

1. Introduction

The BTO Acoustic Pipeline brings cutting-edge sound identification of bats and other nocturnal wildlife to your desktop. It provides the infrastructure to allow audio recordings (wav files) to be uploaded to a secure remote server in the cloud, to be processed to find and identify biological sounds, and to return results back to your computer. The Pipeline has two main parts – a small desktop program that manages the uploading of recordings, and a website where you can review and download results. You will need to register for a BTO online account to access both of these.

The Pipeline currently focusses on **36 species of European bat**, but also identifies **15 small mammal species**, **18 bush-cricket species** and **2 moth species**, where these are recorded as by-catch. Where recorded, **birds** are currently assigned to class (e.g. bird species). We are adding new taxa all the time.



2. Why use the BTO Acoustic Pipeline?

The Pipeline uses different methods to conventional desktop packages which significantly improves the quality and accuracy of the results it will return. In particular:

- The analysis carries out data extraction and analysis using full spectrum data processing, which extracts the maximum information possible from recordings to inform species identification.
- The analysis considers the identification of multiple species where present in a recording, not only the species with the strongest signal, resulting in a greater ability to detect quieter species, such as *Barbastelle*, *Plecotus* and *Myotis* species.

- It is currently the only system that considers the sound identification of bat social calls, reducing the chance of social calls being mis-identified as the wrong bat species.
- It is currently the only system that considers the identification of sounds produced by other species groups, which are often mis-identified as bats, including small mammals and bush-crickets¹. This may be valuable itself for identification of scarce species (e.g. Harvest Mouse *Micromys minutus* and Hazel Dormouse *Muscardinus avellanarius*), or of other interest (e.g. detection of Brown Rats *Rattus norvegicus* on seabird islands)².
- The analysis provides an independent estimate of error in species identification that is more robust than systems that estimate error based on the reference library used to build the classifier, which may not be representative of the species³.
- The analysis flags identifications which are rare or unexpected for the region (UK county or country) to ensure that the user is particularly cautious with unlikely identifications.
- The analysis provides an identification for all recordings, regardless of quality, but provides a warning of low confidence for identifications which we suggest should be discarded.
- Recordings are uploaded and processed 'off-site', freeing you and your computer up to do other things.
- It is unique in providing an easy way for users should they wish to contribute their bat detections to a central online database for improving our understanding of bats in the UK and beyond.
- When requested, projects can be set up, and a project administrator assigned to allow and manage multiple users to upload recordings to a project. Projects can be private and hidden, or public to allow any users to register and take part in a project. This functionality provides support for local atlases and commercial projects. If wanted, a copy of recordings (wav files) can be saved in the cloud for defined period and retrieved later, which may be useful for projects where multiple users are uploading recordings remotely to a project.
- Additional functionality can be provided separately by the BTO for setting up 1-km square sign-up maps for atlas type projects, and for bat detector reservation from hosting centres following <https://www.batsurvey.org/>.

¹ Newson, S. E., Bas, Y., Murray, A. & Gillings, S. 2017. Potential for coupling the monitoring of bush-crickets with established large-scale acoustic monitoring of bats. *Methods in Ecology and Evolution*. DOI: 10.1111/2041-210X.12720

² Newson, S.E., Middleton, N. and Pearce, H. (in press). The acoustic identification of small terrestrial mammals in Britain. *British Wildlife*.

³ Barre, K., Le Viol, I., Julliard, R., Pauwels, J. Newson, S.E., Julien, J-F., Claireau, F., Kerbiriou, C. & Bas, Y. 2019. Accounting for automated identification errors in acoustic surveys. *Methods in Ecology and Evolution* Link to publication View at journal website (DOI: 10.1111/2041-210X.13198)

Recording types allowed

The Pipeline only supports full spectrum wav files recorded in real time. Zero-crossing (zc) recordings are not supported. Time expansion recordings need to be converted to real time before uploading. Dual channel / stereo recordings need to be converted to single channel before uploading.

Importantly: The optimum file length is 5 seconds. We strongly recommend that user define 5 seconds as a maximum file length in the settings for the bat detector before deployment. If recordings of greater than 5 seconds are uploaded, they will be split automatically to 5 seconds by the Desktop App, renamed with the new time before being uploaded, and results produced for each 5 second section. For later auditing / manual checking of recordings it will save you time later, if you set your bat detector to produce wav files that do not exceed 5 seconds in length. See 'Classifier results' below for more discussion on this.

Supported name format of recordings

We support all the main makes of detector (Audiomoth, Batlogger, Peersonic, Petersson, Titley and Wildlife Acoustics), but **importantly please check the requirements for file naming / file format in Appendix 1 before uploading.**

3. Geographic Scope of the Pipeline

The BTO Acoustic Pipeline supports the sound identification of bats across Europe. Regional or country-specific classifiers are used, with additional interpretation to flag identifications of species that are rare or unexpected at a country or UK county scale (see Appendix 2 for a list of species that are currently supported by the Pipeline, including an indication of bat species that we are aware need more work). Please note that the coverage of small mammals and bush-crickets outside the UK is not complete.

4. Registering for an Account

A user can register for an account via the following URL <https://app.bto.org/acoustic-pipeline/public/login.jsp>, and clicking on the '**Don't have an account? Register here**' link.

On doing this a verification email is sent to the registered email address, with instructions to finish setting up your account. On registering all users are given 100 free credits, which is topped up to 100 free credits in each subsequent year. Additional credits can be purchased at any time.

5. The Desktop Client

The Desktop Client manages the uploading of recordings to the cloud (with important metadata) for processing. Uploads can be paused or queued for convenience.

Requirements

- Windows or Apple Mac
- Space (about 12 MB) on hard drive for installing Desktop Client
- Space (see below) on hard drive for temporary saving of wav files during upload.

Importantly if you are uploading e.g. 25 GB of recordings, you will need 25 GB of hard drive space for the temporary storage of a copy of wav files during upload. This is important to be able to resume an upload if paused, or if the internet connection is broken.

The maximum limit for each upload is about 25 GB. For volumes of recordings that are larger than this, it is necessary to split recordings into separate folders, and to treat as separate uploads.

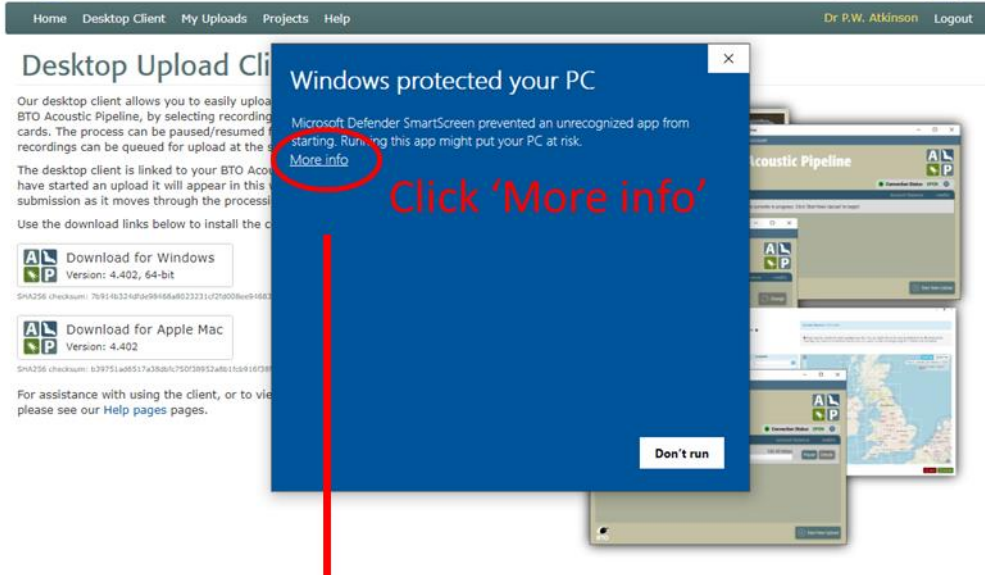
Getting the Desktop Upload Client

To get and install a copy of our Desktop Upload Client, log into our Web Portal (<https://app.bto.org/bat-pipeline/>), and click on the '**Get the Desktop Upload Client**' web link.

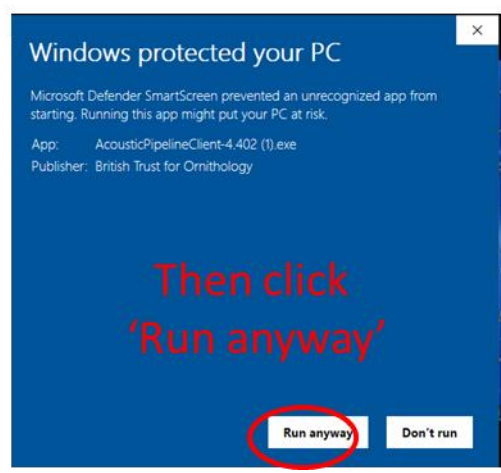
Use the download links provided to install the correct version (for Windows or for Apple Mac) for your computer.

Troubleshooting. Windows Defender says the file might be harmful and not to run it (or other problem in installing)

We are aware of this issue which occurs on PCs (but not Apple Macs). The Desktop Upload Client has been registered with Microsoft and is safe. However, Windows Defender, which protects your computer against viruses etc, will only stop highlighting any new apps once they have been downloaded 3,000 times. The image below is from Windows 10, other versions may vary. Some browsers may also show a similar message. Please click to save the app anyway.



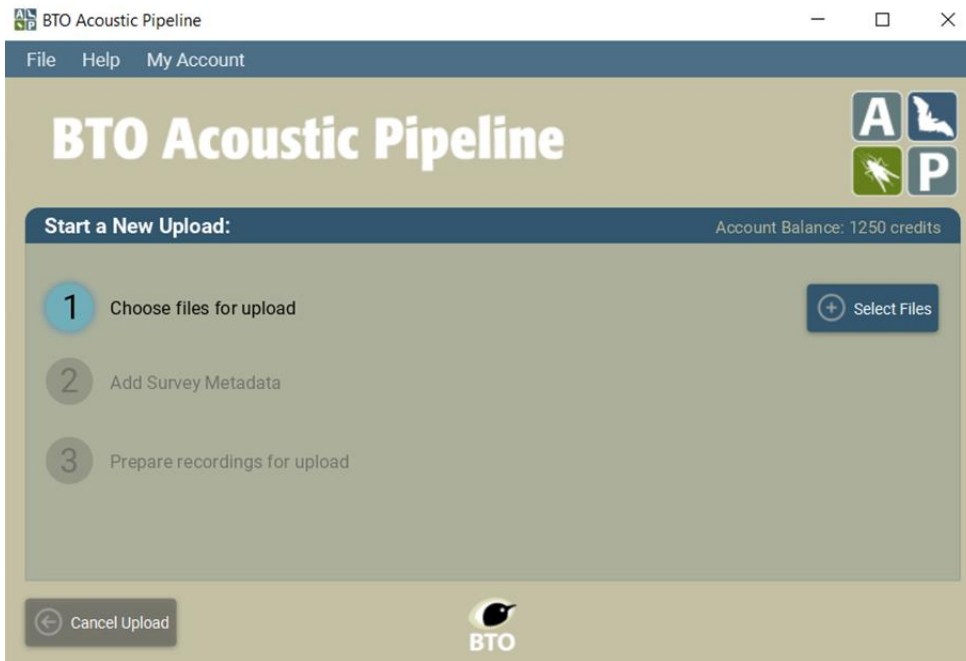
Contact Us | Jobs | Terms & Conditions of use | Privacy Statement | Cookies
© British Trust for Ornithology, BTO, The Nunnery, Thetford, Norfolk IP24 2PU
Tel: +44 (0)1842 750050 Fax: +44 (0)1842 750030 Email: info@bto.org
Registered Charity Number 216652 (England & Wales), SC039193 (Scotland).



If you are not given the above option, and still cannot download the Desktop Upload Client, it is possible that the security settings associated with your browser are preventing download. To address this, please go to your internet browser and settings > advanced > privacy and security > safe browsing – turn that off. Then try again to download the Desktop Upload Client. Once you have downloaded the desktop app, go back to security as above, and turn on safe browsing.

Uploading recordings for processing

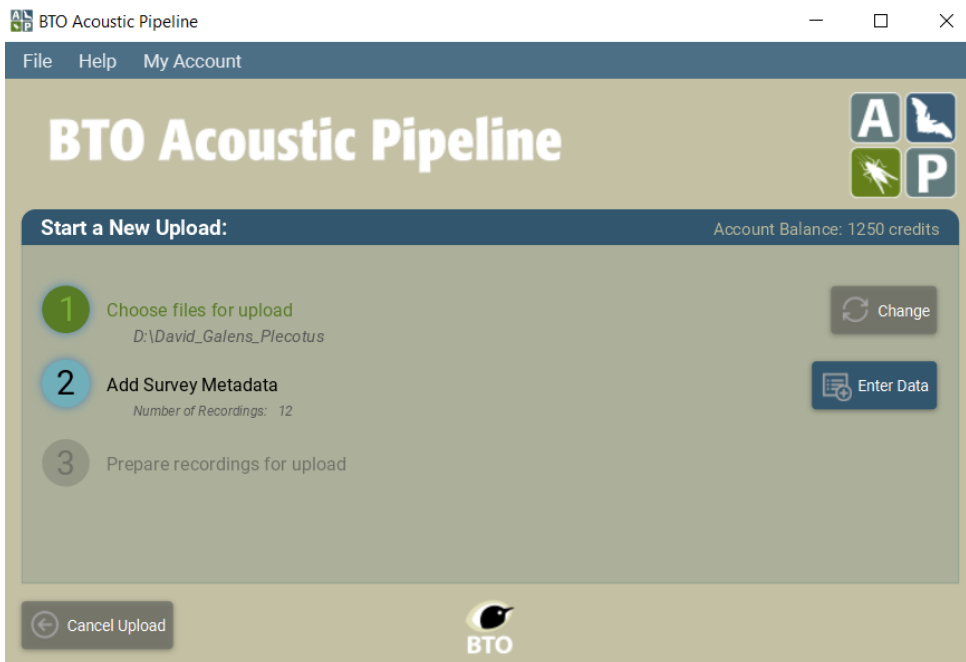
1. Click on the **'BTO Acoustic Pipeline'** icon to open the Desktop App.
2. When requested, enter your email address and password to Log in.
3. Click on **'Start New Upload'** button. This brings up the following screen.



4. Next to '**Choose files for upload**', click on '**Select Files**' button.

5. Select the folder than contains the recordings that you want to process [note that you are not able to select individual wav files within a folder].

Note that the wav files in the selected folder are not shown by the Windows version of the App. This is not a problem.



6. Next to '**Add Survey Metadata**', click on '**Enter Data**' button.

7. Recording Survey Metadata.

This section allows the user to provide an (optional) **Upload Name** to be provided with the results.

Users are also asked to assign the recordings to a **Project**. By default, there are two projects. **Citizen Science – shared** [upload cost: 1 credit per GB], and **Commercial – confidential** [upload cost: 7 credits per GB].

Where the user is happy for the BTO to use the results and recordings on a per upload basis, the pipeline can be used at a reduced rate / cost [1 credit per GB]. To cover the costs of the system, and to ensure that the Pipeline is sustainable and can continue to develop, the conversion rate of credits to GB is higher where it is important that the results and recordings remain confidential [7 credits per GB].

It is also important to ensure that the correct **Latitude** and **Longitude** are provided. The selected Project and Latitude and Longitude must be correct to ensure that the correct regional classifier is applied to the recordings, and that identifications of species that are 'rare or unexpected' at a county level or country are flagged. If the location is embedded in the wav file (using GUANO metadata), this information is pulled out automatically, otherwise the latitude and longitude will need to be inputted. A map facility is provided to help users.

Once you have completed the Survey Metadata, click on '**Save Data**'

BTO Acoustic Pipeline

Survey Metadata

Upload Name: Upload Size: 3.2GB

Project: Upload Cost: 3 credits

Account Balance: 1250 credits

Please specify a lat/lon for each recording (wav file). You can select this via the map by clicking on the location pin button on the recording row. Once you've entered a lat/lon, you can copy it to other recordings using the ... button that will appear.

Filename	Survey Date	Latitude	Longitude	
2020-06-11 22-25-40_00000_000_Pleaus.wav	11/06/2020	49.46276	-2.53876	...
2020-06-11 22-37-18_00000_000_Pleaus.wav	11/06/2020	49.47152	-2.55176	...
2020-06-11 23-51-26_00000_000_Pleaus.wav	11/06/2020	49.46073	-2.54108	...
2020-06-11 23-51-36_00000_000_Pleaus.wav	11/06/2020			📍
2020-06-11 23-57-40_00000_000_Pleaus.wav	11/06/2020			📍
2020-06-11 23-57-54_00000_000_Pleaus.wav	11/06/2020			📍
2020-06-12 00-08-47_00000_000_Pleaus.wav	11/06/2020			📍

Map controls: Road Map, Satellite Map, Zoom to postcode, grid reference or lat/lon, Lat/Lon: 49.46300, -2.55798, Gridref: WV3213279239 (WV3279)

Buttons: Cancel, Save Data

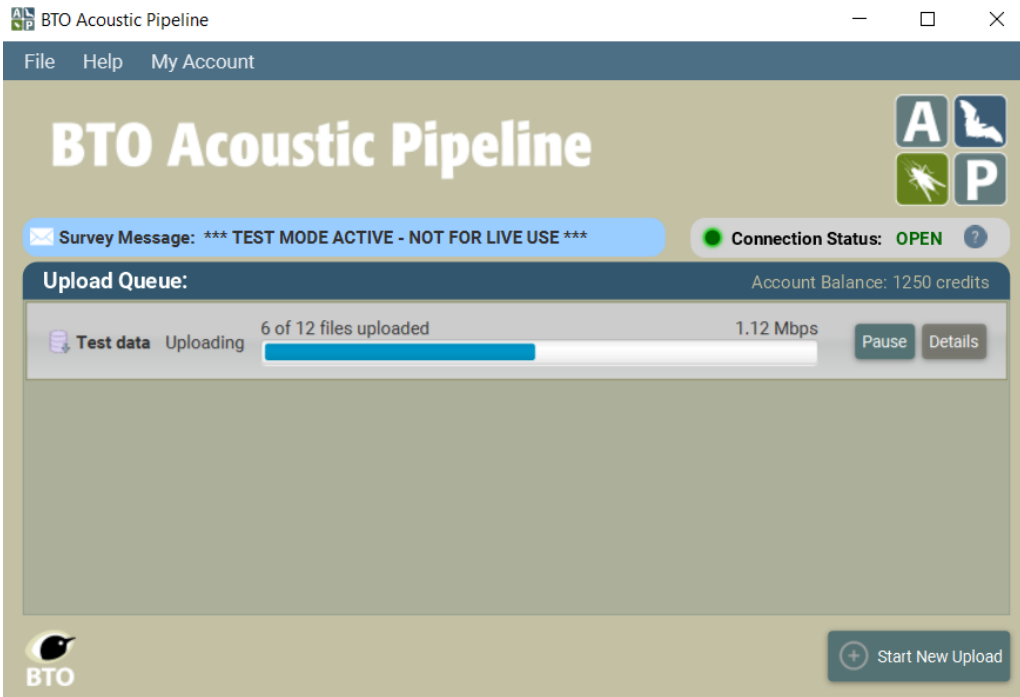
8. Preparing recordings for upload

Now click on '**Prepare Recordings**'. You are now given the option to '**Create personal copy of recordings (optional)**'. This needs some explanation.

If your recordings do not exceed 5 seconds in length (as recommended), saving a copy of your recordings will produce a duplicate set of recordings. However, if your recordings exceed 5 seconds, they will be split to 5 seconds wav files. It in this case, it may be useful for the user to save a copy of the recordings for later auditing.

Now click on '**Start Upload**' to start the upload process.

9. Uploading recordings



The Desktop App shows the progress of the upload. You can Pause and Resume the upload at any point, or if there is a break in internet connection. You can also start another new upload, before the current upload has completed, which will be put in a queue to upload once the first upload has completed.

Note that the speed of upload can be very different depending on the speed of the user's broadband.

Once recordings have uploaded, you can close the Desktop App. You do not need to do anything else. You will be emailed once the recordings have been processed, and the results are ready to view. Results are normally returned within a few hours after uploading. Once processed, you will be emailed to let you know that processing has completed, and the results will be accessible then via the web portal <https://app.bto.org/bat-pipeline/>.

6. The web portal and survey results

Home Page

After logging into the Web Portal, the following default options are available from the Home Page.

- My Account – [to view and update account details](#)
- Get the Desktop Client – [to get the Desktop Client through which recordings are uploaded](#)
- My Uploads – [to view your survey results](#)
- Take part in projects – [to register to take part in a public project if available for your area](#)

Data Home

Welcome to the BTO Acoustic Pipeline! From here you can download the desktop upload client, view the status of your uploads, download the classifier results for your recordings, and take part in citizen science projects. Find out more about the pipeline and its processes in our help pages.

Get started by downloading the desktop client to manage the upload process, queue multiple sets of recordings from your PC or memory cards, and pause/resume the upload as needed. Visit the Take Part in Projects page to contribute to various projects by uploading relevant recordings to be analysed as part of their datasets.

My Stats

Data Processed
486.9MB
Currently Processing: 0 Bytes

Files Processed
3,371
Currently Processing: 0 files

Records Identified
3,076
Number of species IDs classified in recordings *

Citizen Science - not confidential *

Bats	1,661 records 16 species	Bush Crickets	149 records 4 species
Small Mammals	9 records 5 species	Birds	84 records
Other species	0 records		

All Records *

Bats	2,543 records 16 species	Bush Crickets	283 records 4 species
Small Mammals	139 records 7 species	Birds	111 records
Other species	0 records		

* Stats are for records with a classification probability of 0.5 (50%) or greater.

Dr S E Newson

Account Balance: 1250 credits [Buy Credit](#)

- My Account
- Get the Desktop Client
- My Uploads
- Take Part in Projects
- Help & Support
- Pipeline Management

Project Management

- Citizen Science - not confidential
- Natuurpunt Bat Working Group
- Norfolk Bat Survey
- Test Private Project

My Uploads

Once recordings have been processed the survey results can be assessed from the **My Uploads** page.

The Classifier Results can be downloaded as a csv file by clicking on **'Download'** under **Classifier Results**. The csv includes all results (one line for each wav file and species identified – so there may be more than one line for a wav file if multiple species are present in a recording), regardless of the confidence associated with the identification. In addition, a line in the csv file is provided for every wav file, for the user to see where no species identifications are made.

*Currently in development, further interactive visualisations of the results **'Results Output'** will also be produced for each upload. These visualisations will not include results that are flagged with a warning. Warnings include identifications where there is 'low confidence' in the identification being correct, or for species which are flagged as being 'Rare or Unexpected' for the county / region.*

Following Barre *et al.* (2019), **we recommend that identifications flagged as being of 'low confidence' are discarded.** However, all results are included if the user wishes to check these for their own peace of mind. Users should also be particularly cautious when considering identifications which are flagged as 'rare or unexpected' for the region. Identifications flagged with a warning in the csv are not included in the visualisations.

The status column shows uploads that have processed correctly = **'Processed'**; uploads where no identifications were made = **'Complete'**, and uploads where there was an error for some reason with the processing - **'Error'**. Clicking on **'Error'** may provide more information on why the processing failed.

My Uploads

The table below shows the status of your uploads to the BTO Acoustic Pipeline, along with links to the classifier results and visualisations.

[Refresh Status](#)

Show uploads

Upload Date	Upload Name	Survey	Nights	WAV Files	Size	Cost	Status	Classifier IDs	Classifier Results
25/11/2022 16:38:05	new test Key: 202211251638QV/Q062Q	System Test Project	2	2	4.1MB	1	Processed	2	Download
25/11/2022 16:35:16	Tenerife test Key: 202211251635V/H690LJ	System Test Project	1	8	14.5MB	1	Processed	6	Download
25/11/2022 16:33:39	No ID test Key: 202211251633TY/V3E6R	System Test Project	1	4	5.9MB	1	Processed	0	No IDs found
25/11/2022 14:19:34	Test 4 - Tenerife Key: 20221125141981981W0X	System Test Project	1	8	14.5MB	1	Processed	6	Download
25/11/2022 14:16:51	Test from Italy Key: 2022112514165146QE/DK7HT	System Test Project	1	3	7.3MB	1	Processed	6	Download
25/11/2022 14:16:00	Unknown wav file Key: 20221125141600467K/214K1	System Test Project	1	1	2.8MB	1	Processed	1	Download
25/11/2022 14:15:21	Test 1 - Daubenton's ... Key: 202211251415214153RW/98WH2	System Test Project	1	1	1.8MB	1	Processed	2	Download
22/11/2022 15:39:40	Myonat Key: 202211221539VE/48UG6	System Test Project	1	1	2.8MB	1	Processed	1	Download
20/11/2022 18:08:02	Tenerife Key: 2022112018081UF68T9Z	System Test Project	1	8	14.5MB	1	Processed	6	Download
16/11/2022 16:54:38	Key: 202211161654N/CLOQR1	System Test Project	1	1	2.3MB	1	Processed	1	Download
02/11/2022 13:41:49	Key: 20221102134139500FFO	System Test Project	1	4	6.4MB	1	Processed	4	Download
02/11/2022 13:39:49	test Key: 202211021339JTF2ZLN	System Test Project	1	2	3.2MB	1	Processed	2	Download
02/11/2022 11:21:42	GWTS test Key: 20221102112142F37UOSJ	System Test Project	2	10	21.0MB	1	Processed	10	Download
26/10/2022 18:42:18	Leisler's social Key: 2022102618424355A81LU	System Test Project	1	2	4.1MB	1	Processed	2	Download

Classifier Results

A csv containing the results from each upload can be downloaded under the column **Classifier Results**. This file contains the following fields.

FIELD	EXAMPLE	COMMENTS
RECORDING FILE NAME	52~4066309+0~7521987_20190724_214153.wav	Name of wav file as recorded in our pipeline
ORIGINAL FILE NAME	20190724_214153.wav	Original file name
ORIGINAL FILE PART	1	Section number of long wav files split for processing
LATITUDE	52.4066309	
LONGITUDE	0.7521987	
SPECIES	Barbar	Six letter species code
SCIENTIFIC NAME	Barbastella barbastellus	
ENGLISH NAME	Barbastelle	
SPECIES GROUP	Bat	
PROBABILITY	0.95	
WARNINGS	Rare or unexpected	Where the user needs to be particularly cautious
ACTUAL DATE	19/05/2020	
SURVEY DATE	18/05/2020	The recording night
TIME	01:34:51	
CLASSIFIER NAME	ClassifEspGBR-EST2020-0912_1	Regional classifier used for version control
USER ID	SNEWSON	
UPLOAD KEY	202211021121F237UOSJ	A unique key that is specific to the upload
UPLOAD NAME	Garden recordings	Any name given by the user to an upload
SURVEY NAME	Commercial – confidential	The name of project

Where multiple species are identified in a wav file, each identification is returned as a separate line in the csv.

Please note: if you upload long recordings of over 5 seconds, these will be split into 5 second sections before being processed. Each section (ORIGINAL FILE PART) will be numbered (e.g. 1...3) and results returned for each section of the original wav file. If you see that your recordings needed to be split (i.e. in your results if you see any numbers other than 0 in the ORIGINAL FILE PART), please consider changing your bat detector settings to define the maximum file length to be 5 seconds. This will make the process of auditing your results / recordings much easier for you and will reduce the number of identifications that are returned with 'low confidence' or 'No_ID'.

7. Verifying results from the BTO Acoustic Pipeline

A robust process for auditing / verifying the results from the BTO Acoustic Pipeline should be carried out by an experienced bat acoustics analyst before the results are used. To provide some guidance on this, the following approach has been designed to maximise the quality of the dataset whilst minimising time spent in auditing.

1. Error in species identification

- In using the BTO AP, it is important to understand what the **PROBABILITY** returned by the pipeline relates to. Specifically, it 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.

2. Suggested auditing approach

The BTO AP returns all results, regardless of the assigned **PROBABILITY**. This is so users can make their own decision on what to audit. However, the recommendation is that identifications with a probability of less than 0.5 (50%), as supported in Barre *et al.* (2019), are discarded (but depending on the project these may be checked or a sample of these checked).

To facilitate rapid auditing, it is recommended that a copy of recordings which have been assigned to species are (potentially) copied into three main folders:

- **Folder 1.** Copy of recordings into separate species folders where probability ≥ 0.5 (50%)
- **Folder 2.** Copy of recordings into separate species folder where probability < 0.5 (<50%)
- **Folder 3.** A random sample of recordings where no species were identified.

The BTO AP offers an R shiny app to support the above. Specifically, it can read in the results (selected csv file/s) produced by the BTO AP. By then selecting where a copy of the recordings are located, the app will put a copy of recordings into separate species folders based on the results, and what you select to verify (see below for more information on the R Shiny App).

- All recordings in **Folder 1** to be checked. The exception is where there are tens of thousands of recordings of a species, when a random sample should be subject to manual auditing to quantify the error rate for the species. For a large dataset, checking a random sample of 1,000 recordings for a species should be sufficient to obtain a robust estimate of the identification error rate, but it may be possible to justify auditing a smaller sample of recordings, where it has been demonstrated that the error rate for the species is very low and / or depending on the project, where the level of error has few implications (e.g. potentially for common pipistrelle). In all cases, the error rate should be presented e.g. 5 of 1,000 common pipistrelle recordings (0.5% of recordings) were assigned to the wrong species. If on checking a random sample of recordings, the error rate is high, and there are important implications for misidentifying this species, it may be necessary to audit all recordings of the species.
- The BTO AP recommends that recordings in **Folder 2** are discarded, but depending on the project, recordings from **Folder 2** may be checked or a sample checked, to demonstrate or provide peace of mind that the classifier is missing very little that could be assigned by any means to species. Just to reiterate, the thresholds used and the focus here is on species identification. As above, if there are a large number of low confidence identifications for a species, a random sample may be selected for auditing as above, and the error rate presented.

- Depending on the project, a random sample from [Folder 3](#) could be checked, to demonstrate that the classifier is missing very little that could be assigned to species by any means (and to be able to quantify the error rate / the false negative rate).
- Note that as the BTO AP returns results for more than one bat species if present in a single .wav file, a copy of the wav file may go into more than one of the species folders. Auditing should check whether the 'assigned' species is correct (easier than checking every species identification if there are multiple species present in the recording).

If the results include species identifications that are rare or unexpected for the location or region, we recommend that these identifications are supported with further evidence that defines the basis on which the identification was made. The following report provides some examples of how this could be approached <https://www.bto.org/our-science/publications/research-reports/bailiwick-bat-survey-2021-report>.

3. BTO Acoustic Pipeline Tools - R Shiny App

An R Shiny App to support auditing / verification has been made available to support users of the BTO AP <https://github.com/BritishTrustForOrnithology/BTOAcousticPipelineTools>.

Requirements

You will need R installed on your computer. We have tested the app on R versions 3.6.1 and 4.2. You do not need to have RStudio installed but if you are familiar with it this, it may be an easier way to run the code.

You will need the following R packages installed. If you are not familiar with installing R packages we have provided a configuration program (see below). You will only need to run this once. Required packages = shiny, shinyAlert, shinyFiles, shinyjs, devtools, tidy, DT and guano. Note that guano needs to be installed from Github; the rest can be installed from CRAN (see below).

Installation

- Open R, either directly or through RStudio.
- Download the app code: click the green "Code" button above and select Download ZIP.
- Save and unzip the download. Remember where this is, as you will need to navigate to it to run the app.
- From R or RStudio open the script file called 'code/configure_local_machine.R'. Run this script to install/update the required R packages. This only needs to be done once on each computer (though you may need to repeat it if you update R).

Usage

To run the app, with R/RStudio open, open the script file called 'launch_shiny_app.R' and run it. You should not need to change any of the code, but if you are experienced with R and move the 'app.R' file you will need to update path_to_app so that it points to where 'app.R' is located.

Running the 'launch_shiny_app.R' will open the app in a new browser window.

Purpose

This utility is to assist and save users time when auditing identifications provided by the BTO Acoustic Pipeline. The utility can be configured to copying wav files into folders according to the species identified in each sound file (as detailed in the Pipeline results csv file). Copying methods can be adjusted per species to select identities above certainty thresholds, highest scoring identities per survey location, or in order to return a random samples. The last option is useful for very common species and noise (No ID) classes and allows the calculation of identification error rates for the random sample: a low error rate from the random sample may justify not checking all clips for common species.

Step 1: Import Pipeline Results

Select one or more Acoustic Pipeline results csv files. Hold down Ctrl/Command key to select multiple files

Select files

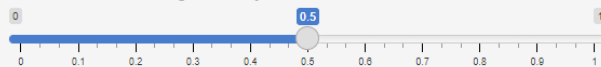
E:/ta_files_archive/SCI/2022/classifier_results1.csv
E:/ta_files_archive/SCI/2022/classifier_results2.csv

Import results

Step 2: Analyse and check sample sizes

Obtain a list of species detected in this dataset and based on a threshold probability set using the slider below, determine the number of audio files of High and Low certainty. We recommend using a threshold of 0.5 but this can be tailored to your situation.

Set threshold for low/high certainty:



Analyse recordings

Diagnostics

Number of results files read: 2
Initial number of records: 446256
Number of records after deduping per species/file: 445759
Initial number of 'No ID' records: 0
Remaining number of 'No ID' records after removing for files with positive IDs: 0
Final number of records: 445759

Species summary

Number of detections by species group, species and ID certainty. If necessary, adjust the probability threshold using the slider and press Analyse recordings to re-run. Files and folders will be made on the basis of the Copy method selected for each species/identity:

- None: no wav files will be copied for this species
- Top hits: for each location and survey night, the x wav files with highest probability will be copied
- High certainty only: all wavs files with probability exceeding the threshold
- High & Low certainty: all wav files for the species, split into High and Low folders according to threshold probability
- Random sample: a random sample of x wav files will be created, separately for High and Low certainty recordings

Group	Species	Species Code	Low	High	Copy Method
bat	Daubenton's bat	Myodau	118	41	High certainty only
bat	Whiskered bat	Myomys	0	2	High certainty only
bat	Natterer's bat	Myonat	6	3	High certainty only
bat	Leisler's bat	Nyclei	10	1	High certainty only
bat	Common noctule	Nycnoc	20	35	High certainty only

8. Advanced: projects and project management

When requested, projects can be set up, and a project administrator/s assigned to allow and manage multiple users to upload recordings to a project. New projects need to be set up via a request. To obtain a quote please email acoustic.pipeline@bto.org. There is no additional cost to set up a project, but the quoted cost will depend on whether the project is best defined as **commercial - confidential**, or **citizen science - shared**, the number of credits initially assigned to the project (based on estimate of likely GB of wav files), and whether there is a need for a copy of recordings (wav files) to be stored in the cloud for later retrieval.

Projects can be private and hidden, or public to allow any users to register and take part in a project. This functionality provides support for local atlases and commercial projects.

Once set up, anyone can register to take part in a **Public Project**. This may be useful for some volunteer projects, where there is no need to restrict the number of people taking part. In both cases, one or more **Project Organisers** are set up, who are responsible for the project, with access to Project Management to manage who takes part, and to have access to results for the project.

To take part in a **Private Project** it is necessary for the individual to first register for an BTO account, and to then provide the Project Organiser with their registered username. A Project Organiser of the project can then invite the user to take part. This is useful where it is necessary to control who can upload recordings to a project.

If you have multiple fieldworkers involved in the same project, there are several advantages of setting up a BTO AP project in the system to support this:

- Recordings can be uploaded remotely by multiple fieldworkers to the same project. A Project Organiser/s can see who is uploading recordings, and all the results for a project as recordings are processed.
- Various visualisations, including summaries of species recorded, timing of activity in the night, maps etc.) of results are produced automatically, and updated weekly for every project. Who has access to view visualisations can be defined on a project basis, as well as the resolution of the mapped data (e.g. https://app.bto.org/acoustic-pipeline/results/project/project_results_choice.jsp?code=CSC)
- Optionally a copy of the recordings (wav files) can be saved in deep glacial storage following processing for a defined term (e.g. for the survey season) and pulled back later for auditing. Recordings are saved in folders named according to a unique upload key. Having recordings saved in the same standard format reduces the need for data cleaning before auditing, which is often needed if data is collated manually from different fieldworkers.

[Back to Organise Project](#)

Bailiwick Bat Survey - View Uploads

Use the filters below to view uploads to the Bailiwick Bat Survey.

Upload Month: Year:

Show project uploads

[Download Classifier Results](#)

Upload Date	Upload Name	User	Nights	WAV Files	Size	Cost	Status	Classifier IDs	Classifier Results
31/10/2022 20:01:55	20th October <small>Key: 202210312001588VD46K</small>	MJL2022	2	5382	9.0GB	10	Processed	191	Download
31/10/2022 12:44:47	WA60095W-2 <small>Key: 202210311244475RFLF6</small>	RMANZARU8	2	5847	7.1GB	8	Processed	5060	Download
31/10/2022 12:27:16	WA58075W-2 Pt2 <small>Key: 202210311227163UJUDK</small>	RMANZARU8	2	3276	9.0GB	9	Processed	123	Download
31/10/2022 12:14:19	La Belleuse Farm <small>Key: 20221031121419V8V9</small>	BATSURVEY	4	3036	5.9GB	6	Processed	2651	Download
31/10/2022 11:42:45	2 RUE DE ROUGEVAL ... <small>Key: 202210311142258RJC5B</small>	MARYCS	5	1605	1.9GB	2	Processed	432	Download
30/10/2022 19:12:13	2 REBOUQUETS WV3... <small>Key: 202210301912134FVUJZF</small>	MARYCS	6	3653	6.2GB	7	Processed	306	Download
30/10/2022 18:28:47	2 RUE GODFREY <small>Key: 202210301828476RWC5D</small>	MARYCS	4	276	548.6MB	1	Processed	41	Download
30/10/2022 16:48:04	WA60095W-2 Pt2 <small>Key: 202210301648045R54F</small>	RMANZARU8	2	4913	5.6GB	6	Processed	3604	Download
30/10/2022 16:38:22	WA58075W-2 Pt3 <small>Key: 202210301638223R7UJUG</small>	RMANZARU8	1	2569	7.6GB	8	Processed	31	Download
30/10/2022 16:23:12	Renoir Walk Oct 22 <small>Key: 202210301623123R8V8V</small>	PUDGELLS	4	2758	4.3GB	5	Processed	2111	Download
30/10/2022 15:59:46	WA56085E-2 <small>Key: 2022103015594640VGA</small>	RMANZARU8	4	746	929.7MB	1	Processed	95	Download
30/10/2022 14:12:39	Casquets La Villaze <small>Key: 20221030141239R8RQ2S</small>	CASQUETS	3	195	279.6MB	1	Processed	104	Download
30/10/2022 12:14:08	Grasmere Garden <small>Key: 202210301214084FL7C2VC</small>	JPNICOLLE	1	107	162.5MB	1	Processed	38	Download

Appendix 1. Supported name format of recordings

Bat detectors are increasingly moving toward embedding metadata associated with e.g. the recording location, date and time in the wav file, using GUANO Metadata, which is a universal, extensible, open metadata format for bat acoustic recordings.

For the following detectors, we can pull metadata directly from the wav file

- Titley Scientific (*Anabat Swift, Walkabout and Chorus – but see comments below on the Chorus*)
- Batlogger (all detectors – with latest firmware)
- Wildlife Acoustics (*Song Meter Mini Bat*)

For the following detectors, it is important that wav files are named as described below.

Audiomoth

It is important to use the more recent Audiomoth firmware (at least version 1.2.2), which adds date and time to the wav file name. With the Audiomoth, it is important to be aware of some additional challenges for some species groups, most notably *Myotis* and *Rhinolophus* species, because the microphone does not perform as well as a commercial bat detector at higher frequencies. The consequence of this, is that there is often attenuation / loss of the weaker ends of the calls, which are important for species identification. The Audiomoth also often produces self-noise artefacts in the recordings, which can also reduce the performance of the pipeline. For the Audiomoth, we also recommend that a sample rate of 384 kHz is used. Without an anti-aliasing filter, there are important problems of clipping if using a lower sample rate, which will reduce the performance of the pipeline. Lastly, if you were thinking about putting your Audiomoths in plastic bags to record, don't.

YEARMMDD_HRSMINSSECS.wav

Examples: 20200501_195401.wav
 #####_20200501_195401.wav (with user defined prefix)
 #####_20200501_195401_#####.wav (with user defined prefix and suffix)

Batlogger (recorded using old firmware)

Batlogger recordings do not have date and time in the name e.g. 10160435.wav. Instead, there is an associated 10160435.xml file with DateTime in the following format e.g. 28.04.2010 21:31:29 along with other metadata. It is essential that the associated xml files are present in the folder with the wav files.

Example: 10160435.wav (with associated xml file 10160435.wav)

Peersonic

If possible, use the 'READ RPA' software available from Peersonic to add date and time to the name of the wav files when copying recordings from the SD card in detector to a computer.

wav####_YEAR_MM_DD_HRS_MINS_SECS.wav (The #### part is the number of the file, starting at 0)

Examples: 2018_07_04__22_58_14.wav
Wav0123_2008_07_04__22_58_14.wav

Alternatively, Peersonic recordings can be renamed with date and time at any time using 'Advanced Renamer' www.advancedrenamer.com/, a free batch file renaming utility for Windows, as follows:-

Add files

1. First you need to add some files to the list. Click the *Add* menu item above the file list.
2. In the dropdown list pick *Files* and a dialog for opening files appear.
3. Select the files you would like to rename and click *Open*.

Setup renaming methods

4. Now you need to setup how the files should be renamed. This is done in the left part of the program where it says *Renaming method list*.
5. Click the button *Add method* and select a method in the appearing window. Select 'New name method', and next to "Apply to" select "Name and extension"
6. In the box called *New Name*, ensure that any text in the box has been deleted, and type or copy the following script.

<Substr:1:6>_<year Modified>_<Month Modified>_<Day Modified>_<Hour Modified>_<Min Modified>_<Sec Modified>.wav

7. If you look in the column called *New Filename* you can see the new filename each file will have.

Start renaming

8. Click the button *Start Batch* in the top of the window to rename recordings.

Petersson (several makes)

For D500x and D1000 detectors, it will be necessary to use BatSound or facility provided by Petersson for this purpose to rename recordings with date and time before uploading.

###YEAR-MM-DD_HRS_MINS_SECS###.wav

Examples: 2010-08-26_10_39_50.wav
ABC2010-08-26_10_39_50_M00667DEF.wav (with user defined prefix and suffix)

Wildlife Acoustics (all makes except Songmeter Mini Bat)

For the SM4Bat FS and Song Meter Mini Bat we suggest setting the gain to 0 db rather than the often recommended 12 db to reduce the change of clipping. If using an Echo Meter Touch, it is important to switch save noise files to off, particularly if you are interested in the sound identification of species groups other than bats.

YEARMDD_HRSMINSSECS.wav

Examples: 20200501_195401.wav
#####_20200501_195401.wav (with user defined prefix)
#####_20200501_195401_#####.wav (with user defined prefix and suffix)

Titely (Swift, Scout, Walkabout and Chorus)

All Titely bat detectors use GUANO Metadata to embed recording location, date and time in the wav file, so are straightforward to use with the Pipeline.

However, we have a couple of recommendations. The first is to set the maximum file length (Max. File Time) to 5 seconds. If this is not implemented the Acoustic Pipeline will cut longer recordings into 5 second chunks (see here in manual). The significance of this is that when Titley recordings are edited in this way, encryption added by Titley to allow free use of their analysis software Anabat Insight is lost. Thus, audio stored in the Pipeline's cloud storage area and retrieved later cannot be opened in the free version of Anabat Insight. Ensuring a maximum file length of 5 seconds removes this issue.

The second recommendation for users of the Chorus and Swift is to disable the 10 kHz High Pass Filter. When enabled, this filter attenuates signals below 10 kHz. This removes parts of the sounds produced by some birds, leaving a residual signature that can be mistaken for certain small mammal species. So, if you have an interest in small mammal species, disabling the filter will allow the Acoustic Pipeline to correctly identify small mammal species.

If you are specifically interested in the sound identification of small terrestrial mammals, we would also recommend using a Minimum Frequency of the Trigger (Min. Freq.) of about 12 kHz, which is lower than might typically be used for bats in the UK and in many parts of Europe. However, if you are not interested in small terrestrial mammals, we would advise against lowering the minimum trigger, because a lot of other sounds, including more bird song will be recorded, which will result in a significant increase in the volume of recordings (in GB) that are collected.

Appendix 2. Taxonomic scope.

The Pipeline currently focusses on **36 species of European bat**, but also identifies **15 small mammal species, 18 bush-cricket species and 2 moth species** where these are recorded as by-catch. Where recorded, **birds** are currently assigned to class (e.g. bird species). We are adding new taxa all the time. We highlight species in red that we are aware need more work.

GROUP	SCIENTIFIC NAME	ENGLISH NAME
bat	Barbastella barbastellus	Barbastelle
bat	Eptesicus anatolicus	Anatolian serotine
bat	Eptesicus isabellinus	Meridional serotine
bat	Eptesicus nilssonii	Northern bat
bat	Eptesicus serotinus	Serotine
bat	Hypsugo savii	Savi's pipistrelle
bat	Miniopterus schreibersii	Schreibers' bat
bat	Myotis alcathoe	Alcathoe bat
bat	Myotis bechsteinii	Bechstein's bat
bat	Myotis blythii	Lesser mouse-eared bat
bat	Myotis brandtii	Brandt's bat
bat	Myotis capaccinii	Long-fingered bat
bat	Myotis crypticus	Cryptic myotis
bat	Myotis dasycneme	Pond bat
bat	Myotis daubentonii	Daubenton's bat
bat	Myotis davidii	David's myotis
bat	Myotis emarginatus	Geoffroy's bat
bat	Myotis escaleraei	Escalera's bat
bat	Myotis myotis	Greater mouse-eared bat
bat	Myotis mystacinus	Whiskered bat
bat	Myotis nattereri	Natterer's bat
bat	Myotis punicus	Felten's myotis
bat	Nyctalus azoreum	Azores noctule
bat	Nyctalus lasiopterus	Greater noctule
bat	Nyctalus leisleri	Leisler's bat
bat	Nyctalus noctula	Common noctule
bat	Pipistrellus hanaki	Hanaki's dwarf bat

bat	<i>Pipistrellus kuhlii</i>	Kuhl's pipistrelle
bat	<i>Pipistrellus maderensis</i>	Maderia pipistrelle
bat	<i>Pipistrellus nathusii</i>	Nathusius' pipistrelle
bat	<i>Pipistrellus pipistrellus</i>	Common pipistrelle
bat	<i>Pipistrellus pygmaeus</i>	Soprano pipistrelle
bat	<i>Plecotus auritus</i>	Brown long-eared bat
bat	<i>Plecotus austriacus</i>	Grey long-eared bat
bat	<i>Plecotus gaisleri</i>	Gaisler's long-eared bat
bat	<i>Plecotus kolombatovici</i>	Kolombatovic's long-eared bat
bat	<i>Plecotus macrobullaris</i>	Alpine long-eared bat
bat	<i>Plecotus sardus</i>	Sardinian long-eared bat
bat	<i>Plecotus teneriffae</i>	Canary big-eared bat
bat	<i>Rhinolophus blasii</i>	Blasius's horseshoe bat
bat	<i>Rhinolophus euryale</i>	Mediterranean horseshoe bat
bat	<i>Rhinolophus ferrumequinum</i>	Greater horseshoe bat
bat	<i>Rhinolophus hipposideros</i>	Lesser horseshoe bat
bat	<i>Rhinolophus mehelyi</i>	Mehely's horseshoe bat
bat	<i>Tadarida teniotis</i>	European free-tailed bat
bat	<i>Vespertilio murinus</i>	Parti-coloured bat
bird	Bird	Bird
bush-cricket	<i>Antaxius pedestris</i>	Common mountain bush-cricket
bush-cricket	<i>Antaxius sorrezensis</i>	French mountain bush-cricket
bush-cricket	<i>Antaxius spinibrachius</i>	Iberian mountain bush-cricket
bush-cricket	<i>Barbitistes constrictus</i>	Eastern saw bush-cricket
bush-cricket	<i>Barbitistes fischeri</i>	Southern saw-tailed bush-cricket
bush-cricket	<i>Barbitistes 'sanzii'</i>	Southern saw-tailed bush-cricket
bush-cricket	<i>Barbitistes serricauda</i>	Saw-tailed bush-cricket
bush-cricket	<i>Bicolorana bicolor</i>	Two coloured bush-cricket
bush-cricket	<i>Conocephalus dorsalis</i>	Short-winged bush-cricket
bush-cricket	<i>Conocephalus fuscus</i>	Long-winged bush-cricket
bush-cricket	<i>Cyrtaspis scutatus</i>	Shielded oak bush-cricket
bush-cricket	<i>Decticus albifrons</i>	White-faced bush-cricket
bush-cricket	<i>Decticus verrucivorus</i>	Wart-biter
bush-cricket	<i>Ephippiger ephippiger</i>	Saddle-backed bush-cricket
bush-cricket	<i>Eupholioptera chabrieri</i>	Chabrier's bush-cricket
bush-cricket	<i>Isophya brunneri</i>	Brunner's plump bush-cricket
bush-cricket	<i>Isophya doneciana</i>	Donetsk plump bush-cricket
bush-cricket	<i>Isophya modesta</i>	Modest plump bush-cricket
bush-cricket	<i>Isophya pyrenaea</i>	Large speckled bush-cricket
bush-cricket	<i>Leptophyes albovittata</i>	Striped bush-cricket
bush-cricket	<i>Leptophyes boscii</i>	Eastern speckled bush-cricket
bush-cricket	<i>Leptophyes punctatissima</i>	Speckled bush-cricket
bush-cricket	<i>Lluciapomaresius stalii</i>	Stal's saddle bush-cricket
bush-cricket	<i>Metrioptera brachyptera</i>	Bog bush-cricket
bush-cricket	<i>Montana montana</i>	Steppe bush-cricket
bush-cricket	<i>Odontura macphersoni</i>	Macpherson's striped bush-cricket
bush-cricket	<i>Phaneroptera falcata</i>	Sickle-bearing bush-cricket
bush-cricket	<i>Phaneroptera nana</i>	Southern sickle-bearing bush-cricket
bush-cricket	<i>Pholidoptera femorata</i>	Large dark bush-cricket

bush-cricket	<i>Pholidoptera griseoptera</i>	Dark bush-cricket
bush-cricket	<i>Platycleis affinis</i>	Tuberous bush-cricket
bush-cricket	<i>Platycleis albopunctata</i>	Grey bush-cricket
bush-cricket	<i>Platycleis falx</i>	Falcate bush-cricket
bush-cricket	<i>Platycleis iberica</i>	Iberian bush-cricket
bush-cricket	<i>Platycleis intermedia</i>	Intermediate bush-cricket
bush-cricket	<i>Platycleis sabulosa</i>	Sand bush-cricket
bush-cricket	<i>Poecilimon heroicus</i>	Heroic bright bush-cricket
bush-cricket	<i>Poecilimon scythicus</i>	Scythian bright bush-cricket
bush-cricket	<i>Poecilimon ukrainicus</i>	Ukraine bright bush-cricket
bush-cricket	<i>Pterolepis germanica</i>	Mediterranean bush-cricket
bush-cricket	<i>Pterolepis grallata</i>	Stilt-legged bush-cricket
bush-cricket	<i>Pterolepis poneli</i>	Ponel's bush-cricket
bush-cricket	<i>Pycnogaster jugicola</i>	Fat-bellied saddle bush-cricket
bush-cricket	<i>Roeseliana fedtschenkoi</i>	Fedtschenko's beadow Bush-cricket
bush-cricket	<i>Roeseliana roeselii</i>	Roesel's bush-cricket
bush-cricket	<i>Ruspolia nitidula</i>	Large cone-head
bush-cricket	<i>Sepiana sepium</i>	Sepia bush-cricket
bush-cricket	<i>Tessellana orina</i>	Orina slender bush-cricket
bush-cricket	<i>Tessellana tessellata</i>	Brown-spotted bush-cricket
bush-cricket	<i>Tettigonia cantans</i>	Upland green bush-cricket
bush-cricket	<i>Tettigonia hispanica</i>	Spanish green bush-cricket
bush-cricket	<i>Tettigonia viridissima</i>	Great green bush-cricket
bush-cricket	<i>Thyreonotus corsicus</i>	Corsican bush-cricket
bush-cricket	<i>Tylopsis lilifolia</i>	Slender bush-cricket
bush-cricket	<i>Uromenus rugosicollis</i>	Rough-backed bush-cricket
bush-cricket	<i>Yersinella raymondii</i>	Raymond's bush-cricket
bush-cricket	<i>Zeuneriana abbreviata</i>	Basque bush-cricket
moth	<i>Yponomeuta evonymella</i>	Bird cherry ermine
moth	<i>Pseudoips prasinana</i>	Green silver-lines
small mammal	<i>Acomys minous</i>	Cretan spiny mouse
small mammal	<i>Allactaga elater</i>	Small five-toed jerboa
small mammal	<i>Allactaga major</i>	Great jerboa
small mammal	<i>Apodemus agrarius</i>	Striped field mouse
small mammal	<i>Apodemus alpicola</i>	Alpine field mouse
small mammal	<i>Apodemus epimelas</i>	Western broad-toothed field mouse
small mammal	<i>Apodemus flavicollis</i>	Yellow-necked mouse
small mammal	<i>Apodemus mystacinus</i>	Broad-toothed field mouse
small mammal	<i>Apodemus ponticus</i>	Black Sea field mouse
small mammal	<i>Apodemus sylvaticus</i>	Wood mouse
small mammal	<i>Apodemus uralensis</i>	Pygmy field mouse
small mammal	<i>Apodemus witherbyi</i>	Steppe field mouse
small mammal	<i>Arvicola amphibius</i>	European water vole
small mammal	<i>Arvicola sapidus</i>	Southwestern water vole
small mammal	<i>Arvicola scherman</i>	Montane water vole
small mammal	<i>Cricetulus migratorius</i>	Gray dwarf hamster
small mammal	<i>Cricetus cricetus</i>	Common hamster
small mammal	<i>Crocidura canariensis</i>	Canarian shrew
small mammal	<i>Crocidura cossyrensis</i>	Pantellarian shrew

small mammal	<i>Crocidura gueldenstaedtii</i>	Gueldenstaedt's shrew
small mammal	<i>Crocidura leucodon</i>	Bicolored shrew
small mammal	<i>Crocidura pachyura</i>	North African white-toothed shrew
small mammal	<i>Crocidura russula</i>	Greater white-toothed shrew
small mammal	<i>Crocidura sicula</i>	Sicilian shrew
small mammal	<i>Crocidura suaveolens</i>	Lesser white-toothed shrew
small mammal	<i>Crocidura zimmermanni</i>	Cretan shrew
small mammal	<i>Dinaromys bogdanovi</i>	Balkan snow vole
small mammal	<i>Dipus sagitta</i>	Northern three-toed jerboa
small mammal	<i>Dryomys laniger</i>	Woolly dormouse
small mammal	<i>Dryomys nitedula</i>	Forest dormouse
small mammal	<i>Eliomys quercinus</i>	Garden dormouse
small mammal	<i>Ellobius talpinus</i>	Northern mole vole
small mammal	<i>Glis glis</i>	Edible dormouse
small mammal	<i>Lagurus lagurus</i>	Steppe lemming
small mammal	<i>Meriones meridianus</i>	Midday jird
small mammal	<i>Meriones tamariscinus</i>	Tamarisk jird
small mammal	<i>Meriones tristrami</i>	Tristram's jird
small mammal	<i>Mesocricetus newtoni</i>	Romanian hamster
small mammal	<i>Micromys minutus</i>	Eurasian harvest mouse
small mammal	<i>Microtus agrestis</i>	Field vole
small mammal	<i>Microtus arvalis</i>	Common vole
small mammal	<i>Microtus bavaricus</i>	Bavarian pine vole
small mammal	<i>Microtus brachycercus</i>	Calabria pine vole
small mammal	<i>Microtus cabrerae</i>	Cabrera's vole
small mammal	<i>Microtus duodecimcostatus</i>	Mediterranean pine vole
small mammal	<i>Microtus epiroticus</i>	Sibling vole
small mammal	<i>Microtus felteni</i>	Felten's vole
small mammal	<i>Microtus gerbei</i>	Gerbe's vole
small mammal	<i>Microtus guentheri</i>	Gunther's vole
small mammal	<i>Microtus levis</i>	East European vole
small mammal	<i>Microtus liechtensteini</i>	Liechtenstein's pine vole
small mammal	<i>Microtus lusitanicus</i>	Lusitanian pine vole
small mammal	<i>Microtus majori</i>	Major's pine vole
small mammal	<i>Microtus multiplex</i>	Alpine pine vole
small mammal	<i>Microtus nivalis</i>	Snow vole
small mammal	<i>Microtus oeconomus</i>	Root vole
small mammal	<i>Microtus savii</i>	Savi's pine vole
small mammal	<i>Microtus socialis</i>	Social vole
small mammal	<i>Microtus subterraneus</i>	European pine vole
small mammal	<i>Microtus tatricus</i>	Tatra pine vole
small mammal	<i>Microtus thomasi</i>	Thomas's pine vole
small mammal	<i>Mus cypricus</i>	Cypriot mouse
small mammal	<i>Mus macedonicus</i>	Macedonian mouse
small mammal	<i>Mus musculus</i>	House mouse
small mammal	<i>Mus spicilegus</i>	Steppe mouse
small mammal	<i>Mus spretus</i>	Algerian mouse
small mammal	<i>Muscardinus avellanarius</i>	Hazel dormouse
small mammal	<i>Myodes glareolus</i>	Bank vole

small mammal	<i>Myodes rufocanus</i>	Grey red-backed vole
small mammal	<i>Myodes rutilus</i>	Northern red-backed vole
small mammal	<i>Myomimus roachi</i>	Roach's mouse-tailed dormouse
small mammal	<i>Neomys anomalus</i>	Mediterranean water shrew
small mammal	<i>Neomys fodiens</i>	Eurasian water shrew
small mammal	<i>Pygeretmus pumilio</i>	Dwarf fat-tailed jerboa
small mammal	<i>Rattus norvegicus</i>	Brown rat
small mammal	<i>Rattus rattus</i>	Black rat
small mammal	<i>Sicista (subtilis) trizona</i>	Hungarian birch mouse
small mammal	<i>Sicista betulina</i>	Northern birch mouse
small mammal	<i>Sicista loriger</i>	Nordmann's birch mouse
small mammal	<i>Sicista severtzovi</i>	Severtzov's birch mouse
small mammal	<i>Sicista strandi</i>	Strand's birch mouse
small mammal	<i>Sicista subtilis</i>	Southern birch mouse
small mammal	<i>Sorex alpinus</i>	Alpine shrew
small mammal	<i>Sorex antinorii</i>	Valais shrew
small mammal	<i>Sorex araneus</i>	Common shrew
small mammal	<i>Sorex arunchi</i>	Udine shrew
small mammal	<i>Sorex caecutiens</i>	Laxmann's shrew
small mammal	<i>Sorex coronatus</i>	Crowned shrew
small mammal	<i>Sorex granarius</i>	Iberian shrew
small mammal	<i>Sorex isodon</i>	Taiga shrew
small mammal	<i>Sorex minutissimus</i>	Eurasian least shrew
small mammal	<i>Sorex minutus</i>	Eurasian pygmy shrew
small mammal	<i>Sorex samniticus</i>	Apennine shrew
small mammal	<i>Stylodipus telum</i>	Thick-tailed three-toed jerboa
small mammal	<i>Suncus etruscus</i>	Etruscan shrew

Appendix 3. Understanding and optimising the performance of the pipeline

It is important to understand that the performance of the pipeline for a given species will vary geographically depending on the suite of potential species present in the region. As an example, the performance of the pipeline for Leisler's bat (*Nyctalus leisleri*) in Ireland, is likely to be better than the performance of the pipeline for Leisler's bat in southern Britain, where two potential confusion species, noctule (*Nyctalus noctula*) and serotine (*Eptesicus serotinus*) are also present.

It is also important to appreciate that the performance of the pipeline will be strongly influenced by the quality of the recordings that you provide the pipeline to process. This is something that you can influence, and will depend on the detector used, the detector settings, and importantly how the detector / microphone is positioned to record. In the section that follows this, we provide some discussion on some of the steps that you can take to improve the quality of your recordings.

To give some quantitative information on the performance of the pipeline, although with a focus on bats and small mammals in England, we present the results from an automatic analysis by the pipeline followed by extensive manual verification of the identification, carried out by viewing (and playing where useful) the spectrograms in Sonobat by an experienced bat acoustics analyst. This comprises an analysis of recordings from a Defra-funded project on bats on farmland in England, with recording carried out in six study areas (Dartmoor, Yorkshire Dales, fens in Cambridgeshire and Norfolk, Essex, Sussex and Warwickshire). We exclude rare species, where the small sample of recordings (less than 20 recordings) limits interpretation that can be made.

Whilst the pipeline assigns Brandt's bat (*Myotis brandtii*) and whiskered bat (*Myotis mystacinus*) to species, no robust criteria for manually confirming the identification is available at the current time, so the results for these species are shown combined. This focusses on species identifications with a probability of 0.5 (50%) or more as recommended above. For common pipistrelle (*Pipistrellus pipistrellus*) and soprano pipistrelle (*Pipistrellus pygmaeus*) we selected a random sample of 1,000 recordings of each species for checking, whilst for other species, manual verification was carried out for all species recordings, comprising

84,055 recordings in total. The only exceptional thing to note, was the large number of whiskered or Brandt's bat recordings from northern England.

This results in the below confusion matrix that compares the number of recordings that were assigned by the pipeline to each species, and identification following a process of manual verification (Table 1).

Steps that you can take to improve the performance of the pipeline

For the study described above (and for all our projects), we always take steps to try and get the best quality field recordings that we can. The better the quality of recordings, the better the Acoustic Pipeline will perform, but also the better your chances of being able to manually assign unknown recordings to species.

Probably the most important consideration is placement of the microphone. Ideally the microphone, or detector (if the microphone is inbuilt) should be pole mounted, raised up into the bat's flyway, and positioned at least 1.5 meters away from any flat surfaces or vegetation. The worst thing that can be done is to attach a detector, particularly if it has an inbuilt microphone to a flat surface like a tree trunk, or to try and hide the detector and microphone within or close to vegetation. This can result in acoustic mush, that is difficult to do much with by any means, particularly for some of the more cryptic species where recording quality is most critical.

If recording at a bat roost, the performance of the pipeline will be considerably better if you position the bat detector directly away from emergence itself (10-15 meters away). If recording directly at emergence, the calls of bat are often elevated in frequency and are not very typical of the calls of free-flying individuals, on which the pipeline was trained. The performance of the pipeline is also likely to be reduced if recording is carried out inside a bat roost. In this situation, echolocation calls are often atypically short in duration (in extreme clutter), a broad range of social calls are often produced in this situation that are not encountered outside a roost, and the recordings can often be distorted, and or otherwise of poor quality.

It is also recommended that you do not convert full spectrum recordings to zero-crossing before auditing the recordings / results. This is most likely to be done by bat workers who have used zero-crossing in the past, but it will result in a significant proportion of recordings that would have been assigned to species, being missed. It may also introduce biases in your data, which could influence your interpretation, which I will explain with an example. Suppose that bat recording is carried out at two locations, where there is similar level of barbastelle (*Barbastella barbastellus*) activity. However, at one location, there is also high bush-cricket activity. The pipeline is efficient at finding weak barbastelle calls in noisy recordings like this, so based on the pipeline, the activity of barbastelle according to the pipeline should be similar. However, when the recordings are converted to zero-crossing, the barbastelle calls may be lost where there are noisy bush-crickets. This example highlights why converting full spectrum recordings to zero-crossing for auditing should be avoided, and that it has the potential to result in an incorrect interpretation.

Lastly, and specific to the pipeline we recommend that bat detector settings are used that define the maximum wav file length to be 5 seconds. 5 seconds is the optimum for the pipeline to be able to identify multiple species in a recording. Longer recordings can be uploaded and will be processed by the pipeline, but it is important to understand that long recordings are split automatically by the desktop app into 5 second sections before they are processed. Note that the desktop app provides the option for the user to save a copy of the wav files as they will be processed, so including split wav files.

The consequence of this is that results are also returned for each 5 second wav file section. For example, if a 15 second recording is uploaded, the recording will be split into three, and results returned for each 5 second file. Auditing could then be carried out at the 5 second section level, or the pipeline results could be summarised to collapse down the results by the ORIGINAL FILE NAME which is included as a column in the results. A second consequence of uploading long recordings is that there will be a greater proportion of results flagged as low confidence, and more wav files where no species are identified (No_ID in the species column). The reason for this, is that the last 5 second section of a long wav file often contains weak calls at the end of a sequence that are more difficult to assign to species with confidence, or do not contain anything to identify. A positive consequence of processing 5 second recordings, even if long recordings are uploaded, is that comparisons of activity based on the number of recordings are more standardised within and between different projects.

The error matrix produced when the BTO Acoustic Pipeline was applied to an extensive dataset for bats from farmland study areas in England, where classifier identities are compared to what are believed to be the true identities from manual checking for recordings above the recommended threshold of 0.5 or more. * For common and soprano pipistrelle, a random sample of 1,000 recordings from 277,624 and 79,888 recordings respectively were selected for auditing.

	MANUAL IDENTIFICATION																				Grand Total	% correct
	Barbar	Eptser	Myobra / Myomys	Myodau	Myonat	Myotis spp	Nyclei	Nycnoc	Nyctalus spp	Pipnat	Pippip	Pippyg	Pipistrellus spp	Pleaur	Plecotus spp	Ratnor	Sorara	Sormin	shrew spp	other spp		
Barbar	3,339	3	0	6	1	37	0	0	8	0	9	8	1	4	3	0	0	0	0	4	3,423	97.5
Eptser	0	610	0	0	0	0	2	9	30	0	0	1	1	0	0	0	0	0	0	0	653	93.4
Myobra / Myomys	1	0	21,766	3	0	113	1	0	1	5	48	9	1	0	0	0	0	0	0	2	21,950	99.2
Myodau	49	0	8	8,683	4	220	2	0	0	0	75	8	29	0	0	0	0	0	0	40	9,118	95.2
Myonat	0	0	51	4	10,984	135	0	0	0	0	6	1	1	0	0	0	0	0	0	1	11,183	98.2
Nyclei	0	1	0	0	0	0	1,367	8	2	0	0	0	0	0	0	0	0	0	0	0	1,378	99.2
Nycnoc	1	38	0	0	0	0	629	27,530	3	0	1	2	1	1	0	0	0	0	0	1	28,209	97.6
Pippip	0	0	0	0	0	0	0	0	0	0	1000*	0	0	0	0	0	0	0	0	0	1,000	100
Pippyg	0	0	0	0	0	0	0	0	0	0	0	1000*	0	0	0	0	0	0	0	0	1,000	100
Pleaur	0	1	0	0	0	2	0	1	4	0	45	36	53	6,769	1	0	0	0	0	4	6,916	97.9
Ratnor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	152	0	0	1	3	156	97.4
Sorara	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	379	0	0	60	441	85.9
Sormin	0	0	0	0	0	0	0	0	0	0	3	5	1	0	0	1	5	558	0	55	628	88.9
Grand Total	3,390	653	21,825	8,696	10,989	507	2,001	27,548	48	5	188	71	88	6,774	4	153	384	558	2	171	86,055	

Species codes: Barbar = barbastelle, Eptser = serotine, Myobra / Myomys = Brandt's bat or whiskered bat, Myotis species = belonging to the genus Myotis, but species level identification not possible, Nyclei = Leisler's bat, Nycnoc = noctule, Nyctalus species = belonging to the genus Nyctalus, Pleaur = brown long-eared bat, Plecotus species = brown or grey long-eared bat, Ratnor = brown rat, Sorara = common shrew, Sormin = Pygmy shrew, shrew species = common, pygmy or water shrew.