BTO RESEARCH REPORT 783

Passive acoustic monitoring with Heal Rewilding, 2024 – piloting the rewilding monitoring framework

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BTO Birds Science People

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SUMMARY

Background This report presents results from the first year of Passive Acoustic Monitoring as part of the pilot of the Rewilding Monitoring Framework. These data will contribute to baselining and monitoring rewilding progress and its impact on biodiversity.

Coverage The project focuses on four target taxa: birds, bats, small mammals and insects that produce ultrasound. Two of these taxa, birds and bats have been chosen as key indicators in the Rewilding Monitoring Framework. We also test the use of two Soundscape indices, as another key indicator in the Monitoring Framework.

Results In total, this study identified 90 species in Heal including 40 bird species, 15 bat species, 6 small mammal species, 6 bush-cricket species, and 1 moth species.

1. BACKGROUND

Over recent years, Rewilding Britain has increasingly been providing support to the Rewilding Network, which connects members rewilding at scale across Britain on what to measure and how to measure, in order to evidence change over time.

Rewilding is a dynamic, unpredictable process that can challenge the monitoring approaches used to track changes at more traditional nature conservation sites. Although rewilding sites collect data and can demonstrate ecological, social and economic changes to a certain extent, there is, as yet, no framework that lays out the most appropriate, measurable metrics for monitoring rewilding progress.

2. AIMS AND OBJECTIVES

We aimed to pilot the use of passive acoustic monitoring (PAM) to baseline and monitor changes in biodiversity at Rewilding Britain member sites. PAM can be used to monitor three key indicators included in the Rewilding Britain monitoring framework: birds, bats and soundscapes We aimed to survey birds, bats, small mammals, insects that produce ultrasound, and soundscapes on rewilding sites in 2024.

3. METHODS

Planning, deployment of recording equipment, collation of audio recordings and processing through the BTO Acoustic Pipeline were undertaken by Heal Rewilding (DH). Acoustic identification verification, data analysis and reporting were undertaken by BTO (SEN, AW and AAB).

3.1 Static recorder protocol

Our protocol enabled passive acoustic recorders (Song Meter Mini Bats) to record birds during the day, and to automatically trigger and record the calls of bats, small terrestrial mammals, or ultrasound produced by bush-crickets or moths during the night.

The recorders were placed out to record over two discrete recording sessions of a minimum of seven consecutive days at each location. Multiple days of recording increase the chance of recording species if present and are likely to reduce the impact of 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).

Survey sites were taken from a 500 m grid over the whole project area, where half of the grid squares were chosen as sampling sites to achieve good coverage. For larger sites (>1000 ha), half of the sampling squares are surveyed in the first year, and half in the following year. By doing this, we aim to provide representative survey coverage of the area of interest in any year, whilst managing the sampling effort needed each year by site staff. For a 2,000 hectare site, which equates to 80 x 500-m squares, 40 sampling squares would be surveyed in total, with 20 sampling squares/year. Two survey sessions (May - July, and August - September) were chosen to cover the breeding season of birds and bats, as well as the post-breeding period for bats.

The recorders were programmed to cycle between recording birds using an acoustic microphone, and bats, small mammals and bush-crickets with an ultrasonic microphone. For birds, a sample rate of 22,050 Hz was used, 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 was 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 and deployed at least 1.5 m in any direction from vegetation, water or other obstructions to avoid recording sound reflected off these surfaces.

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*, we checked a random sample of 1,000 recordings to quantify the error rate in the dataset. 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.

3.2.1 Soundscape indices

Another approach to analysing audio data is whole soundscape analyses using soundscape indices. A soundscape approach focuses on broader acoustic dynamics and patterns. Soundscape indices are rapid to compute and do not need specialist knowledge to check and validate data. We tested the use of two bioacoustic indices on audible recordings (recordings that include all audible sound, including, but not limited to bird vocalisations):

Bioacoustic Index. Higher values indicate a greater disparity between the loudest and quietest bands. Originally designed to reflect the complexity of Hawaiian birdsong, to act as a proxy for relative avian abundance.Eldridge *et al.* (2018) reported strong positive associations between the Bioacoustic Index and avian species richness in UK woodland habitat, and Bradfer-Lawrence *et al.* (2020) report strong associations between Bioacoustic Index and mean avian species richness across a range of habitats in Republic of Panama.

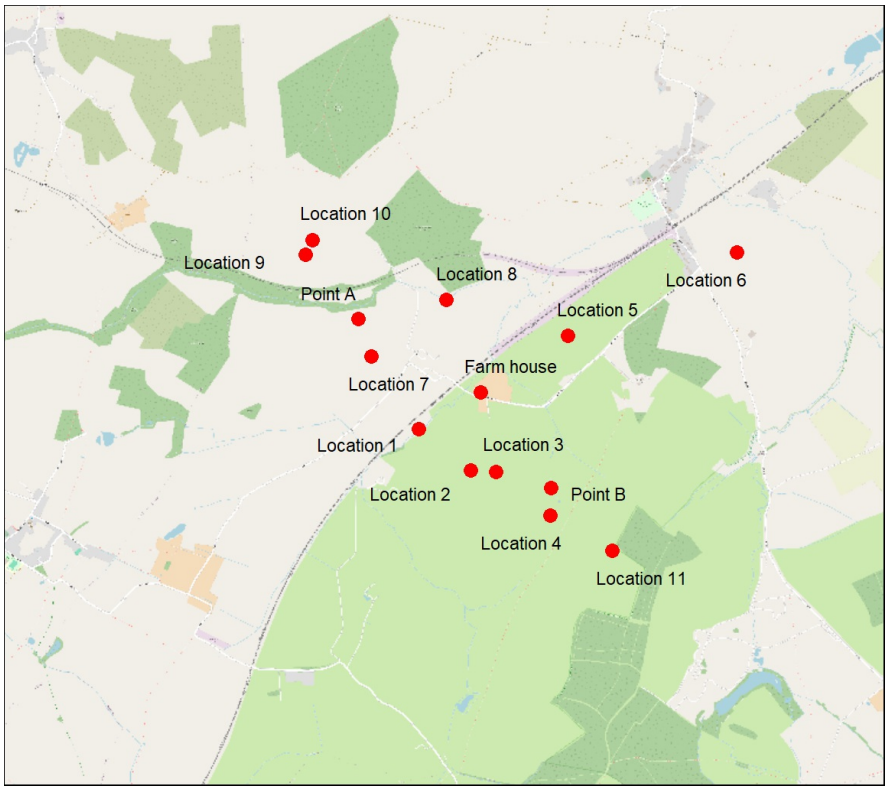
Normalised Difference Soundscape Index (NDSI) Values closer to +1 indicate a soundscape dominated by biophony (biological sounds), values closer to -1 indicates high levels of anthropophony (human sounds e.g. cars, planes). NDSI has been found to be correlated with both biotic and anthropogenic sound diversity in urban settings (Fairbrass *et al*. 2017).

4. RESULTS

4.1 Survey coverage

The distribution of sites surveyed during 2024 are shown below. Collectively across all these sites, 553 days of recording effort was conducted. The recording effort spanned 73 different days and 7 months.

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



4.2 General results

Processing of audible recordings by BirdNET followed by manual verification confirmed the presence of 40 bird species over two sites (Points A and B). In addition to the audible data, following analyses and validation of data collected from 14 sites (all locations in the map above), the ultrasonic recordings were found to include 152,327 bat identifications, and 655 small terrestrial mammal identifications. In addition, 4 species of bush-crickets, and one species of audible moth species was recorded (see tables below). Following validation, the presence of at least 15 bat species, 6 small mammal species, 4 bush-cricket species, and one audible moth species can be confirmed.

In the following tables, we consider conservation status of birds according to Birds of Conservation Concern 5 (Stanbury *et al*. 2021) which assigns species to a Red List and Amber list according to measured population declines

and range contractions. For other species groups we use categories from the IUCN Red List of Threatened Species (www.iucnredlist.org/): Critically Endangered, Endangered, Vulnerable, Near Threatened, and Data Deficient.

The full list of the species detected, the proportion of sites a species was detected and the conservation status.

Birds

Species	No. of different sites (% of total)	Conservation status
Blackbird, *Turdus merula*	2 (14.3%)	
Blackcap, *Sylvia atricapilla*	1 (7.1%)	
Blue Tit, *Cyanistes caeruleus*	2 (14.3%)	
Bullfinch, *Pyrrhula pyrrhula*	1 (7.1%)	Amber
Buzzard, *Buteo buteo*	2 (14.3%)	
Carrion Crow, *Corvus corone*	2 (14.3%)	
Chaffinch, *Fringilla coelebs*	2 (14.3%)	
Chiffchaff, *Phylloscopus collybita*	2 (14.3%)	
Coal Tit, *Periparus ater*	2 (14.3%)	
Dunnock, *Prunella modularis*	2 (14.3%)	Amber
Goldcrest, *Regulus regulus*	1 (7.1%)	
Goldfinch, *Carduelis carduelis*	2 (14.3%)	
Great Spotted Woodpecker, *Dendrocopos major*	2 (14.3%)	
Great Tit, *Parus major*	2 (14.3%)	
Green Woodpecker, *Picus viridis*	2 (14.3%)	
Greenfinch, *Chloris chloris*	1 (7.1%)	Red
House Martin, *Delichon urbicum*	1 (7.1%)	Red
Jay, *Garrulus glandarius*	1 (7.1%)	
Kestrel, *Falco tinnunculus*	2 (14.3%)	Amber
Lesser Whitethroat, *Curruca curruca*	1 (7.1%)	
Linnet, *Linaria cannabina*	2 (14.3%)	Red
Long-tailed Tit, *Aegithalos caudatus*	2 (14.3%)	
Magpie, *Pica pica*	2 (14.3%)	
Marsh Tit, *Poecile palustris*	1 (7.1%)	Red
Nuthatch, *Sitta europaea*	1 (7.1%)	
Pheasant, *Phasianus colchicus*	1 (7.1%)	
Raven, *Corvus corax*	2 (14.3%)	
Redstart, *Phoenicurus phoenicurus*	2 (14.3%)	Amber
Robin, *Erithacus rubecula*	2 (14.3%)	
Rook, *Corvus frugilegus*	2 (14.3%)	Amber
Siskin, *Spinus spinus*	1 (7.1%)	
Song Thrush, *Turdus philomelos*	2 (14.3%)	Amber
Stonechat, *Saxicola rubicola*	1 (7.1%)	
Swallow, *Hirundo rustica*	2 (14.3%)	
Tree Pipit, *Anthus trivialis*	2 (14.3%)	Red
Treecreeper, *Certhia familiaris*	2 (14.3%)	
Whitethroat, *Curruca communis*	1 (7.1%)	Amber
Willow Warbler, *Phylloscopus trochilus*	1 (7.1%)	Amber
Woodpigeon, *Columba palumbus*	2 (14.3%)	Amber
Wren, *Troglodytes troglodytes*	2 (14.3%)	Amber

Bats

Species (/call type)	No. of recordings following validation	No. of different sites (% of total)	Conservation status

Species (/call type)	No. of recordings following validation	No. of different sites (% of total)	Conservation status
Barbastelle feeding buzzes, *Barbastella barbastellus*	27	5 (35.7%)	Vulnerable
Barbastelle social calls, *Barbastella barbastellus*	5	3 (21.4%)	Vulnerable
Barbastelle, *Barbastella barbastellus*	3,839	14 (100%)	Vulnerable
Bechstein's Bat social calls, *Myotis bechsteinii*	2	2 (14.3%)	
Bechstein's Bat, *Myotis bechsteinii*	134	12 (85.7%)	
Brown Long-eared Bat, *Plecotus auritus*	2,000	14 (100%)	
Common Noctule feeding buzzes, *Nyctalus noctula*	103	12 (85.7%)	
Common Noctule social calls, *Nyctalus noctula*	1	1 (7.1%)	
Common Noctule, *Nyctalus noctula*	3,666	14 (100%)	
Common Pipistrelle feeding buzzes, *Pipistrellus pipistrellus*	2,723	14 (100%)	
Common Pipistrelle social calls, *Pipistrellus pipistrellus*	3,286	13 (92.9%)	
Common Pipistrelle, *Pipistrellus pipistrellus*	82,982	14 (100%)	
Daubenton's Bat feeding buzzes, *Myotis daubentonii*	3	1 (7.1%)	
Daubenton's Bat, *Myotis daubentonii*	1,281	14 (100%)	
Greater Horseshoe Bat, *Rhinolophus ferrumequinum*	342	13 (92.9%)	
Grey Long-eared Bat, *Plecotus austriacus*	2	1 (7.1%)	Endangered
Leisler's Bat, *Nyctalus leisleri*	70	10 (71.4%)	Near threatened
Lesser Horseshoe Bat, *Rhinolophus hipposideros*	901	14 (100%)	
Nathusius' Pipistrelle, *Pipistrellus nathusii*	5	4 (28.6%)	Near threatened
Natterer's Bat social calls, *Myotis nattereri*	1	1 (7.1%)	
Natterer's Bat, *Myotis nattereri*	9,091	14 (100%)	
Serotine feeding buzzes, *Eptesicus serotinus*	6	4 (28.6%)	Vulnerable
Serotine, *Eptesicus serotinus*	881	14 (100%)	Vulnerable
Soprano Pipistrelle feeding buzzes, *Pipistrellus pygmaeus*	2,054	12 (85.7%)	
Soprano Pipistrelle social calls, *Pipistrellus pygmaeus*	2,538	14 (100%)	
Soprano Pipistrelle, *Pipistrellus pygmaeus*	16,999	14 (100%)	
Whiskered Bat social calls, *Myotis mystacinus*	1	1 (7.1%)	Data deficient
Whiskered or Brandt's Bat, *Myotis mystacinus or M. brandtii*	20,028	13 (92.9%)	Data deficient

Small mammals

Species	No. of recordings following validation	No. of different sites (% of total)	Conservation status
Brown Rat, *Rattus norvegicus*	36	3 (21.4%)	
Common Shrew, *Sorex araneus*	48	4 (28.6%)	
Eurasian Pygmy Shrew, *Sorex minutus*	258	12 (85.7%)	
Hazel Dormouse, *Muscardinus avellanarius*	320	5 (35.7%)	Vulnerable
House Mouse, *Mus musculus*	1	1 (7.1%)	
Wood Mouse, *Apodemus sylvaticus*	3	3 (21.4%)	

Bush-crickets

Species	No. of different locations (% of total)	Conservation status
Dark Bush-cricket, *Pholidoptera griseoaptera*	7 (50%)	
Long-winged Conehead, *Conocephalus fuscus*	11 (78.6%)	
Roesel's Bush-cricket, *Roeseliana roeselii*	12 (85.7%)	
Speckled Bush-cricket, *Leptophyes punctatissima*	8 (57.1%)	

Moths

Species	No. of different locations (% of total)	Conservation status
Bird Cherry Ermine, *Yponomeuta evonymella*	4 (28.6%)	

Birds, bats and small mammals recorded by site between May-July (early survey) and August-September (late survey). For bats and small mammals we present the average number of recordings / night (rounded to nearest whole number) as a measure of activity. For birds, we present the average number of detections / day (rounded to nearest whole number).

Birds

	Point A		Point B	
	E	L	E	L
Blackbird	1	0	13	0
Blackcap	1	0	7	0
Blue Tit	1	0	1	0
Bullfinch	1	0	1	0
Buzzard	5	0	2	0
Canada Goose	1	0	1	0
Carrion Crow	1	0	1	0
Chaffinch	1	0	27	0
Chiffchaff	7	0	1	0
Coal Tit	1	0	1	0
Common Redpoll	1	0	3	0
Crossbill	1	0	1	0
Cuckoo	4	0	1	0
Curlew	1	0	2	0
Dunnock	3	0	1	0
Garden Warbler	7	0	1	0
Goldcrest	1	0	1	0
Golden Plover	1	0	1	0
Goldfinch	1	0	1	0
Great Spotted Woodpecker	5	0	1	0
Great Tit	1	0	0	1
Green Sandpiper	0	1	0	1
Greenfinch	0	1	0	0
Greenshank	0	1	0	1
Grey Wagtail	1	0	0	1
Greylag Goose	2	7	1	0
House Martin	0	0	1	0
Jay	2	0	0	1
Kestrel	2	0	0	1
Lapwing	0	0	1	0
Linnet	17	0	17	0
Long-tailed Tit	2	0	3	0
Magpie	0	1	0	1
Meadow Pipit	23	0	68	0
Merlin	1	0	1	0
Mistle Thrush	5	0	1	0
Nuthatch	1	0	2	0
Oystercatcher	15	0	1	0
Peregrine	6	0	1	0
Pheasant	1	0	3	0
Pied Flycatcher	3	0	0	1
Pied Wagtail	1	0	1	0
Pink-footed Goose	0	2	0	2

	Point A		Point B	
	E	L	E	L
Raven	1	0	1	0
Redstart	2	0	10	0
Reed Bunting	1	0	1	0
Robin	6	0	1	0
Rook	1	0	1	0
Sand Martin	2	0	1	0
Siskin	1	0	1	0
Skylark	15	0	2	0
Snipe	1	0	0	1
Song Thrush	1	0	1	0
Stock Dove	1	0	1	0
Swallow	1	0	1	0

Bats

	Farm house		L1		L10		L11		L2		L3		L4		L5		L6		L7		L8		L9		Point A		Point B	
	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L
Barbastelle	0	3	1	2	1	1	43	40	143	1	63	75	2	4	2	6	10	0	16	15	2	2	45	140	2	20	64	5
Barbastelle feeding buzzes	0	0	0	0	0	0	2	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	1	0	4	2	0
Barbastelle social calls	0	0	0	0	0	1	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bechstein's Bat	0	2	0	0	1	0	3	0	0	0	1	2	10	1	3	2	2	1	0	1	2	1	1	0	8	2	1	2
Bechstein's Bat social calls	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Brown Long-eared Bat	0	17	1	1	2	7	7	5	5	9	5	28	16	13	18	16	1	2	6	9	11	11	2	7	21	27	23	23
Common Noctule	0	7	7	1	9	59	16	15	14	101	14	70	68	51	37	12	3	1	14	147	38	2	13	24	37	196	5	14
Common Noctule feeding buzzes	0	0	1	0	0	19	1	0	1	3	1	4	6	2	3	0	0	0	2	3	1	0	1	0	2	10	0	2
Common Noctule social calls	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Pipistrelle	0	110	275	91	28	9	1,106	2,666	261	5	224	808	741	349	46	2,053	170	353	86	2,582	160	28	2,337	2,387	146	26	1,850	48
Common Pipistrelle feeding buzzes	0	2	5	0	1	0	41	69	7	0	24	176	27	27	3	26	2	1	12	103	6	2	301	47	5	0	64	2
Common Pipistrelle social calls	0	2	3	1	0	0	51	125	10	1	1	26	22	4	2	42	2	3	2	413	3	2	77	439	2	2	280	0
Daubenton's Bat	0	7	4	2	2	2	8	36	4	2	5	7	26	13	3	27	3	4	3	71	3	2	6	3	2	2	159	2
Daubenton's Bat feeding buzzes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Greater Horseshoe Bat	0	3	2	1	1	1	28	0	12	0	2	13	5	0	23	4	2	1	5	3	4	0	2	0	0	2	0	0
Grey Long-eared Bat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Leisler's Bat	0	0	0	0	0	2	0	0	1	3	0	1	0	0	1	1	0	1	2	0	2	0	0	3	10	9	0	1

	Farm house		L1		L10		L11		L2		L3		L4		L5		L6		L7		L8		L9		Point A		Point B	
	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L
Lesser Horseshoe Bat	0	3	1	0	1	1	16	50	6	0	22	7	1	1	2	3	3	9	10	5	4	1	7	9	2	2	1	0
Nathusius' Pipistrelle	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Natterer's Bat	0	17	5	3	3	9	58	75	89	225	26	17	50	21	48	125	3	5	61	119	81	25	13	43	13	6	15	3
Natterer's Bat social calls	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serotine	0	3	9	5	2	51	16	0	2	5	5	6	3	7	6	7	4	5	6	6	11	5	6	9	13	8	0	7
Serotine feeding buzzes	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0
Soprano Pipistrelle	0	11	4	4	7	7	584	522	38	4	17	133	172	17	31	84	24	23	10	215	7	3	65	33	35	14	152	5
Soprano Pipistrelle feeding buzzes	0	1	1	1	2	0	71	95	2	1	12	82	12	3	4	10	12	1	5	45	4	0	83	9	0	0	0	0
Soprano Pipistrelle social calls	0	4	0	1	0	1	107	422	3	0	1	3	3	3	9	63	1	0	0	14	1	0	1	1	4	10	61	0
Whiskered Bat social calls	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiskered or Brandt's Bat	0	9	4	18	2	2	60	1,405	4	1	36	45	751	66	4	685	4	15	15	1,734	10	17	7	9	0	0	5	1

Small mammals

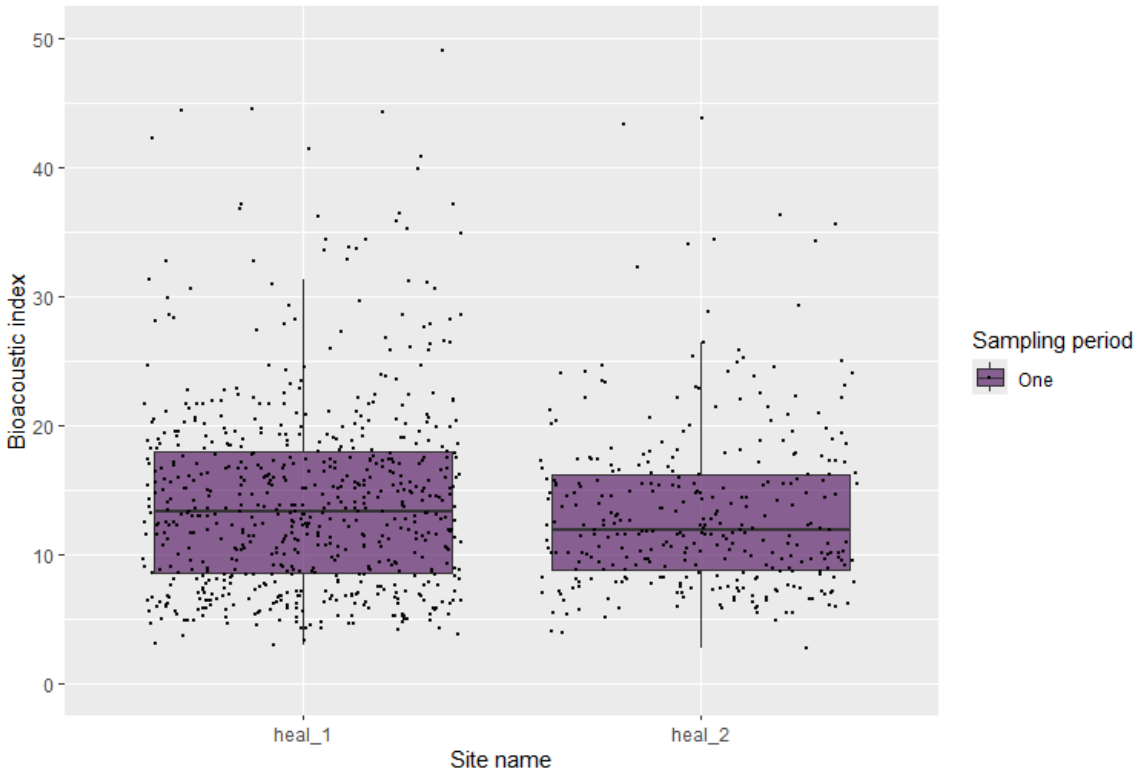
	Farm house		L1		L10		L11		L2		L3		L4		L5		L6		L7		L8		L9		Point A		Point B	
	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L
Brown Rat	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	15	1	0	0	0	0
Common Shrew	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	18	0	0	0	4	6	0	0
Eurasian Pygmy Shrew	0	2	0	0	0	0	4	1	1	2	3	1	8	0	5	0	1	0	6	4	8	4	3	1	19	4	3	5
Hazel Dormouse	0	0	0	0	0	0	1	26	0	0	0	1	0	0	0	0	0	0	1	3	59	0	0	4	25	0	0	0	0
House Mouse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Wood Mouse	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0

The number of species of Birds of Conservation Concern 5 (BOCC5) and IUCN (International Union for Conservation of Nature) Red List species detected overall.

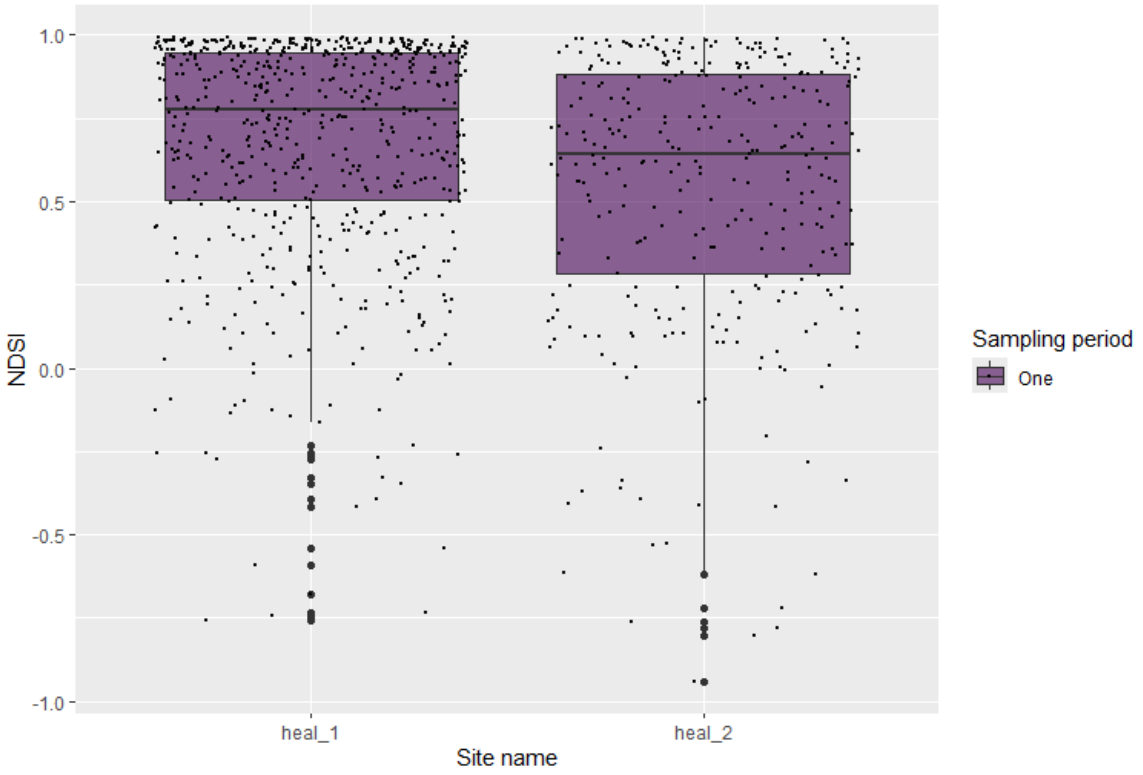
	Number of species
All birds	40
Birds of Conservation Concern 5 (BOCC5) - Red-listed	5
Birds of Conservation Concern 5 (BOCC5) - Amber-listed	10
All bats	15
IUCN Red Listed Threatened Species - Near threatened	2
IUCN Red Listed Threatened Species - Vulnerable	2
All small mammals	6
All bush-crickets	4
All moths	1

4.3 Soundscape indices

The following figure displays box and whisker plots of Bioacoustic Index soundscape indices for two sites at Heal, separated by sampling period. The Bioacoustic Index was calculated for every one-minute low frequency recording at each site. Horizontal lines represent the 25%, 50% and 75% quantiles and all values are plotted using a jitter function so the spread of the data can be seen.



The following figure displays box and whisker plots of NDSI soundscape indices for two sites at Heal, separated by sampling period. The NDSI was calculated for every one-minute low frequency recording at each site. Horizontal lines represent the 25%, 50% and 75% quantiles and all values are plotted using a jitter function so the spread of the data can be seen.



5. CONCLUDING REMARKS

In this report we demonstrate how PAM can be used to collect data over multiple taxonomic groups, including for bats and birds which are key indicators on the Rewilding Monitoring Framework.

If carried out at regular intervals, in the future, these data can be valuable to measure changes in species presence and activity for these taxonomic groups during the rewilding process.

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Images: Common Pipistrelle, by John Black; Bullfinch, by Gray Images / BTO; Bechstein's Bat, by Chris Damant, Bernwood Ecology; Long-tailed Tit, by John Proudlock / BTO.
Cover image: Common Dormouse, by Ruud Foppen.

Passive acoustic monitoring with Heal Rewilding, 2024 – piloting the rewilding monitoring framework

This report presents the main findings from survey work delivered using passive acoustic monitoring devices deployed with Heal Rewilding in 2024. 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 birds, bats, small terrestrial mammals and insects. Through the approach we provide robust datasets that can be used to inform better decision-making processes.

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

Ashton-Butt, A., Hill, D., Higgins, S.L., Wetherhill, A. & Newson, S.E. 2025. Passive acoustic monitoring with Heal Rewilding, 2024 – piloting the rewilding monitoring framework. *BTO Research Report* **783**, BTO, Thetford, UK.

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