly activity



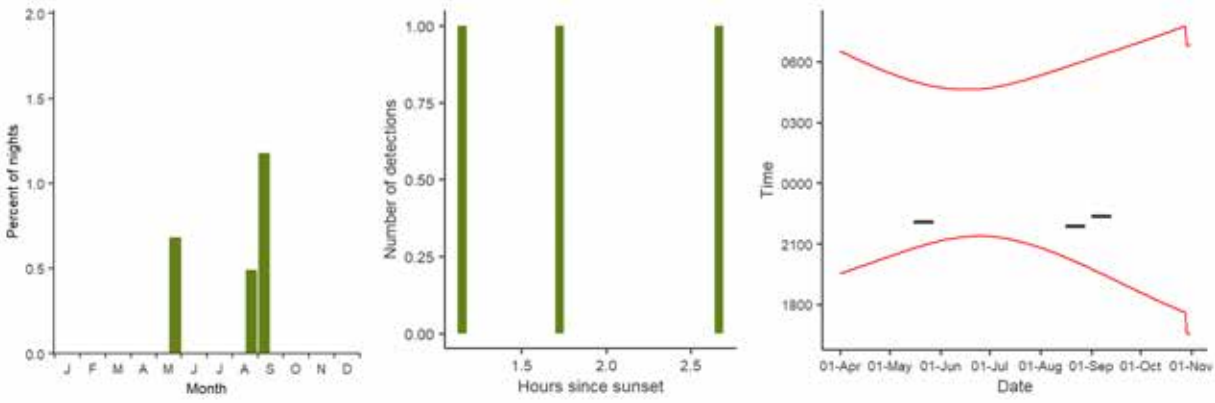
Common Noctule feeding buzzes

Common Noctule feeding buzzes *Nyctalus noctula* were recorded on three nights, from 3 locations, giving a total of 3 recordings.

Spatial pattern of activity



Seasonal and nightly activity

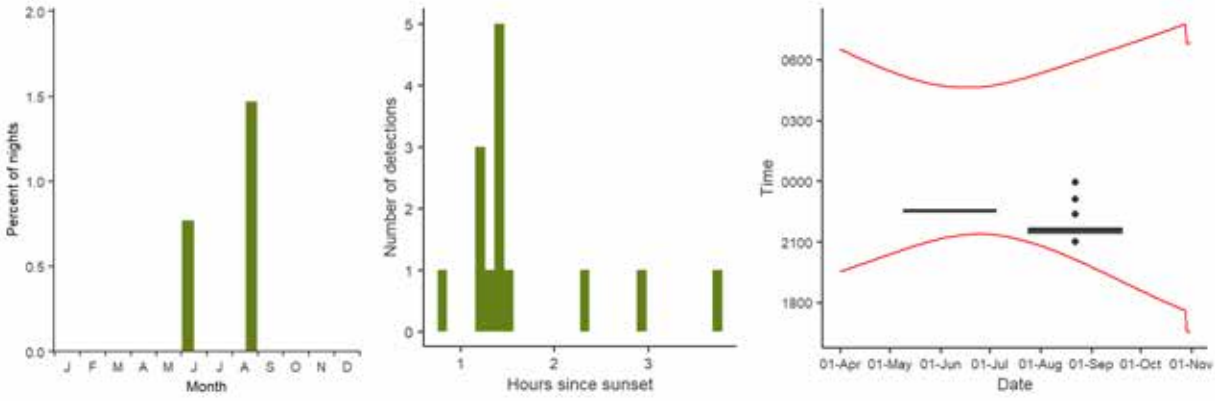


Common Noctule social calls

Common Noctule social calls *Nyctalus noctula* were recorded on three nights, from 3 locations, giving a total of 14 recordings.

Spatial pattern of activity

Seasonal and nightly activity

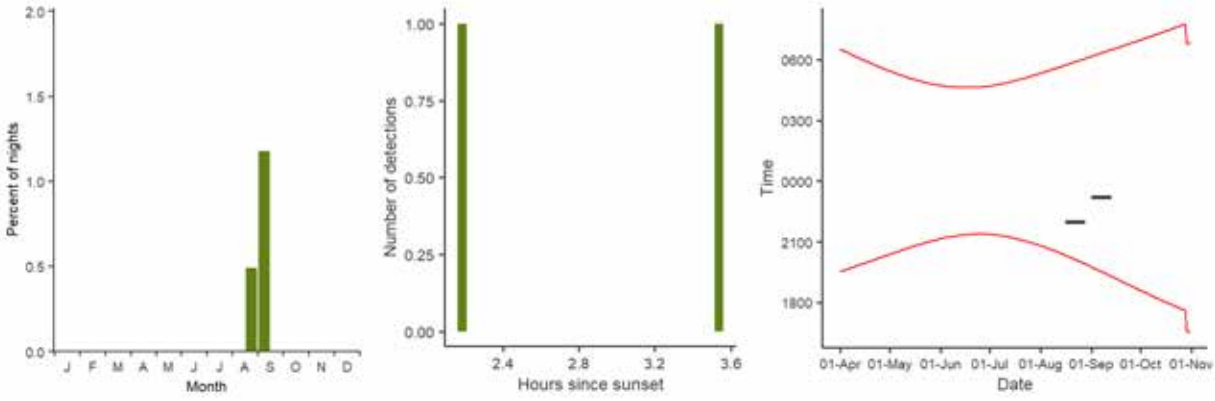


Nathusius' Pipistrelle echolocation calls

Nathusius' Pipistrelle echolocation calls *Pipistrellus nathusii* was recorded on two nights, from 2 locations, giving a total of 2 recordings.

Spatial pattern of activity

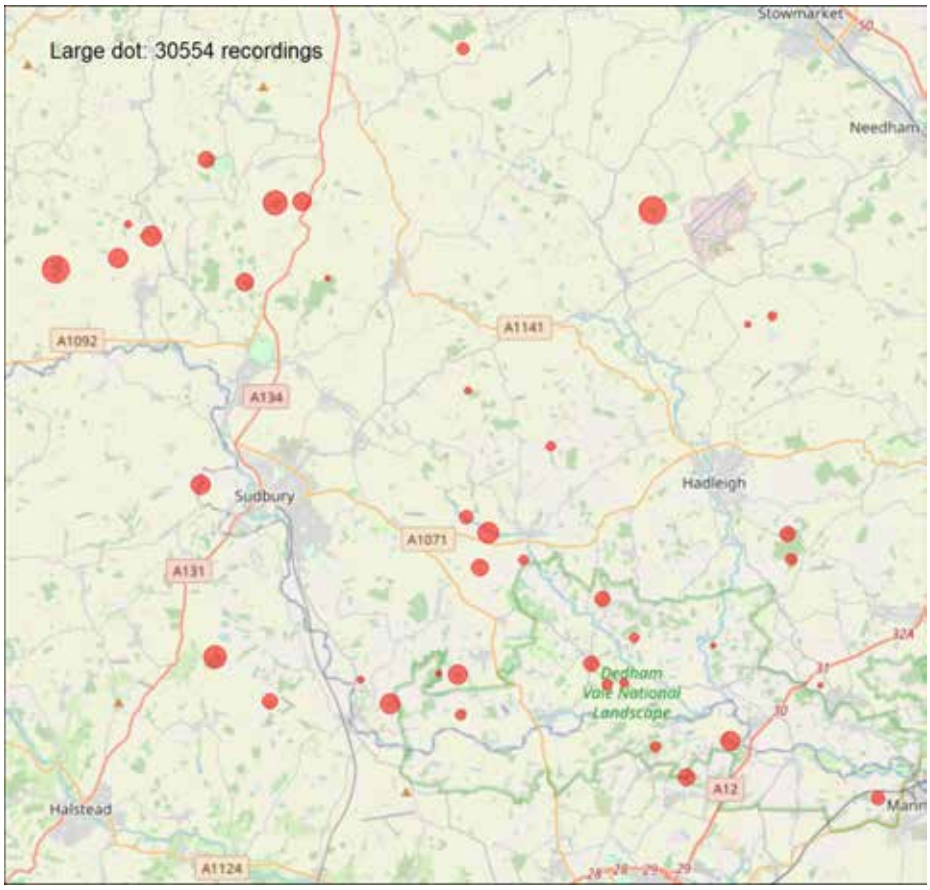
Seasonal and nightly activity



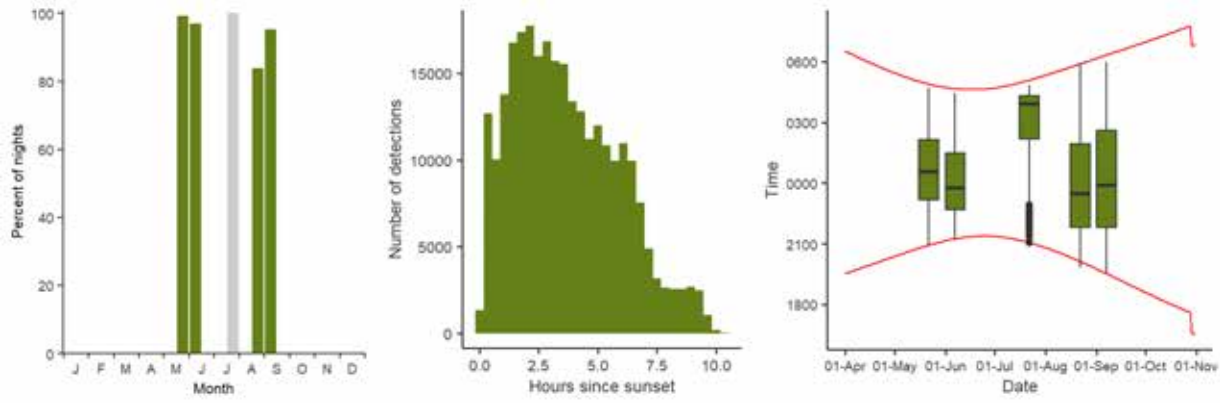
Common Pipistrelle echolocation calls

Common Pipistrelle echolocation calls *Pipistrellus pipistrellus* was recorded on 41 nights, from 40 locations, giving a total of 274,357 recordings.

Spatial pattern of activity



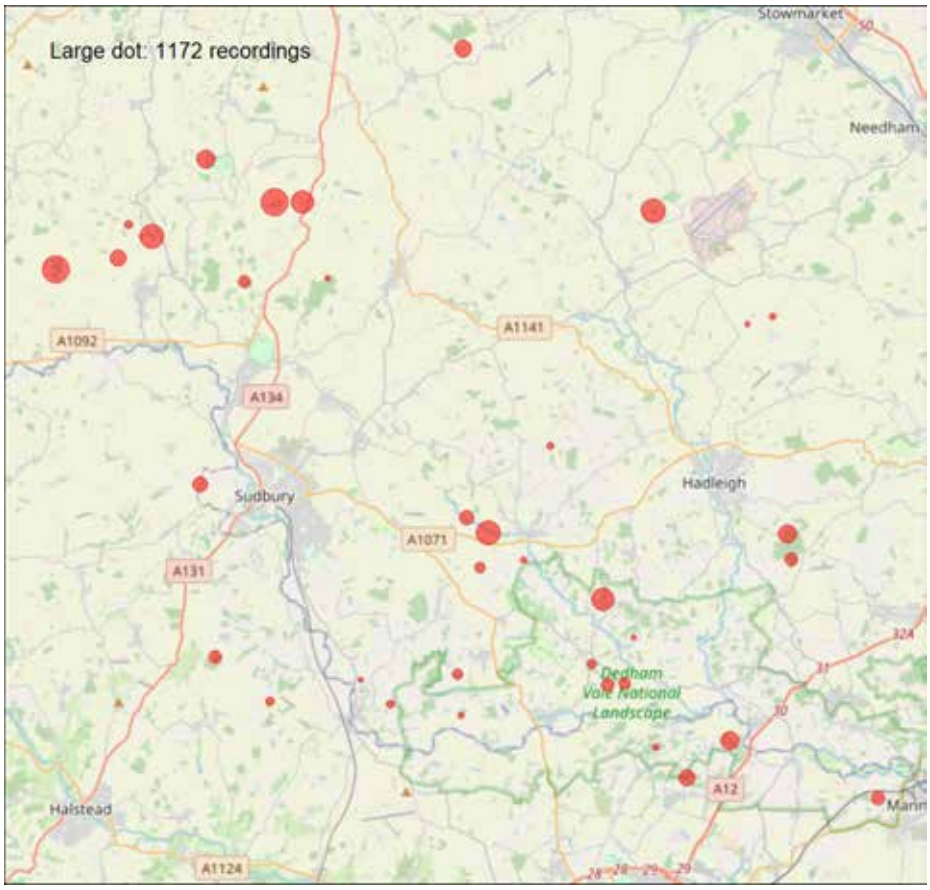
Seasonal and nightly activity



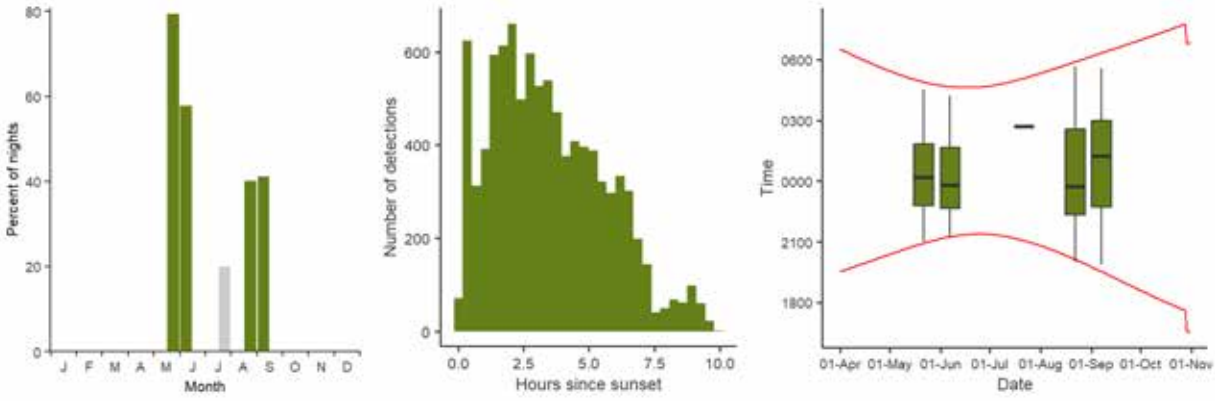
Common Pipistrelle feeding buzzes

Common Pipistrelle feeding buzzes *Pipistrellus pipistrellus* were recorded on 36 nights, from 36 locations, giving a total of 9,461 recordings.

Spatial pattern of activity



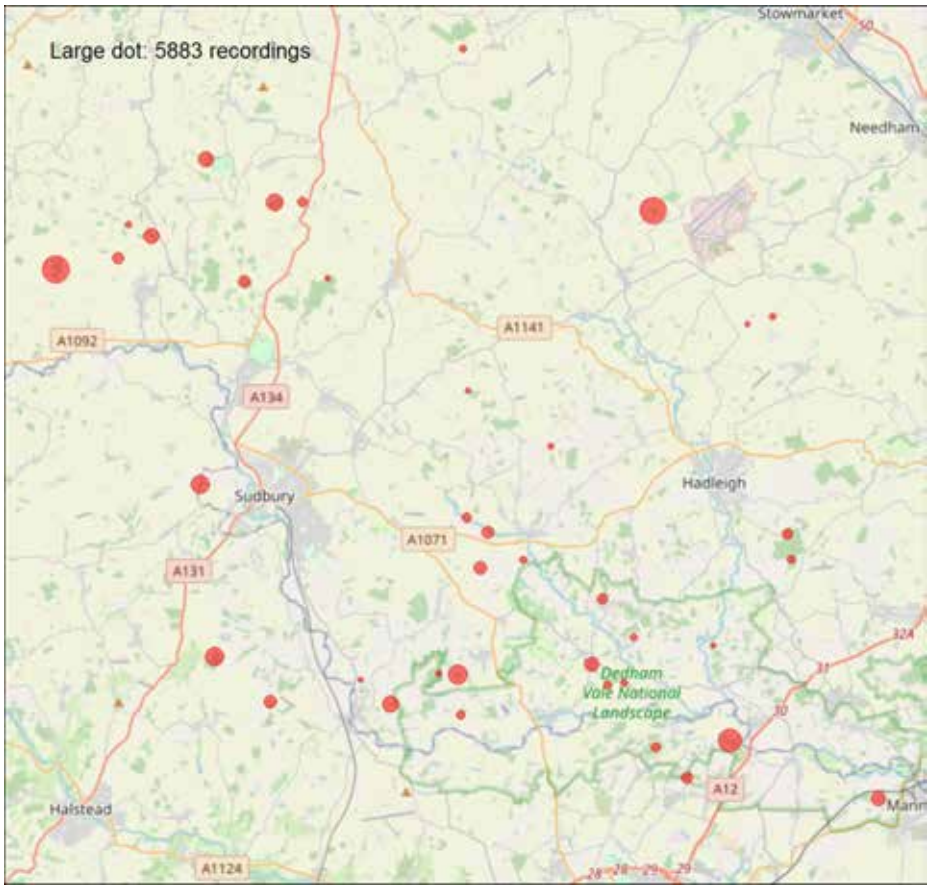
Seasonal and nightly activity



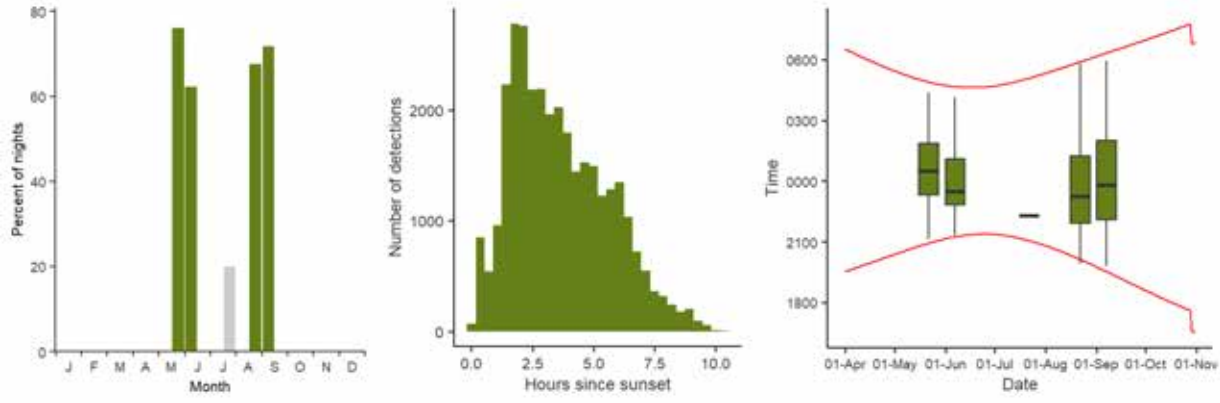
Common Pipistrelle social calls

Common Pipistrelle social calls *Pipistrellus pipistrellus* were recorded on 37 nights, from 39 locations, giving a total of 32,422 recordings.

Spatial pattern of activity



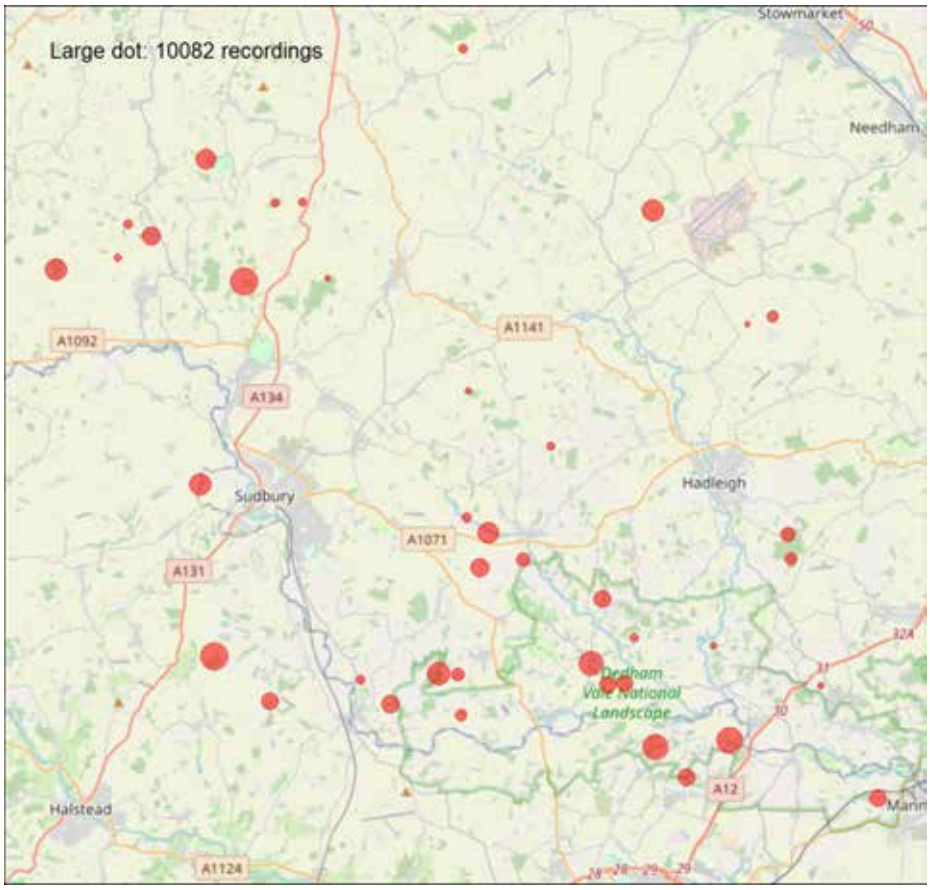
Seasonal and nightly activity



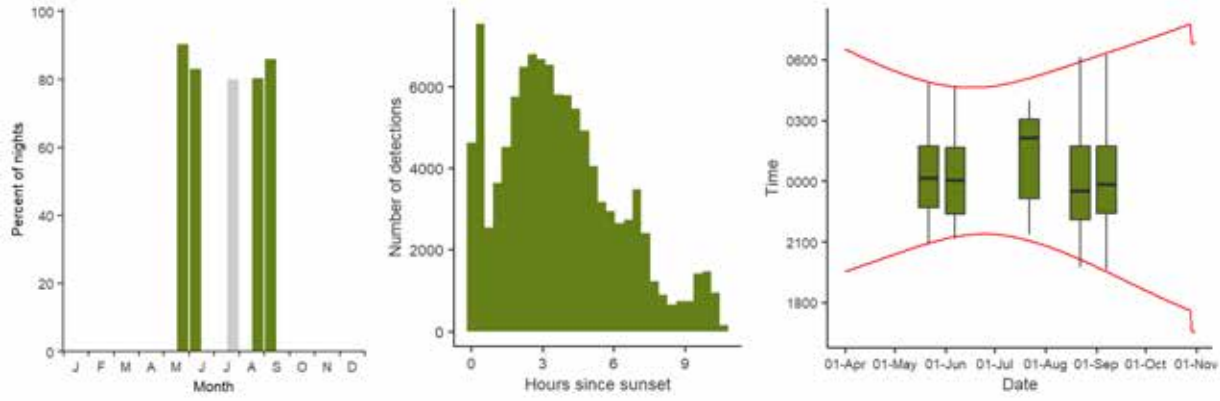
Soprano Pipistrelle echolocation calls

Soprano Pipistrelle echolocation calls *Pipistrellus pygmaeus* was recorded on 40 nights, from 40 locations, giving a total of 106,964 recordings.

Spatial pattern of activity



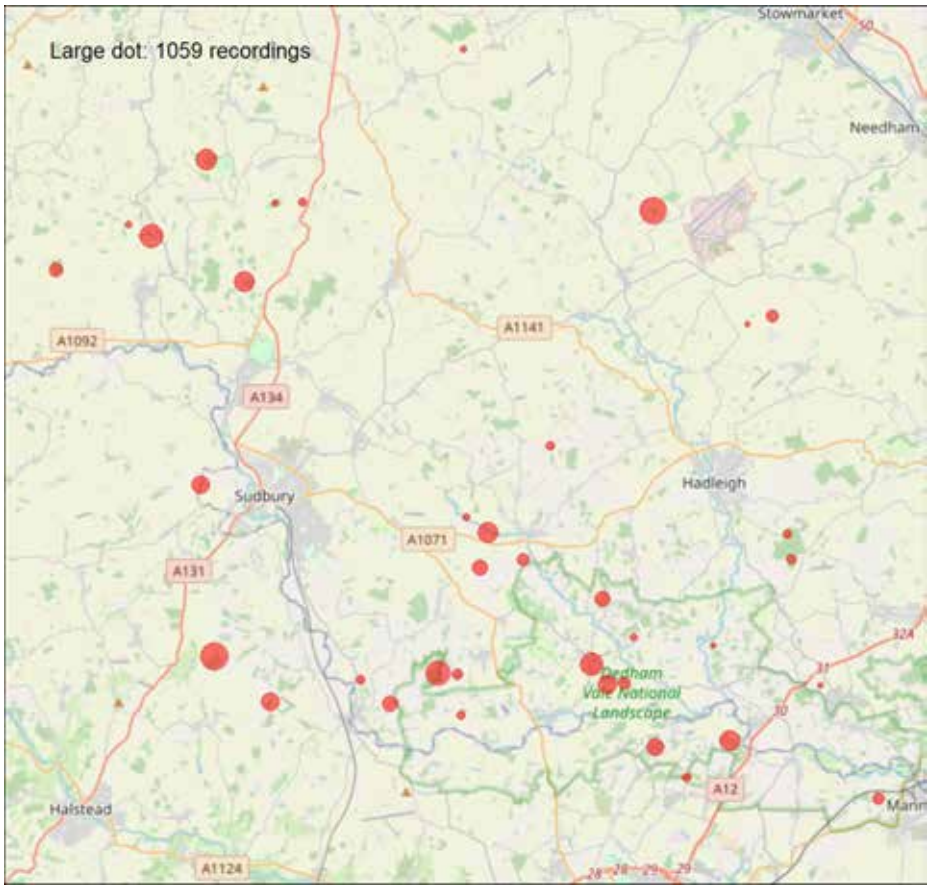
Seasonal and nightly activity



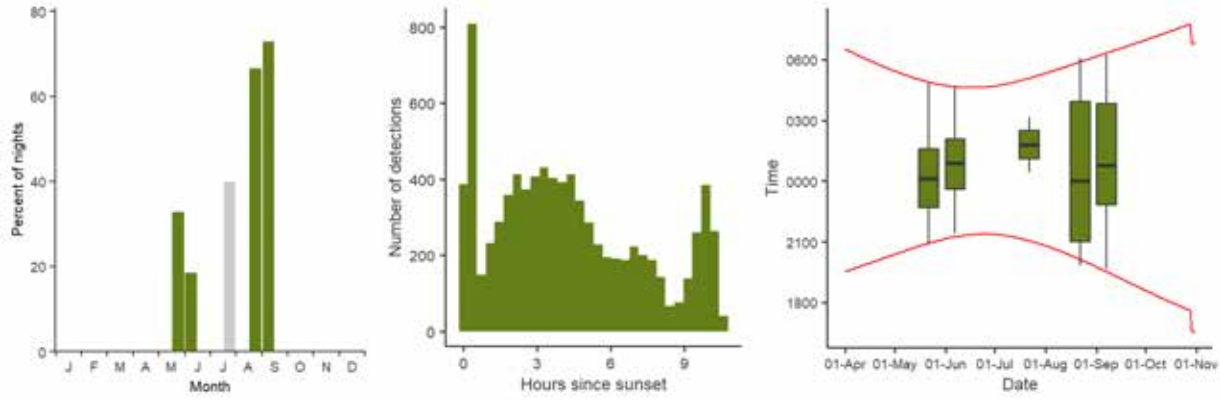
Soprano Pipistrelle feeding buzzes

Soprano Pipistrelle feeding buzzes *Pipistrellus pygmaeus* were recorded on 37 nights, from 37 locations, giving a total of 8,464 recordings.

Spatial pattern of activity



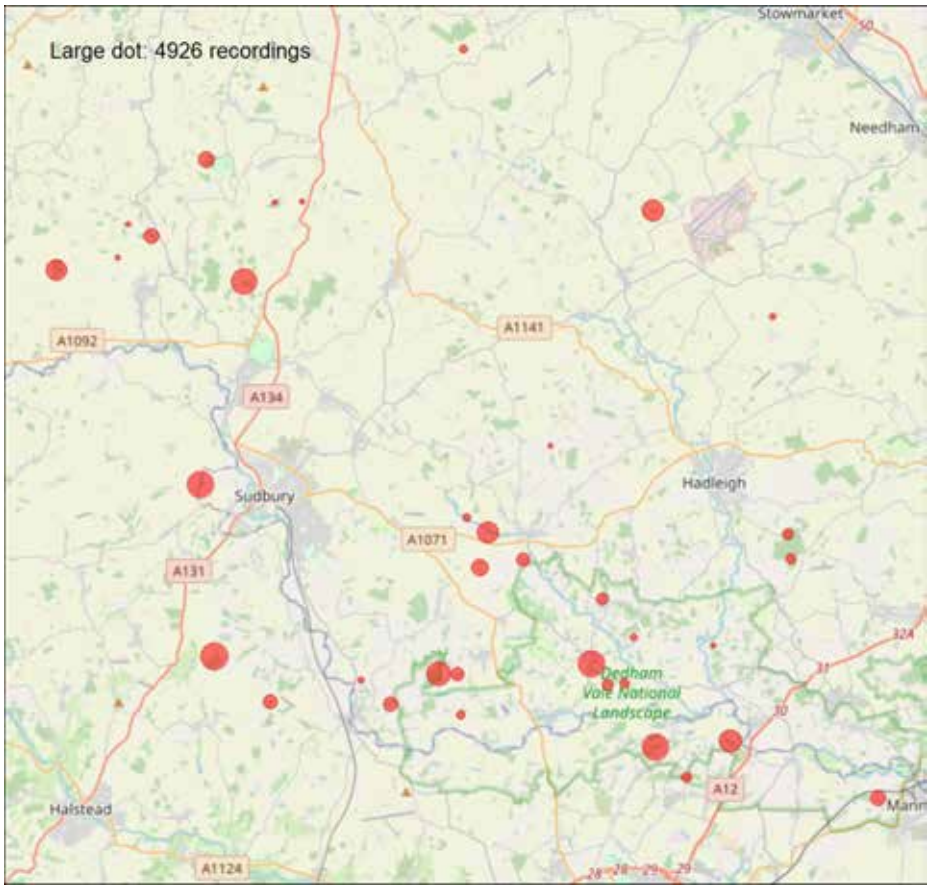
Seasonal and nightly activity



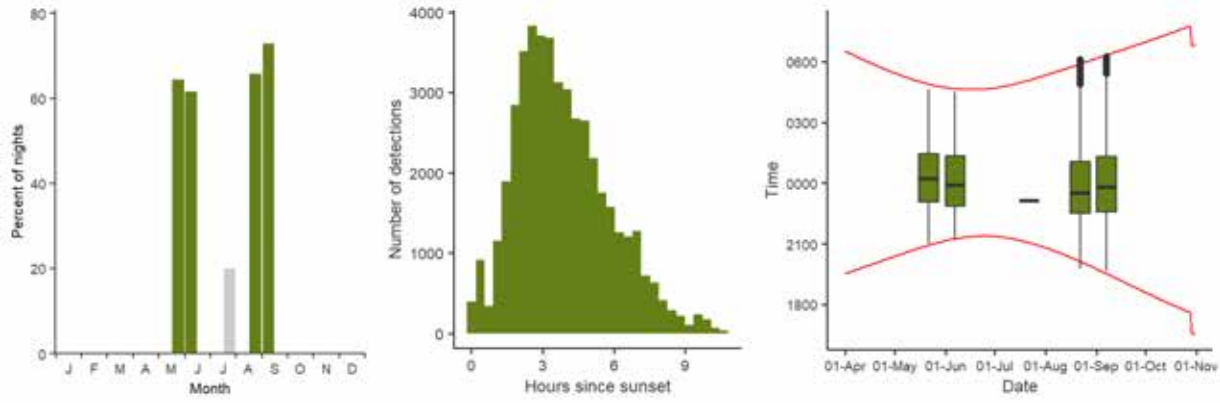
Soprano Pipistrelle social calls

Soprano Pipistrelle social calls *Pipistrellus pygmaeus* were recorded on 37 nights, from 36 locations, giving a total of 45,869 recordings.

Spatial pattern of activity



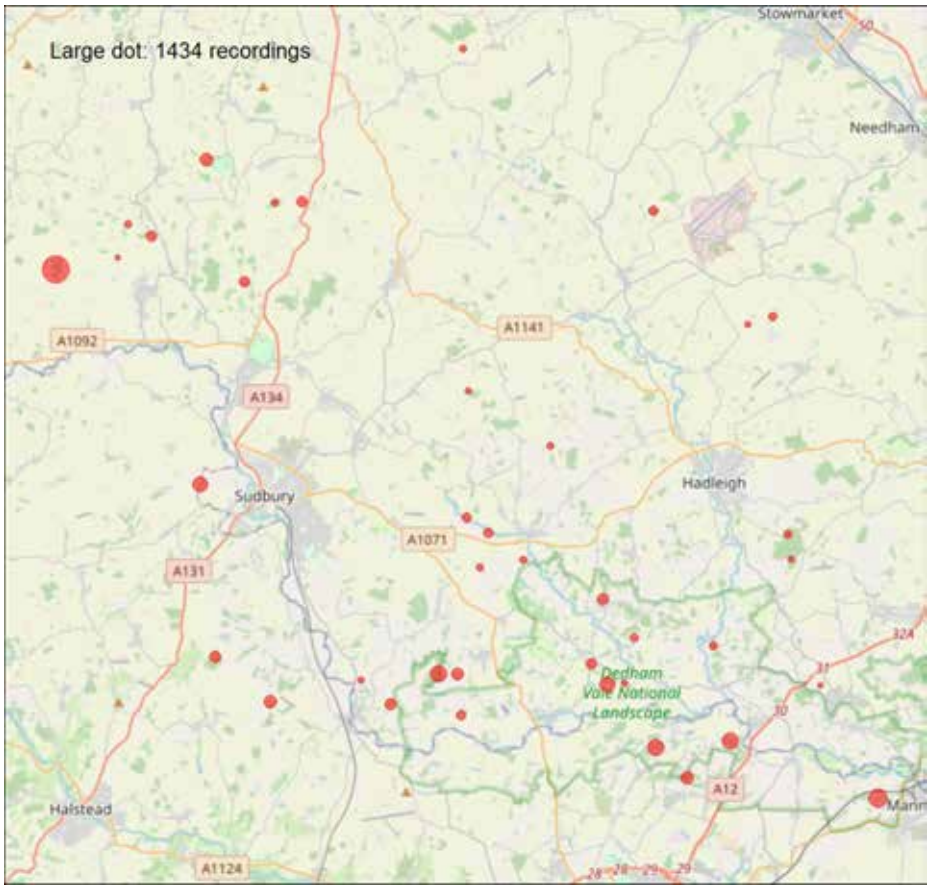
Seasonal and nightly activity



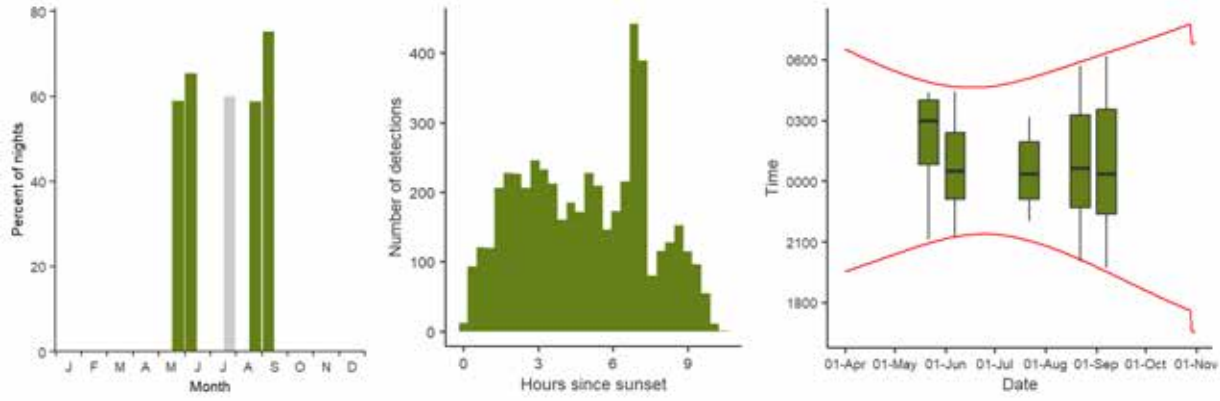
Brown Long-eared Bat echolocation calls

Brown Long-eared Bat echolocation calls *Plecotus auritus* was recorded on 37 nights, from 39 locations, giving a total of 4,972 recordings.

Spatial pattern of activity



Seasonal and nightly activity

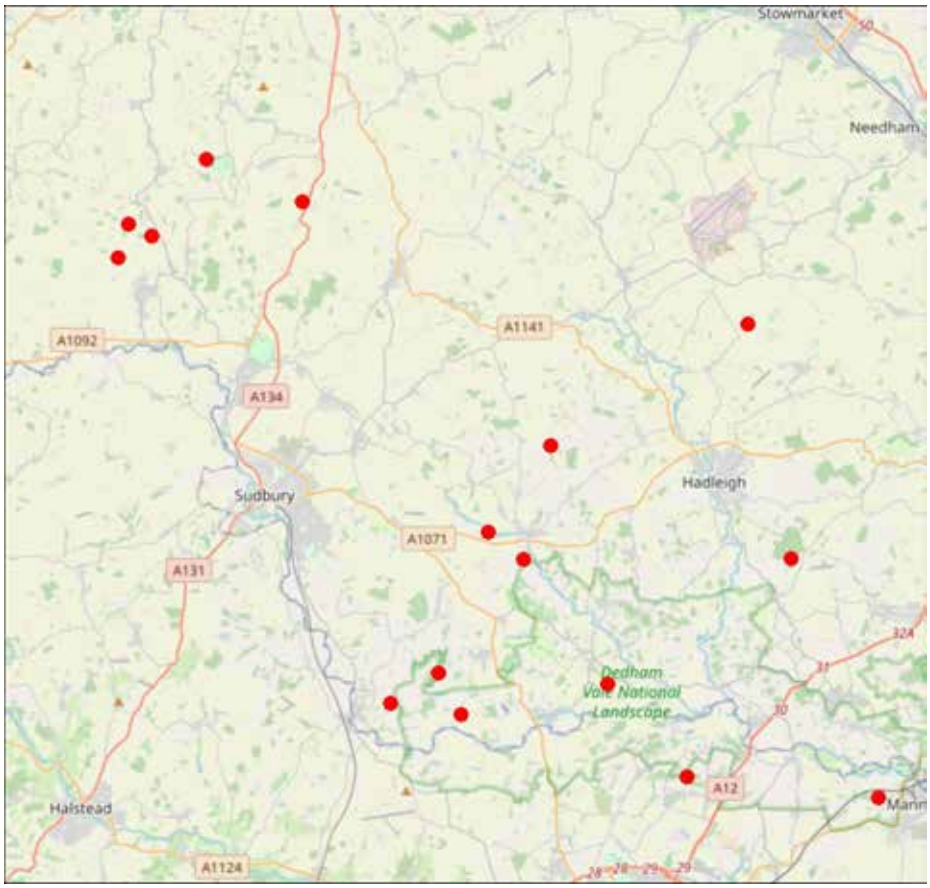


4.3.4 Bird species

Blackbird

Blackbird *Turdus merula* was recorded from 16 locations.

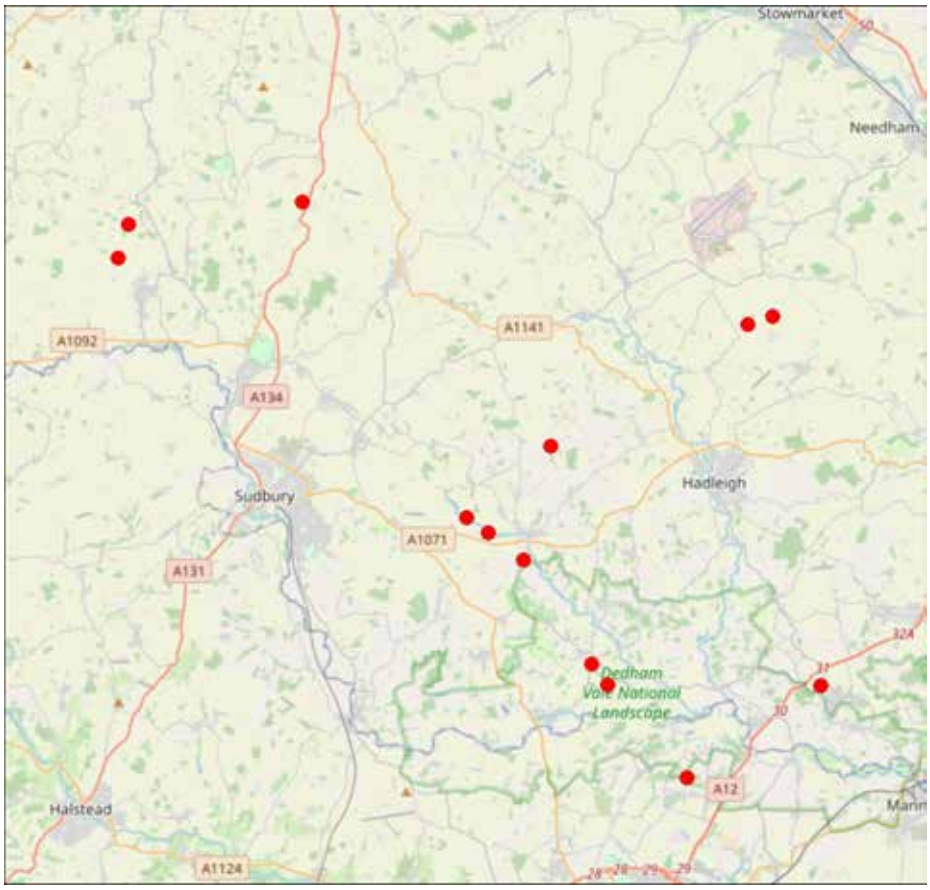
Spatial pattern of detections



Blackcap

Blackcap *Sylvia atricapilla* was recorded from 13 locations.

Spatial pattern of detections



Black-headed Gull

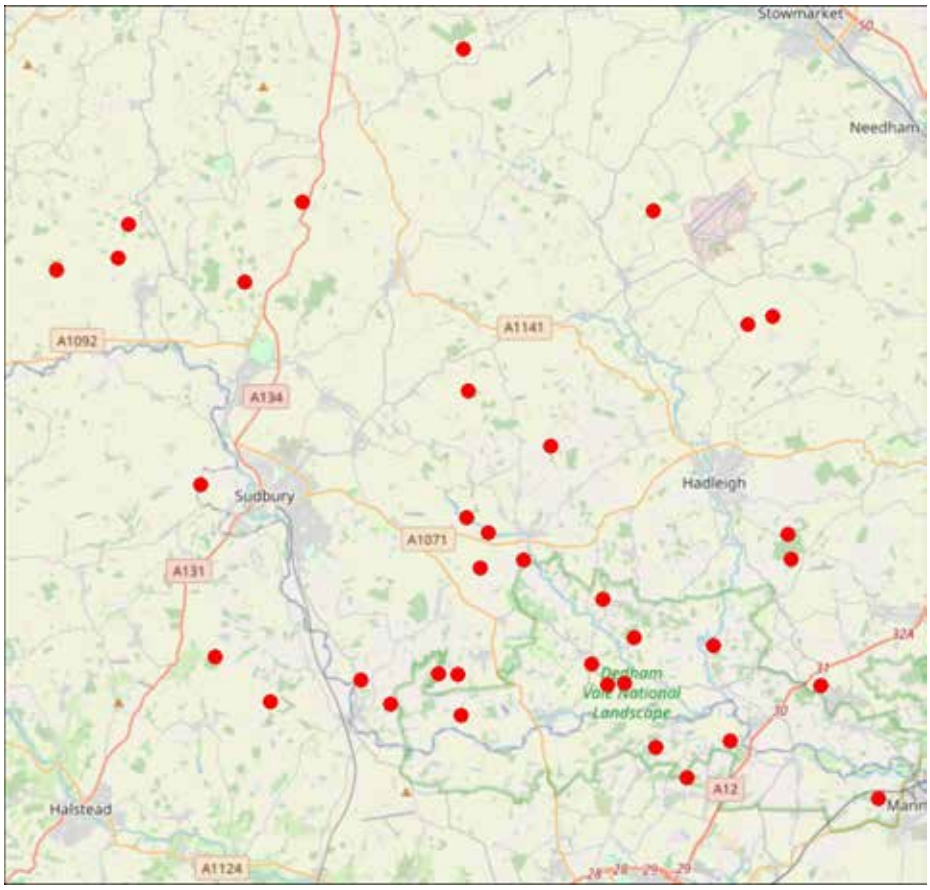
Black-headed Gull *Chroicocephalus ridibundus* was recorded from one location.

Spatial pattern of detections

Blue Tit

Blue Tit *Cyanistes caeruleus* was recorded from 36 locations.

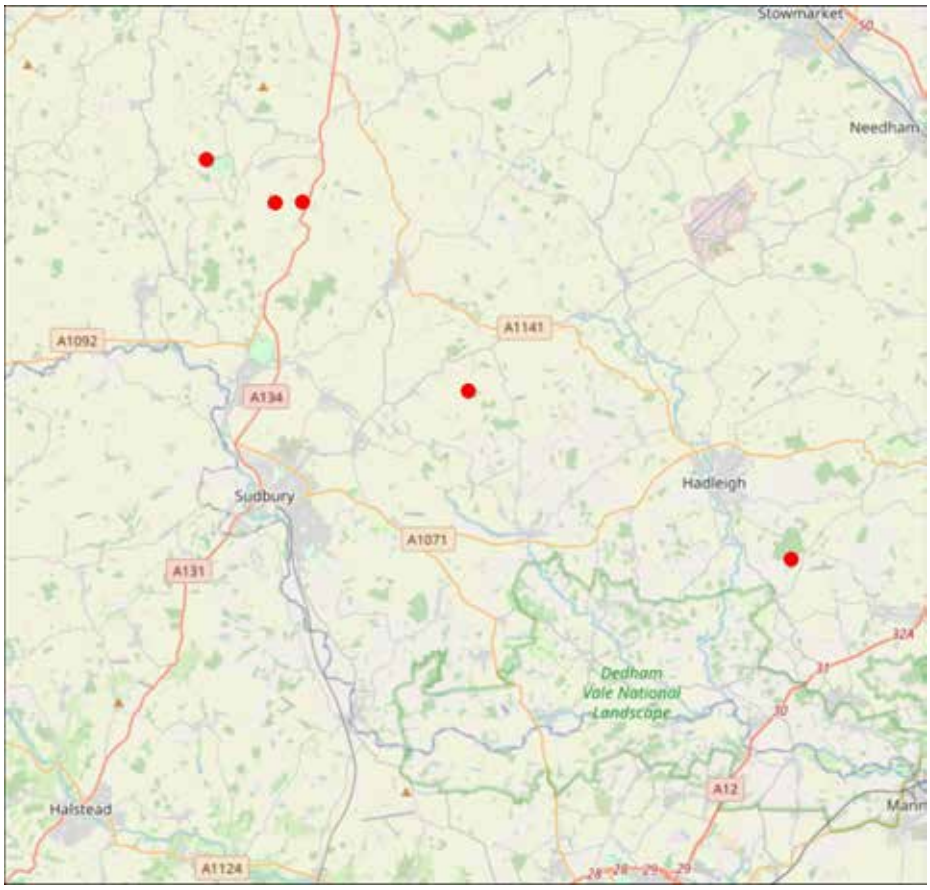
Spatial pattern of detections



Bullfinch

Bullfinch *Pyrrhula pyrrhula* was recorded from five locations.

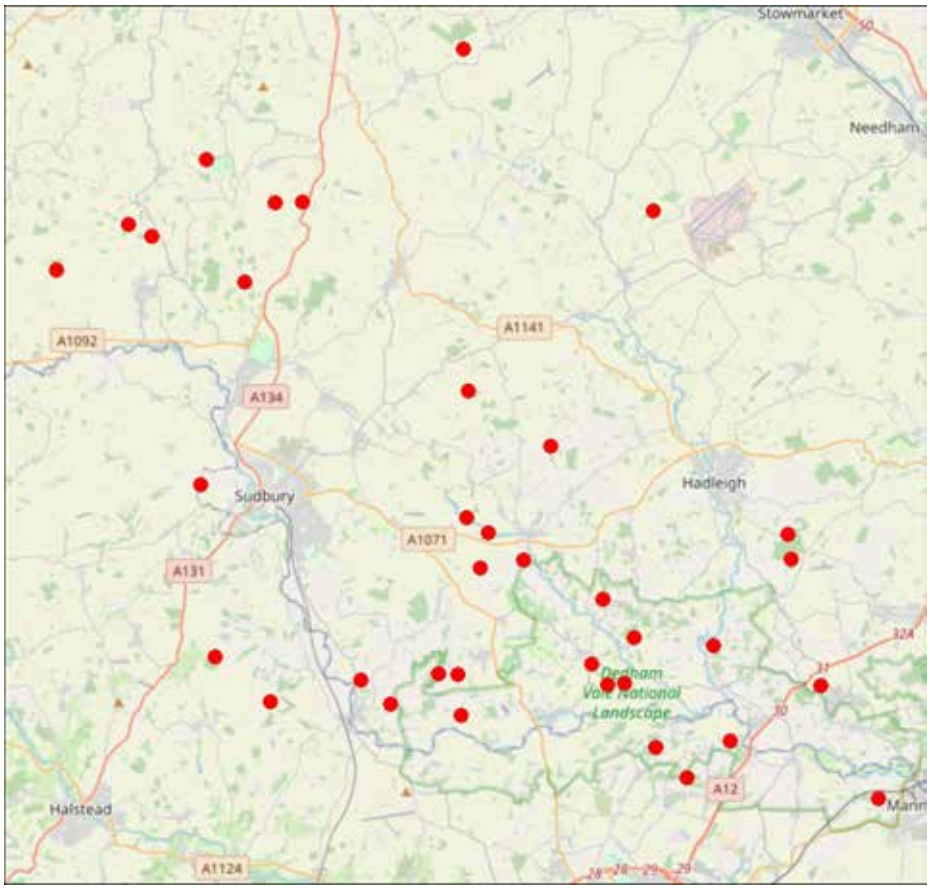
Spatial pattern of detections



Buzzard

Buzzard *Buteo buteo* was recorded from 36 locations.

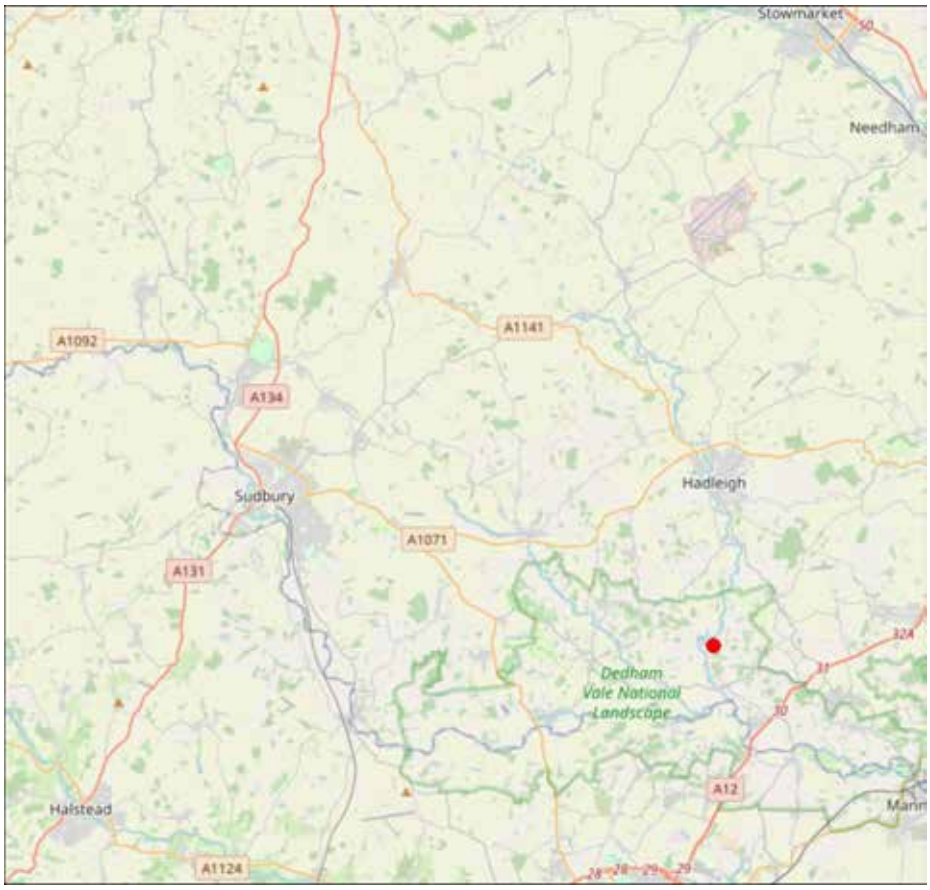
Spatial pattern of detections



Canada Goose

Canada Goose *Branta canadensis* was recorded from one location.

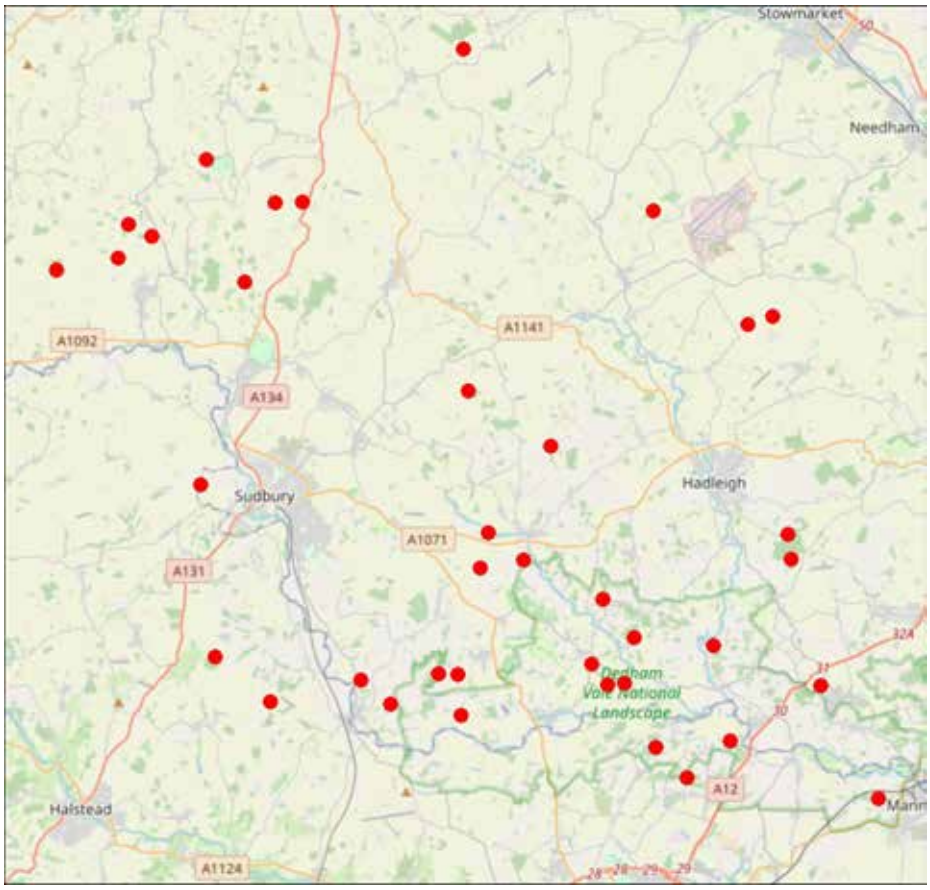
Spatial pattern of detections



Carrion Crow

Carrion Crow *Corvus corone* was recorded from 38 locations.

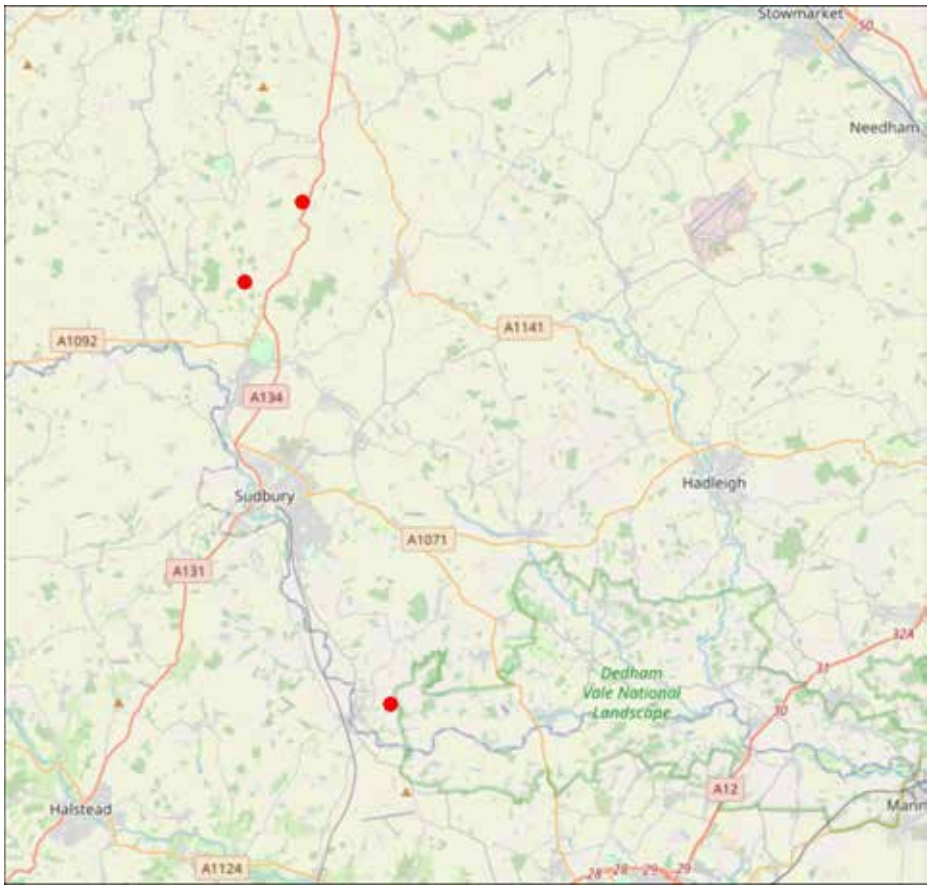
Spatial pattern of detections



Chaffinch

Chaffinch *Fringilla coelebs* was recorded from three locations.

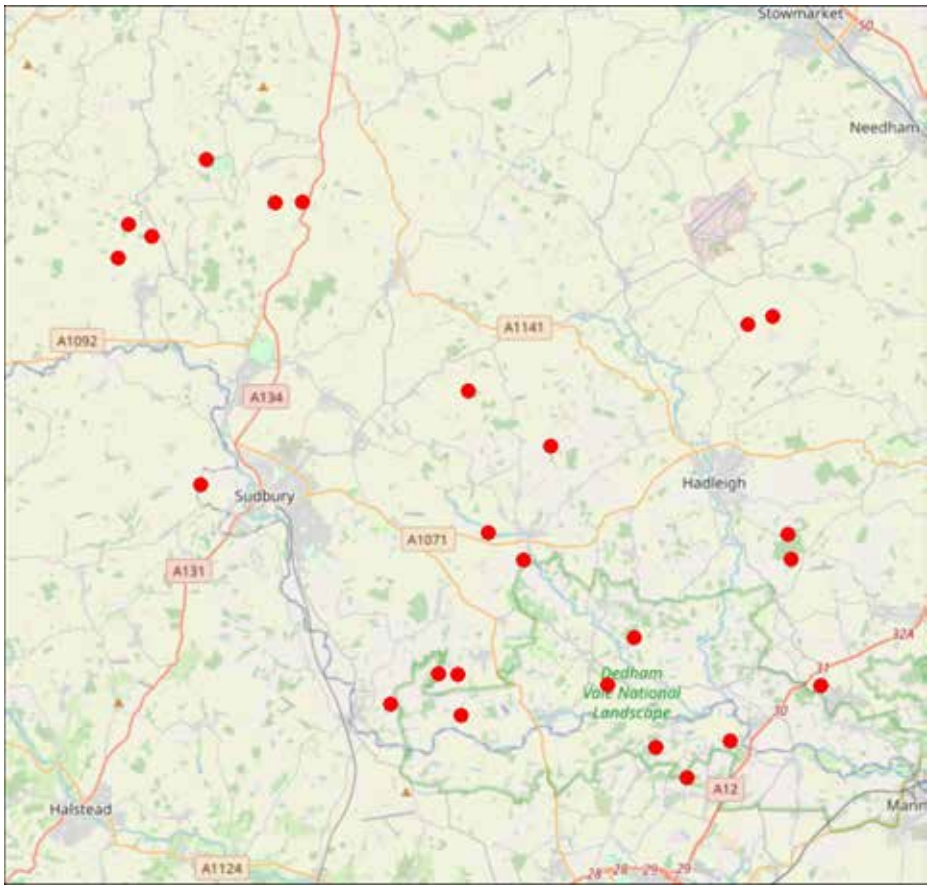
Spatial pattern of detections



Chiffchaff

Chiffchaff *Phylloscopus collybita* was recorded from 25 locations.

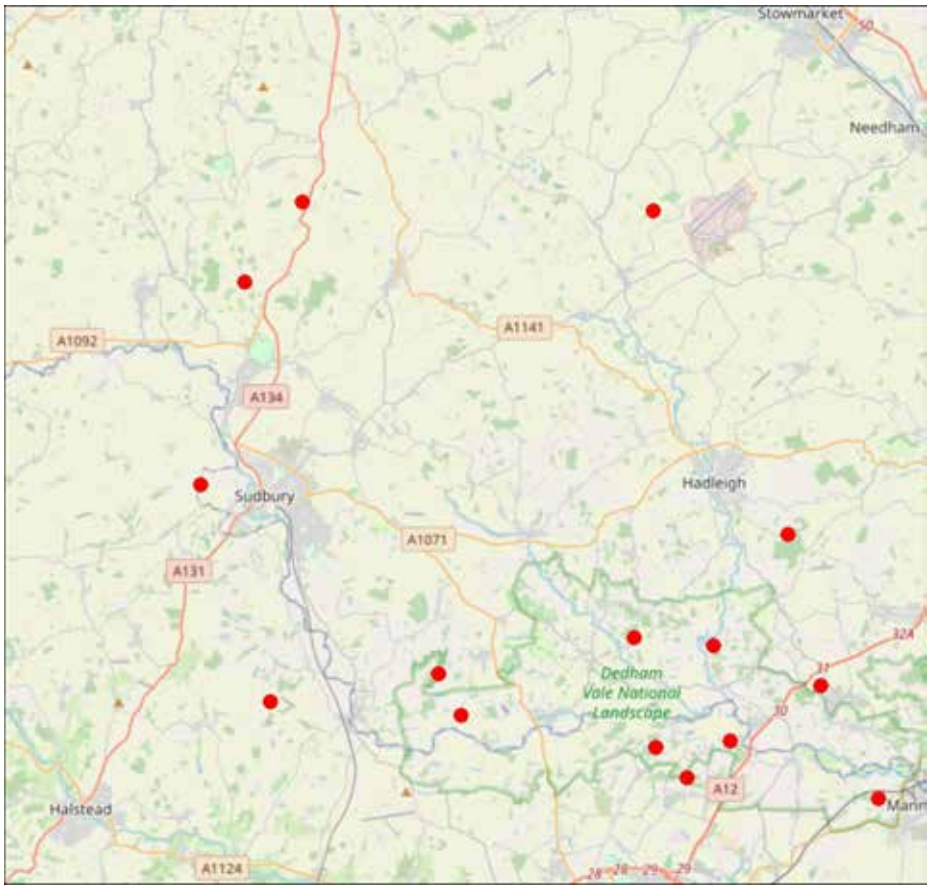
Spatial pattern of detections



Coal Tit

Coal Tit *Periparus ater* was recorded from 15 locations.

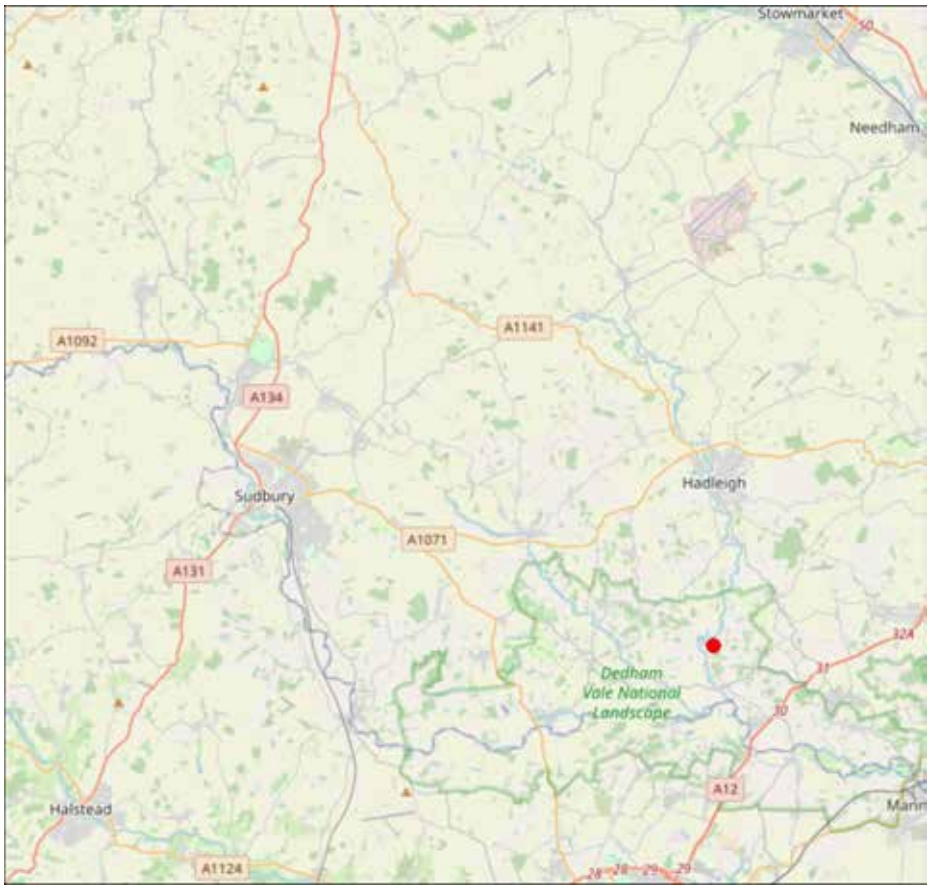
Spatial pattern of detections



Coot

Coot *Fulica atra* was recorded from one location.

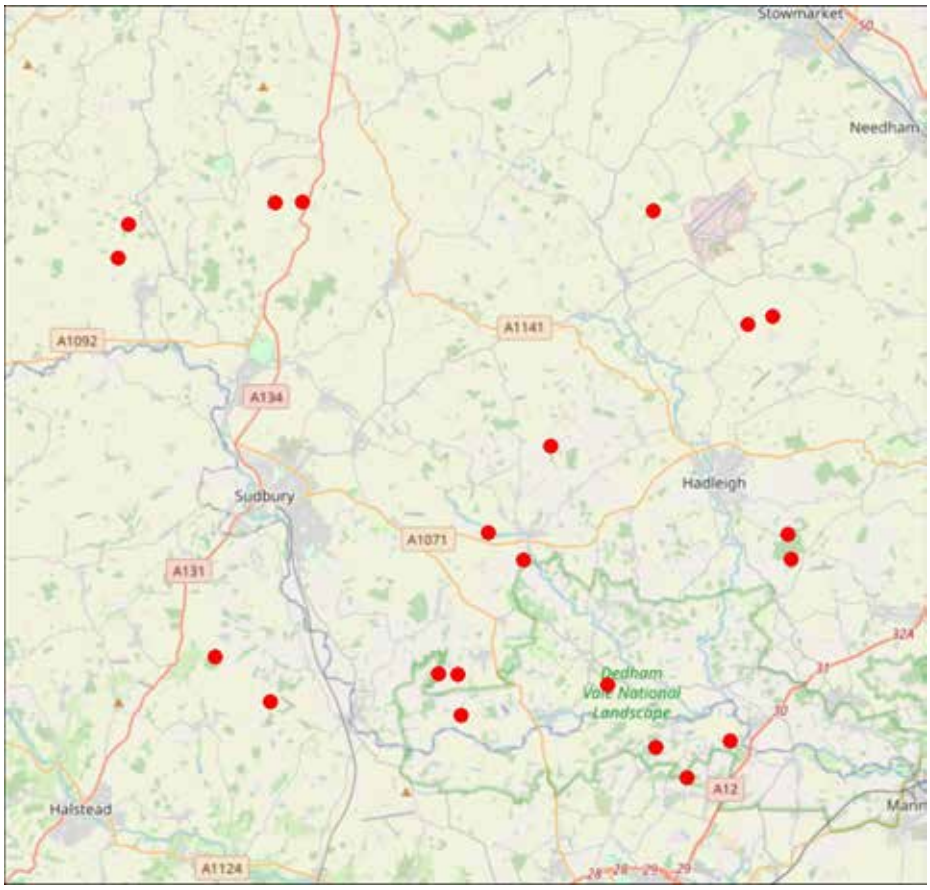
Spatial pattern of detections



Dunnock

Dunnock *Prunella modularis* was recorded from 21 locations.

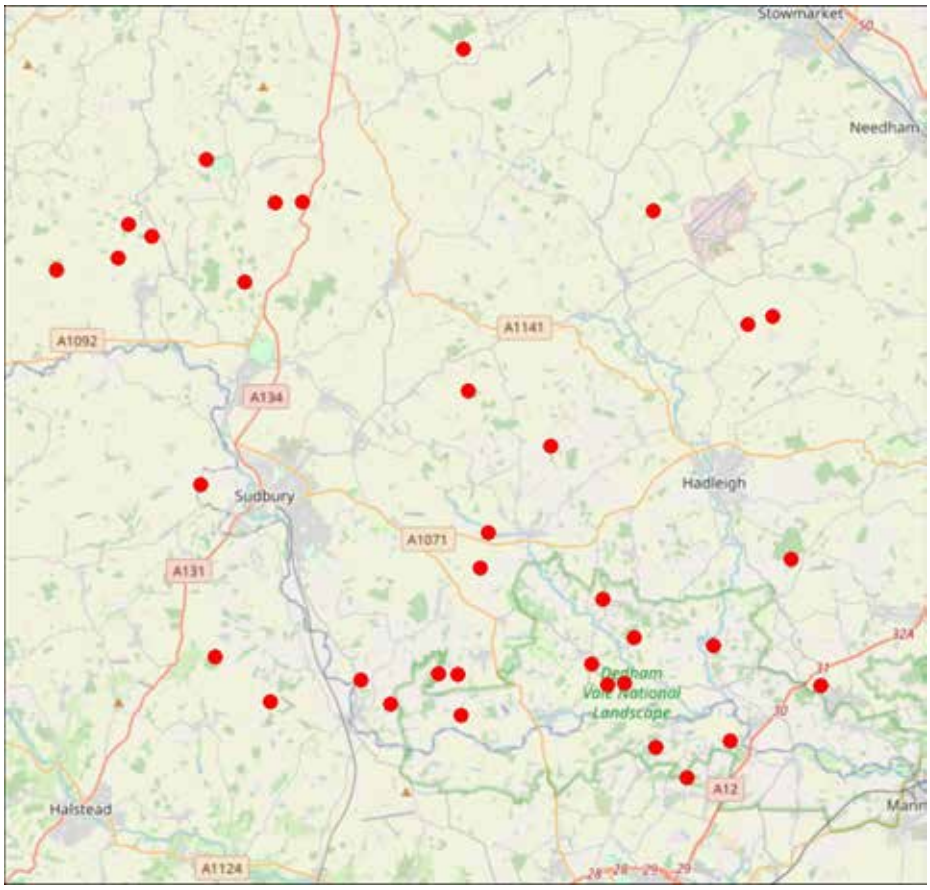
Spatial pattern of detections



Goldcrest

Goldcrest *Regulus regulus* was recorded from 35 locations.

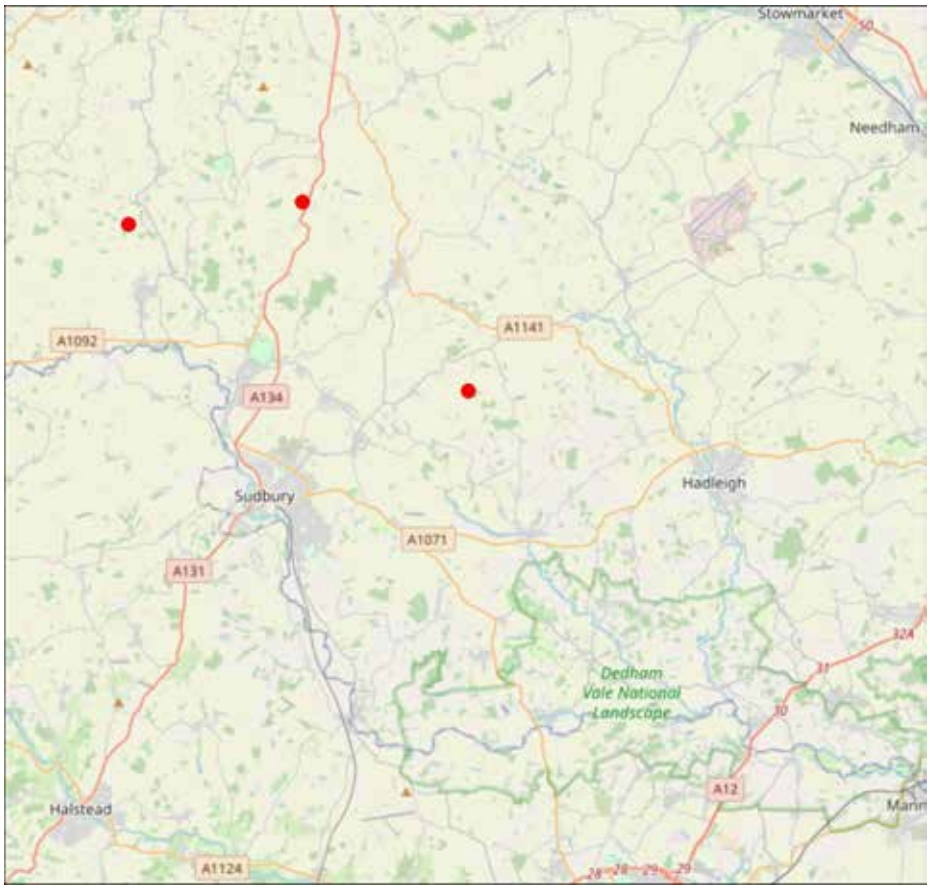
Spatial pattern of detections



Goldfinch

Goldfinch *Carduelis carduelis* was recorded from three locations.

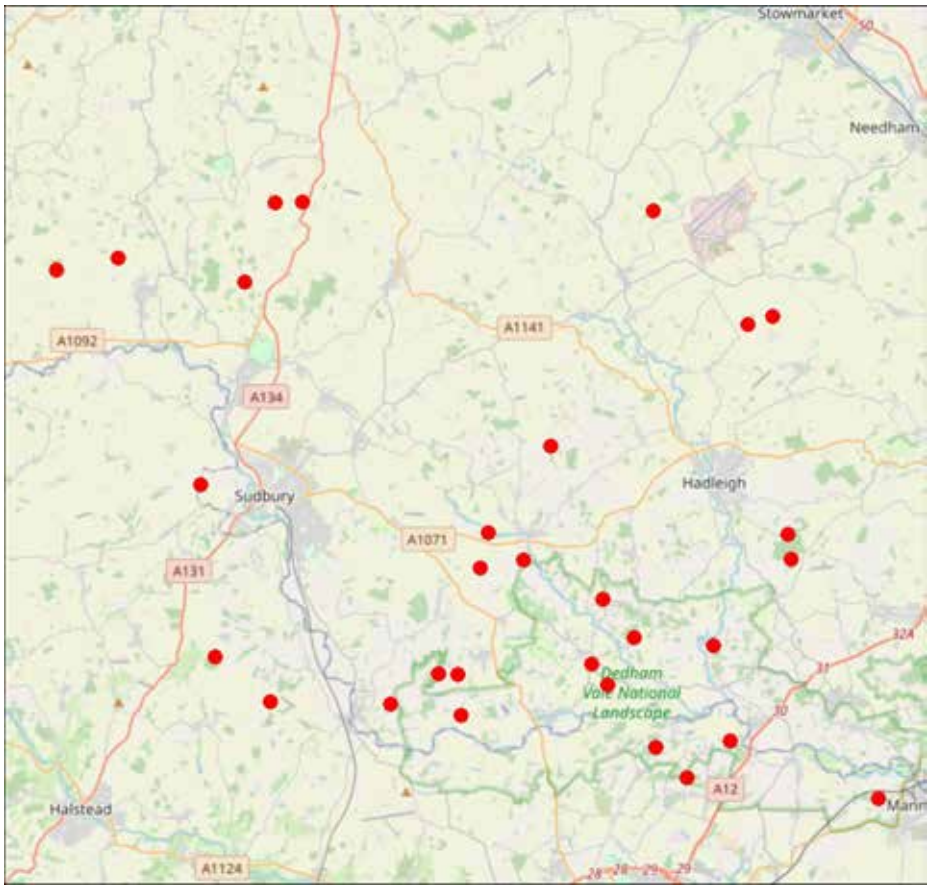
Spatial pattern of detections



Great Spotted Woodpecker

Great Spotted Woodpecker *Dendrocopos major* was recorded from 30 locations.

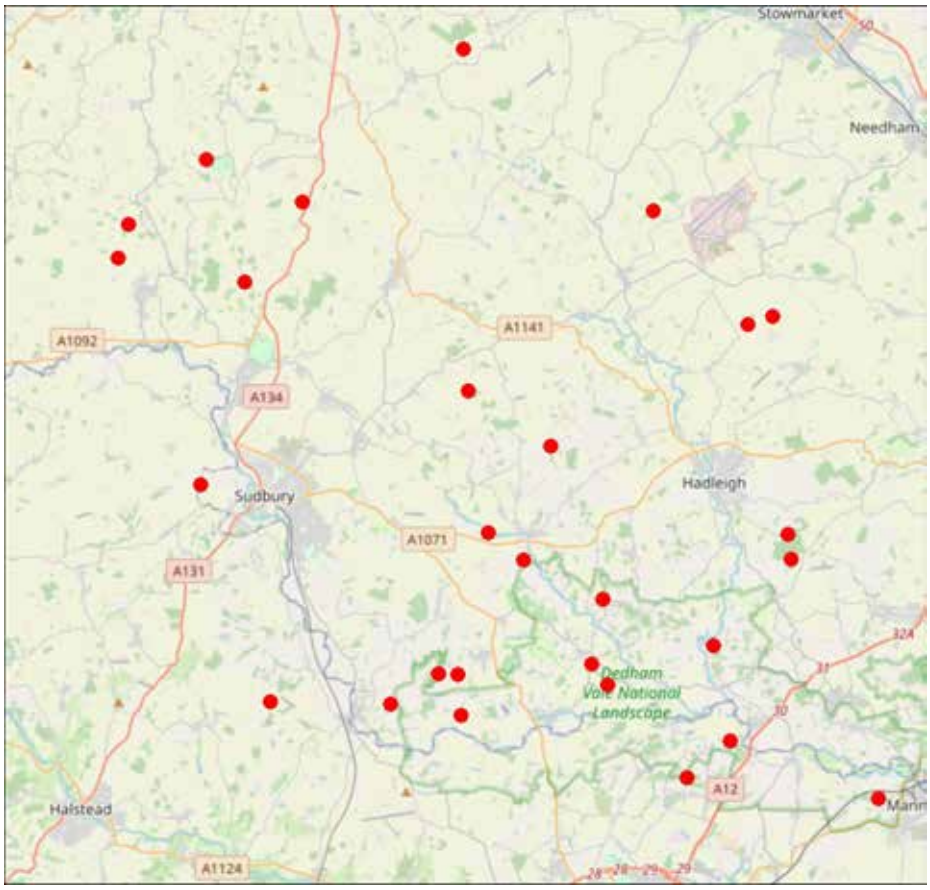
Spatial pattern of detections



Great Tit

Great Tit *Parus major* was recorded from 28 locations.

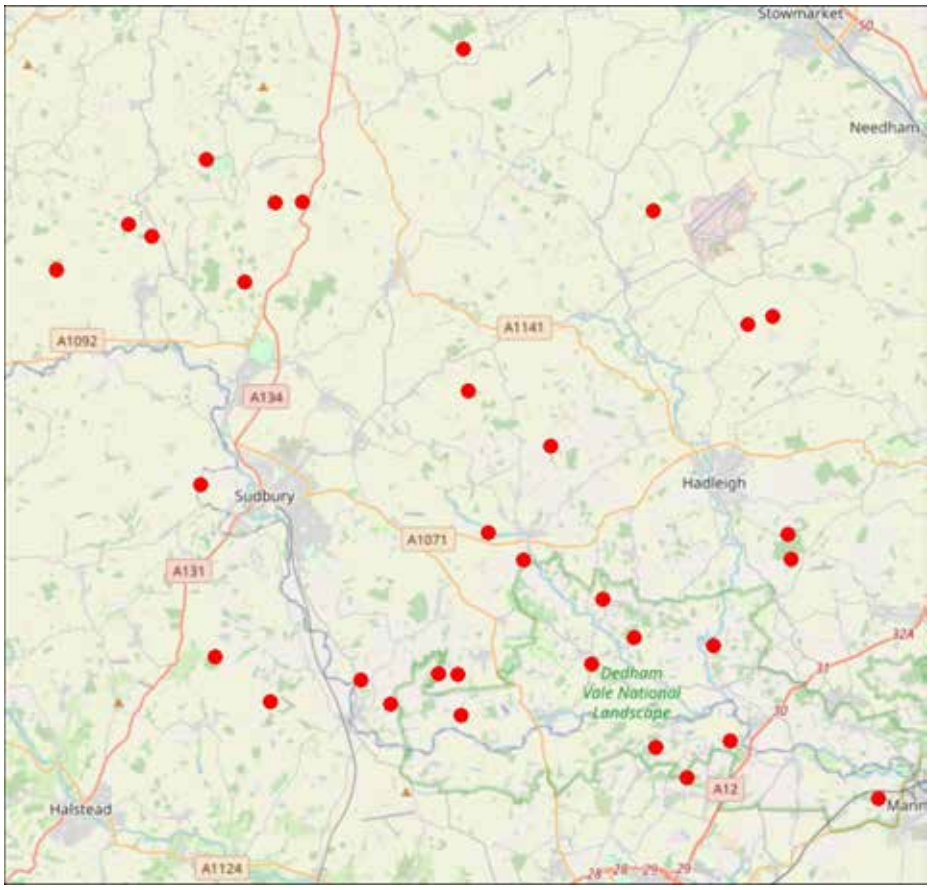
Spatial pattern of detections



Green Woodpecker

Green Woodpecker *Picus viridis* was recorded from 33 locations.

Spatial pattern of detections



Greenfinch

Greenfinch *Chloris chloris* was recorded from five locations.

Spatial pattern of detections

Grey Heron

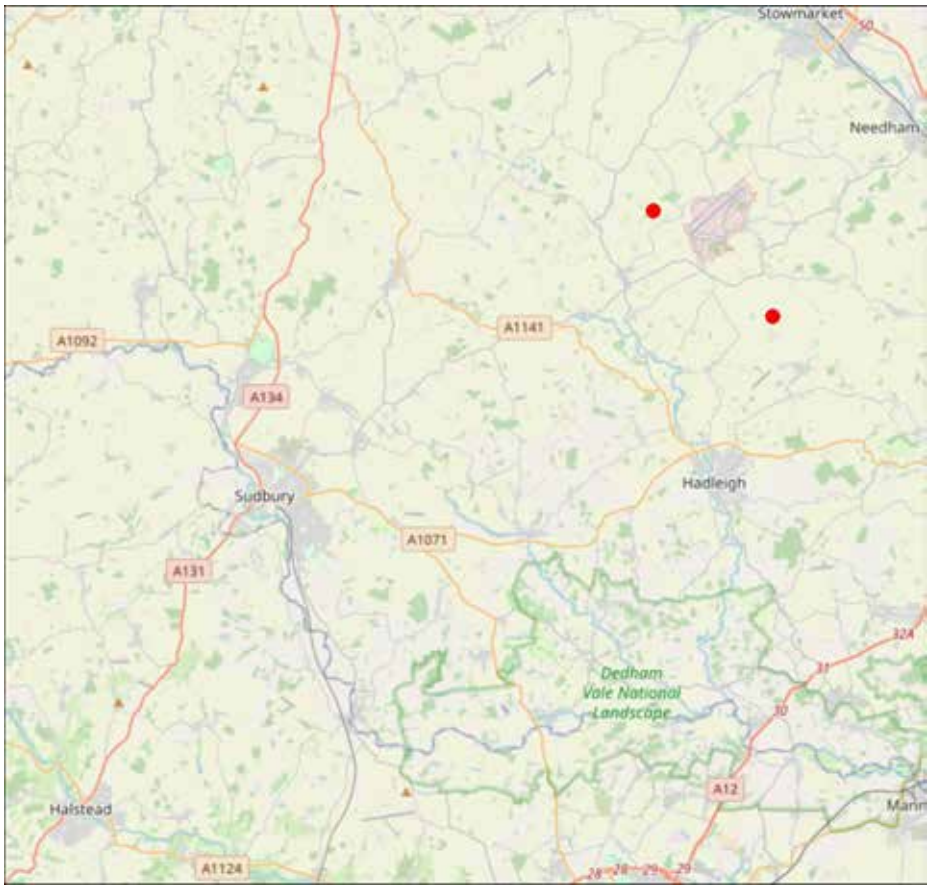
Grey Heron *Ardea cinerea* was recorded from one location.

Spatial pattern of detections

Grey Wagtail

Grey Wagtail *Motacilla cinerea* was recorded from two locations.

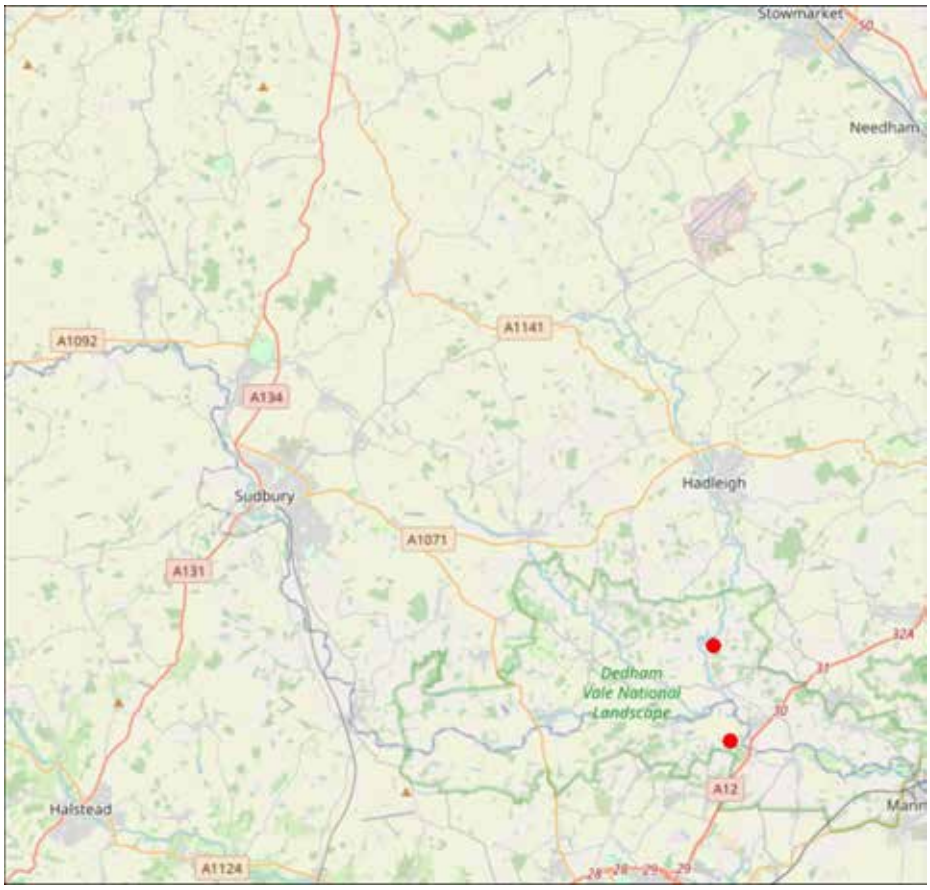
Spatial pattern of detections



Greylag Goose

Greylag Goose *Anser anser* was recorded from two locations.

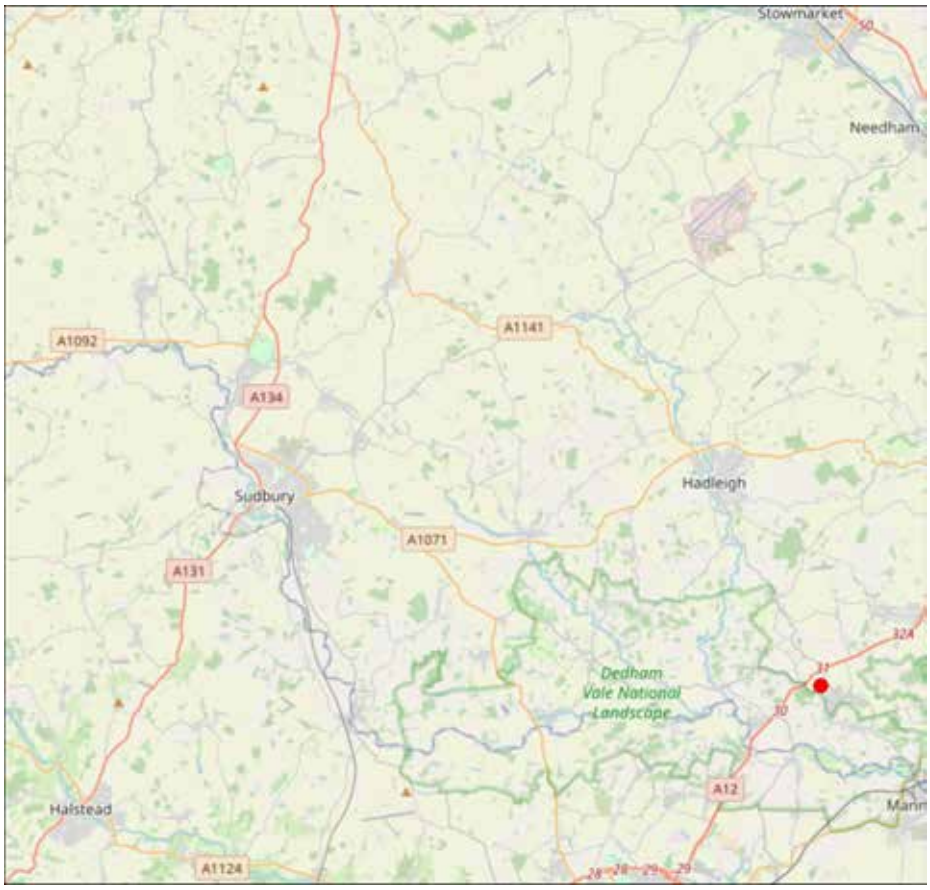
Spatial pattern of detections



Hawfinch

Hawfinch *Coccothraustes coccothraustes* was recorded from one location.

Spatial pattern of detections



Herring Gull

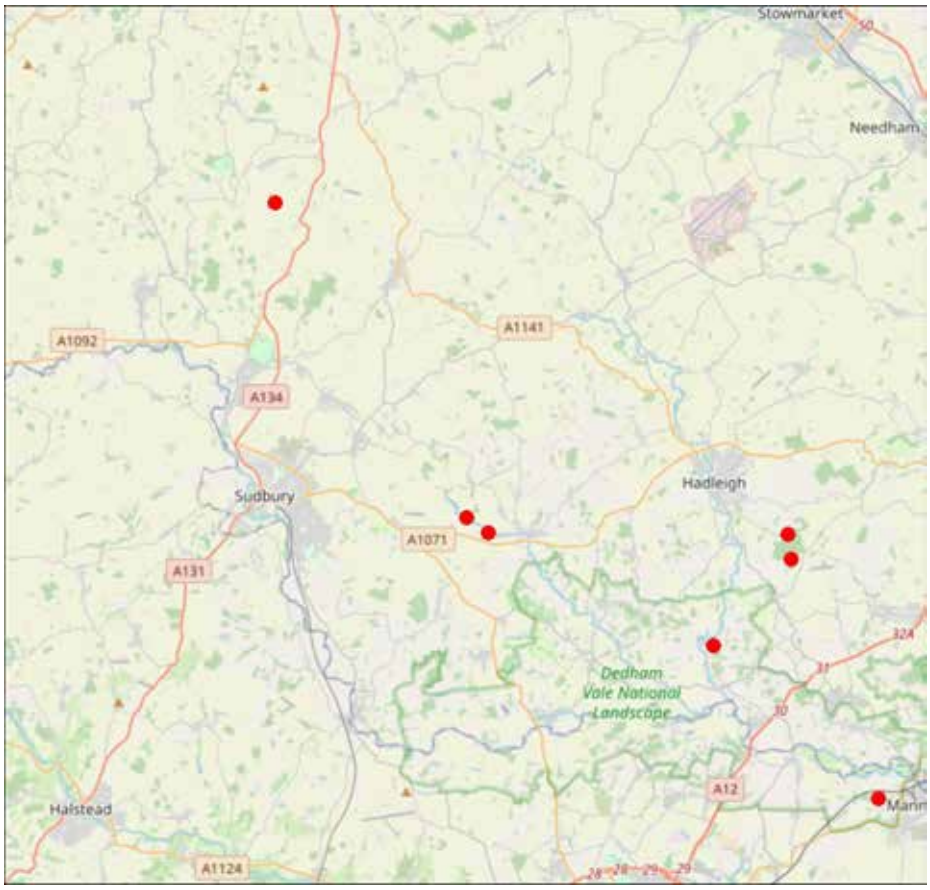
Herring Gull *Larus argentatus* was recorded from two locations.

Spatial pattern of detections

Hobby

Hobby *Falco subbuteo* was recorded from seven locations.

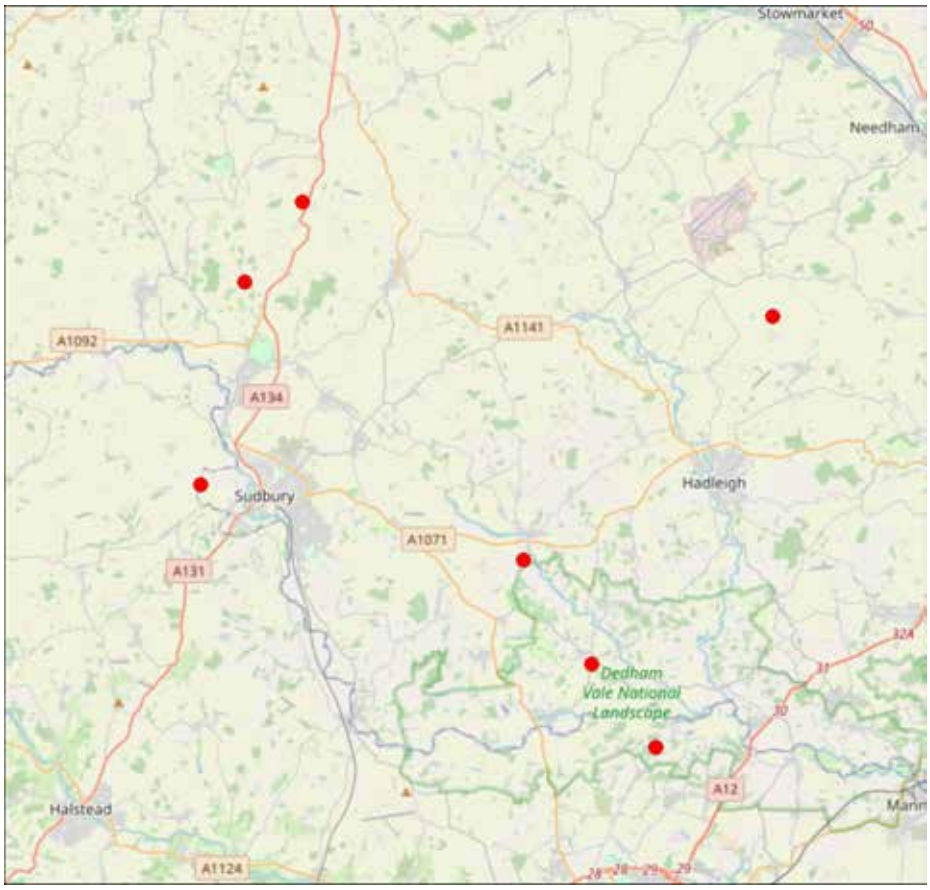
Spatial pattern of detections



House Martin

House Martin *Delichon urbicum* was recorded from seven locations.

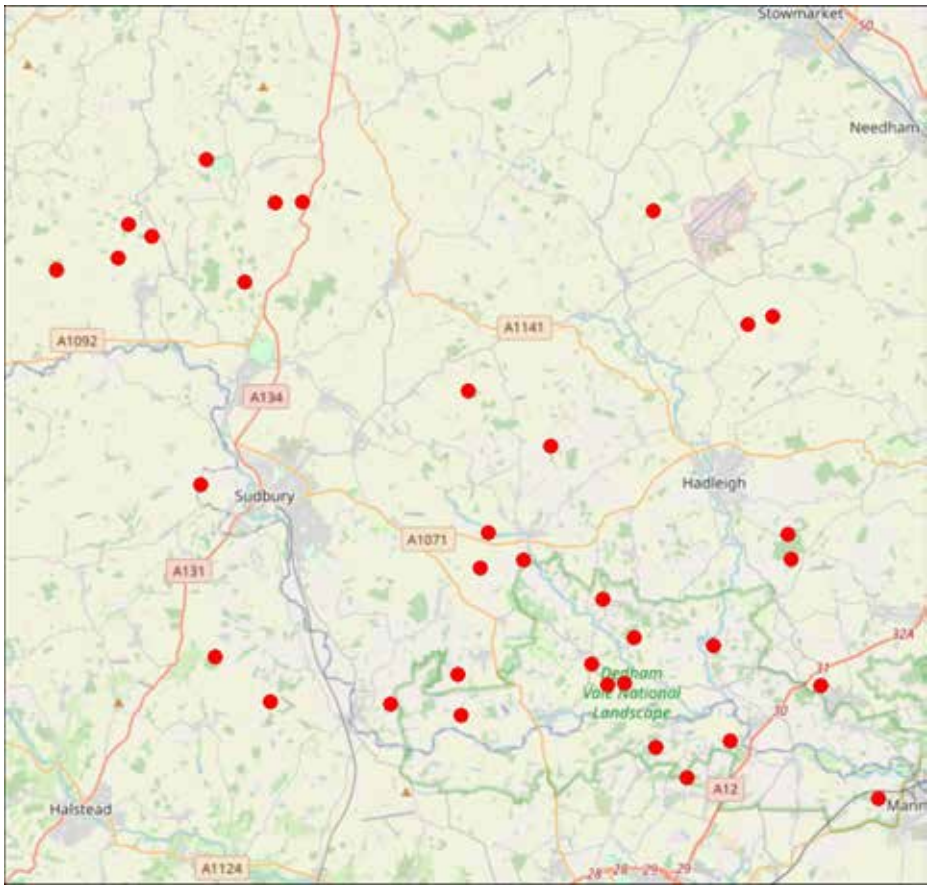
Spatial pattern of detections



Jackdaw

Jackdaw *Coloeus monedula* was recorded from 35 locations.

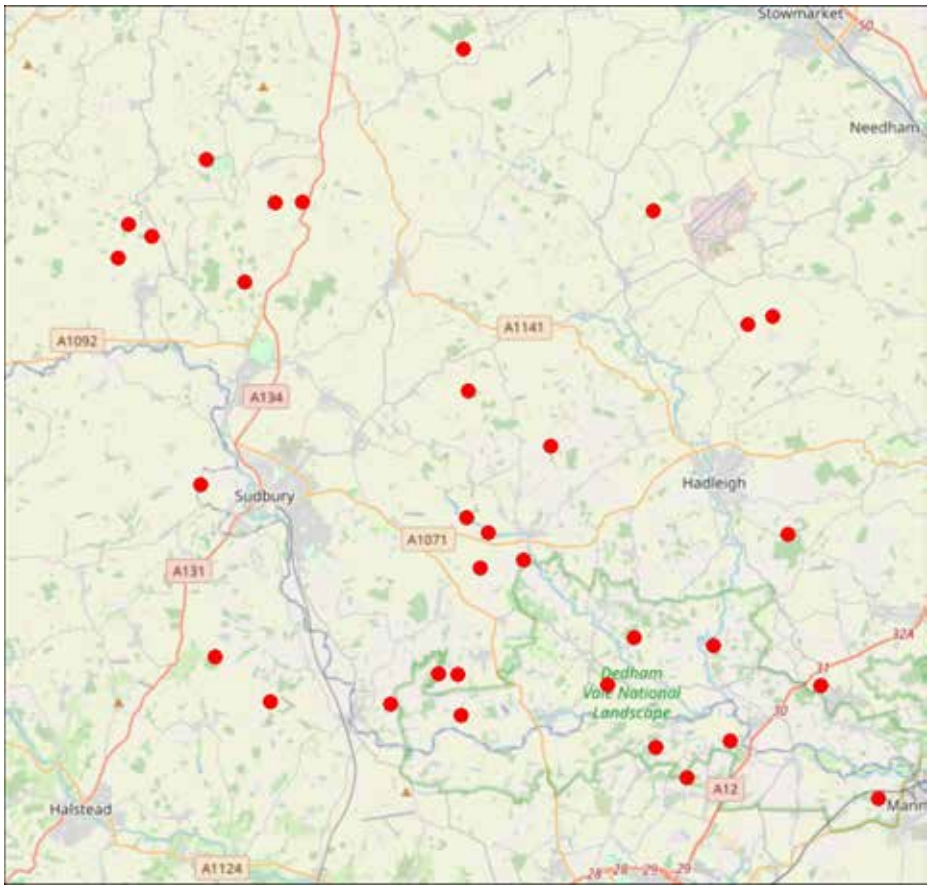
Spatial pattern of detections



Jay

Jay *Garrulus glandarius* was recorded from 33 locations.

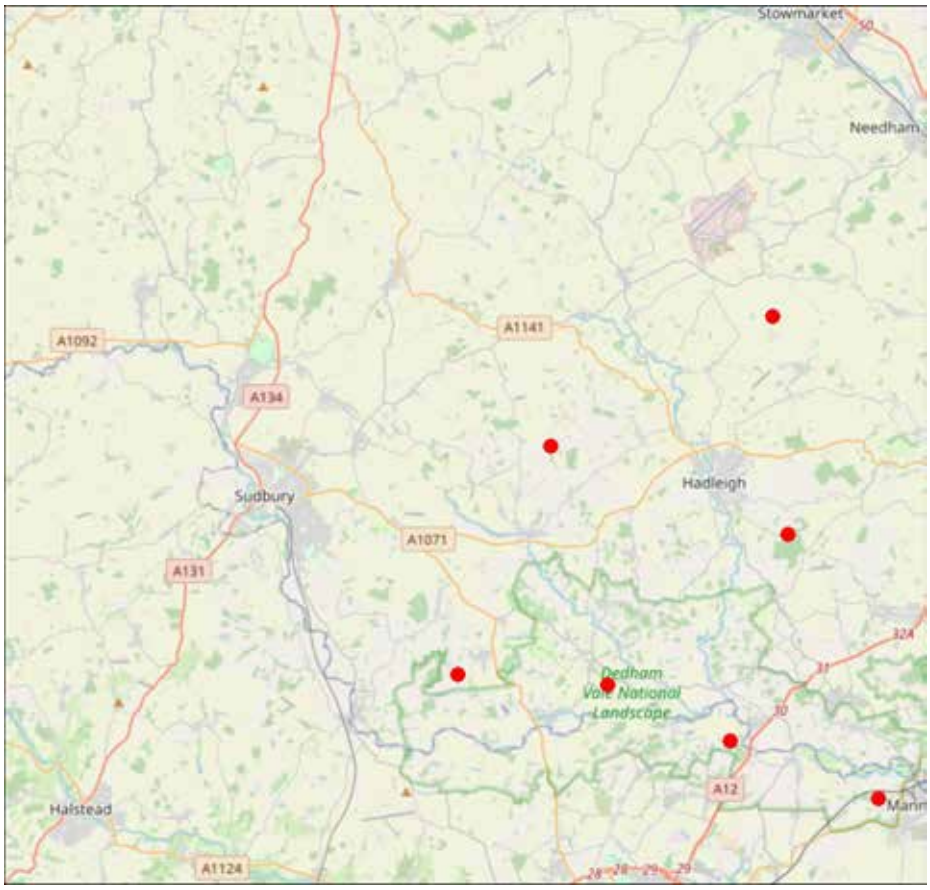
Spatial pattern of detections



Kestrel

Kestrel *Falco tinnunculus* was recorded from seven locations.

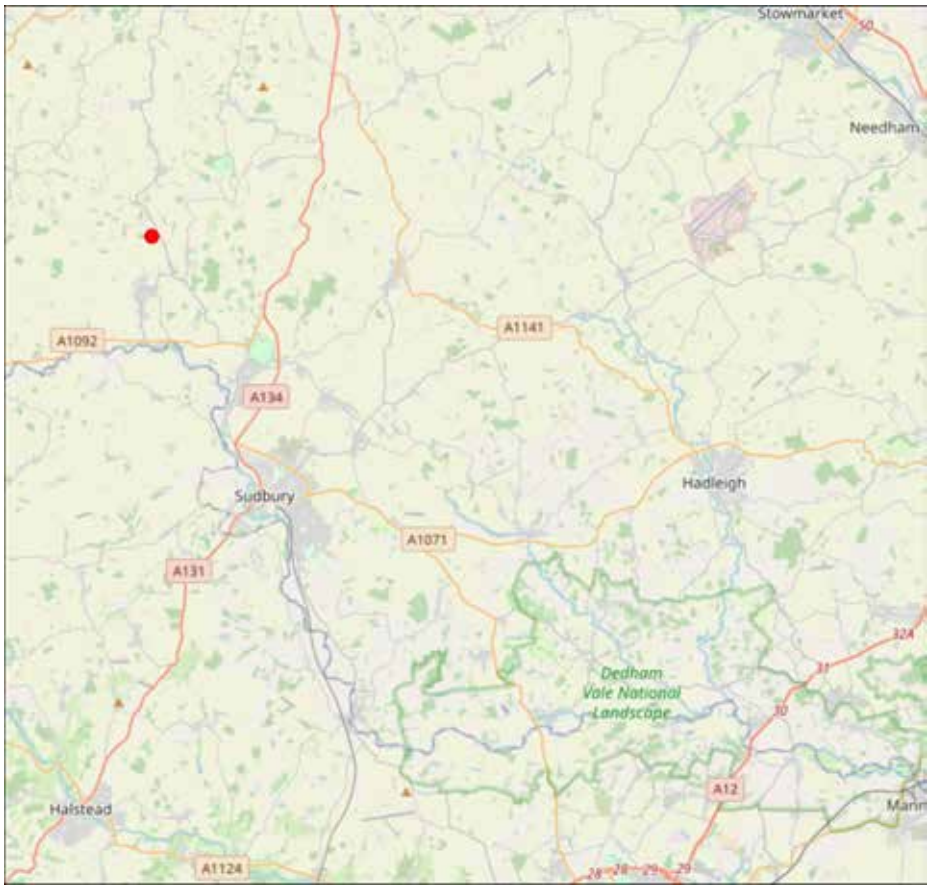
Spatial pattern of detections



Kingfisher

Kingfisher *Alcedo atthis* was recorded from one location.

Spatial pattern of detections



Linnet

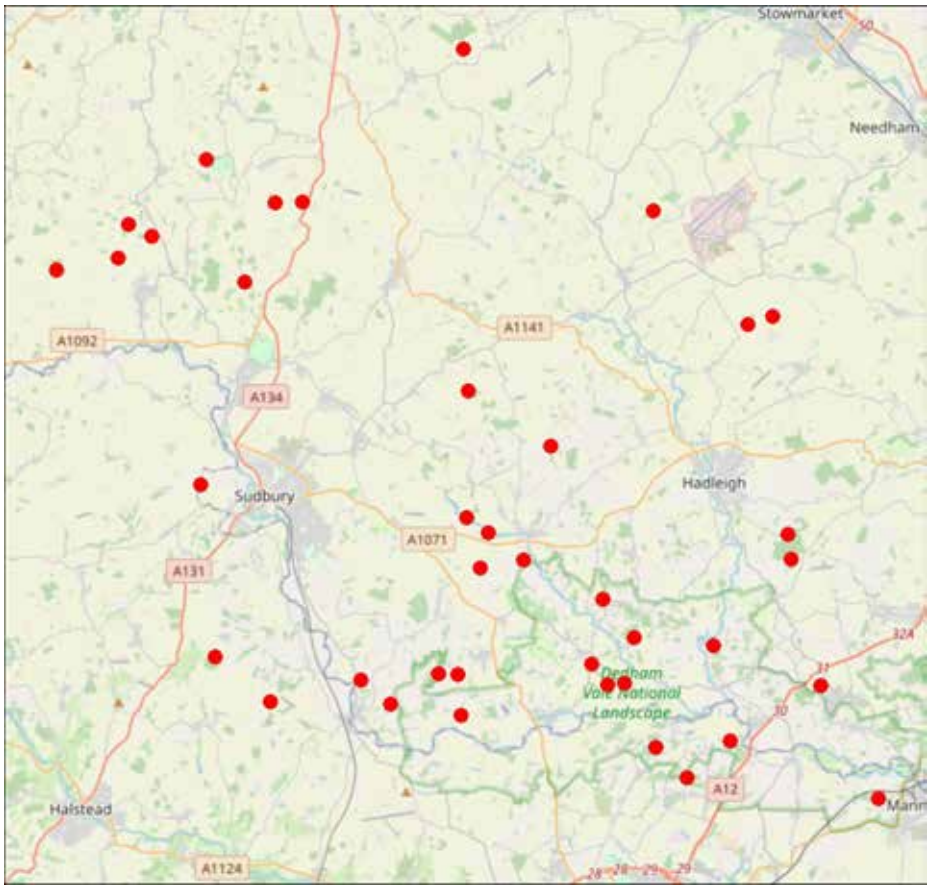
Linnet *Linaria cannabina* was recorded from one location.

Spatial pattern of detections

Long-tailed Tit

Long-tailed Tit *Aegithalos caudatus* was recorded from 39 locations.

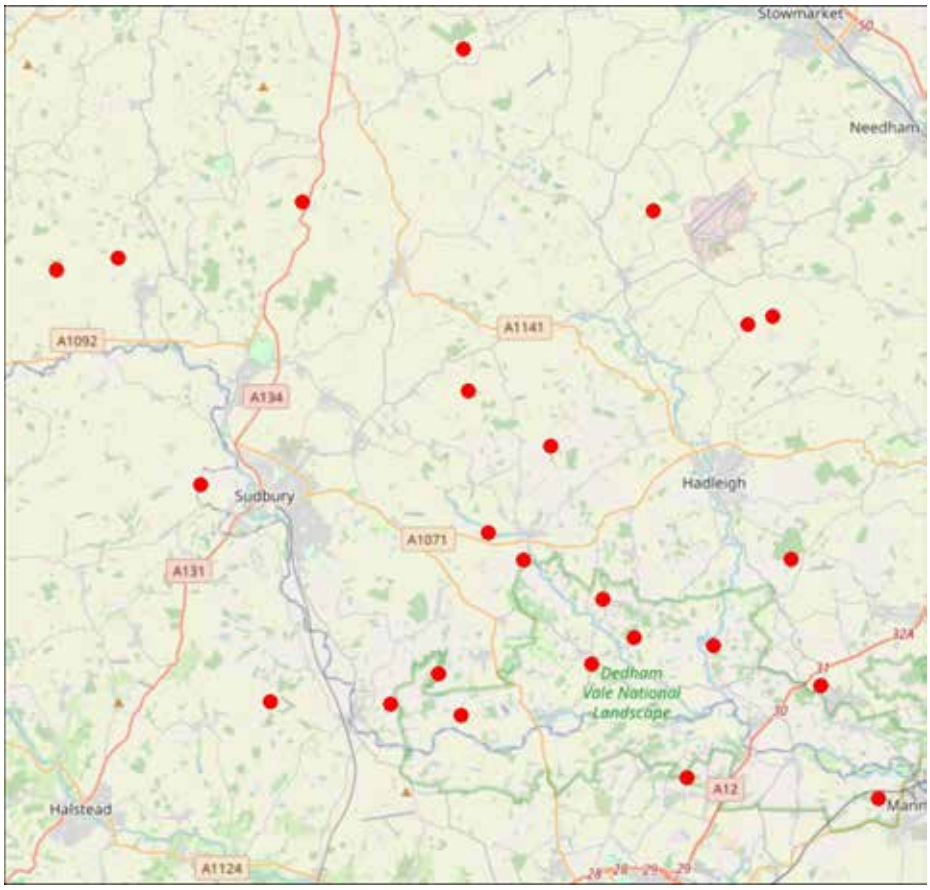
Spatial pattern of detections



Magpie

Magpie *Pica pica* was recorded from 24 locations.

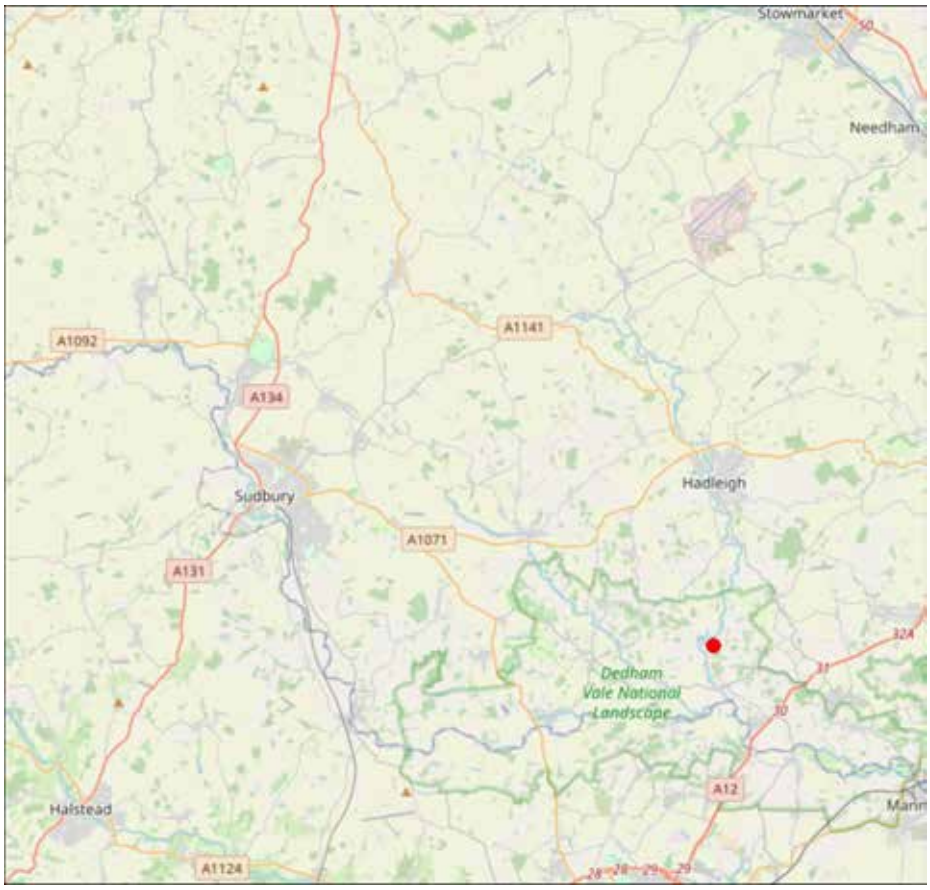
Spatial pattern of detections



Mallard

Mallard *Anas platyrhynchos* was recorded from one location.

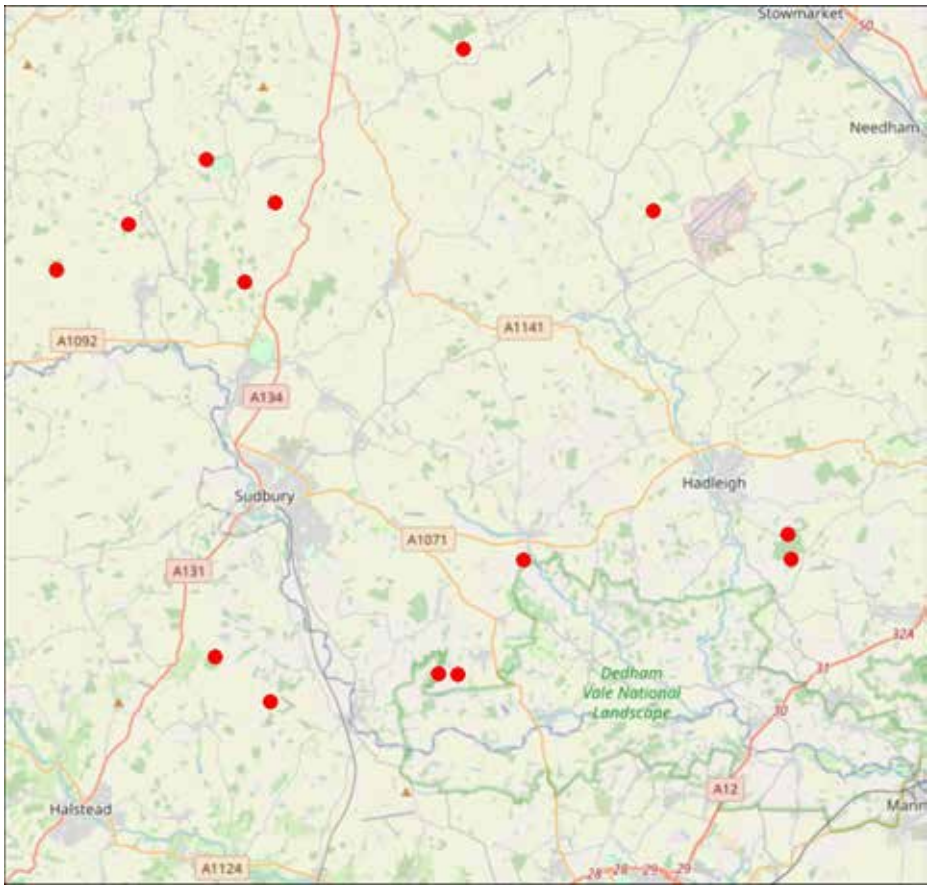
Spatial pattern of detections



Marsh Tit

Marsh Tit *Poecile palustris* was recorded from 14 locations.

Spatial pattern of detections



Moorhen

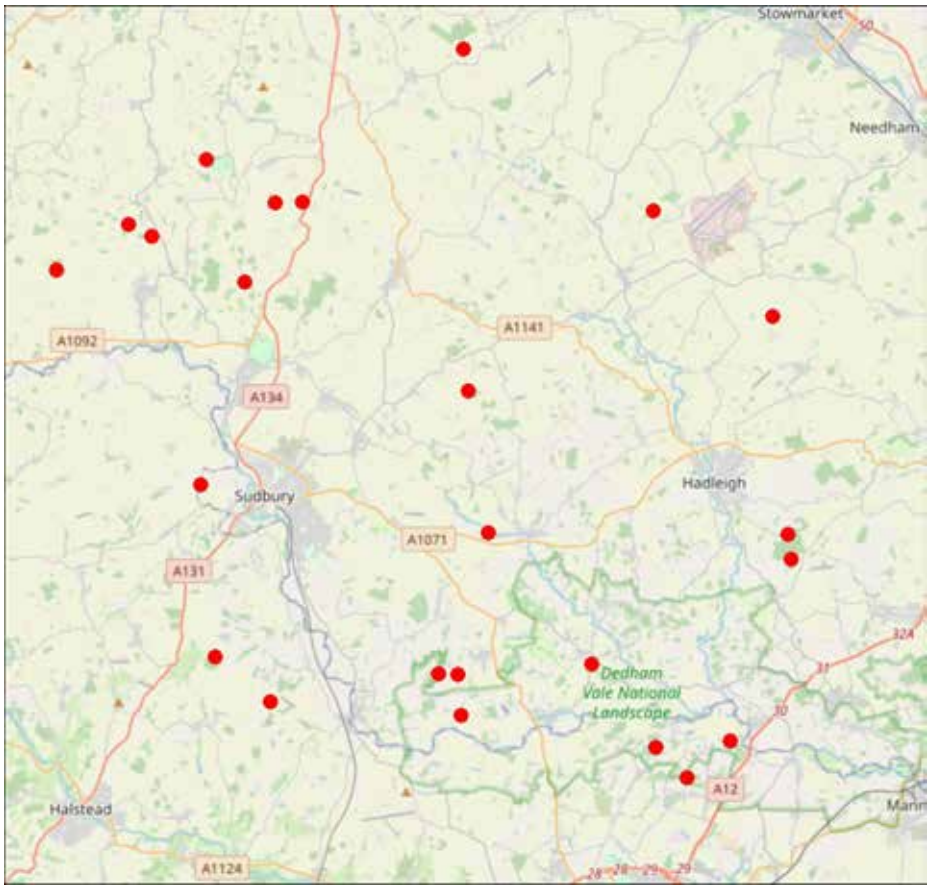
Moorhen *Gallinula chloropus* was recorded from two locations.

Spatial pattern of detections

Nuthatch

Nuthatch *Sitta europaea* was recorded from 24 locations.

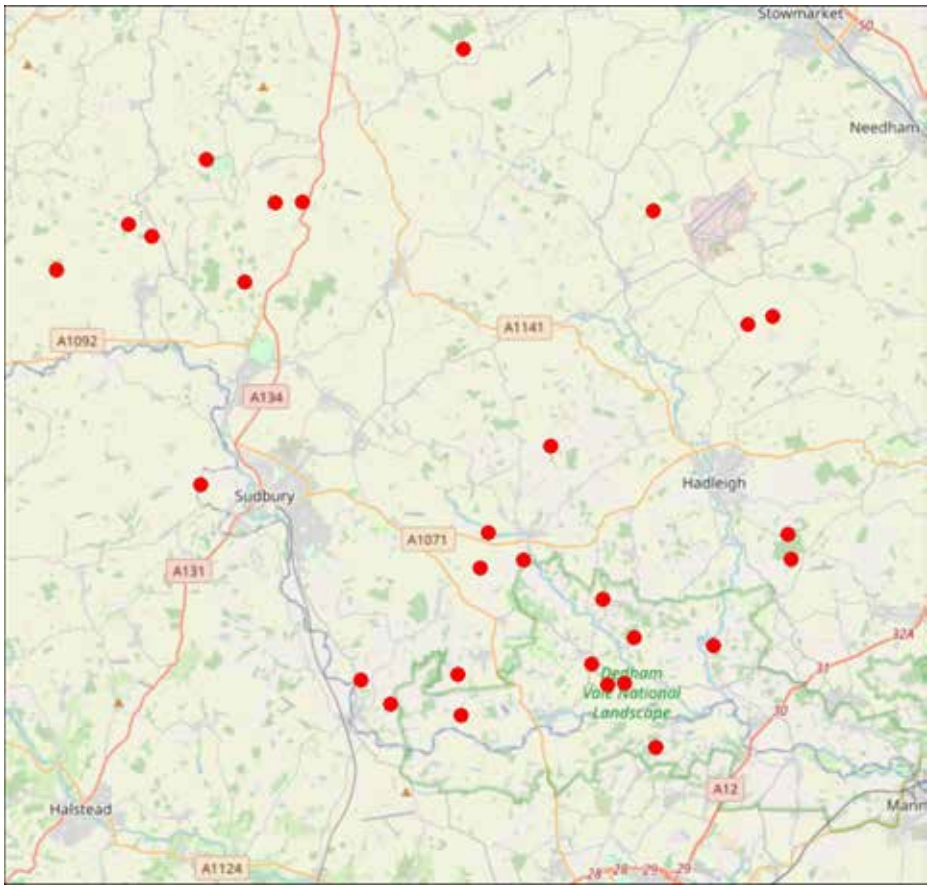
Spatial pattern of detections



Pheasant

Pheasant *Phasianus colchicus* was recorded from 29 locations.

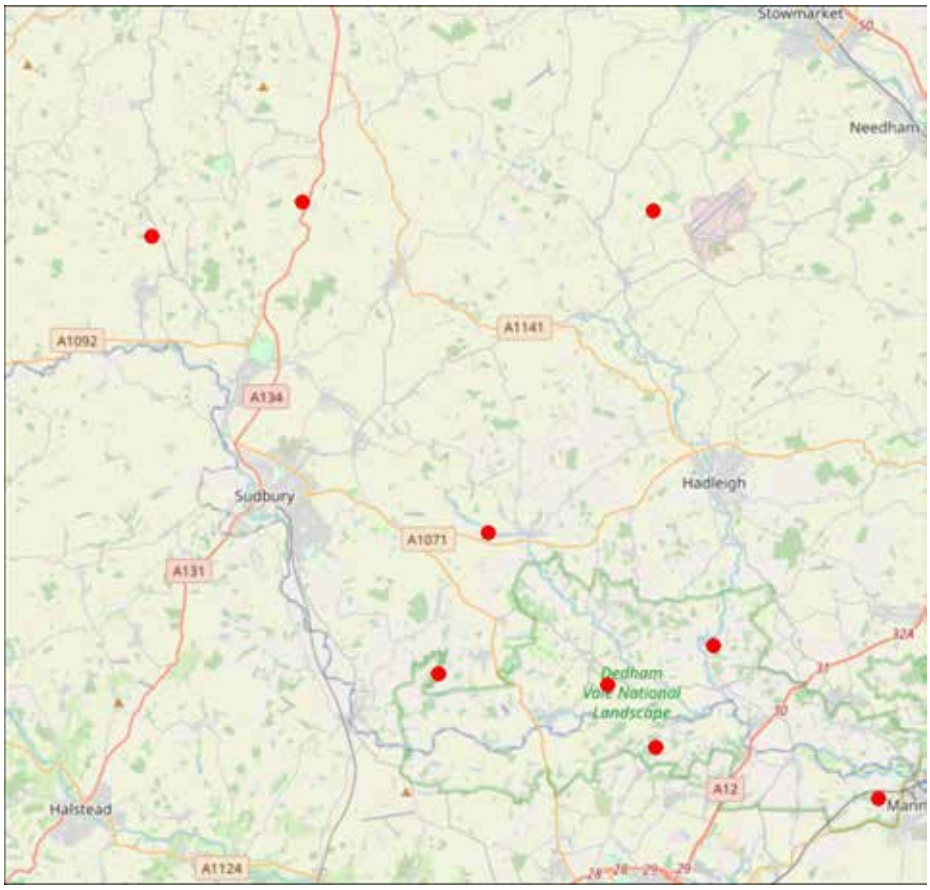
Spatial pattern of detections



Raven

Raven *Corvus corax* was recorded from nine locations.

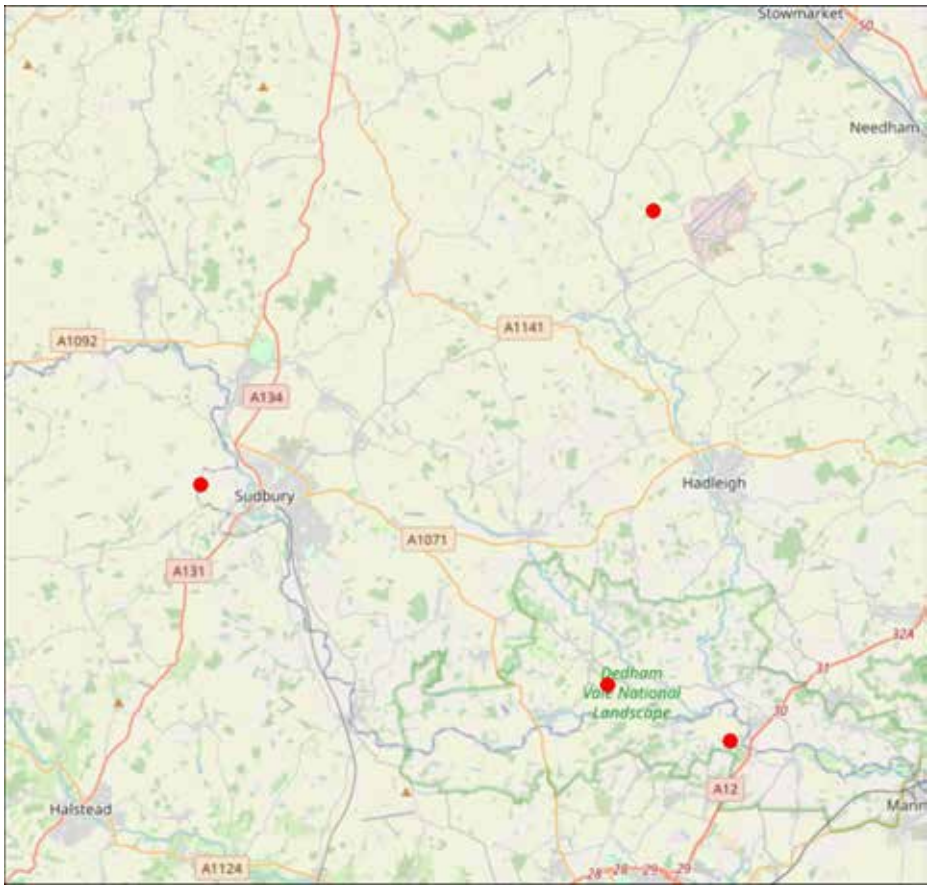
Spatial pattern of detections



Red Kite

Red Kite *Milvus milvus* was recorded from four locations.

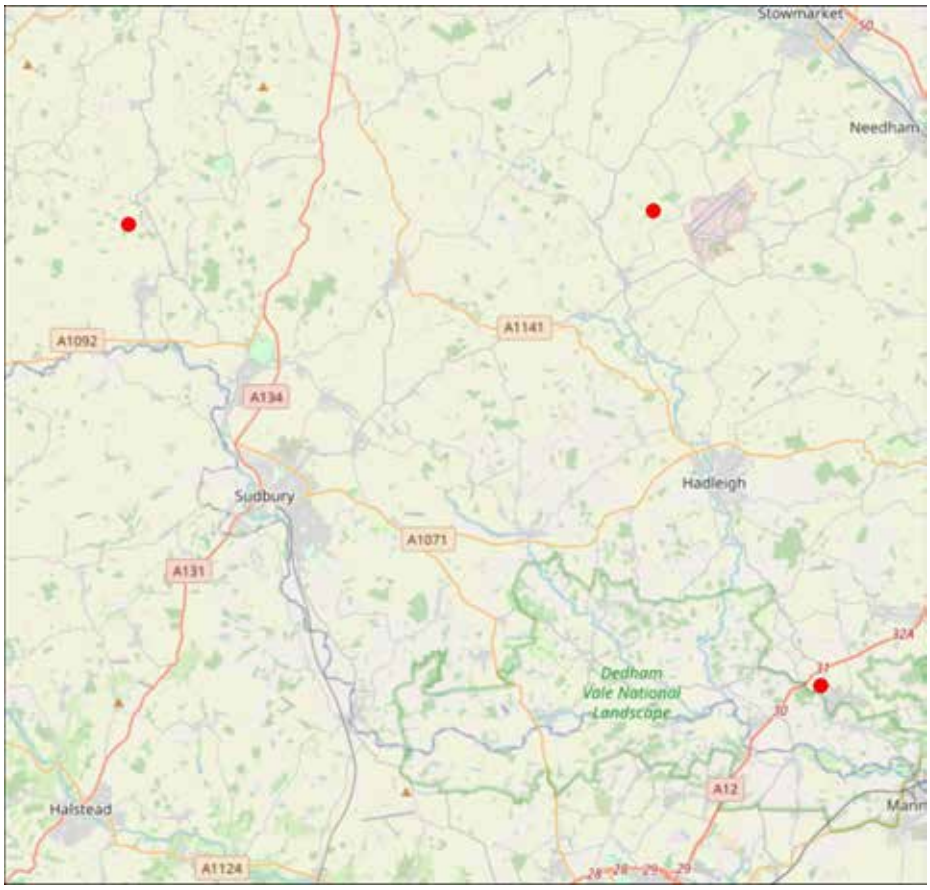
Spatial pattern of detections



Red-legged Partridge

Red-legged Partridge *Alectoris rufa* was recorded from three locations.

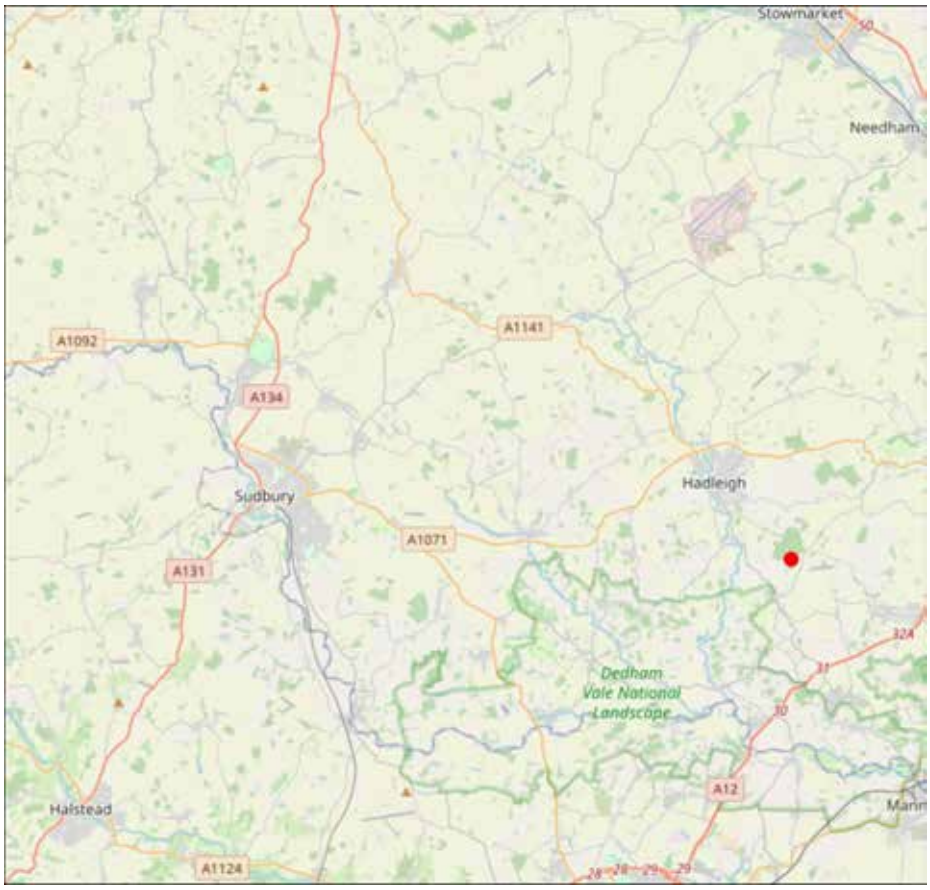
Spatial pattern of detections



Redstart

Redstart *Phoenicurus phoenicurus* was recorded from one location.

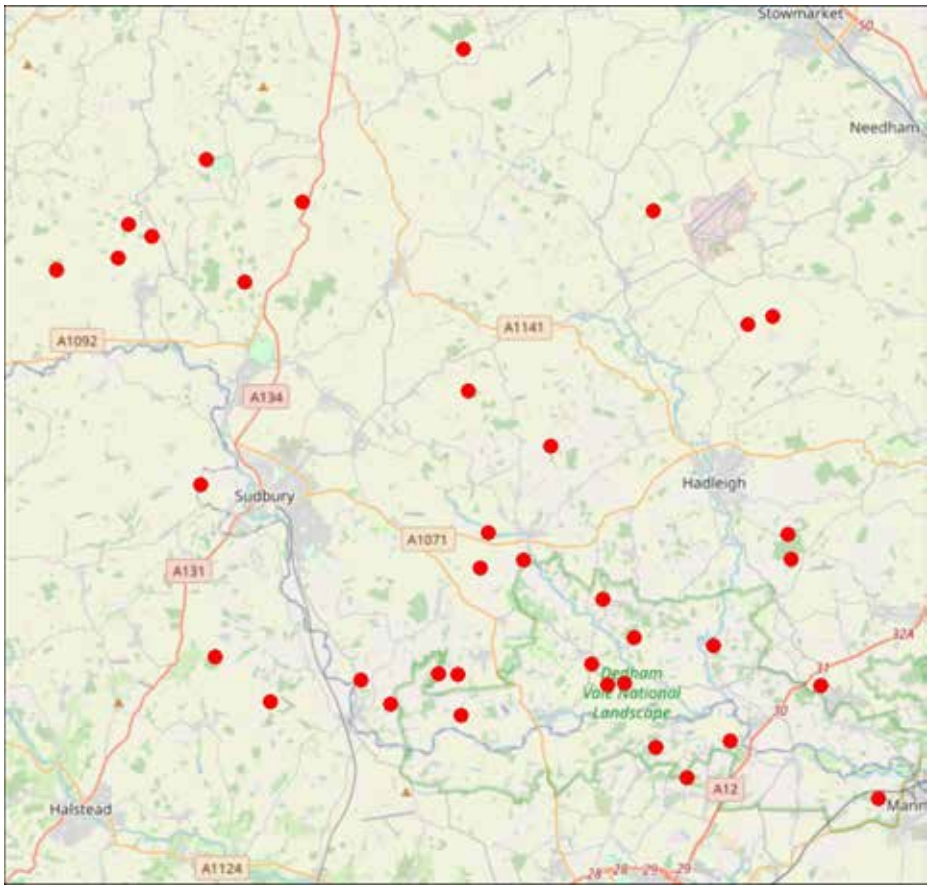
Spatial pattern of detections



Robin

Robin *Erithacus rubecula* was recorded from 37 locations.

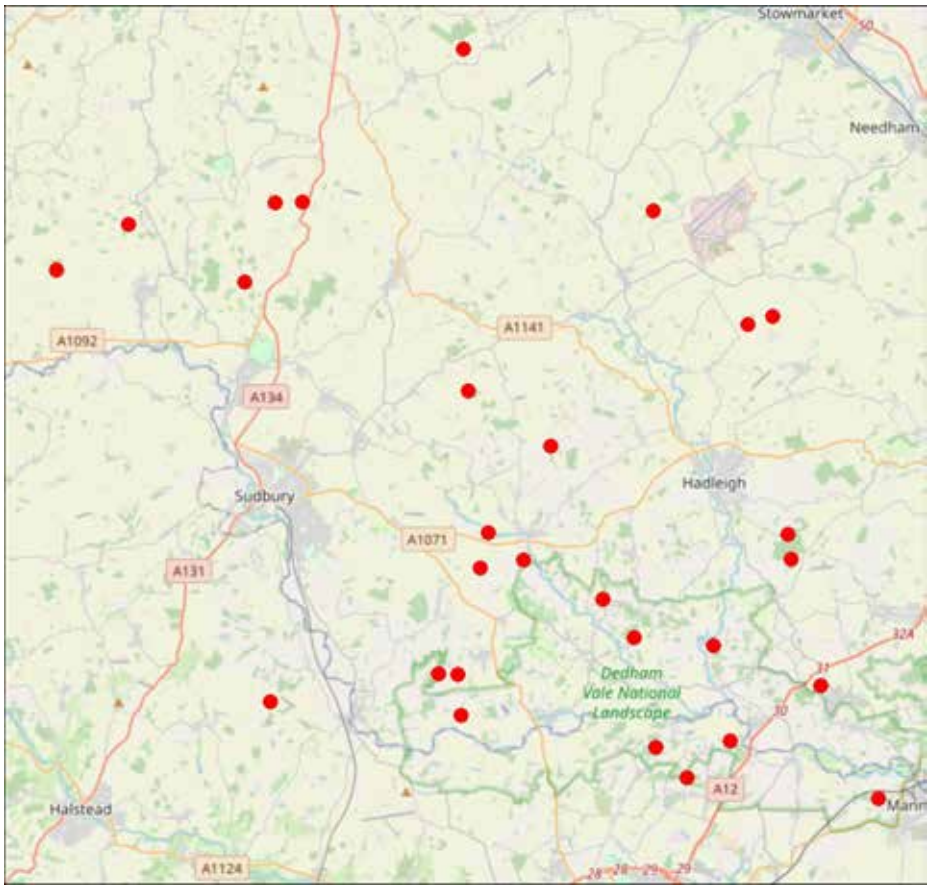
Spatial pattern of detections



Rook

Rook *Corvus frugilegus* was recorded from 28 locations.

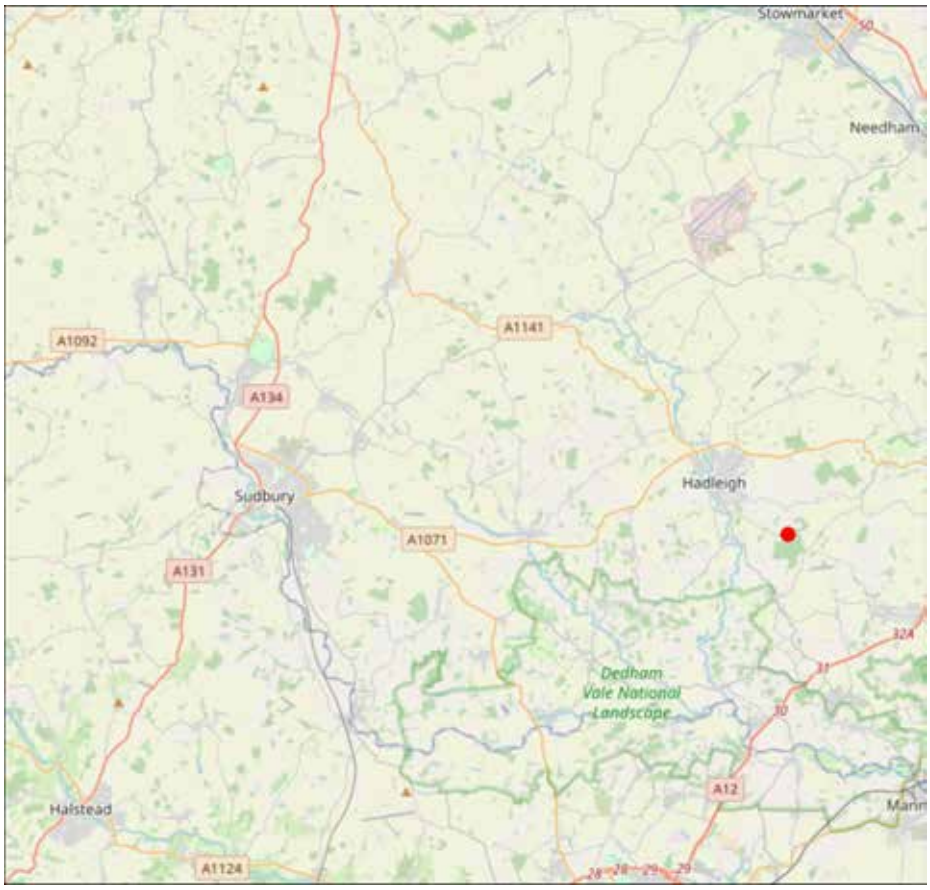
Spatial pattern of detections



Siskin

Siskin *Spinus spinus* was recorded from one location.

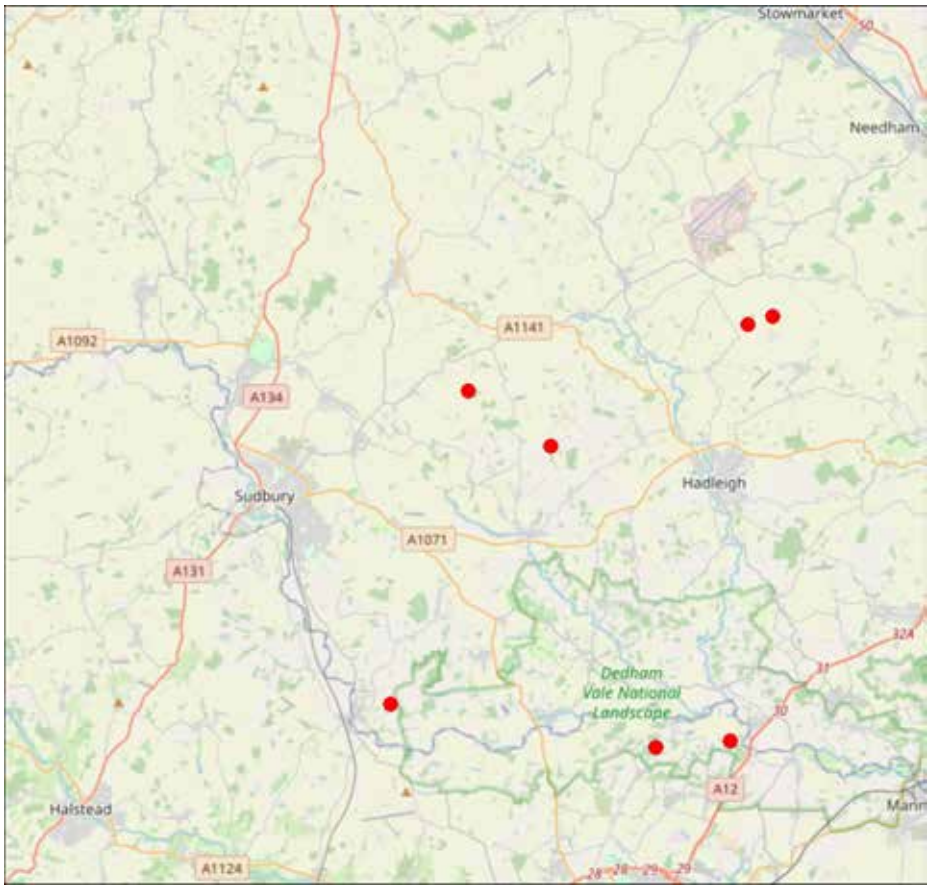
Spatial pattern of detections



Song Thrush

Song Thrush *Turdus philomelos* was recorded from seven locations.

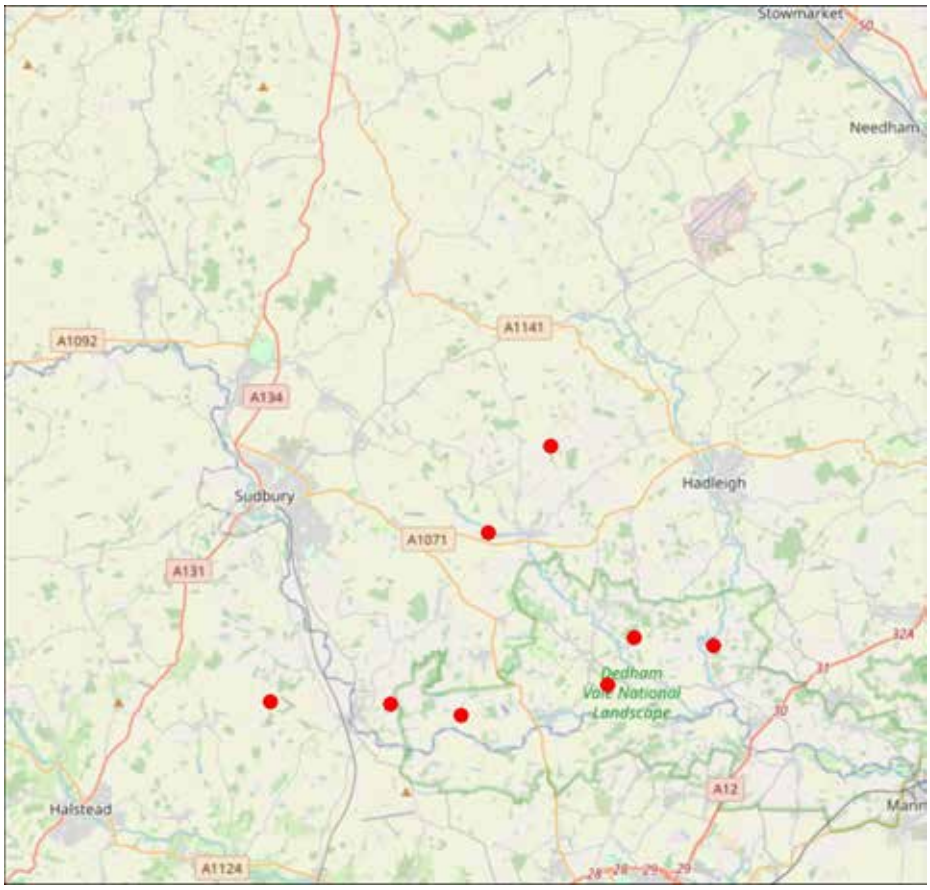
Spatial pattern of detections



Spotted Flycatcher

Spotted Flycatcher *Muscicapa striata* was recorded from eight locations.

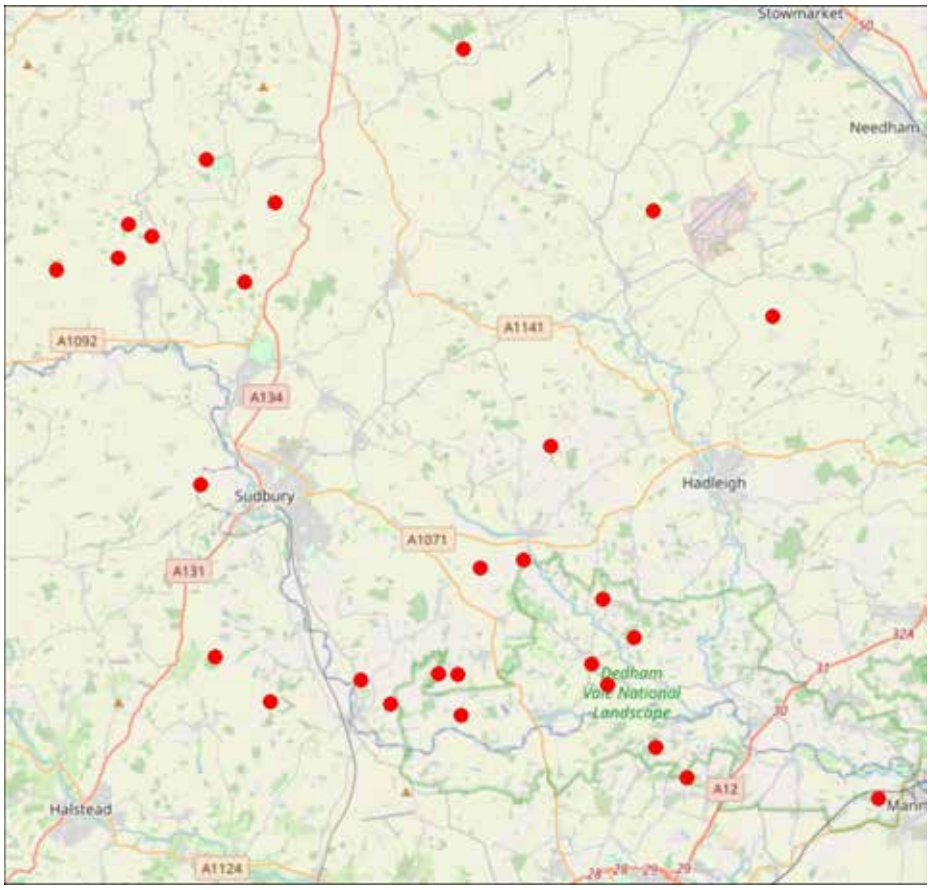
Spatial pattern of detections



Stock Dove

Stock Dove *Columba oenas* was recorded from 28 locations.

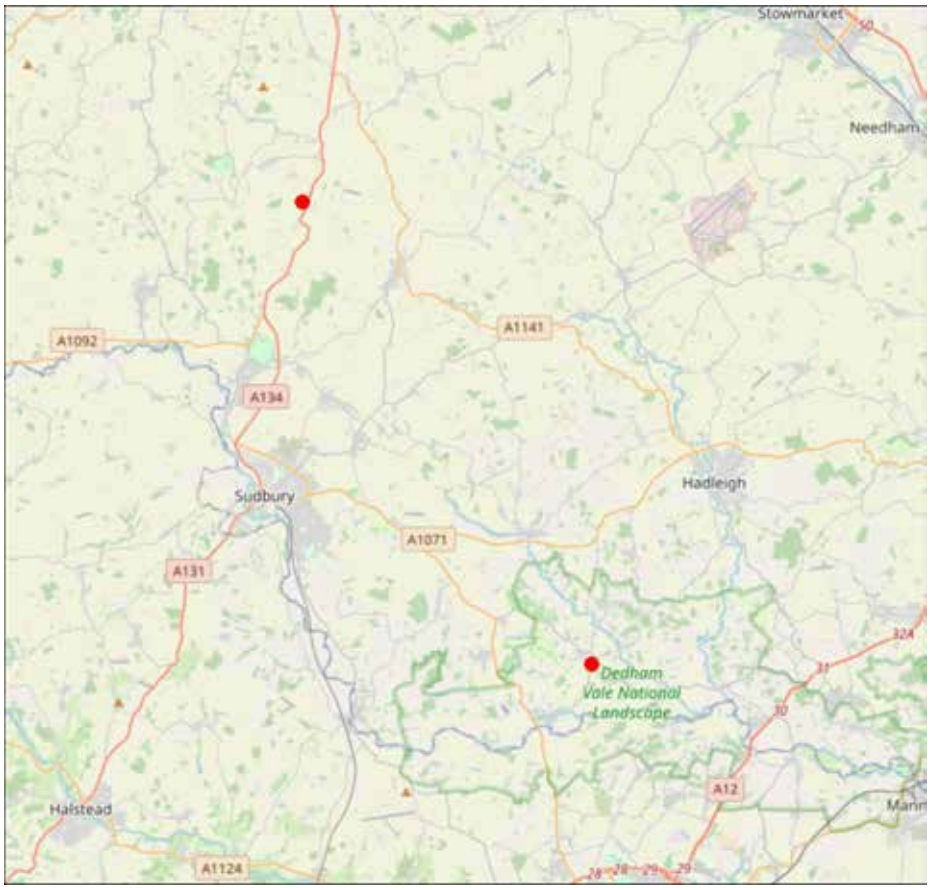
Spatial pattern of detections



Swallow

Swallow *Hirundo rustica* was recorded from two locations.

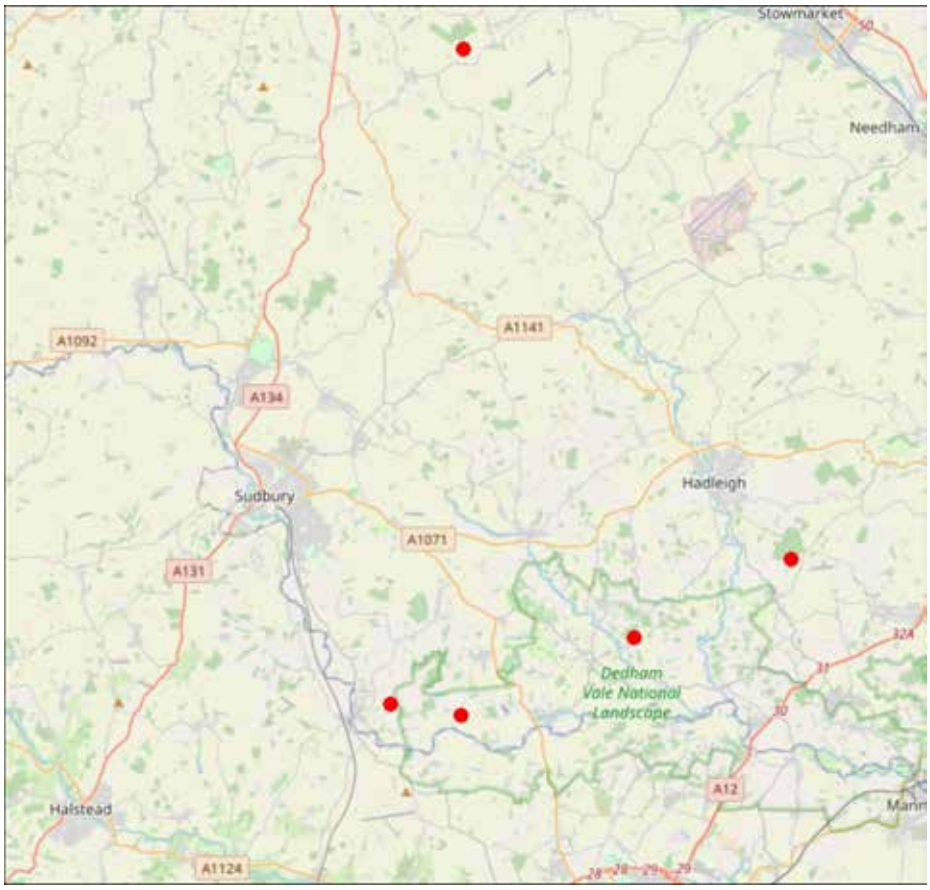
Spatial pattern of detections



Tawny Owl

Tawny Owl *Strix aluco* was recorded from five locations.

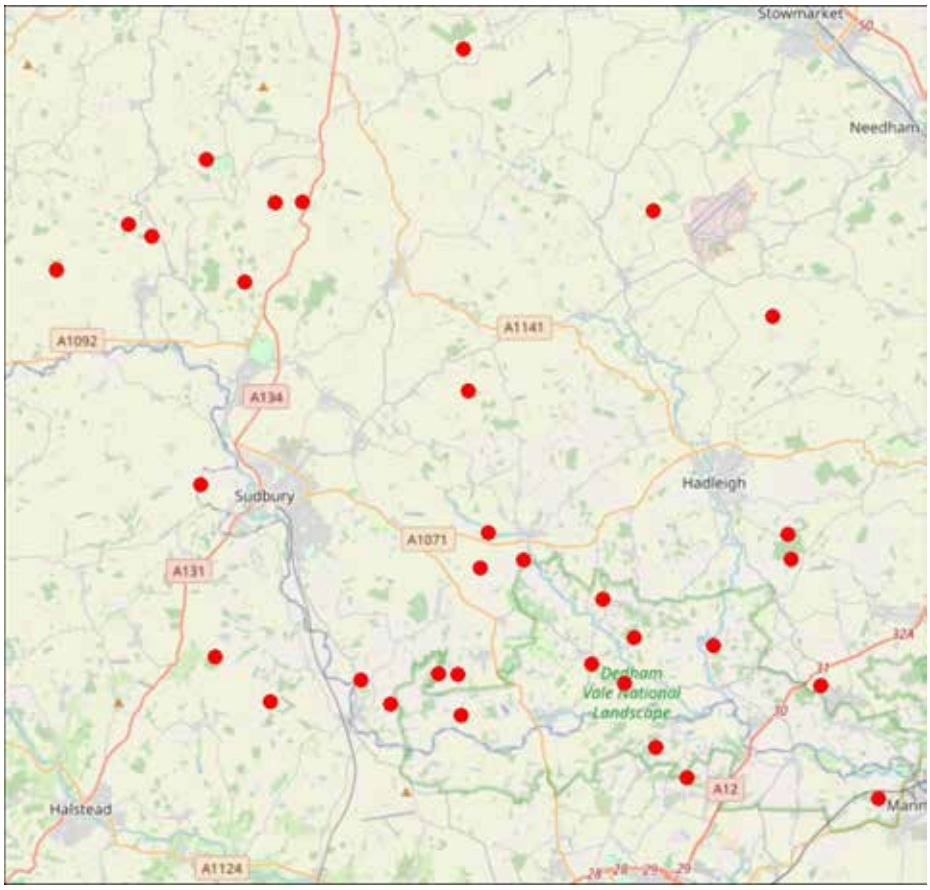
Spatial pattern of detections



Treecreeper

Treecreeper *Certhia familiaris* was recorded from 33 locations.

Spatial pattern of detections



Willow Warbler

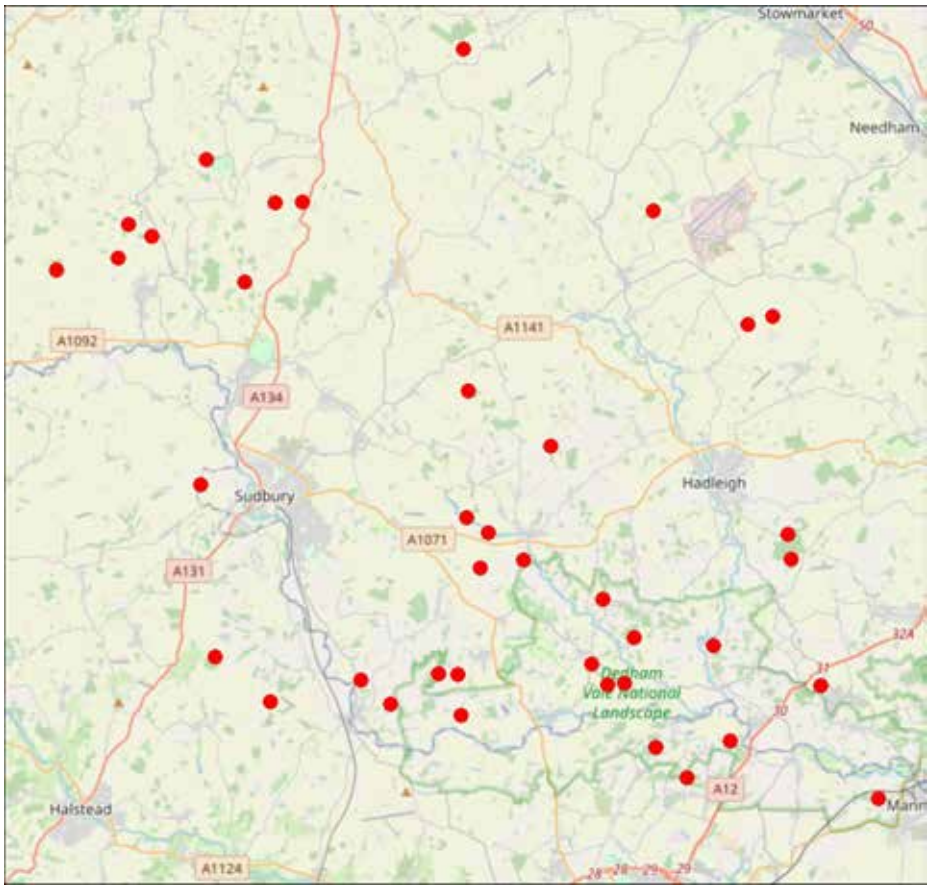
Willow Warbler *Phylloscopus trochilus* was recorded from one location.

Spatial pattern of detections

Woodpigeon

Woodpigeon *Columba palumbus* was recorded from 39 locations.

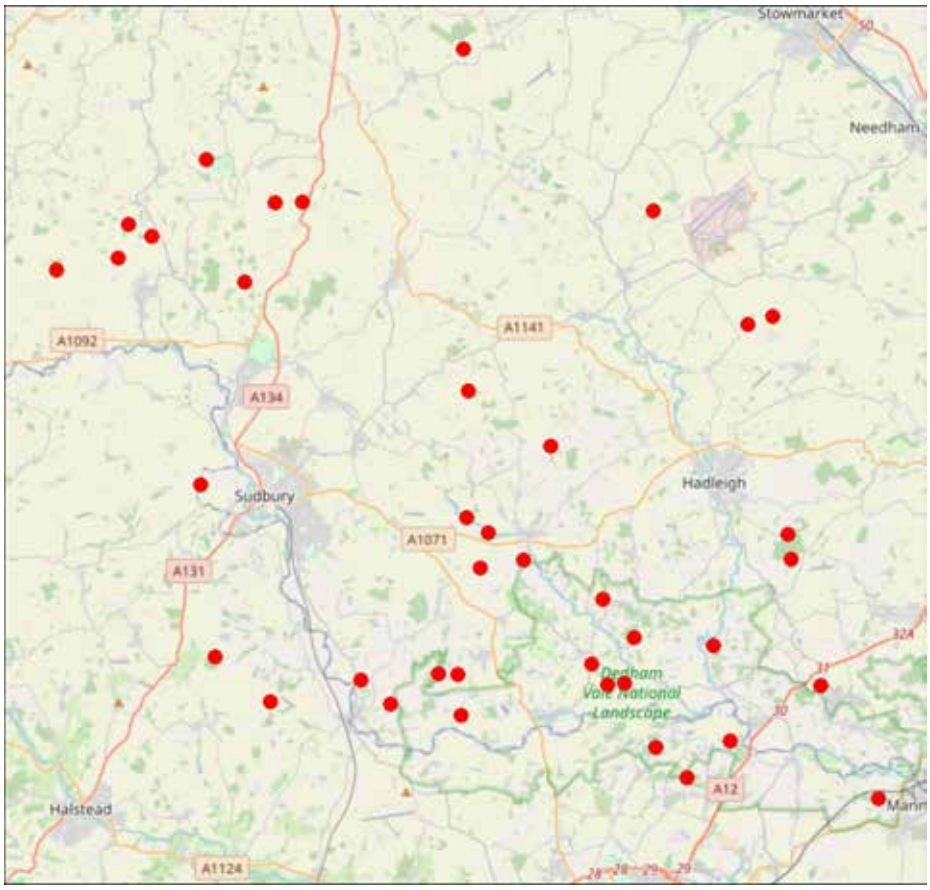
Spatial pattern of detections



Wren

Wren *Troglodytes troglodytes* was recorded from 39 locations.

Spatial pattern of detections



4.3.5 Bush-crickets

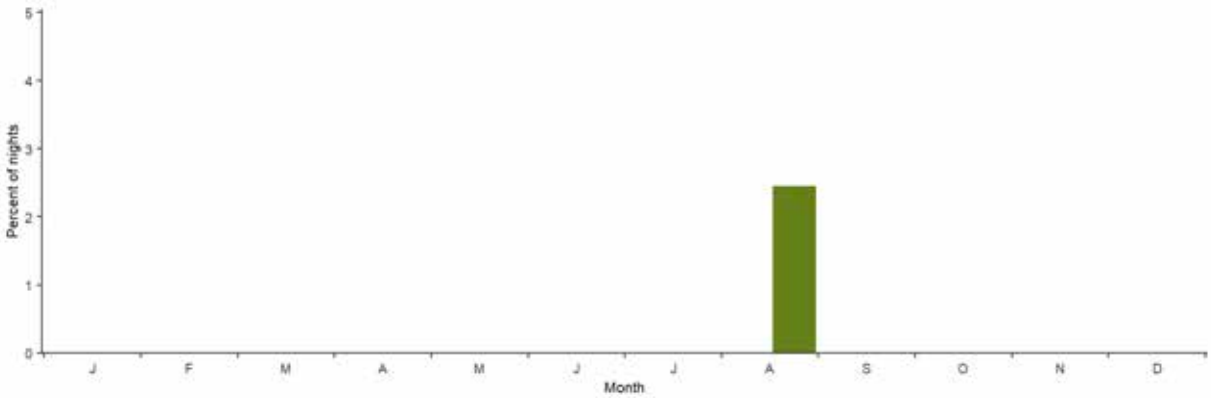
Being stationary, and calling for long periods, the number of recordings is not an informative measure of abundance. For this reason, bush-cricket data are shown as presence information rather than activity information.

Long-winged Conehead

Long-winged Conehead *Conocephalus fuscus* was recorded on five nights, from one location.

Spatial pattern of detections

Seasonality

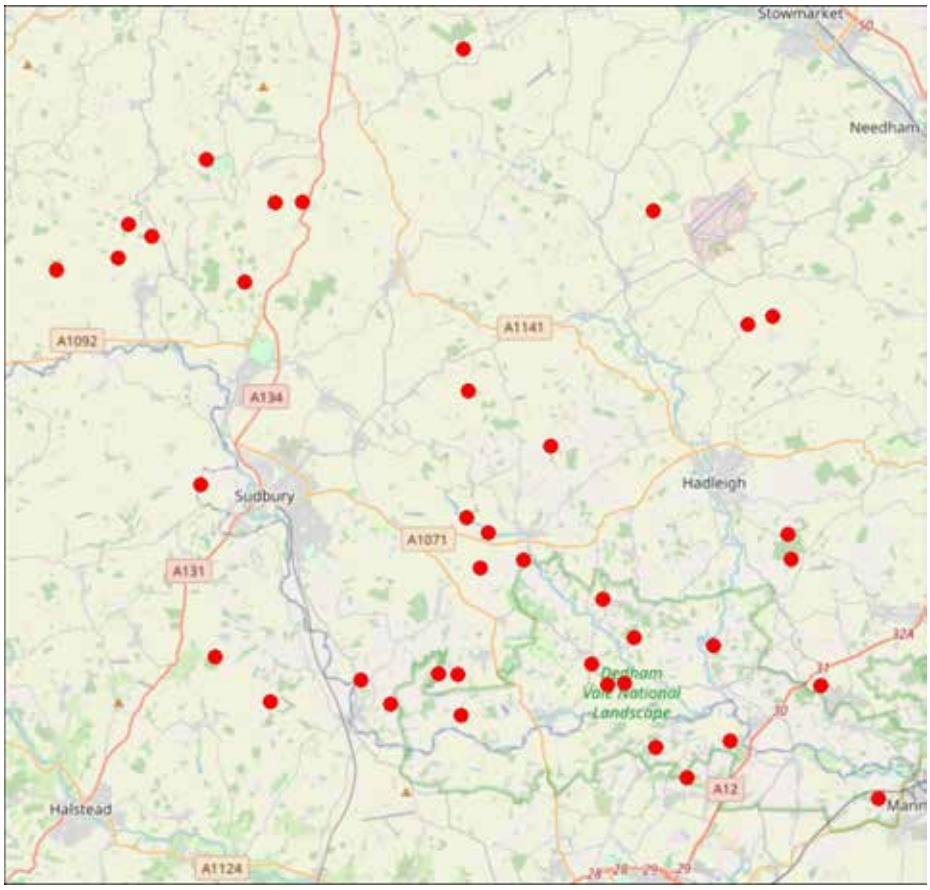


Long-winged Conehead was recorded from 304 locations between July and the end of October each year with records from Guernsey, Alderney, Sark, Herm, Jethou and Lithou. Long-winged Conehead produces 'calls' with a peak frequency about 26 kHz. It is most similar acoustically to Short-winged Conehead which was only recorded in 2021, but it produces three-syllable calls (two short calls, pause, followed by one longer duration call).

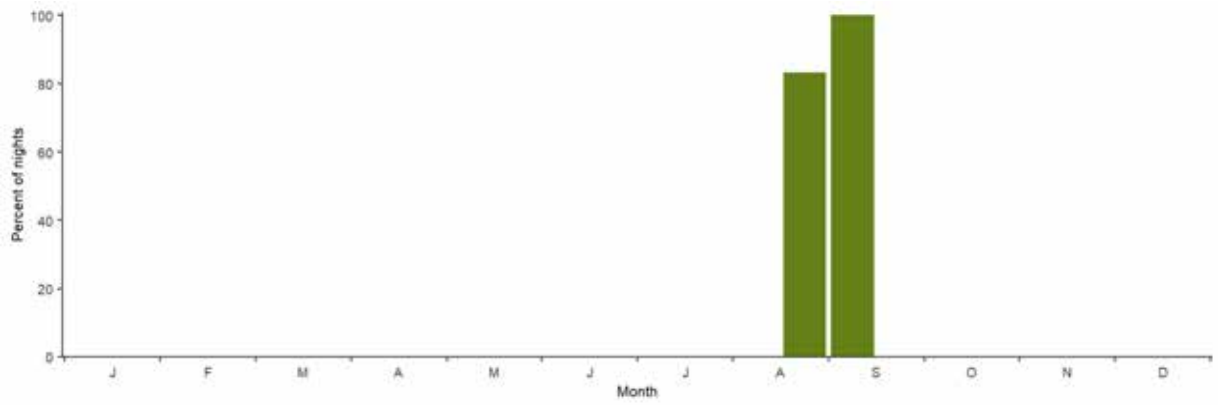
Speckled Bush-cricket

Speckled Bush-cricket *Leptophyes punctatissima* was recorded on 16 nights, from 39 locations.

Spatial pattern of detections



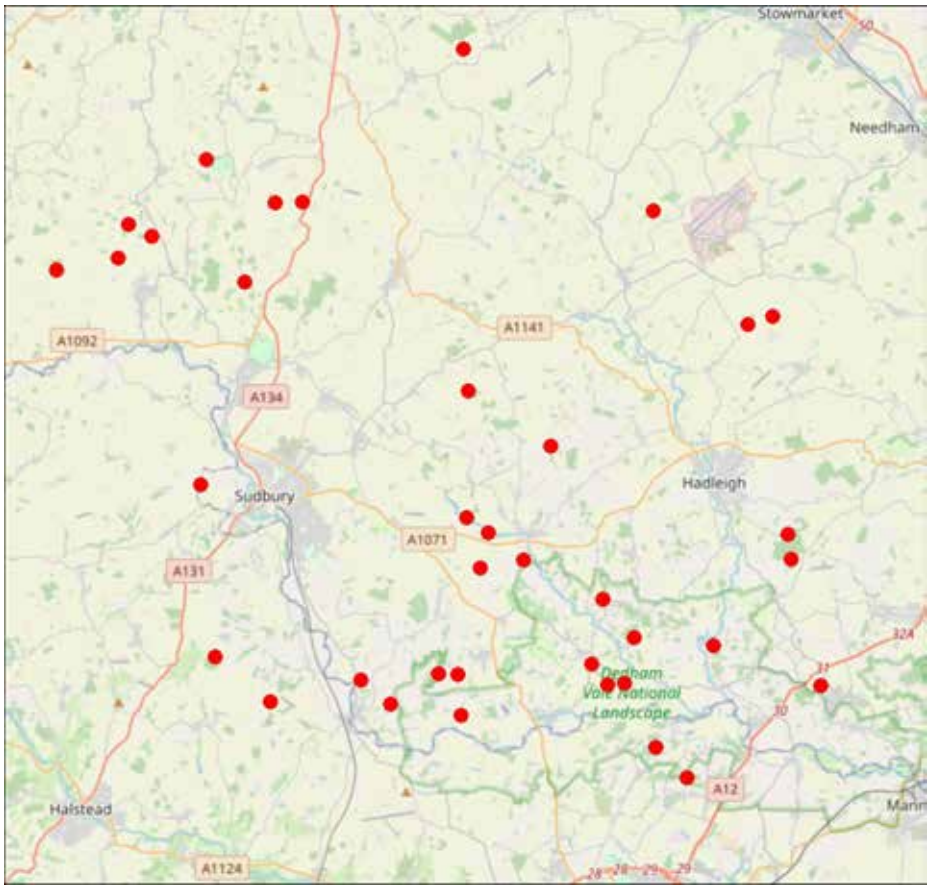
Seasonality



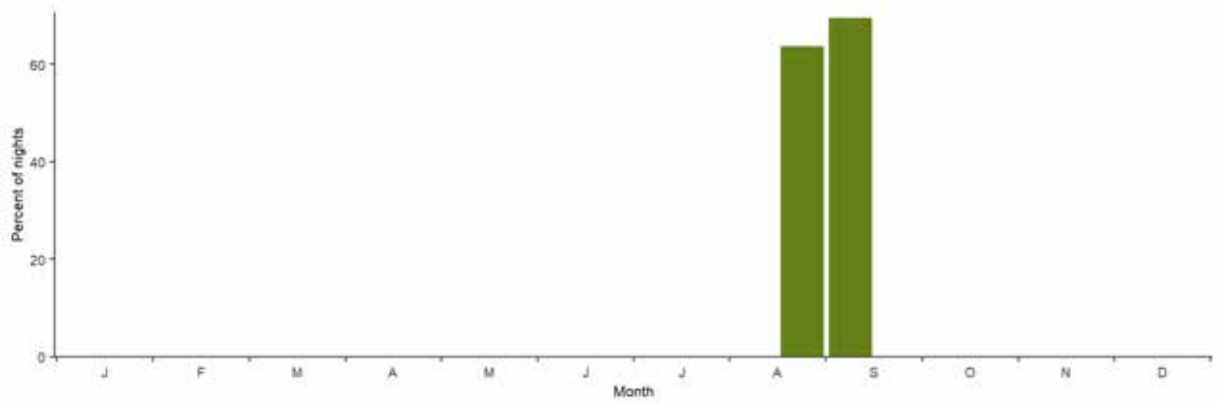
Dark Bush-cricket

Dark Bush-cricket *Pholidoptera griseoaptera* was recorded on 16 nights, from 37 locations.

Spatial pattern of detections



Seasonality

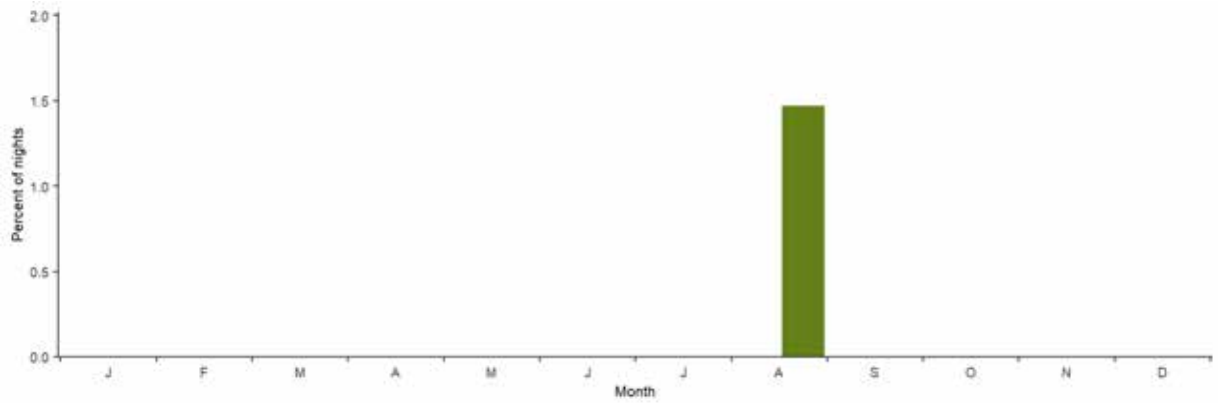


Roesel's Bush-cricket

Roesel's Bush-cricket *Roeseliana roeselii* was recorded on three nights, from one location.

Spatial pattern of detections

Seasonality

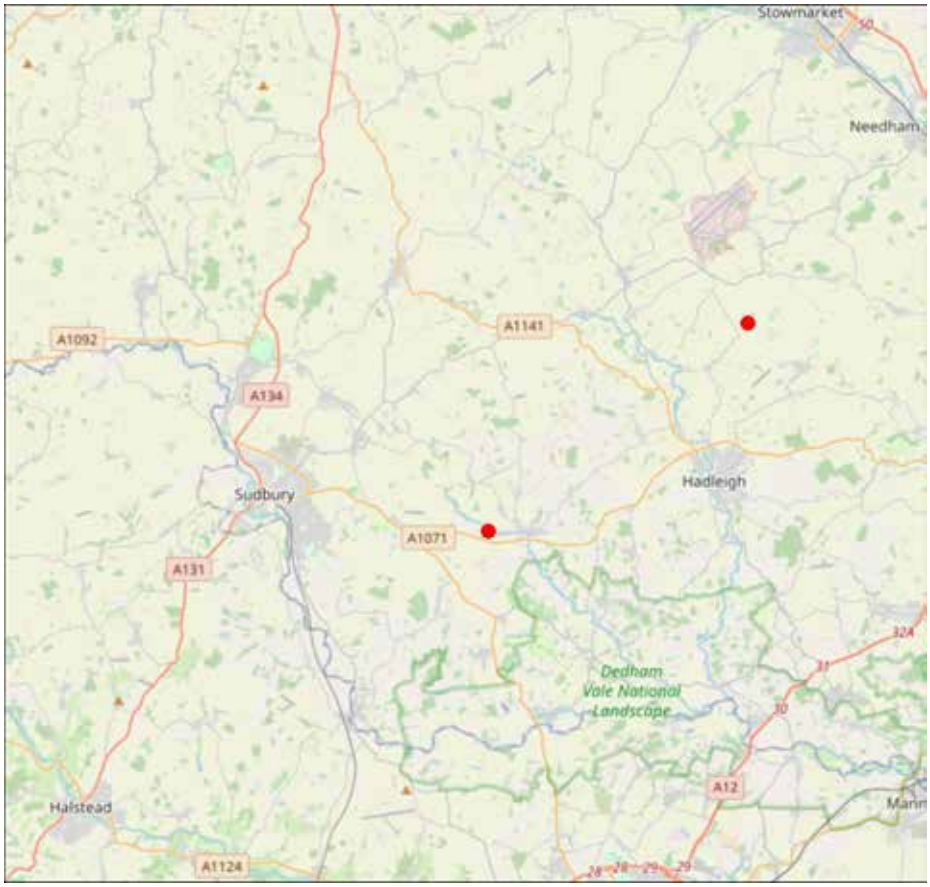


4.3.6 Audible moth species

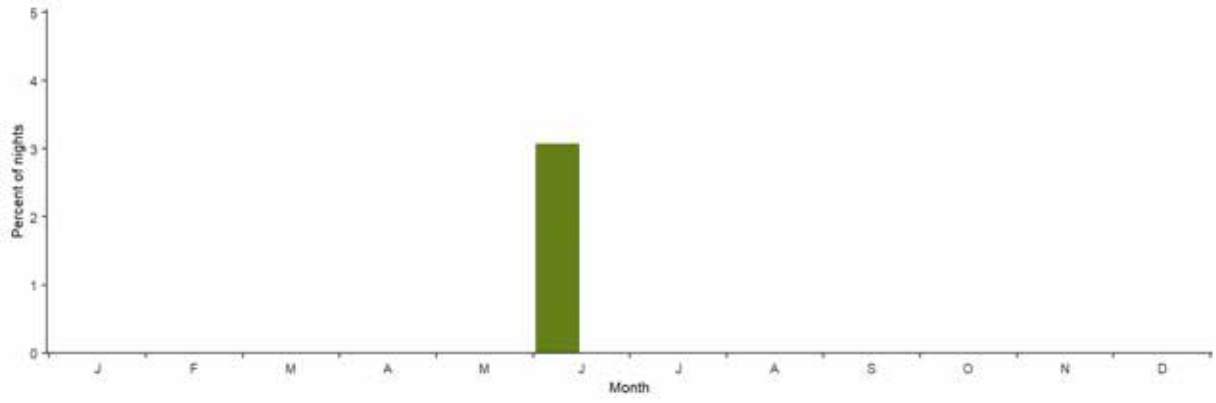
Green Silver-lines

Green Silver-lines *Pseudoips prasinana* was recorded on three nights, from two locations.

Spatial pattern of detections



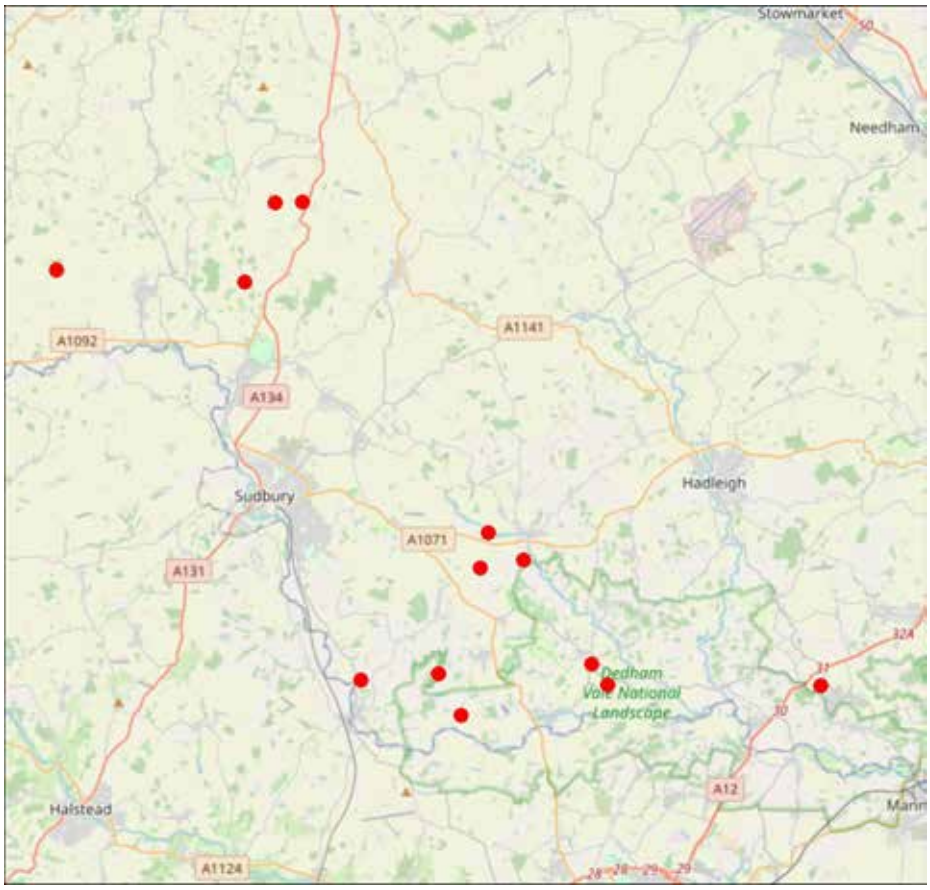
Seasonality



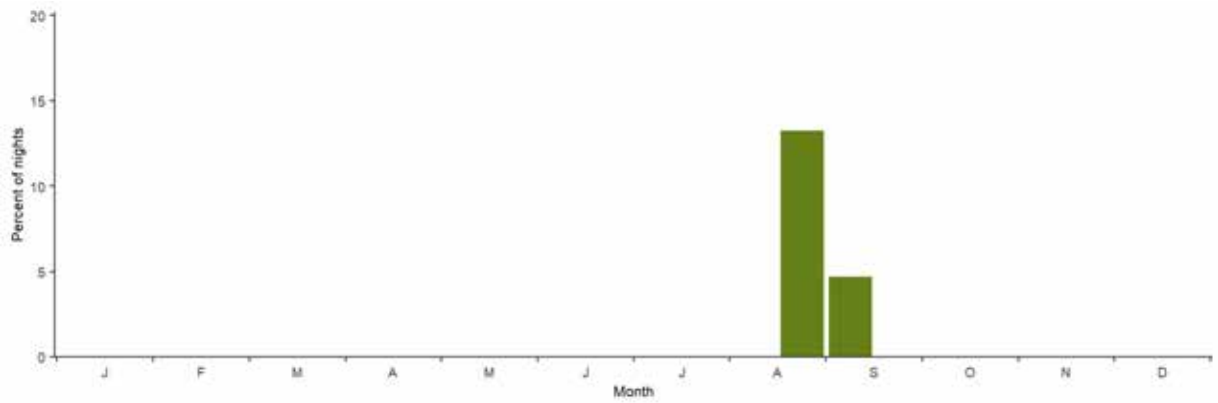
Bird Cherry Ermine

Bird Cherry Ermine *Yponomeuta evonymella* was recorded on 14 nights, from 13 locations.

Spatial pattern of detections



Seasonality



5. DISCUSSION

This dataset confirms the presence of Hazel Dormouse at two sites. The passive acoustic monitoring method used made it possible to survey multiple taxonomic groups simultaneously resulting in a total of: 54 bird species, at least 11 bat species, 4 small mammal species (including Hazel Dormouse), 4 bush-cricket species, and 2 audible moth species.

5.1 Hazel Dormouse

Results from the BTO Acoustic Pipeline for Hazel Dormouse build on other projects that have highlighted the potential for using acoustics and the Acoustic Pipeline for detecting the presence of this species.

5.2 Bats and other ultrasonic species

Configuring the recorders to switch to ultrasonic recording at night provided additional data on other species groups at minimal extra cost. These data provide valuable context to deliver biodiversity friendly farming and conservation initiatives within the National Landscape. Unexpected and very notable, was that Barbastelle, which is IUCN listed as vulnerable in England, which after Common Pipistrelle and Soprano Pipistrelle, was the third most commonly recorded bat species in this project, with 11,569 Barbastelle recordings collected over the course of the project. Unmanaged woodland with high structural and floral diversity is considered to be optimal roosting habitat for Barbastelle, although ancient woodland sites where a policy of minimum intervention is carried out to restore diversity can be of equal high value, provided that dead trees are retained (Russo *et al*. 2004, Zeale 2011, Carr *el al*. 2018). It is thought that Barbastelle's are not able to persist in woodland where intensive management and non-selective logging is conducted, although where these habitats exist around optimal roost sites, they can provide additional, albeit limited, roosting opportunities.

5.3 Recommendations

Data from 2024 indicate some of the knowledge gains that can be made by careful deployment of acoustic monitoring technology. Yet this isn't without its challenges and improvements could be made. Potential areas for improvement include:

- a clear data management plan. Acoustic monitoring generates large volumes of audio files. It is easy to get muddled when working with multiple memory cards and survey locations. A clear data management plan covering how to name, organise and store files should be developed prior to recording and reviewed regularly during fieldwork to check it is fit for purpose. Audio files should be backed up regularly and logs made of which batches have been processed through the Acoustic Pipeline to avoid results duplication.

- improve BTO Acoustic Pipeline species coverage. Adding more bird species to the BTO Acoustic Pipeline is a high priority so that it can become a single tool for providing acoustic data management for multi-taxa monitoring projects.

6. ACKNOWLEDGEMENTS

We are very grateful to the landowners farms who took part in Connecting Constable and Gainsborough Country – using acoustics to support landscape recovery project in 2024. Lastly we would like to thank Defra for funding this project. BTO Acoustic Pipeline classifiers are trained on a combination of recording sources, including those owned by BTO, those kindly shared with BTO, and open access repositories such as xeno-canto. We are grateful to all sound recordists who have made their recordings available to us. For more details see here (https://www.bto.org/our-science/products-and-technologies/bto-acoustic-pipeline/how-acoustic-pipeline-works).

7. REFERENCES

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*.

Carr, A., Zeale, M. R. K., Weatherall, A., Froidevaux, J. S. P., and Jones, G. 2018. Ground-based and LiDAR-derived measurements reveal scale-dependent selection of roost characteristics by the rare tree-dwelling bat Barbastella barbastellus. *Forest Ecology and Management* 417, 237-246.

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

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. & Panter, T.L. 2024. Ryevitalise - Bats and Ancient Trees, 2020-2024 Report. BTO Research Report 775, BTO, Thetford.

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.

Russo, D., Cistrone, L., Jones, G., and Mazzoleni, S. 2004. Roost selection by barbastelle bats (Barbastella barbastellus, Chiroptera : Vespertilionidae) in beech woodlands of central Italy: consequences for conservation. *Biological Conservation* 117, 73-81.

Zeale, M. R. K. 2011. Conservation biology of the barbastelle *Barbastella barbastellus*: applications of spatial modelling, ecology and molecular analysis of diet. PhD thesis, University of Bristol, United Kingdom.


Images: Common Pipistrelle, by John Black; Wood Mouse, by Moss Taylor; Speckled Bush-cricket, by Mike Toms; Green silver-lines, by Andy Musgrove.
Cover image: Common Dormouse, by Ruud Foppen.

Connecting Constable and Gainsborough Country – using acoustics to support landscape recovery.

This report presents the main findings from survey work delivered using passive acoustic monitoring devices deployed across *Connecting Constable and Gainsborough Country* Landscape Recovery Project 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 this 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*, *Plecotus* or *Nyctalus*/*Eptesicus*). Where such species are recorded, we provide additional information to support their identification. A secondary aim of our work is to improve the wider understanding of species identification, inspiring a culture of critical thinking and the use of emerging technologies to improve the current knowledge base.

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