ECO²SCAPE

Mastering AudioMoth: Preparing and Using Your Device

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FEdA

Aim

This document was created to guide beginners using AudioMoths: practitioners, students, researchers and teachers. It takes the reader step by step through the process of preparing and configuring the AudioMoth, the actual fieldwork and the data analysis. It is supposed to be hands-on while relying on scientific data and the technical manual of the manufacturers.

For advanced application and configuration of the device please find detailed instructions (Rhinehart 2019). There are additional useful features, which are not mentioned here, like the clock-function or wireless configuration.

The manual is based on the following firmware and software version:

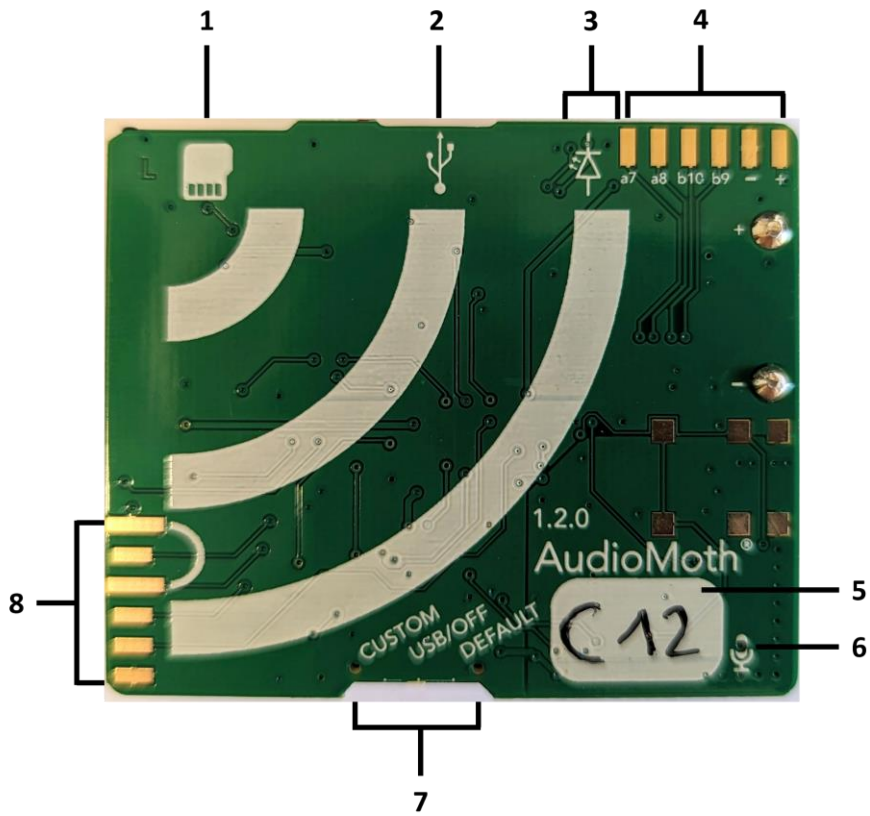
- AudioMoth type 1.1.0 and 1.2.0 by Open Acoustic Devices
- AudioMoth firmware version 1.10.1
- Audiomoth Configuration App version 1.11.1
- BirdNET-Analyzer version 2.4
- BatDetect2 version 1.0.6

Therefore, we cannot guarantee problems caused by future version updates.

Content

Device Layout **3**
Basic Equipment **4**
Preparation: Set up AudioMoths before the field work **5**
Updating firmware 5
Technical configuration 5
Recording tab. 6
Schedule tab. 7
Further settings 8
Memory size & energy consumption 8
Example settings 9
Preparation: Planning the field work **10**
Sampling (research) design 10
Principles 10
Sample size 10
Site selection 11
Additional tips for field design 12
Setting up QField for Field Work 13
Deployment: Bring out AudioMoths in the field **14**
Planning AudioMoth setup 14
AudioMoth setup in the field 14
Recording details 14
Activation 14
Collection 14
Data processing after the field **15**
Visualizing spectrogram in Audacity 15
Visualizing spectrogram in R 16
Workflow of sound recognition models 17
BirdNET 17
BatDetect2 19
Maintenance **21**
Exchanging acoustic vents for AudioMoth cases 21
Regular battery charging check when unused 21
References **22**

Device Layout



The picture above shows an AudioMoth (own image). Numbers in the layout indicate:

1. **MicroSD card slot:** Insert microSD card here to store recording. For advice on handling the card, see "Choice of SD card memory & expected energy consumption".
2. **USB port:** Connect AudioMoth to a computer using a standard microUSB cable
3. **Status LEDs:** A green and a red LED used to communicate the status of the AudioMoth. Find more information here: link
4. **Exposed GPIO pins:** A set of general purpose pins which can be used to communicate with and add external modules (e.g., GPS-synced clock module for the future update)
5. **Blank field:** We advise you to label your device here and assign a specific ID to it.
6. **Microphone:** An analogue MEMS microphone. When putting the device into a case, make sure to insert it the right way, so the **microphone lies underneath the little hole with the acoustic vent.**
7. **Mode switch:** Change between three modes: "CUSTOM", "USB/OFF", and "DEFAULT". See "Technical configuration" for more information.
8. **Programming header:** A series of pins which can be used to apply firmware to the AudioMoth

Basic Equipment

Necessary:

Battery + Charger	Each AudioMoth is fed by 3 AA - batteries. Make sure they are fully charged before your use. One example of a recommended brand is Powerowl AA rechargeable batteries (link). One example of a recommended brand is ANSMANN POWERLINE 8 (link).
Cases	It is mandatory to use one case per device to protect the electronic parts. **Make sure to check the little vent, covering the microphone hole.** They tend to break easily, which can affect your recordings.
Micro SD card	Case-specific minimum memory size of SD cards for AudioMoth devices is given by the configuration Apps. However, in order to remain flexible and to be able to make longer recordings at a high sample rate if required, a memory size of 64 GB or more is recommended. See section "Memory size & energy consumption"
Laptop	To set up your AudioMoths you will need a laptop or desktop PC. There are no special requirements regarding technical features.
Cable	Use a micro USB cable to connect the devices with your laptop or desktop PC.

Optional:

Pole and hammer	Think ahead on how to safely install the audio devices in the field. If possible, use trees and available poles to take advantage of their stability and the discrete placement of the device. More on what to keep in mind when bringing the devices out in the field is explained in section "AudioMoth setup in the field". However, you cannot predict every tree, so take some wooden poles and a rubber hammer to ensure flexibility.
Rubberbands and velcro stripes	Use rubber bands or velcro strips to attach the devices at poles and trees. Rubber bands turned out to be more forgiving regarding the size of the pole. Take both to be sure.
Camouflage fabric	Depending on your project, decide if it is necessary to take some camouflage fabric to cover the recording devices.
Ladder	This is helpful for those who want to deploy at a greater height.

Preparation: Set up AudioMoths before the field work

Updating firmware

Before you start to configure the device, make sure to update its firmware. Therefore,

- download the current **AudioMoth Flash App** from the applications page,
- connect the device to your computer via micro USB cable,
- follow the steps in the app to update.

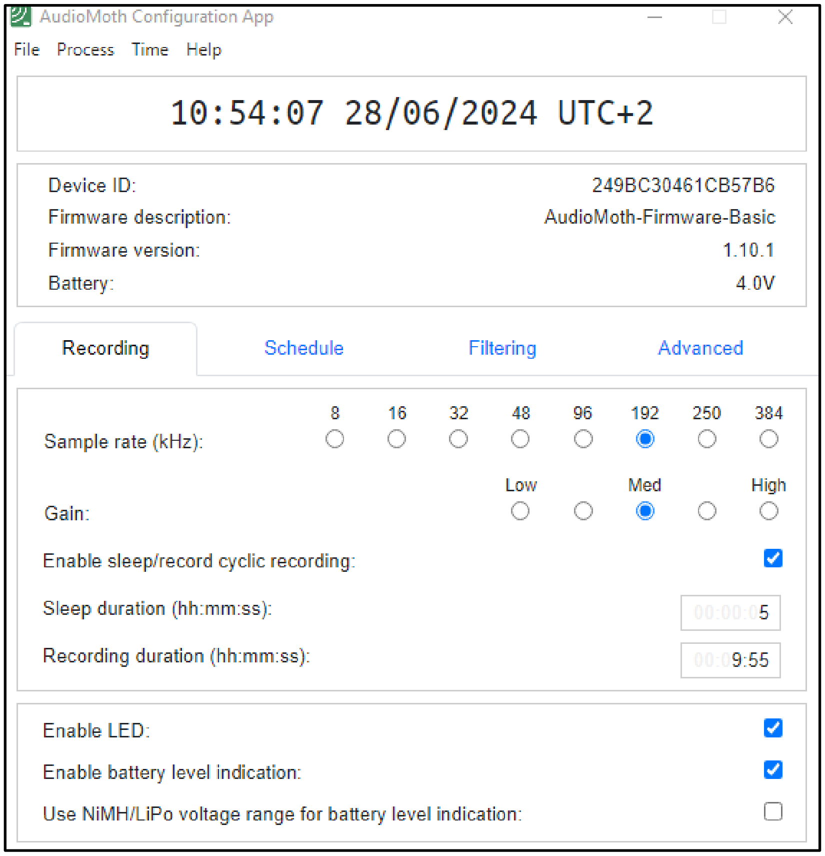
Technical configuration

You can choose between **"DEFAULT" and "CUSTOM" mode**. The former records at a sample rate of 48 kHz for unlimited time.The latter allows you to customize the recordings, such as setting up specific times or frequencies, which is useful for targeting specific species. A configuration applied to a device is kept even if power is lost. Only the current time will be reset. Make sure to put batteries in the device before configuring if you want to set up a timed schedule for your recordings.

Install and open the second important software for the use of your AudioMoth, the **AudioMoth Configuration App** (can be downloaded from applications page).
Connect one AudioMoth in **"USB/OFF"** mode to your computer using a micro USB cable.

The app has four tabs: We only get into the *Recording* and *Schedule* section of the app, as they are the basic ones.
Keep an eye on the bottom of the configuration window. There you find the calculated storage needed for your schedule per day and the daily energy consumption depending on your settings. This allows you to constantly check if your settings are in the range of your technical capacities.
Important to note that: you can save your configuration and load it later to keep it constant over many devices in the "File" section.

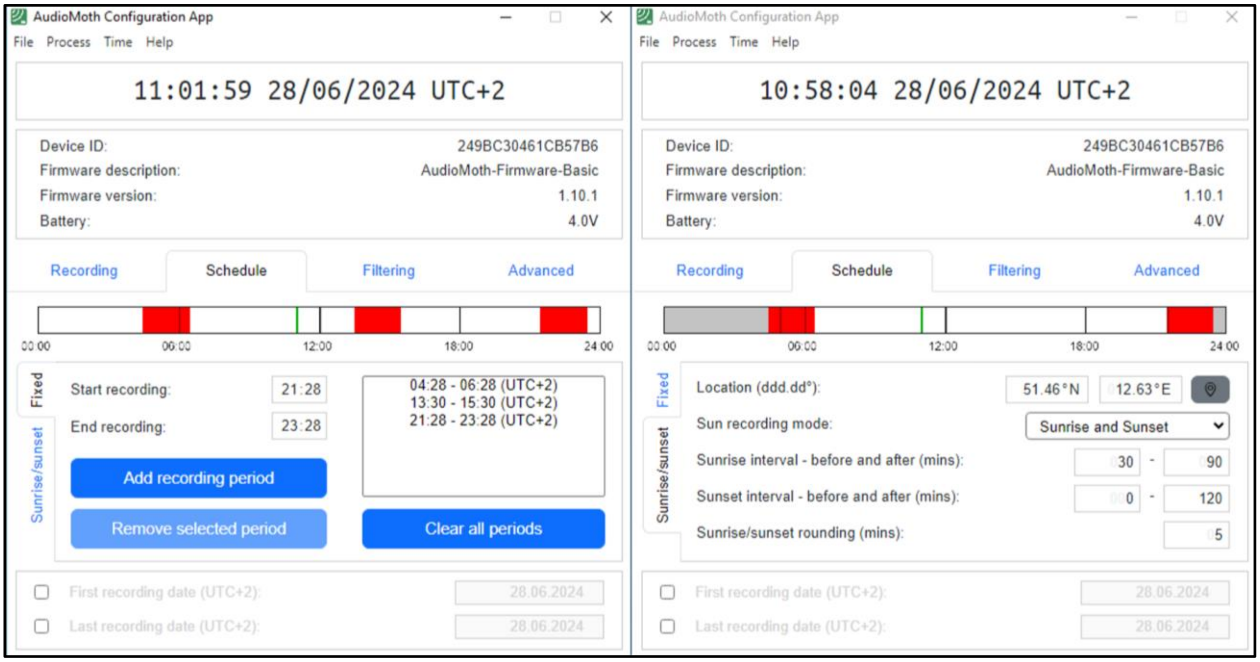
Recording tab.



Display screen of *Recording* tab in AudioMoth Configuration App, exemplary settings from ECO²SCAPE fieldwork.

- **Sample rate (kHz)**: The sample rate is the number of audio samples captured per second. Higher sample rates result in recordings with a wider frequency bandwidth, but larger file sizes.
  Rule of thumb. You should use a sample rate that is **at least two times the highest frequency you wish to record** (Nyquist 1928).
- **Gain**: The Gain describes how much the recordings are amplified. If there are no extreme sound disturbances, you can leave it at "Medium". If the gain is too low the device may miss distant audio, by setting it very high you risk your recording to clip and distort the original sound.
- **Enable Sleep/Record Cycle**: When you check this box, the device is going to alternate between recording and not recording according to the duration you set below. If you want your device to record constantly in the time frame you set in the schedule, mind to disable this box.
- **Sleeping duration (hh:mm:ss) & Recording duration (hh:mm:ss)**: When creating a schedule for your recordings, the device will still switch between sleep and record during the scheduled time frames. A separate audio file is written to the SD card for each record-sleep cycle.

Schedule tab.



Display screen of Schedule tab in AudioMoth Configuration App, exemplary settings from ECO²SCAPE fieldwork (separate periods for birds (morning), grasshoppers (afternoon) and bats (evening)).

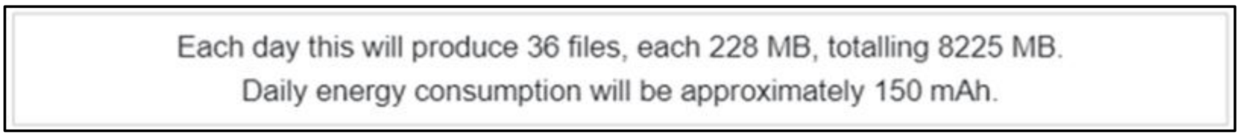
- **Time**: In the “Time” section in the upper part of your window you can choose local timezone instead of UTC. Mind that when using the schedule function, you need the devices to be constantly powered so the clock does not stop.
- **Recording periods**: You can create up to four fixed recording periods of any length which will recur every 24 hours. It is also possible to adjust the recording periods to the sunrise and sunset or the civil, nautical or astronomical dawn (to also be changed in the "File" section) at a specific location.
- **Recording dates:** The first and/or last recording date can be set in order to avoid unnecessary recordings. Furthermore, uniforming the schedule is highly recommended if comparability of data from multiple devices is required.

Further settings

“Filtering” Tab: The Filtering tab becomes important when your recordings may extend storage or power limits. The device then only stores relevant information - your preset frequencies and amplitudes.

“Advanced” Tab: Here you can enable some additional recording settings and functions. We do not recommend changing this tab unless you really know what you are doing.

Memory size & energy consumption



Daily storage and energy consumption displayed in AudioMoth Configuration App (bottom) based on the exemplary settings used in figures of “Recording” and “Schedule” tabs (total daily recording time of 6h with 192 kHz).

At the bottom of the window, the configuration app will show you how much storage you need and how high the daily energy consumption will be with the schedule and sample rate set. Therefore, check whether the free memory of the microSD card is enough.

Example settings

Here we show several examples of AudioMoth configuration settings. However, it is always recommended to find out the specific frequency of your target species, if possible (Hill et al. 2019).

Species to be tracked	**Frequency range**	**Minimum sample rate**	**Schedule Recommendations (based on peak activity periods)**
Insects	Species-specific, < 1 kHz up to 150 kHz (Robinson and Hall, 2002)	depends on frequency range of target species (see *Recording* tab.)	species-specific
birds	2-16 kHz	32 kHz	Around sunrise and sunset, e.g. 1 hour before sunrise until 2 hours after + 1 hour either side of sunset (link)
bats	20-60 kHz (Fenton et al. 1998). Highest frequency can be at 212 kHz (*Cloeotis percivali*; Fenton and Bell 1981)	192 kHz	Around sunset, e.g. 0.5h before to 1.5h or more after

Preparation: Planning the field work

Sampling (research) design

Sampling (research) design is crucial to obtain high-quality data to provide credible results in PAM. If your field design and objectives are already priorly determined, you can skip to [Deployment: Bring out AudioMoths in the field](#).

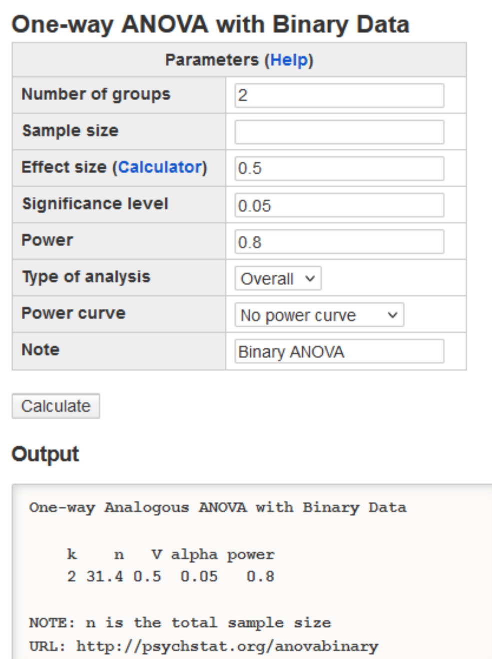
Principles

Green (1979) suggested 10 principles of research design in ecology & environmental sciences. The concepts are therefore applicable to the case of PAM. We briefly list his principles here:

- Be able to state research question explicitly
- Take replicate samples for each combination of time, location, and any objective-specific variable
- Randomly allocate equal numbers of replicates for each combination of variables
- Include a control (e.g. a reference point) in the sampling design (for experimental design)
- Carry out preliminary sampling, if possible
- Validate efficient and unbiased sampling method
- Stratify sampling into subareas if the study area has a large-scale spatial pattern
- Select an appropriate sample unit size and sample number
- Select statistical analysis based on the data property
- Accept the result for the best statistical method

Sample size

We will introduce a straightforward method for estimating the appropriate sample size using the WebPower website (Mai and Zhang 2017). The interface of the WebPower software will help you determine the minimum sample size (for example, the number of sites) needed for binary data based on a species' detection/non-detection or count data based on a species' vocal counts.



Example

We aim to study whether the occupancy (i.e., presence/absence) of Eurasian skylark (*Alauda arvensis*) differs between fallowland and cropland. To examine the difference, we conduct a power analysis to calculate the required number of sampling locations.

- **Group** = 2 (groups of fallowland vs. cropland)
- **Effect size** = 0.2 (small), 0.5 (medium), or 0.8 (large) suggested by Cohen (1988)

- **Significance level** = 0.05 as default by Cohen (1988)
- **Power = 0.8** as default by Cohen (1988)

Once we specify the ideal values, we input them into the cells and get the ideal sample size (e.g., each of fallowland and cropland: n = 31 in right figure).

Site selection

Site selection should be decided based on the study design objective. Wood and Peery (2022) presented two sampling designs for a species' occupancy (i.e., presence/absence): preferential sampling and random sampling.

- **Preferential sampling** requires knowledge about locations with biological significance and the target species' space use. It is most feasible for smaller research sites to determine the occupancy rate of the area of occupancy.
- **Random sampling** is commonly used in landscape to regional-scale projects to rapidly achieve a representative coverage and determine the occupancy rate in the extent of occurrence.

For both sampling designs, each AudioMoth is ideally deployed with a large distance to the next (case-specific, we recommend minimum 150m) to avoid identifying the same vocalization from multiple devices, which causes the issue of pseudoreplication in statistical analysis. Although Wood and Peery's focus is primarily a species' occupancy status, they also discussed the potential of these sampling designs into vocal activity rates.

Overview of preferential and randomized sampling by Wood and Peery (2022)

	Preferential sampling	Randomized sampling
Measured value	occupancy rate of the area of occupancy	occupancy rate in the extent of occurrence
Method	AudioMoths are installed at locations frequently visited by species	observed sites are randomly distributed in grid
species range in terms of	area of occupancy, often connected to biological information of territory	extent of occurrence
Pros and Cons	simpler interpretation, greater precision but pre-knowledge necessary	logistically simple study design

Additional tips for field design

- General overview of study design: links for birds and bats
- Mind the topography. In hillier territories, an optimal placement of sound detection devices can halve the required number of devices (Piña-Covarrubias et al. 2019)
- Try an app for rule of thumbs on the study design (a webpage, Rainforest Connection provide an example)
- Unless you have specific objectives, avoid selecting where there are any obstacles which block audio recording (e.g., highway, noisy water pathway, wind turbine, big electric infrastructure).

Especially in agricultural landscapes: check accessibility and prepare a few backup sites (trees or shrubs, where audio recorders are planned to be attached, may have either died or been cut down; crops like sunflowers and corn can make it impossible to reach the site if it is completely enclosed by the field).

Setting up QField for Field Work

After finalizing your field design and deciding where to deploy the AudioMoths, you can prepare an online field plan map to have a better overview over your AudioMoth locations. This map will help you to set the devices in the field and allows you to share information with co-workers. The QField app is a useful tool for this purpose which you can use on your smartphone or tablet. There are many other apps you can use, but we recommend QField. To use the QField app follow the steps below:

- **Create a QGIS project with the needed information.** You can set up forms to collect additional data to your AudioMoth locations during the field work.
- **Create a QFieldCloud account.** Load your QGIS project into the cloud so you can get access to the project in the QField app.
- **Share map with co-workers.** Add their QFieldCloud account to the project so everyone can use/edit the same QGIS project in the field.
- **Install QField app.** Download the respective version for your Android or iOS device.
- **Load the map project.** Open the app and load the map project that contains the planned locations. You can either download it from the QFieldCloud (recommended) or load it from the local storage of your phone.
- **Locate planned locations.** Use the app to navigate to the planned locations marked on the map. At each location, follow your equipment setup procedure.
- **Save Locations (optional)**. If required, you can also save new locations with the exact coordinates of the devices.
- **Capture field data (optional).** Entering environmental data in the form of the QGIS project created at the beginning.
- **Export the map or relevant data from QField.** If you are working with QFieldCloud just synchronize the QGIS project.

Deployment: Bring out AudioMoths in the field

Planning AudioMoth setup

If there are long distances or geographical obstacles between the sites, a reasonable route should be prepared using the locations' coordinates. Having a laptop with the AudioMoth configuration app and a micro USB cable up your sleeve, any preparation errors realized during fieldwork can be corrected on site.

AudioMoth setup in the field

Once at the site, the device must be installed in the best possible way according to the local conditions, especially if the local vegetation is used for attachment and hiding. This is where the optional equipment (Basic Equipment section) can be useful. Height and microphone direction should be uniformed, particularly when recording along hedges, tree rows etc. Regardless of acoustic implications, the rule of thumb is to install the audio recorders above head height (approx. 1.8 m) to avoid the reach and visual detection from most animals (Hill et al. 2019).

Recording details

Now the device ID and, if different from the planning, the exact coordinates should be documented. Photos can be taken to make it easier to find the AudioMoth, especially after long recording periods with changes in vegetation. These can also be linked directly to the location in QField.

Activation

If not already done, the **device switch** is now changed from **"DEFAULT"** to **"CUSTOM"**. You can double check if the recording schedule is conducted properly by looking at the status of the LED. A single green flash (10 ms) every two seconds while the red remains unlit means sleeping mode and an intermittently single red flash means recording mode. For more details, visit this link.

Collection

After the recording period, the devices are collected using the coordinates and photos. If possible, the person who deployed the devices should collect them for faster retrieval.

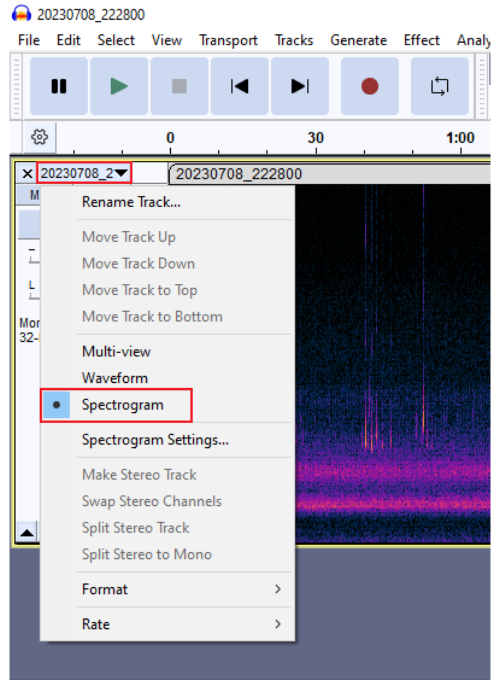
Data processing after the field

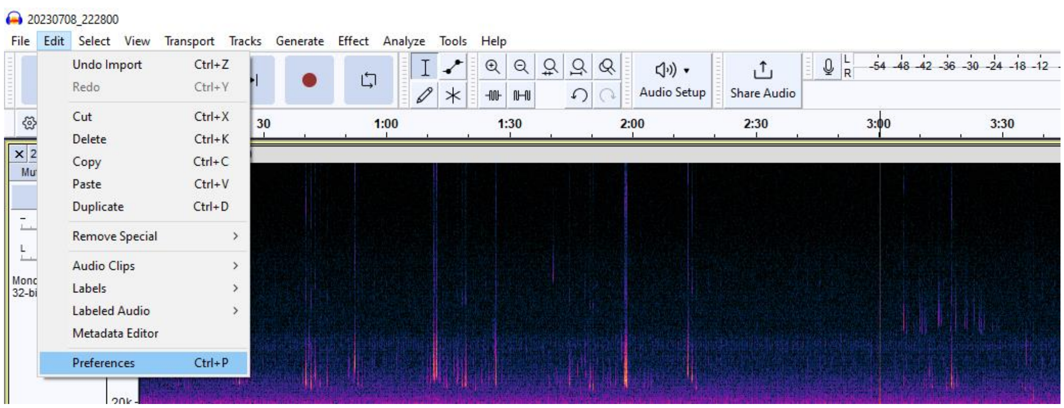
Visualizing spectrogram in Audacity

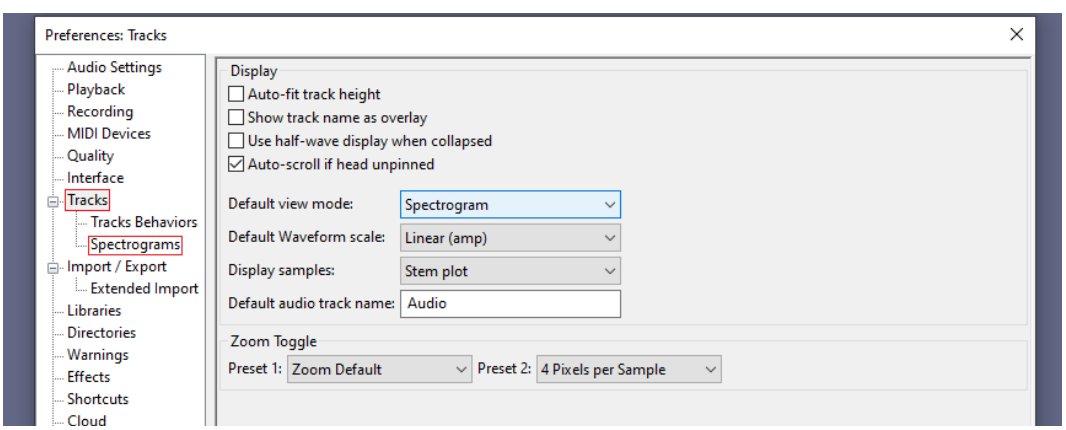
Audacity is a free to use software for visualizing and editing sound recordings. The program can also be used to display spectrograms for audio data.

Audio files can be imported into the program via File > Import > Audio or by dragging a file into the interface. For a quick switch to the spectrogram view for only one audio track, follow the instructions as shown in the right picture.

If you want to change the default settings so that the spectrogram view is displayed from the beginning, you can do this via Edit > Preferences > Tracks (see pictures below). Further settings for the spectrogram view, for example the maximum frequency or the format of the scale, can also be changed here in the Spectrograms tab.







Visualizing spectrogram in R

Our focus in this section is to demonstrate the very basic process of reading and segmenting audio files for visual presentation, as conducting a comprehensive acoustic analysis in R is outside the scope of this document. For those interested, Sueur (2018) explains a thorough methodology and synthesis about sound analysis using R.

Prerequisite:

- Any WAV file from field survey (sample file is available from here: audiomoth_handbook.wav)
- Program R is installed on your computer
- Basic knowledge of R programming

Rscript (click visualizing_spectrogram_in_R.R to download the Rscript)

```
# Install R packages
install.packages(c("tuneR", "seewave"))

# load packages
library(tuneR)
library(seewave)

# read in WAV file using readWave() function from “tuneR” package
inp <- readWave(".../audiomoth_handbook.wav") # please specify folder path in “...”

# Segment audio data for a specific time span using cutw() function from “seewave” package
# Here, we segmented wav object between 132 and 140 seconds, assuming we already knew where a
bird song can be found
d <- cutw(inp, from = 132, to = 140, output = "Wave")

# Visualize segmented wav object as spectrogram using spectro() function from “seewave” package
spectro(d)
```

Workflow of sound recognition models

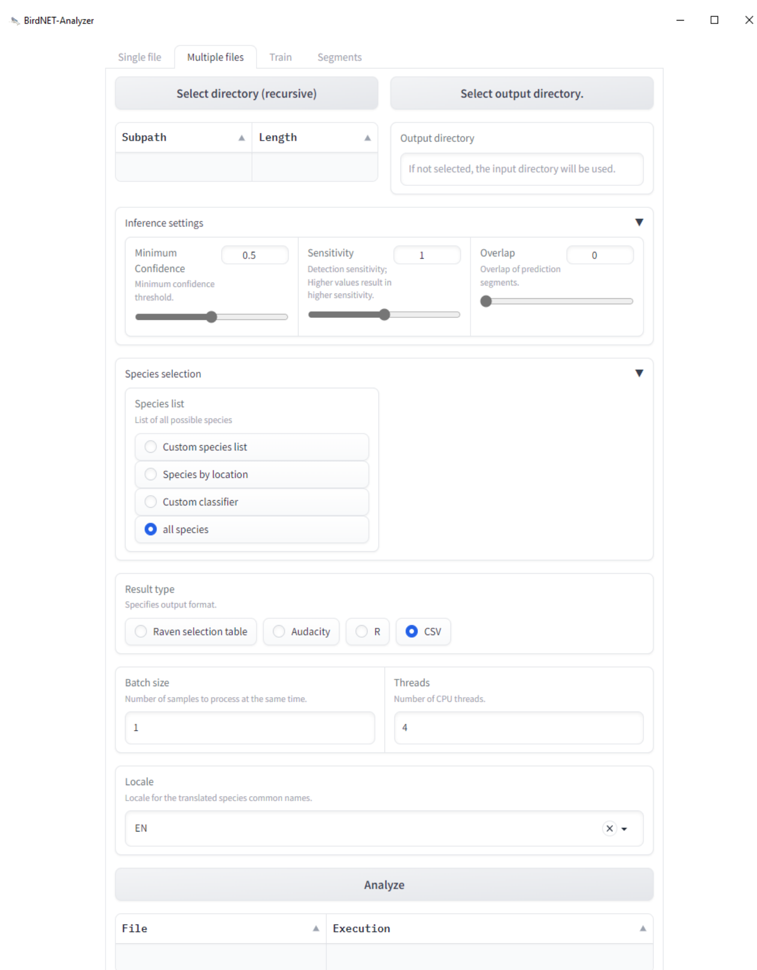
Sound recognition models allow us to automatically identify species based on spectrograms derived from audio recordings. Caution is needed that the models can make mistakes, such as imperfect detection and misidentification of species. The given confidence score indicates how likely the identified species is true: The higher the confidence score is, the more likely the identification is true. However, even with a high confidence score, there is always a possibility of error, so results should be interpreted carefully depending on the quality of sound recognition models. **Note that download instructions frequently change with the version update. We suggest readers carefully follow the recent installation instructions.**

BirdNET

BirdNET is a freely available model classifying bird species through audio data (Kahl et al. 2021). You can run BirdNET models using a graphic user interface (GUI) that assists you to process audio data without any programming skills. Please visit this link and follow the recent instructions for downloading.

How to use the GUI with sample data, based on BirdNET-Analyzer version 2.4:

- Once you start the GUI, select "Multiple files" tab.
- Select the folder directory where the audio data is stored and specify a folder where you want to save.
- **Inference settings**: 1) Minimum confidence is the threshold that every species detection has to pass. We recommend setting at 0.01, because you can set ideal thresholds later in CSV. 2) Sensitivity indicates true positive detection rate (default *sensitivity* = *1*). 3) Overlap is the overlap of segments from 0 to 3 seconds (default overlap = 0).
- **Species selection**: Unless you are an advanced user, check "all species"
- **Result type**: Check "CSV"
- **Batch size & Threads**: Leave as they are
- **Locale**: Choose language for birds' common name (EN for English)
- Click "**Analyze**"



The picture below is an example of BirdNET output as CSV.

	A	B	C	D	E
1	Start (s)	End (s)	Scientific name	Common name	Confidence
2	0	3	Atrichornis rufescens	Rufous Scrub-bird	0.0777
3	0	3	Modulatrix stictigula	Spot-throat	0.0448
4	0	3	Epimachus fastosus	Black Sicklebill	0.0347

- **Start (s)**: Start of audio segment in second
- **End (s)**: End of audio segment in second
- **Scientific name**: Detected species with scientific name
- **Common name**: Detected species with common name
- **Confidence**: Confidence value of species identification, ranging from 0 to 1 (all identifications above setted “Minimum Confidence” value are listed)

BatDetect2

BatDetect2 is a deep learning-based model that detects bat calls and classifies bat species in audio data (Aodha et al. 2022). The model is freely available and is recommended to use in a Python environment in the Anaconda distribution. The Python version may need to be adjusted according to the most updated BatDetect2 package. The model is used by entering commands in the command line of a terminal, which may be more difficult steps for readers than to download the BirdNET model. Therefore, we explain how to install BatDetect2 (you can find how-to here).

- Download and install the Anaconda distribution (the installation step here).
- After the installation, open the Anaconda Prompt or the Anaconda Powershell Prompt Terminal (search for Anaconda Prompt in the Windows start menu).
- Create a new Python environment by entering the following command in the command line of the Terminal: `conda create -y -name batdetect2 python==3.xx` With this command, the Python version is automatically set to a specific version (e.g., python==3.10). Please select the proper Python version which the webpage suggests.
- To activate the environment, enter the command: `conda activate batdetect2`.
- After activating the environment, BatDetect2 is installed with the command: `pip install batdetect2`

How to use BatDetect2 with sample data

- Open the Anaconda Prompt Terminal and activate the BatDetect2 environment with the command: `conda activate batdetect2`
- Enter the command: `batdetect2 detect AUDIO_DIR ANN_DIR DET_THRESHOLD`

  AUDIO_DIR: The folder path in which the audio recordings to be analyzed can be found.
  ANN_DIR: The folder in which the result output is saved. For each recording, the output is saved as a .csv and .json file.
  DET_THRESHOLD: The threshold at which minimum detection probability value the bat calls are displayed in the results table. The value has to be between 0 and 1. The lower the value, the higher the number of detected calls.

  Example: `batdetect2 detect C:\audiodata C:\audiodata\results 0.1`

- For receiving further call parameters, the command --spec_features can be used. It is added to the command which is explained above. The results are shown in another output table.

  Example: `batdetect2 detect C:\audiodata C:\audiodata\results 0.1 --spec_features`

- For further usage options (e.g. training the model with own audio data), read more here.

The picture below is an example of the output as .csv

id	det_prob	start_time	end_time	high_freq	low_freq	class	class_prob
0	0.104	0.0015	0.0111	30414	18593	Nyctalus noctula	0.049
1	0.118	0.0155	0.0468	80281	68437	Rhinolophus ferrumequinum	0.117
2	0.672	0.3225	0.3361	24790	20312	Nyctalus noctula	0.48
3	0.504	0.7415	0.758	26328	21171	Nyctalus noctula	0.337
4	0.216	0.8835	0.8969	28889	23750	Nyctalus leisleri	0.094

- **id**: call number
- **det_prob**: confidence value of call detection
- **start_time**: start of the bat call in the recording in s
- **end_time**: end of the bat call in the recording in s
- **high_freq**: highest frequency of the bat call in Hz
- **low_freq**: lowest frequency of the bat call in Hz
- **class**: detected bat species with scientific name
- **class_prob**: confidence value of species identification

The picture below is an example of the output from the --spec_features command as .csv

duration	low_freq_bb	high_freq_bb	bandwidth	max_power_bb	max_power	max_power_first	max_power_second	call_interval
0.00958	18.593	30.414	11.820	20.312	20.312	19.453	20.312	
0.03127	68.437	80.281	11.844	79.609	16.015	94.218	28.046	0.00442
0.01355	20.312	24.790	4.477	21.171	21.171	22.031	20.312	0.27573
0.01649	21.171	26.328	5.156	23.750	23.750	23.750	21.171	0.40545
0.01338	23.750	28.889	5.139	24.609	24.609	10.539	60.703	0.12551
0.01516	20.312	24.670	4.358	22.031	20.312	22.031	20.312	0.23562

- **duration**: duration of the detected bat call in s
- **low_freq_bb**: lowest frequency in the call in kHz
- **high_freq_bb**: highest frequency in the call in kHz
- **bandwidth**: difference between highest and lowest frequency
- **max_power_bb**: frequency with the maximum power in the call in kHz. This parameter is computed between the start and end time and the highest and lowest frequency of the call.
- **max_power**: frequency with the maximum power in the spectrogram in kHz. This parameter is computed between the start and end time of the call and across all frequencies.
- **max_power_first**: frequency with the maximum power in the first half of the call in kHz
- **max_power_second**: frequency with the maximum power in the second half of the call in kHz
- **call_interval**: time span between the call and the previous call in s

Maintenance

The devices should be maintained regularly. This includes version updates of the firmware and if necessary, repair work at the device's hardware and at the microphone cover of the protecting case.

Exchanging acoustic vents for AudioMoth cases

To use the AudioMoths they are to be put in a waterproof case. The cases come with acoustic vents, covering the hole where the microphone lies. Due to hardly avoidable circumstances, like curious insects and weather conditions, the vents tend to break. Therefore, it is necessary to regularly exchange the broken electronic vents. We use GORE Portable Electronic Vents (GAW 3345.09.4). They deliver an even higher performance than the originally built-in vents.
For detailed instructions on where to buy and how to exchange the vents consult this website. The following steps are taken from there. What should be done is:

- It's recommended to use gloves.
- Remove broken vent using tweezers or anything small capable of scraping.
- Clean the surface (using isopropyl alcohol e.g.) and dry it.
- Using round shaped tweezers remove a new vent from the liner and put it on the INSIDE of the AudioMoth case covering the microphone hole. DO NOT touch the center of the vent to avoid damaging it.
- Ensure that the vent is firmly and evenly attached to the case. Therefore, find a way to compress without touching the center area of the vent.

Regular battery charging check when unused

Even if you are not using the batteries, they are drained day by day. If the battery voltage is too low, they will degrade. Therefore, it is often recommended to periodically charge all batteries even during a non-field period.

- If the multimeter drops too low, you need to discharge the battery (you can check how to test batteries with a multimeter from here). → Batteries can be charged up to 1.4-1.5 V and have a voltage of around 1.0-1.2 if they are empty.
- The recommended frequency of charging when not in use depends on the type of battery. However, for example when you have a Nickel-Metal Hydride (NiMH) battery, the recommended frequency of battery charging is once per 90 days (read here).
- A charging, discharging & recharging cycle is necessary to maintain battery capacity, monitor battery health, optimize battery performance, and so on (more detail in here). However, some rechargeable batteries may not require the cycle, therefore always follow the manufacturer's guidelines and recommendations first.

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