Acoustic Recording Analysis Protocol

Bioacoustic Unit

November 2015



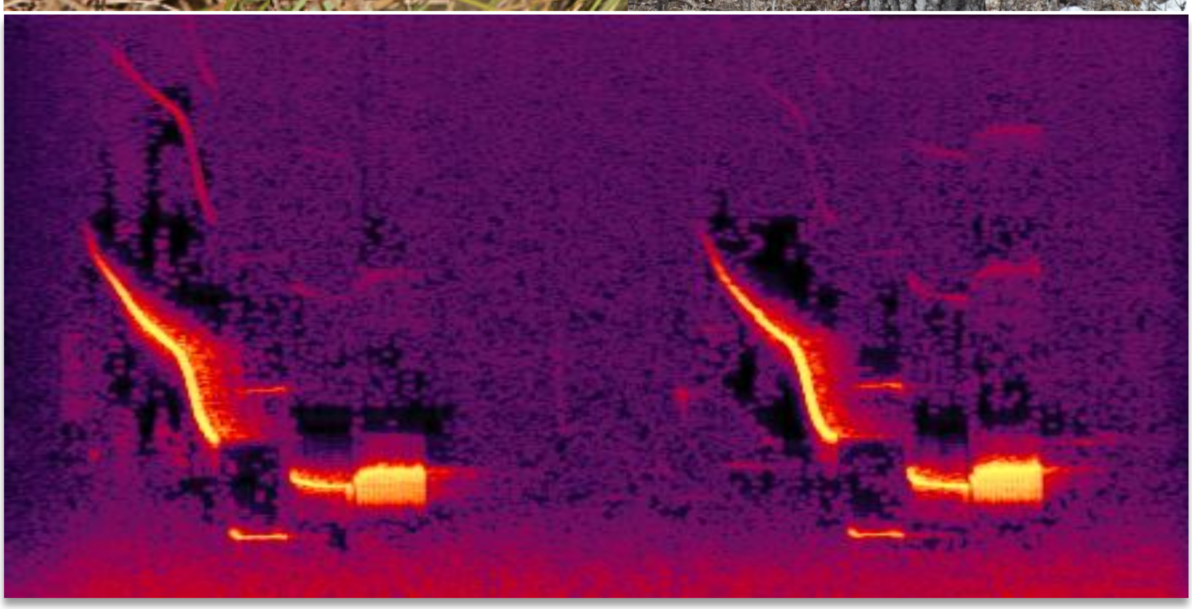

Table of Contents

1 OVERVIEW

The Bioacoustic Unit (BU) is a partnership between the Alberta Biodiversity Monitoring Institute (ABMI) and the University of Alberta. The BU is a full-service organization that provides everything a client requires for wildlife acoustic studies. We provide advice, supply standardized protocols, provide equipment, conduct field work, process audio recordings, and report on the results. Our team is actively conducting leading-edge research to improve methods and to understand acoustic wildlife communities better.

The recording equipment typically used for BU studies are manufactured either by Wildlife Acoustics (Song Meters SM2+ or SM3, www.wildlifeacoustics.com) or River Forks (www.riverforks.com).

Clients regularly collaborate with us to assist with their wildlife monitoring needs. Our involvement varies from client to client and spans the full range of services from simply providing information to conducting a full research project on their behalf.

This protocol describes how the BU processes acoustic data into tabular data, how to manage acoustic data, and how to enter the data into a database. This protocol is intended to accompany a Microsoft Access database file (BU_Database_FrontEnd) that you may use to enter your data.

Note that while BU staff follow this protocol and use the same database structure, there will be minor details in this protocol that apply only to BU staff.

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- Database access protocols, data management

2 MATERIALS, SOFTWARE AND BASIC DATA ORGANIZATION

2.1 Required Equipment

The following equipment and software is required for processing acoustic data. Both Mac and Windows operating systems are suitable but you will need to install a partition that runs Windows programs if you use a Mac in order to use Microsoft Access (the database program).

- Computer
- Sound editing software (See Sections 2.2 and 2.4; Appendix 2)
- Microsoft Access
- Copy of Access Database file (BU_Database_FrontEnd)
- Bird identification resources (Section 3.3.1)
- Headphones with the following specifications
    - Stereo
    - Circumaural (fully enclosing the ear)
    - Frequency range: 5-30,000 Hz
    - No bass boost; headphones should have a flat frequency response
    - Make sure to read specifications before purchasing headphones. Our preferred headphone make and model are SONY MDR-V6[1]

2.2 Converting Recordings

To date, all BU recordings are recorded in WAC, a proprietary compressed file format that cannot be listened to directly using standard audio software. They must first be converted to a **WAV file format** using Wildlife Acoustics' software, **Kaleidoscope[2]**.

2.2.1 Using Kaleidoscope Software

Refer to Section 2.3 (File Organization) for appropriate directory structure.

Opening the program brings you to the main screen (see Figures 2.1 and 2.2)

- Place all WAC recordings to be converted into one folder. Select this folder in 'Input Directory'.

- Check the WAC files box – only include subdirectories if WAC files are stored within multiple folders.

[1] https://en.wikipedia.org/wiki/Sony_MDR-V6
[2] http://wildlifeacoustics.com/products/kaleidoscope-software

- Select the output directory (i.e., folder where the WAV recordings will be stored). Note that you cannot select the same input and output directories and the output directory cannot be nested within an input directory.
- Check the WAV files box and uncheck the split channels box on the 'Outputs' side of the window.
- Click 'Process files'

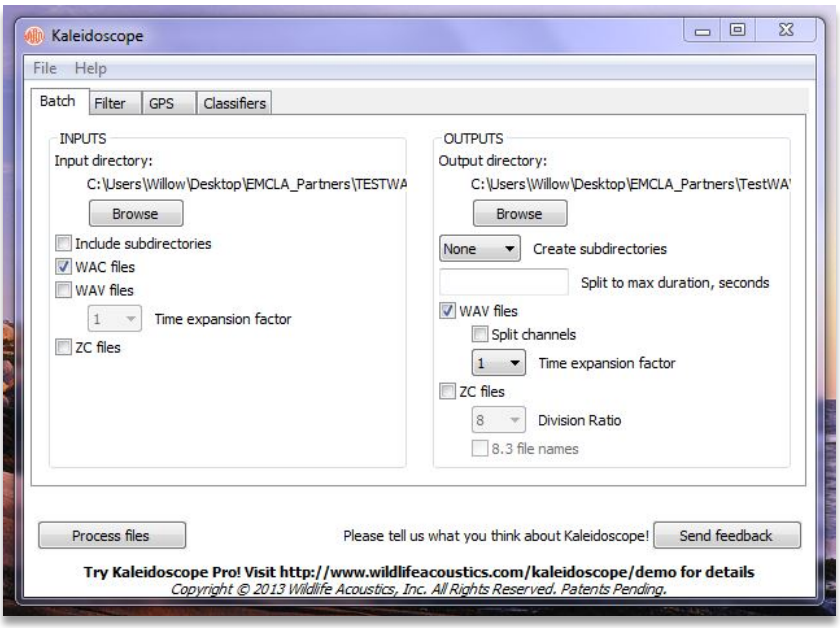


Figure 2.1 – Kaleidoscope Example 1. Settings for converting WAC to WAV. Remember to uncheck the split channels box so that you do not separate the right and left channels of a stereo recording.

The conversion process can take a few minutes depending on how many recordings are being converted. It is also important to note that WAV files are uncompressed and are approximately double the volume of their WAC counterparts, therefore, be sure your computer or hard drive has enough free space before converting.

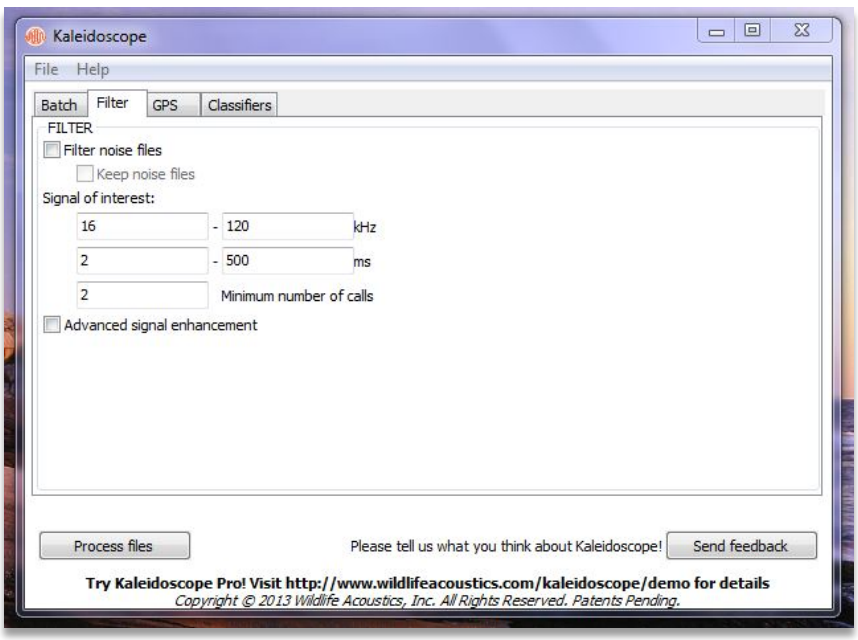


Figure 2.2 – Kaleidoscope Example 2. Uncheck the 'Filter noise files' box. This is not applicable to regular acoustic recordings.

2.3 File Organization

Create a local folder on your computer or hard drive labelled **[Your Name]_AudioWorkSpace**. Within this main folder, create four subfolders:

- **WACfiles** – for WAC files downloaded from the server
- **WAVfiles** – for WAV files once they are converted (see Section 2.2) – also create 2 subfolders labelled "Listened" and "NotListened" to separate work you have done from unprocessed files

- **[Your Name]_Unknowns** – for unknown bird calls (see Section 3.4)
- **[Your Name]_Examples** – for examples of particularly clear bird recordings, multiple individuals, unique dialects, mammal sounds, abiotic sounds or anything you might find interesting or helpful
- You should divide folders further by listening assignments to keep track of files.

This folder is where you should store all audio files related to listening work. It is important to keep a local copy of these recordings so that you can go back to them easily and share them with other listeners. Organize yourself ahead of time. If you have a specific block of recordings to complete and they are stored online or on a remote server, first download them from the server (if necessary) and convert them from WAC to WAV files (see Section 2.2). The recordings contain a large volume of data and can take a long time to download, especially if you have a slow internet connection. Having recordings stored locally and in the proper format will also prevent lost time if the server goes offline, which occasionally happens. Alternatively, you may be given a set of files by the Data Processing Coordinator or copy them off a local hard drive instead of a server. In these situations, it is also good to get enough files for a few days of work at a time so that you spend less time on file conversion.

2.4 Listening Software

The main software we use is **Adobe Audition**[3] and **Audacity**[5]. Other programs such as **Raven Pro**[6]**,** or **SongScope**[4] may be used for specific tasks but will not be your standard listening software. Audacity is available free online; however, the default settings are not good for listening. Please refer to Appendix 3 for information on how to adjust settings for both Adobe Audition and Audacity.

All the above programs use a spectrogram. A **spectrogram** is a visual representation of sound frequencies over time. Rather than only listening to the recordings, spectrograms facilitate the visual interpretation of the sound signature. The main properties of a spectrogram are the frequency and amplitude, which, when combined with sound, creates a unique signature. Individuals of the same species can have their own unique variations of song that even a keen ear cannot distinguish but that are detectable on a spectrogram. Audition, Raven Pro, Audacity and SongScope all display this information in similar ways with parameters that can be adjusted to optimize spectrogram visualization (see Appendix 2). It is vital to use both the auditory and visual signals when listening as this greatly improves one's ability to accurately identify species.

[3] https://creative.adobe.com/products/audition
[5] http://audacityteam.org/
[4] http://wildlifeacoustics.com/products/song-scope-overview

3 HOW TO RECORD DATA

All data entry takes place within the **Listening** tab of the Navigation Form. The Listening data entry form is an interface to enter data into the tables in the SQL database. These tables can then be queried to extract the data for analysis.

There are some basic rules that apply to all forms:

- Always enter and/or select from the top down so that the relationships among tables are properly maintained
- Always check to ensure that the record you are trying to create does not already exist in the database. Duplicates must be avoided.
- Most fields in the database are required and you will get an error message if you move on to the next section without filling them in.
- Always ask questions if you are not sure how something works or how to enter a certain kind of information.
- Do not rush: incorrect data entry results in incorrect data and some errors are very time consuming and difficult to correct.

BEFORE BEGINNING ANY RECORDINGS, YOU MUST COMPLETE SECTION 5 OF THE PROTOCOL FOR HEADPHONE AND COMPUTER CALIBRATION

3.1 Navigating to the Correct Record

Users navigate to the correct record by choosing, in this order:

- **Project ID**: This is a 1-to-4 letter code identifying the project you are listening for and should correspond to the project id in the file name of the recording you are analyzing
- **Cluster-Site**: For some projects, there is no Cluster number. In these cases, dropdown shows "99999" and the site number. In all other cases, there will be a two number combination with numbers separated by a dash (e.g. 03-223).
- **Station**: Select the correct station number or letter to correspond to the station in the file prefix of the recording you are analyzing.
- **Year-Round**: This lets you select the correct year for data. This is particularly important for stations that have been sampled multiple times either between or within years. Round refers to within year resampling of a location.

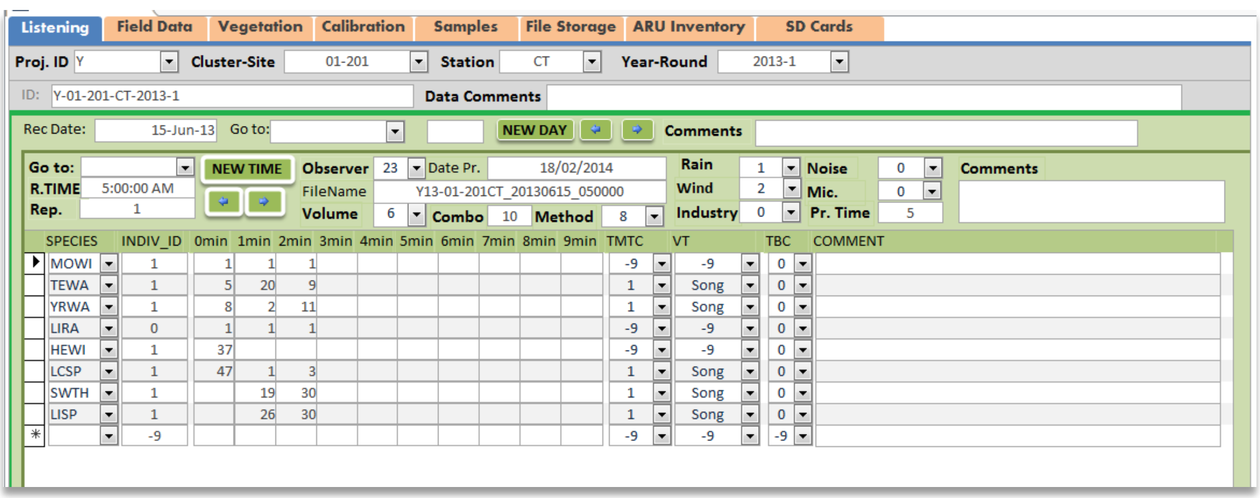
These fields serve as your primary navigation tool in order to select the appropriate location to enter your data. Once these options are selected, the Recording Date, Recording Time and

Detection data entry forms load onto the screen. Remember to double-check that the audio filename corresponds to the date that you have selected.

For most data sets, the identifying information will be contained in the file prefix of the acoustic recording you are working on. For example, in the file name “OW-01-001-SW_20150316_000000” the project ID is “OW”, the cluster is “01, the site is “001”, the station is “SW”, the date is 2015 March 16 and the time is 12:00:00 AM (midnight).

3.2 Filling Out Primary Fields

The next two sub-forms require you to enter data manually. Other users may be entering data for the same date, therefore, make sure that the DATE RECORDED or TIME RECORDED do not already exist for the particular entry you are about to create so that you do not create unwanted duplicate records in the database.


Listening | Field Data | Vegetation | Calibration | Samples | File Storage | ARU Inventory | SD Cards

Proj. ID Y | Cluster-Site 01-201 | Station CT | Year-Round 2013-1

ID: Y-01-201-CT-2013-1 | Data Comments

Rec Date: 15-Jun-13 | Go to: | NEW DAY | Comments

Go to: | NEW TIME | Observer 23 | Date Pr. 18/02/2014 | Rain 1 | Noise 0 | Comments

R.TIME 5:00:00 AM | FileName Y13-01-201CT_20130615_050000 | Wind 2 | Mic. 0

Rep. 1 | Volume 6 | Combo 10 | Method 8 | Industry 0 | Pr. Time 5

SPECIES	INDIV_ID	0min	1min	2min	3min	4min	5min	6min	7min	8min	9min	TMTC	VT	TBC	COMMENT
MOWI	1	1	1	1								-9	-9	0	
TEWA	1	5	20	9								1	Song	0	
YRWA	1	8	2	11								1	Song	0	
LIRA	0	1	1	1								-9	-9	0	
HEWI	1	37										-9	-9	0	
LCSP	1	47	1	3								1	Song	0	
SWTH	1		19	30								1	Song	0	
LISP	1		26	30								1	Song	0	
	-9											-9	-9	-9	

Figure 3.1 – Example of a filled-in form

- **REC DATE (DATE RECORDED)**
    - Either ENTER or SELECT the correct date that corresponds to the date in the file name. Use the drop down menu in the ‘GO TO’ field to check if a recording date has already been added for a station. If the date you need is already in the drop down, click on that date in the dropdown to load it into the ‘REC DATE’ field. If the date you need does not exist, click on the ‘NEW DAY’ button to add a new record. Then enter the date in the ‘REC DATE’ field.

- **R. TIME (TIME RECORDED)**
    - This is the second field you will fill out on the data-entry form (see Figure 3.1). It corresponds to the time in the name of the file you are analyzing. As with the DATE RECORDED field, you may encounter that certain times already exist. Use the drop down in the 'GO TO' field just about the 'R. TIME' field to check if the time you are going to enter already exists. If you find the time, then the recording has already been analyzed. *Do not make another entry for the same time unless your assignment is to listen to a set for recordings for a second time*. Once you have ensured that the time you are entering does not already exist, you can click on the 'NEW TIME' button to open a blank record for the SITE, STATION, DATE DEPLOYED, and DATE RECORDED condition you have selected.

- **REP. (REPLICATE)**
    - Next, fill out the replicate box. The replicate refers to the number of times the same recording has been processed. If you are the first person to the process the recording, the replicate is '1', the second person, the replicate is '2' and so on. If you are processing the same recording for the second time, the replicate is also '2'.

- **OBSERVER**
    - This refers to the person who did the listening and is a drop-down box where you select your name. If your name is not listed, please inform the Database Manager so they can add you to the list
        - If you are the second observer analyzing the same record, scroll to a specific SITE, STATION, DATE DEPLOYED, DATE RECORDED and RECORDING TIME. Then add a new record for RECORDING TIME, re-enter the recording time, enter the replicate as '2' (or '3' depending on how many times the recording has already been analyzed and add yourself as the observer. This will correctly create two records with the same time but different observers.

- **FILENAME**
    - Copy the file name of the original WAC recording into the file name field. <u>Ensure this is copied correctly from the original WAC recording.</u> Note that when Kaleidoscope converts the files to WAV, it tacks on three zeros. Do not include these in the file name field.

- **DATE CREATED**
    - This corresponds to the date the recording was listened to. This is automatically filled in by the database when a new record is created.

- **INDUSTRY, RAIN, WIND and NOISE**
    - See Section 4 – ASSESSING ABIOTIC NOISE

- **MICROPHONE**
  - Every recording contains a certain level of background static due to the pre-amplifiers; however, problems, such as, electrostatic discharge on the microphones, faulty wiring, poorly installed microphones and/or missing microphones can occur causing excess static or 'dead' channels. Use the codes below to enter such problems in the database. Use the comments section to describe the frequency or severity of the microphone issues as well.
    - **0 –** No microphone related issues
    - **1 –** Left microphone cuts out intermittently
    - **2 –** Right microphone cuts out intermittently
    - **3 –** Both microphones cut out intermittently
    - **4 --** Left Channel Failed
    - **5** – Right Channel Failed
    - **6** – Both Channels Failed
    - **7** – Left Side Extra Static
    - **8** – Right Side Extra Static
    - **9** – Both Sides Extra Static
    - **10** -- Other Issues
    - **11** – Unbalanced Channels
    - **-9** – Not assessed

- **VOLUME**
  - This is the volume setting on your computer (see Section 5: HEADPHONE VOLUME CALIBRATION)

- **PROCESSING METHOD**
  - This project uses various types of listening methods to focus on certain species or to be able to compare different data processing methods. The processing method field is set to a default value of '-9'. Change this value to reflect the correct processing method below unless you did not process the recording. Here are brief descriptions of the other processing methods. Always make sure you are using the correct one:
    - **0** – Standard: A full 10-minute recording is processed, with all species and individuals identified
    - **1** – Presence/absence of species by first detection
    - **2** – Presence/absence of species by minute-interval detection
    - **3** – Presence/absence of individual and species by first detection
    - **4** – Recording analyzed for owls (listener not trained to identify other species)
    - **5** – Recording analyzed for amphibians
    - **6** – Recording visually scanned for yellow rail
    - **7** – Recording analyzed for noise reduction

- **8** – 3 min full analysis followed by 7 min visual scan for selected species. Only the first 3 minutes of a recording is processed with all species and individuals being identified. the last 7 min are scanned visually for species at risk (SAR): BTNW, BRCR, BBWA, CMWA, CAWA, OSFL, CONI, RUBL…. There may also be project specific species of interest (SOI). Check these with the Data Processing Coordinator. If a species is detected visually, record it in the database the same as a normal detection. If a SAR is detected in the first three minutes, continue recording detections in the last seven.
- **9** – MP3 file type, use for MP3 versus WAV experiment.
- **10** – Call Rate Analysis: used by undergraduate projects in 2013/14
- **11** -- 3 min full analysis, same method as 8 but no 7 min visual scan for SAR
- **12** – 1 min full analysis no visual scan
- **13** – 1 minute full analysis with fixed-time
- **14** – 3 minute full analysis with fixed-time
- **-9** – recording not processed
- **-8** – recording incompletely processed

- **PROCESSING TIME**
  - Before beginning to the listen to the recording, note the start time (a helpful hint is to mark the time in the comments section). Mark the time it took in minutes to complete the recording, including the time to enter metadata (site, dates, etc.) and the species identifications. This does not include the time taken to make clips, samples and identify unknown species.

- **COMBO (HEADPHONE-COMPUTER COMBINATION)**
  - This corresponds to the combination of headphones and computer that each person uses for listening (see Section 5: HEADPHONE VOLUME CALIBRATION)

- **COMMENTS**
  - Use this field liberally to make any comments about the entire recording (note that there is a 255 character maximum for this field).

3.3 Entering Species Data

Once you start listening to the recording, you will use the detection table. The final table is a spreadsheet-style form where you will enter the species and abiotic data for a recording. Note that these instructions are for a standard 10-minute recording (processing method ‘0’). You will enter data for **species**, **number of individuals, minute-by-minute detection times**, **vocalization type (VT), abundance (TMTC – too many to count), confidence of identification (TBC – to be checked)** and **comments** (when necessary). Section 3 clarifies the use of TBC and Section 4 for abiotic data. You cannot enter species data until all fields in the recording table are completed. If for whatever reason, you need to abort or cannot start a recording, fill in the method as '-8' and make a note in the comments.

The **SPECIES** column has a drop-down box including birds, mammals, amphibians, as well as abiotic noise codes (see Section 4.1: Abiotic Codes and Descriptions). Select the species/noise you hear by using drop-down or typing the 4-letter AOU code. The complete list of species and AOU codes is also available in the Look-Up Tables section of the database. Not all sounds are identifiable (Section 3.4 clarifies unknown observations). If no species are detected throughout the recording, fill in a species code box with '**NONE'** (here it is not necessary to fill out minute-intervals). Use this code for recordings with no species to flag that the recording was processed. Entering which recordings have no species is essential for data analysis.

3.3.1 Resources to Assist Species Identification

Use the following sources to help you identify bird as well as some amphibian and mammal species:

- Environment Canada's *Dendroica* (http://www.natureinstruct.org/dendroica/)
- *All About Birds* from Cornell University (http://www.allaboutbirds.org/guide/search)
- Thayer's Birding Software (http://www.thayerbirding.com/)
- Barb Beck's Bird Call Collection (See Database Manager for Access)
- Xeno-Canto (http://www.xeno-canto.org)
- Bioacoustic Unit Listener's Website (https://sites.google.com/site/birdsoundsab/)
- Bioacoustic Unit Sound Library

Be aware that some of these libraries do not have examples of western birds; there are dialect differences between different parts of the country. The **Barb Beck Collection**, **Dendroica** and **Xeno-Canto** are the references of choice. Importing birdsong and calls directly to your audio software allows you to flip quickly back and forth through spectrographs for comparison.

- **Xeno-Canto:** mp3s and spectrograms of birdsong and calls from all over the world. This site is incredibly useful with dozens of examples of most species.
- **Dendroica:** A great resource for learning bird groups. The 'Manage Lists' button allows the user to select birds from a certain geographical region as well as the option to show rare and migratory birds.
- **Bioacoustic Unit Listener's Website:** an ongoing development of teaching and training materials for active listeners

3.3.2 Entering Species Data

This is the last part of the form that you need to fill out. Enter this information as you go through each recording and identify the species. Make sure you understand how to enter species data for the different methods listed above. Please refer to Appendix 3: Summary Tables.

- **INDIV_ID (Individual Number)**
  - The default value for this field is '1'. It corresponds to uniquely identified individuals of a species on the recording. In other words, if you hear two Ovenbirds in the recording, you would have one row with **'OVEN 1'** and second row with **'OVEN 2'**. As many individuals as you can identify can be added. Evidence for multiple individuals needs to be strong (see TMTC below and Section 3.3.3). Fill in the field with '0' if the species is 'NONE'.

- **0 – 9 MIN (Minute-interval columns)**
  - Enter the second when each individual was detected within each minute. In other words, every box should either be empty, signifying that individual was not heard during that minute or have a value between 1 and 59. Detections made within the first 1 second (e.g. <1) are labeled as '1'. Each audio program contains a digital timer to help pinpoint the second the species was heard.

- **TMTC (Too Many to Count)**
  - The TMTC column is used to store abundance information for each detection; either TMTC is '1' for 1 individual or '2' for many individuals. See Section 3.3.3 for further details on abundance measurements. We use two different TMTC measurements: one for birds and mammals and one for amphibians.

Distinguishing TMTC for Birds and Mammals

When birds (or mammals) become TMTC, the observer is indicating an "uncountable" abundance of a particular species. Most often, this occurs with flocking species, such as Canada Geese and White-winged Crossbills or gregarious species, such as Black-capped Chickadees or Gray Jays. In either case, the number of calling or singing individuals must be large enough that the observer cannot pinpoint which individual is calling during each minute-interval. A '2' is entered in the TMTC column.

Distinguishing TMTC for Amphibians

Amphibians are ranked by call intensity rather than by distinguishing individuals. Use the following call intensity codes. See Section 3.3.3 for more detailed information on how to assign call intensity code

Table 3.1 – Amphibian TMTC codes and their descriptors.

TMTC	*Description*
3	CI1: Individual amphibians can be counted; there is no overlapping of calls
4	CI2: individuals can be distinguished but there is some overlapping of calls
5	CI3: Full amphibian chorus, calls are constant, continuous and overlapping

- **VT (Vocalization Type)**
  - This field describes the type of vocalization each detected species/individual made:

Table 3.2 – Vocalization type codes and their descriptions.

Vocalization Type	Description
CALL	Use this for call notes, alarm calls and non-passerine vocalizations
SC (Single Call)	Use this for call notes from passerines and non-passerines that occur *only once* for the entire listening time
SONG	Use this for territorial or mating songs
SS (Single Song)	Use this for songs that occur *only once* for the entire listening time
NV (Non-vocal)	Non-vocal sounds (see below) made from tails, feathers or other body parts

**Single Calls and Single Songs have a* lower chance of being identified correctly, especially if they are faint, because there is not chance of looking at a clearer call or song later in the recording.
*For passerines, songs or other primary vocalizations, take priority over calls if both occur on a recording because songs are used for territorial behaviour and mate attraction.
*For Common Nighthawk (CONI), Wilson Snipe (WISN) and Roughed Grouse (RUGR), NV sound take priority over calls if both occur in a recording because non-vocal sounds (wing booms) indicate territoriality more than calls.

<u>Differentiating Vocalization Types</u>

Here is a list of species differentiated into **calls, songs** and **non-vocal sounds**:

Table 3.3 – Vocalization type codes organized by taxa.

Vocalization Type	Species

SONG (or SS)	Male passerine mating and territorial vocalizations, all amphibians and owl primary vocalizations
CALL (or SC)	Passerine call notes, mammals; and non-passerine primary vocalizations from the following families: Anseriformes (ducks), Apodiformes (swifts, hummingbirds), Caprimulgiformes (nighthawks), Charadriiformes (shorebirds, gulls, terns), Ciconiiformes (herons), Columbiformes (doves), Accipitriformes/Falconiformes (hawks, eagles, falcons), Coraciiformes (kingfisher), Cuculiformes (cuckoos), Piciformes (woodpeckers), Galliformes (pheasants), Gruiformes (cranes, rails), Gaviiformes (loons), Pelecaniformes (pelicans, cormorants), Podicipediformes (grebes)
NV	Winnowing of a Wilson's Snipe (WISN), woodpecker drumming, Common Nighthawk flight display ('*boom*'), wingbeats of all duck species (indicate **UNDU** and flyover in the comments), Ruffed Grouse drumming, **CRCH** ("crunch" - noise made by approaching mammals)

- **TBC (To Be Checked)**
    - This column is for keeping track of songs or calls that you want other observers to check. A set of numerical codes will correspond to the checked status of the song or call. Use this column in accordance with the guidelines set out in Section 3.4.
        - **0 –** *Default value* – The observer is confident with the species identification provided
        - **1 –** *To be checked* – Use this for any sound or vocalization where you cannot identify the species; always create a sound clip for TBC1 (see Section 3.4)
        - **2 –** *Species Confirmed* – Sound has been checked and second observer agrees with first observer
        - **3 –** *Changed to Unknown* – Sound has been checked and second observer disagrees with first observer, changed to unknown and both guesses entered in the comments field with observer names
        - **4 –** *Unknown Confirmed* – Sound has been checked but neither observer can identify it
        - **5 –** *Unknown Far* – Sound is recorded but is likely too faint or degraded for anyone to identify. A sound clip does not have to made.
        - **-9 –** *Not assessed*. This is the default value and must be changed when needed to the correct value.

- **VB (Verified By)**

- The second person who assesses a species' identification. This will always be an equally or more experienced listener.

- **COMMENTS**
  - Use this column liberally to make notes about any of the songs or calls relating to the species in question, especially in the case of unknowns.

SPECIES	INDIV_ID	0min	1min	2min	3min	4min	5min	6min	7min	8min	9min	TMTC	VT	TBC	COMMENT
BCFR	1	1	2	1	1	32	1	3	1	1	1	4	Song	0	
CONI	1	3		12	5		58				44	1	NV	0	'peents' and 'booms'
WISN	1	6	10	8	4	1	1	4	7	9	1	1	Call	0	Call and winnowing
GRYE	1	16	4			31	32	13				1	Call	0	
RNGR	1		12					42	11		3	1	Call	0	
COLO	1			14								1	SC	0	
RNDU	1				37	43						1	Call	0	
LINO	0						3		19			-9	-9	0	7:19: airplane
RNGR	2		12					42	43			1	Call	0	
	-9											-9	-9	-9	

FIGURE 3.2 – Example of a completed detection table; here we have Boreal Chorus Frogs (BCFR) singing at an intensity of 4, meaning their songs are overlapping but have distinguishable individuals. A Common Nighthawk (CONI) vocalizes irregularly with both types of signals indicated by the observer in the Comments section. 'Booms' are the primary non-vocal sound of the CONI which supersedes the 'peent' call vocalization, therefore VT = NV. A Wilson's Snipe (WISN) calls and winnows (NV) frequently throughout the recording and has detections in every minute interval. There are two Red-necked Grebes on the recording that call in the 1, 6 and 7 min intervals, with only the 1st individual calling in the 9 min interval. Since both sexes vocalize the same, they receive the VT 'call'. A Greater Yellowlegs (GRYE) also calls throughout the recording at various times. A Common Loon (COLO) is heard only once throughout the recording so it receives the 'single call' or SC vocalization type. A Ring-necked Duck (RNDU) is also briefly heard in the middle of the recording only in the 3 min and 4 min intervals. Finally, the observer detected abiotic noise in the 5 min and 7 min intervals describing the nature of the noise in the comments. Note the INDIV_ID code annotated as '0', and the TMTC and VT fields as '-9'. The observer was confident of all their identifications so all TBC fields receive '0'. Note, that time of first detection for each minute interval is indicated – even if the individual vocalizes multiple times.

3.3.3 Abundance Measurements (TMTC)

Individuals should be differentiated wherever possible, and the TMTC = 2 designation should only be used when you are sure you cannot tell individuals apart, especially for territorial species where you mostly have only 2 to 3 individuals but less commonly up to 5 or 6. If you are unsure of how many individuals you can tell apart, use the more conservative number. There is no hard and fast rule for doing this but the following tips will help. Once you are trying to tell more than three birds apart, you need to make sure that you can consistently use these methods to tell the individual apart throughout the course of the recording.

It is common to have more than one individual of the same species on a recording. Whether or not it is possible to tell how many there are depends on several factors. We can identify multiple individuals of the same species by:

- Timing
    - *Overlap* between calls or songs or
    - *Spacing* between vocalizations
        - Even spacing = more likely to be same individual
        - Odd spacing = more likely to be more than on
- Variation in:
    - *Directionality*: which side of ARU is singing from,
    - *Intensity*: how close the bird is to the ARU, or
    - *Song*: differences in pitch, length, syllables and structure are all indicators

The number of individuals that are identifiable is often dependent on the species and their behaviour. Under the following circumstances, it will be difficult to distinguish individuals.

- *Flocking* - vocalize and move together
    - Crossbills, waxwings, PISI, swallows, chickadees, GRAJ, CANG, gulls and terns
- *Rapidly changing location*
    - CONI, WISN, CORA, AMCR, ducks, shorebirds, woodpeckers
- Have *short, invariable songs*
    - LEFL, YBFL
- *Jumbled* or, *disjointed songs*
    - AMRO, RBGR, vireos

Typically, multiple factors come into play to properly discern >2 individuals on a recording. Estimating individuals (1 to 5+) is possible when birds are:

- *Territorial* - are separated spatially from each other
    - OVEN, TEWA, SWTH, LCSP
- *Sedentary* - tend to sing from one general location
    - OSFL
    - Have *variable songs* between individuals-Warblers, sparrows, wrens, kinglets

For amphibians calls from different individuals cannot be distinguished from each other using the same methods as for birds. In stead they are qualtified using call in intensity by assessing the space between calls. The system we use was adapted from the North American Amphibian Monitoring Program (NAAMP) Amphibian Calling Index (ACI) (2005):

Call intensity 1 (CI1): calls do not overlap. A single call can be seen on the spectrograph, and no other calls occur within the duration of that call.
Call intensity 2 (CI2): calls overlap, but can be distinguished
Call intensity 2 (CI3): overlapping calls are constant and cannot be distinguished. A full chorus of calls may not appear distinguishable visually on the spectrograph. The image will most often look like a continuous line of noise.

3.4 HOW TO CLASSIFY UNKNOWNS

There is a degree of uncertainty in identifying species on a recording, because birds make a variety of different sounds and the ability of an observer to identify ~300 boreal birds, amphibians and mammals by vocalizations is learned over long expanses of time. Sounds that cannot be identified are entered as unknowns in the database.

There are various reasons why unknowns occur:

- The vocalization is clear but the observer is unable to identify it
- The vocalization is too degraded or faint, or masked to identify
- The vocalization is a short call note or alarm call
- The vocalization is some other sound (i.e. abiotic)

To aid identification of these unknowns, try to place the call/song to the best of your ability into one of the unknown categories in Table 3 in Appendix 3.

Other than primary songs, passerines also have alarm calls, flight calls and call notes. Using these as species identifiers is difficult and unreliable. Therefore, we are avoiding clipping and attempting to identify songbirds based on calls. If at any point, the bird sings, and you cannot identify it, make a clip. Generally, you should only make clips of the unknown only if the individual calls more than once – in most cases a single call does not provide enough information. Use the **TBC column to indicate whether the entry needs to be verified by another observer and write in the comments section a detailed account of the sound (See Table 3.4)**.

Table 3.4 – How to enter unknown species codes and their according vocalization type, TBC status and comments.

Sound type	Species Code	VT	TBC	Comments
Unknown passerine call	UNPA	SC/ Call	0	
Unknown passerine song	UNPA	SS/ Song	1	0150-UNPA1. Short

				description.
Unknown non-passerine call: SC or very short	UNKN	SC	0	
Unknown non-passerine call:	UNKN	Call	1	0345-UNKN1. Short description.

Here is a full list of the UNKN codes in the database:

- Unknown Accipiter (UNAC)
- Unknown blackbird (UNBL)
- Unknown Buteo (UNBU)
- Unknown corvid (UNCV)
- Unknown duck (UNDU)
- Unknown flycatcher (UNFL)
- Unknown gull (UNGU)
- Unknown (UNKN) *used if you can't narrow down to any other group
- Unknown owl (UNOW)
- Unknown passerine (UNPA)
- Unknown shorebird (UNSH)
- Unknown sparrow (UNSP)
- Unknown swallow (UNSW)
- Unknown tern (UNTE)
- Unknown thrush (UNTH)
- Unknown triller (UNTRLL)
- Unknown vireo (UNVI)
- Unknown warbler (UNWA)
- Unknown woodpecker (UNWO)
- Unknown yellowlegs (UNYE)

Some sounds are so faint or degraded that they are likely unidentifiable by anyone. These sounds labelled 5 in the TBC column, which means that clips do not have to be made, and there will be no further attempt to identify the sound. The threshold between identifiable and likely unidentifiable sounds is based on how degraded, faint of masked the sound is, what type of sound it is and the skill of the listener. To get an idea when to use the TBC 5 code, refer to TBC5 samples in the BU Sound Library.

3.5 Sample Tracks

We are continually updating the BU call and sound reference library. To do this, we need to set aside examples of unique and/or very clear vocalizations and sounds. We also need samples of song variations, multiple individuals and faint calls. You might have a recording that has a very clear spectrogram of two counter-singing male Ovenbirds or you get a very clear Barred Owl duet. You might find a confusing call that turns out to be yet another variation of a Yellow-rumped Warbler or American Redstart. A few examples of odd abiotic sound will be useful as well. When you get a sample you feel might be useful for you later or to share, take a 20 second or longer sample from the main recording and save it as a new sound file. **<u>The new file should be in WAV format, 16 bit, stereo, and a sample rate of 44100 Hz</u>**. Label the file with the original file name in addition to the time in the recording and the species on the track. For example, if you found a good Yellow-rumped Warbler call on a track at 1:35 at Site 6, Station FI6 on June 25th, 2012 at 6:00 AM, you would label it as follows: **06-FI6-20120625_060000_0135_YRWA.** Store copies of all your samples in the BU_Examples folder in your BU_AudioWorkSpace.

To create a clip or sample:

- Find a section of the recording where the unknown is singing/calling, ideally without interference from other species or abiotic noise
- Highlight the song/call on the spectrograph incorporating a couple seconds before and after to provide context
- Right-click the highlighted section and click “Save Recording As…”
- In the subsequent window, save the clip using the following conventions:
    - Project ID-Cluster-Site-Station_Date_Time of recording_Time of clip_Species code_Number of Individuals.wav
        - Example: **Y-01-200-CT_20130528_040000_0322_UNKN_3.wav**
    - <u>WAV format, 16-bit, stereo and a sample rate of 44100 Hz</u>
    - Save in Unknowns folder within Audio Workspace folder.
- Be sure to include the time and species code information of the filename in the comments for the species you are clipping for easy reference (i.e. put 0322_UNKN as the first part of the comments for that detection.
- One song is often not enough information to identify an unknown. An unknown recording will have a greater chance of being identified if there are multiple examples. To quickly make a clip with multiple examples: Select the area of one song and save it as a new file using the naming convention. Then repeat for at least two more examples or enough that any variation is captured and add them to the end of the first sample.

4 ASSESSING ABIOTIC NOISE

The recording units pick up all noise, including weather-related and anthropogenic noise. We need to assess background noise because it affects species detection. Noise on recordings originates from different sources. Certain recorders were placed very close to features such as compressor stations or industrial sites where noise is almost constant throughout the entire recording (i.e. motors, fans, engines running 24/7). Others were located near busy roads where noise is variable throughout a recording (passing cars and trucks). Wind and rain also create an identifiable noise signature.

All these sources of noise have their own sound signature and are identifiable both by ear and by viewing the spectrogram. We use four-letter codes (similar to the bird species codes) to record rain, wind, industrial and background noise in the data-entry form. Generally, constant industrial noise, such as compressor stations, occurs below 500 kHz but louder noise can cover a greater frequency range (up to 1000 kHz for light noise, up to 1500 kHz for moderate industrial noise (MONO) and up to 2000 kHz for heavy industrial noise. Low-intensity wind blowing against the microphones also creates noise that is generally below 2000 kHz but can muffle all frequencies. Rain tends to create broad-spectrum noise from 0 to > 10,000 kHz.

There are four categories: wind, rain, industrial noise and other background noise. Refer to Table 2 in Appendix 3: Summary Tables for a handy reference of what goes in each category.

ARUs produce about a certain amount of static from the unit itself (30 dB for most recordings – new recording devices may have lower background noise). Do not record this static as noise because it occurs on all recordings!

4.1 Abiotic Codes and Descriptions

RAIN

- **0 –** No rain present on track. (No code since there is no rain)
- **1 –** Light rain present on track - affects the ability to hear distant/faint species, drops seldom hit microphones. (Code: **LIRA**)
- **2 –** Moderate rain present on track - affects the ability to hear nearby species, drops often hit microphones. (Code: **MORA**)
- **3 –** Heavy rain present on track - significantly affects the ability to detect species, drops very frequently hit microphones. (Code: **HERA**)

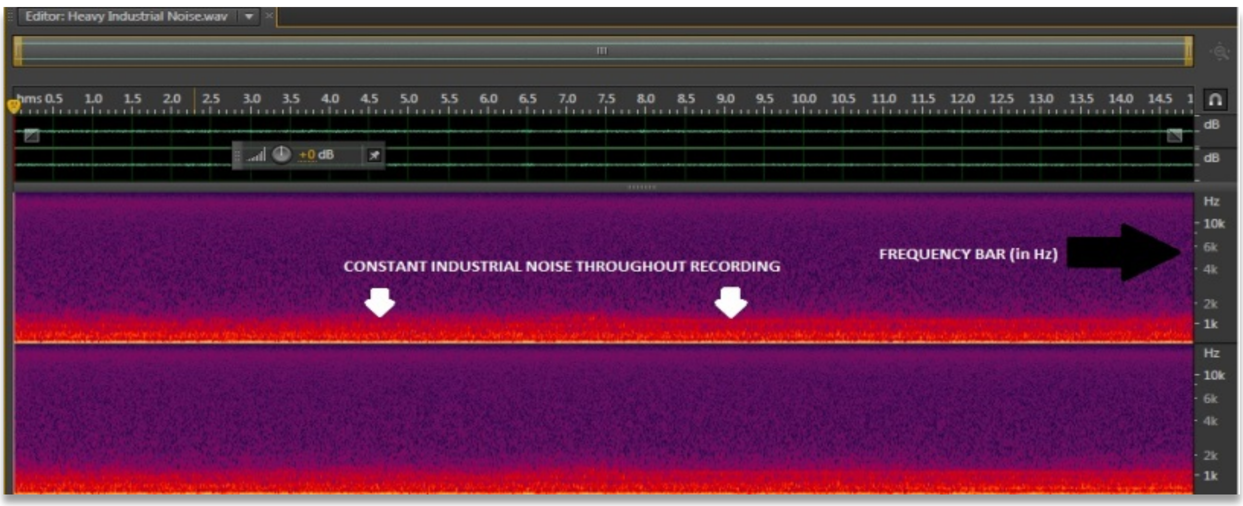


Figure 4.1 – Example of heavy industrial noise (HENO) as seen on a spectrogram in Adobe Audition.

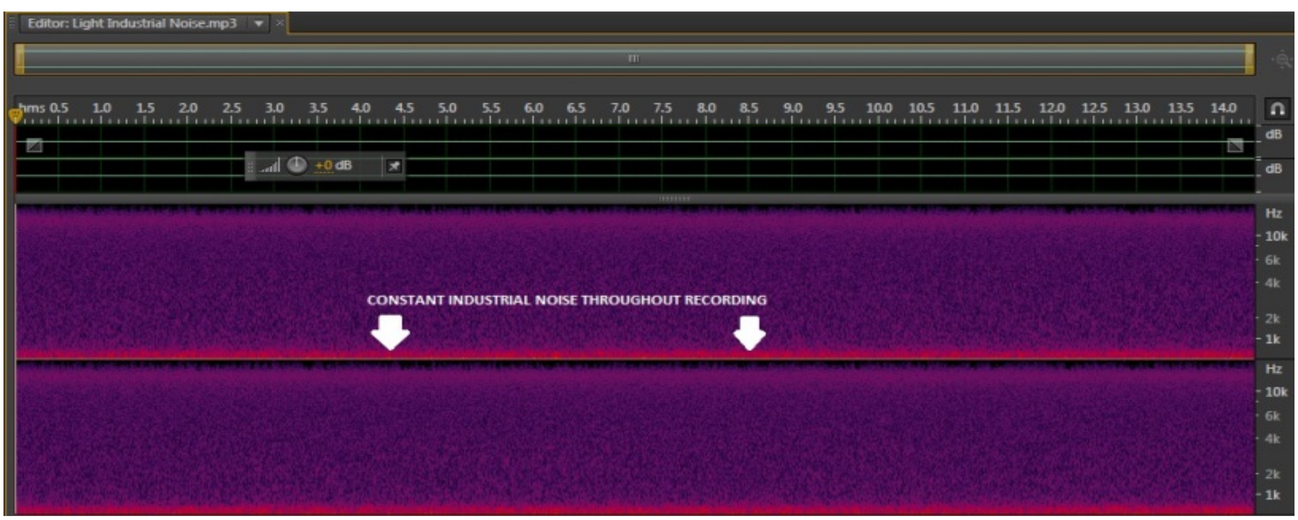


Figure 4.2 – Example of light industrial noise (LINO) as seen on a spectrogram in Adobe Audition.

WIND

- **0 –** No wind present on track. (No code since there is no wind)
- **1 –** Light wind present on track - usually hear rustling leaves/trees creaking (background noise), affects ability to detect distant/faint species. (Code: **LIWI**)
- **2 –** Moderate wind present on track - begins to muffle microphones (frequency and decibel rates begin to spike), occasionally affects ability to detect nearby species. (Code: **MOWI**)
- **3 –** Heavy wind present on track - always muffles microphones, frequency and decibel graphs spike constantly (sometimes cuts out due to noise threshold). (Code: **HEWI**)

INDUSTRIAL NOISE

- **0 –** No industrial noise present on track. (No code since there is no noise)
- **1 –** Faint industrial noise present on track (a distant truck, a low hum from a processing plant) – affects distant/faint species detection. (Code: **LINO**)
- **2 –** Moderate industrial noise present on track (a pump-jack whirring nearby, significant noise from processing plants) – begins to affect species detection. (Code: **MONO**)
- **3 –** Heavy industrial noise present (trucks driving by the recorder, loud processing plants, plane flying overhead) – significantly affects ability to detect close-range species. (Code: **HENO**)
-

BACKGROUND NOISE

- **0 –** No background noise detected
- **1 –** Faint background noise present (e.g. running water not close to recorder; distant thunder rumble) – affects detection of distant/faint species. (Code: **LIBA**)
- **2 –** Moderate background noise present on track (e.g. moderately loud water) – begins to affect detection of closer species. (Code: **MOBA**)
- **3 –** Heavy background noise present (e.g. running water or rapids very close to recorder; mosquito sitting on top of the microphone) – species difficult to detect even if present. (Code: **HEBA**)

4.2 Assessing Abiotic Noise on a Recording

Assessing the noise on a recording involves two steps. Firstly, **enter noise codes according to their minute-–by-minute detection on a recording**, just as you would for birds, amphibians and mammals. At each 1-minute interval where a type of background noise is present, the code must be re-entered the same as for species data. If a background noise is present at the same level throughout the entire recordings, enter a value a “1” in *every* minute box to indicate that the event occurred first within the first second of each minute. For example, if there is light wind throughout the recordings, you would enter 1 for each of the 10 minute intervals. There is no need to assess a vocalization type or number of individuals –INDIVID = 0 . The VT and TMTC fields can be left at their default value of “-9”; but, if you would like another observer to assess your ability to quantify noise level, you may change TBC to "1" for review – do not forget to indicate a clip note in the comments and properly store it in your unknowns folder.

In some cases, such as for gusts of wind or vehicles passing the recorder, there will be more than one intensity of background noise within one minute. For example, if there is low level industrial noise throughout the recording, but a car drives by at 1:20, the second minute interval would have LINO entered as 1 (beginning of the minute) and HENO entered as 20 to correspond with the car passing at 1 min 20 s into the recording. In Figure 4.3, traffic passes very close to a recorder; note that amplitude and frequency will spike while traffic passes (up to 10 kHz). Rain, wind and noise are not mutually exclusive: they will often occur during the same recording, most often with rain and wind (i.e., a storm). Do you best to rate each background noise on a recording independently of the other.

Secondly, **create an average based on the noise throughout the whole recording**. Fill in these averages at the end of the recording in the fields above the comments section. Process the entire recording and then create the averages in the appropriate noise fields (industry, rain, wind, noise) after the recording is finished. How many minutes you create the averages over depends on the analysis method. For example, for Method 0, the average is based on all 10 minutes. For Method 11, the average is based on only the first 3 minutes. If there is variability in intensity for one kind of background noise, only change the average if the different intensity is present at least 1/3 of the time. For example, if there is light wind (LIWI) and it only increases to being heavy wind (HEWI) for only one minute, the recording average should still be LIWI. However if you have LIWI in 5 of the 10 minutes, MOWI in 1 minute and HEWI in the other 4 minutes, you might put an average of MOWI for the entire recording. Rain intensities rarely change during recordings (chances are that the rain will not pick up or settle down with 10 minutes), nevertheless, note any rain intensity changes if they do occur.

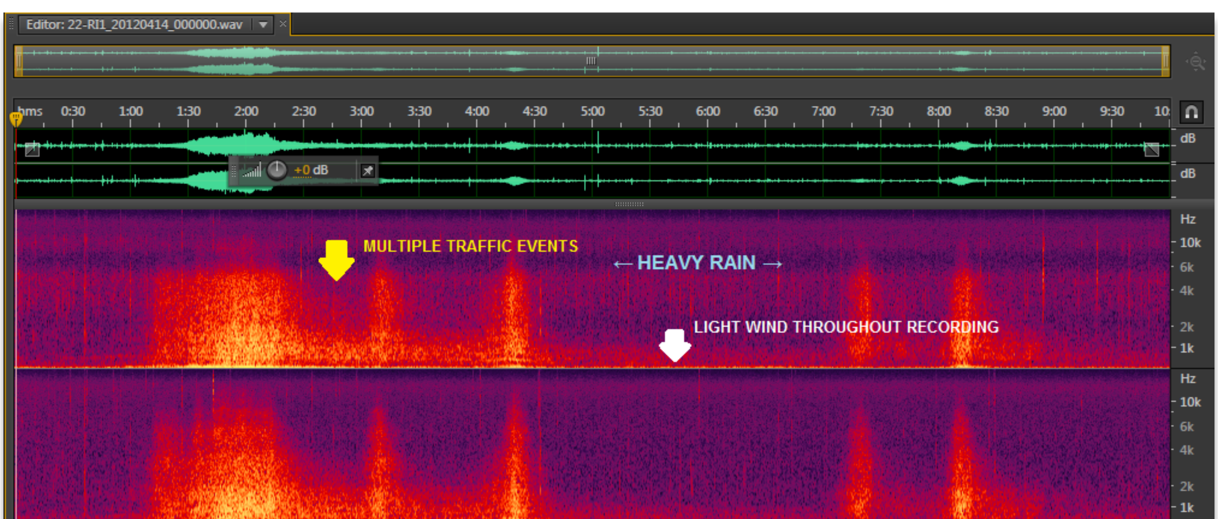
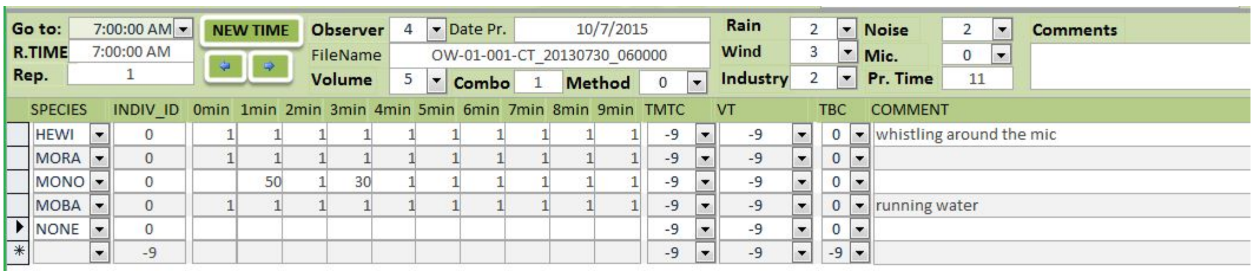


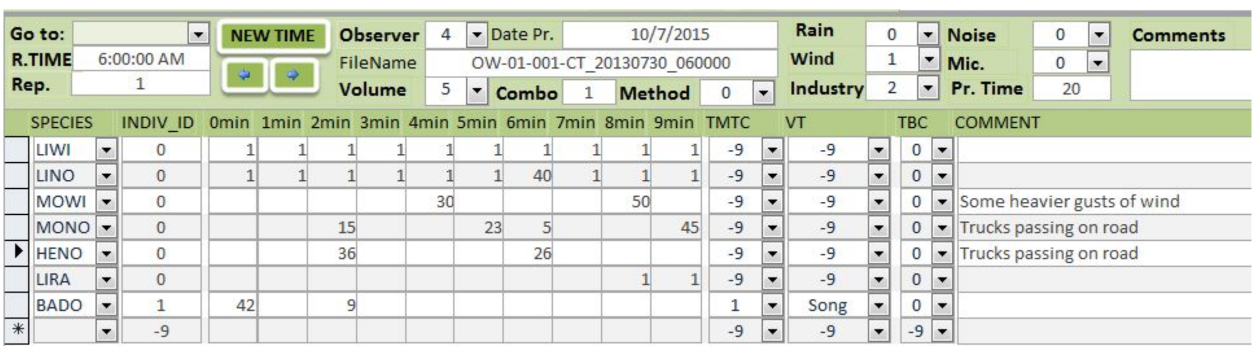
Figure 4.3 – Example of a complex set of abiotic noise events as seen on a spectrogram in Adobe Audition. Note the variable traffic noises (HENO), heavy rain (HERA) and light wind (LIWI) occurring.



Go to: 7:00:00 AM | NEW TIME | Observer 4 | Date Pr. 10/7/2015 | Rain 2 | Noise 2 | Comments
R.TIME 7:00:00 AM | FileName OW-01-001-CT_20130730_060000 | Wind 3 | Mic. 0
Rep. 1 | Volume 5 | Combo 1 | Method 0 | Industry 2 | Pr. Time 11

SPECIES	INDIV_ID	0min	1min	2min	3min	4min	5min	6min	7min	8min	9min	TMTC	VT	TBC	COMMENT
HEWI	0	1	1	1	1	1	1	1	1	1	1	-9	-9	0	whistling around the mic
MORA	0	1	1	1	1	1	1	1	1	1	1	-9	-9	0	
MONO	0		50	1	30	1	1	1	1	1	1	-9	-9	0	
MOBA	0	1	1	1	1	1	1	1	1	1	1	-9	-9	0	running water
NONE	0											-9	-9	0	
	-9											-9	-9	-9	

Figure 4.4 – Example of a very noisy recording. Note "NONE" is still entered to indicate no species were detected.



Go to: | NEW TIME | Observer 4 | Date Pr. 10/7/2015 | Rain 0 | Noise 0 | Comments
R.TIME 6:00:00 AM | FileName OW-01-001-CT_20130730_060000 | Wind 1 | Mic. 0
Rep. 1 | Volume 5 | Combo 1 | Method 0 | Industry 2 | Pr. Time 20

SPECIES	INDIV_ID	0min	1min	2min	3min	4min	5min	6min	7min	8min	9min	TMTC	VT	TBC	COMMENT
LIWI	0	1	1	1	1	1	1	1	1	1	1	-9	-9	0	
LINO	0	1	1	1	1	1	1	40	1	1	1	-9	-9	0	
MOWI	0					30				50		-9	-9	0	Some heavier gusts of wind
MONO	0			15			23	5			45	-9	-9	0	Trucks passing on road
HENO	0			36				26				-9	-9	0	Trucks passing on road
LIRA	0									1	1	-9	-9	0	
BADO	1	42		9								1	Song	0	
	-9											-9	-9	-9	

Figure 4.5 – Example of recording with variation in both type of noise and intensity of noise.

As wind, rain and industry increase in intensity, biotic sounds are harder to detect. With certain listening assignments, you will be asked avoid recordings where abiotic noise is above a certain level (usually moderate). For example, you might be instructed to listen only to tracks with RAIN, WIND, INDUSTRY and/or NOISE of "0" to "1". If you open a recording and find that it has a Noise rating of 2 or 3 AND you are not supposed to listen to recordings with this much noise, then fill in the date, time, replicate and observer other recording related information BUT leave the Detection from BLANK. **Fill in the processing method a -9 (recording not processed)**. It is important to leave the species table blank to differentiate from recordings where there were no species detected (refer to section on NONE birds). **<u>Only do this if you are specifically instructed to do so. Check with the listening co-ordinator what, if any, background noise cut-offs are applicable to your assignments.</u>**

5 HEADPHONE VOLUME CALIBRATION

5.1 Hearing Safety

The volume in headphones can reach levels that are damaging to human hearing. Technicians listen to recordings for 4 to 8 hours a day, therefore, we need to ensure that volume levels do not exceed amplitudes that would incur hearing damage. Occupational health and safety requires that hearing protection be worn if workplace noise exceed 85 dB (A-weighted) over the course of the day. *A-weighted* sound levels are artificially adjusted to match the biased hearing spectrum of the human ear.

The challenge is to measure the volume level at the eardrum, because the human ear amplifies different frequencies of sound differently. Figure 5.1 shows a graph for the Transfer Function of the Open Ear (TFOE), which illustrates how mid-range frequencies may be amplified by up to 15 dBA between the outside of the ear and the ear drum. Large amphibian choruses, such as exist on a number of the wetland recordings, are very loud and composed of midrange frequencies. Therefore, these are of the greatest concern in regards to hearing safety. Heavy wind and industrial noise can also reach high volumes. A good system is to **always start listening to a recording at a lower volume and turn it up as needed.**

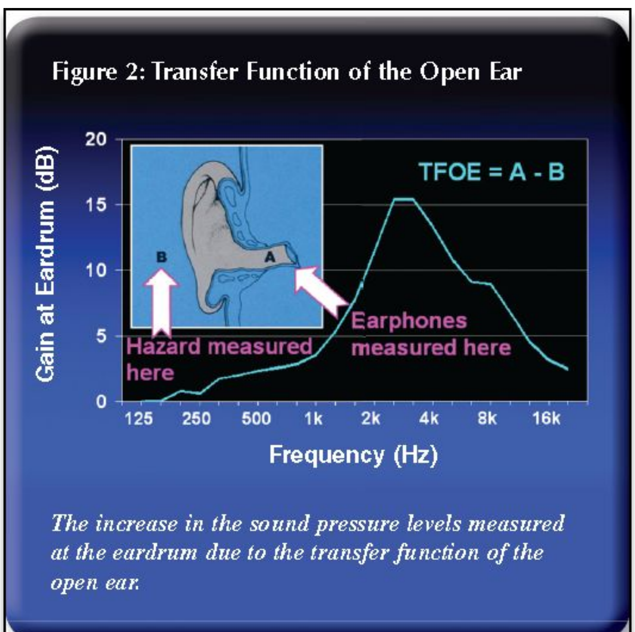


Figure 5.1 – Transfer Function of the Open Ear

Table 1B* Noise Exposure Limits when Criterion Level = 85 dB(A)		
3 dB(A) Exchange Rate	**Maximum Permitted Daily Duration (hours)**	**5 dB(A) Exchange Rate**
Allowable Level dB(A)		Allowable Level dB(A)
85	8	85
88	4	90
91	2	95
94	1	100
97	0.5	105
100	0.25	110

Table 5.1 – Noise Exposure Limits at 85 dB(A)

*http://www.ccohs.ca/oshanswers/phys_agents/exposure_can.html

The following references give more information on occupational health and safety standards and on listening health for headphone users. Please take the time to read them:

- **Noise - Occupations Exposure Limits in Canada**
    - http://www.ccohs.ca/oshanswers/phys_agents/exposure_can.html
- **Berger, E. H., S. C. megerson, and M. E. Sterger. August 11, 2009. Personal Music Players: Are We Measuring the Sound Levels Correctly? The Asha Leader**
    - http://www.asha.org/Publications/leader/2009/090811/f090811b.htm
- **Article about headphones**
    - http://www.headwize.com/articles/hearing_art.htm
- **Researchers Recommend Safe Listening Levels for Apple iPod**
    - http://phys.org/news80304823.html

5.2 Volume and Detection

The volume at which recordings are listened to may affect the number of species and individuals that are detected. The playback volume that each person chooses on their own will be affected both by the gain (loudness) of the recording and the comfort level of the listener. Some people have a tolerance for louder headphone volume than others. To account for this difference between observers, we need to play recordings at constant volumes that are safe and comfortable for all listeners. At the same time, recordings have different gain levels due species and noise proximity. For example, an amphibian chorus right beside the recorder will result in a louder recording than if the amphibian chorus was 200 m away. Owls have very low frequency calls and are detected over great distances. They are detectable on very quiet recordings only if the computer volume is turned up high. Using identical volume levels for loud amphibian choruses will be detrimental to hearing.

5.3 Computer and Headphone Calibration

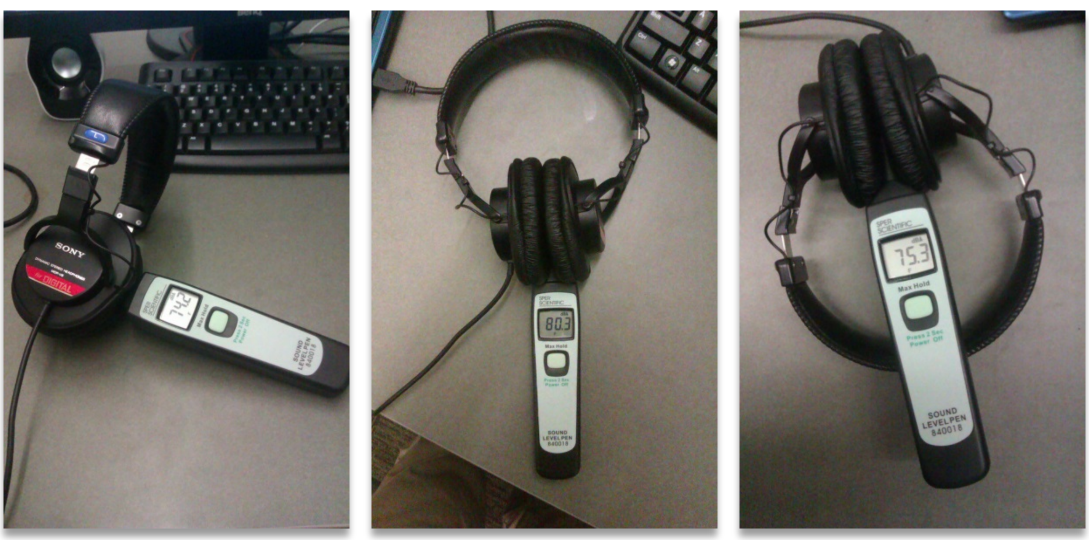


Figure 5.2 – Placement of sound pen during headphone calibration.

We will calibrate the computer/headphone combination that each observer is using codes to indicate at which volume level a recording is processed so that we can account for differences between observers and equipment and reproduce the volumes at which recordings are listened to. Use the following protocol to calibrate your computer/headphone combination:

IMPORTANT: DO NOT PLACE HEADPHONES ON EARS FOR THIS EXERCISE!

Instructions

- Play test tone. This is a computer generated tone of 3000Hz and -25dBfs (The is available on in the Listener Info folder on the SharePoint site or can be sent to you directly)
- Use Sound Level Pen to measure output volume (dBA) from headphones. Place cups of headphones against each other (see photo) and place Sound Level Pen in between (put the pen in 3 different positions for the three repeated measurements: insert from bottom, side and top. Make sure that the sound level pen does not move during each calibration run. Use a rubber band to hold the two headphones together. Do this calibration in a quiet room, preferably with the sound meter reading 45 dBA or less. Try to place the sound pen so that the tip is in the middle of the space between the headphones.
- Play the test tone at a volume that gives you an output as close to 50 dBA as possible. Note what the volume setting on your computer is at this point (look at the number on the volume scroll bar (e.g. you might be at 10% of total volume). Enter the value in the volume calibration chart under “Computer Volume”. Also, enter the exact dBA of the tone at this computer volume. This is Volume Level 1. NOTE FOR MAC USERS: There is no function for volume percentage because the computers used volume increments from 1 to 16. Indicate volume on a scale of 1-16.
- Increase the volume until the Sound Level Pen is registering 55 dBA. This is Volume Level 2. Note what the position on the computer volume adjuster is.
- Do this for increments of 5 dBA until you are at the maximum volume that the computer can produce through those headphones.

After you complete your calibration, please enter the information into the Calibration from in the database. Use the “New” button to create a new record and fill in all information except the Combination number. The Database Manager will provide you a Combination to enter when you listen to recordings. **<u>When you get a new computer-headphone combination, you will need to re-calibrate and have a new combination number assigned.</u>**

Table 5.2 – Example of a headphone volume calibration test.

Computer make and model:	Acer Aspire 5560
Headphone make and model:	Sony MDR-V6
Observer Name:	Joe Blow
Sound Level Pen Serial Number:	051448
Test Tone Used:	3000Hz, -25dBfs

			Test 1 (bottom)		Test 2 (side)		Test 3 (top)	
Volume Level	**Target dBA***	**Average Computer volume**	Computer volume	Actual dBA	Computer volume	Actual dBA	Computer volume	Actual dBA
1	**50 (65)**	**1**	1	50.5	1	50.7	1	49.2
2	**55 (70)**	**3**	3	54.7	3	56.4	3	54
3	**60 (75)**	**6**	6	61.4	6	60.3	6	60.8
4	**65 (80)**	**8**	8	65.7	9	65.4	8	64.5
5	**70 *(85)***	**12**	12	70.4	13	70.8	12	69.7
6	**75 *(90)***	**18**	16	75	18	75	18	75.7
7	**80 *(95)***	**25**	24	80.3	26	80.4	25	80.1
8	**85 (100)**	**35**	33	85.6	37	85.8	36	85.4
9	**90 (105)**	**44**	42	90.3	45	90.7	44	90.5
10	**95 (110)**	**58**	58	95.5	59	94.9	58	95.3
11	**100 (115)**	**77**	78	100.1	75	100.7	78	100.4
12	**105 (120)**	**100**	100	103.2	100	102.9	100	103.4

*The target dBA indication what the Sound Level Pen should display. The value in brackets indicates the volume at the ear drum after adding the TFOE: the volume at the eardrum may be as much as 15 dBA greater than measured by the sound meter. Underlined values shown in red are in range of volume that is dangerous to listen to for more than a few minutes.

IMPORTANT: Do not listen to any files, even quiet night-time recordings, over volume level 8. Level 8 is sufficient to detect most birds, even far-away owls. In addition, as you increase the volume, both the calls will play louder and the background static and noise become louder and, after a certain point, an increase in volume will not help in differentiating vocalizations from background noise.

APPENDIX 1 – HEADPHONE CALIBRATION DATA SHEET

Computer make and model:
Headphone make and model:
Observer Name:
Sound Level Pen Serial Number:
Test Tone Used: 3000Hz, -25dBfs

			Test 1 (bottom)		Test 2 (side)		Test 3 (top)	
Volume Level	**Target dBA***	**Average Computer volume**	Computer volume	Actual dBA	Computer volume	Actual dBA	Computer volume	Actual dBA
1	**50 (65)**							
2	**55 (70)**							
3	**60 (75)**							
4	**65 (80)**							
5	**70 *(85)***							
6	**75 *(90)***							
7	**80 *(95)***							
8	**85 (100)**							
9	**90 (105)**							
10	**95 (110)**							
11	**100 (115)**							
12	**105 (120)**							

*The target dBA indication what the Sound Level Pen should display. The value in brackets indicates the volume at the ear drum after adding the TFOE: the volume at the eardrum may be as much as 15 dBA greater than measured by the sound meter. Underlined values shown in red are in range of volume that is dangerous to listen to for more than a few minutes. DO NOT LISTEN TO THE TEST TONE AT THIS VOLUME: ONLY USE THE SOUND METER

Note: You can enter this information directly into the Calibration form if you have access to the BU_Database_FrontEnd.

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APPENDIX 2 – HOW TO ADJUST AUDIO SOFTWARE

Two different programs are at our disposal to visualize recordings: Adobe Audition and Audacity. The latter is free open-source software that is available across all operating systems. With an ever-increasing number of new listeners working with the EMCLA, Audacity is software that will save money and allow users to process recordings in the same way they would with Audition. Audacity offers an intuitive layout, easy to manipulate settings and grayscale spectral displays which are the same as reference recordings from resources like Dendroica and Xeno-Canto.

Spectral displays are most useful when they are personally adjusted for each user. A spectrograph displays audio files in frequency (kHz) over time (seconds/minutes). Principally, settings are adjusted to accommodate screen resolution, screen size and study goals. Ideally, each user would set up their spectral display so they can have the clearest picture of birdsong and/or amphibian calls. Our goal is to set the frequency, time and spectral resolution settings to have the most detailed image of a birdsong without comprising the efficiency of interpreting and annotating a recording.

Calibrating spectral displays in Adobe Audition

Certain components of Adobe Audition need to be adjusted in order to effectively use spectral displays for wildlife listening purposes. Calibration is not specifically standardized as factors such as screen size and screen resolution are different from user to user. However, certain guidelines should be followed to ensure using Audition as listening software. Three settings must be calibrated appropriately: **frequency range, timeframe** and **spectral resolution**. The examples below illustrates when settings favour songbird and amphibian detections (see Table 8for other study species).

In Audition the frequency panel can be manually adjusted to a logarithmic or linear scale; both scales have their advantages and disadvantages to displaying spectral signatures. By right-clicking on the frequency scale on the right side of the spectral display, a user can adjust the log-to-linear scale until the spectral display resembles the one like in Figure A2.1. The ideal range is to have frequencies below 1 kHz and above 10 kHz as compressed as possible because birds and amphibians rarely vocalize in these ranges. The majority of the frequency information should be centralized between 1 kHz and 8 kHz (see corresponding figures below for impractical displays).

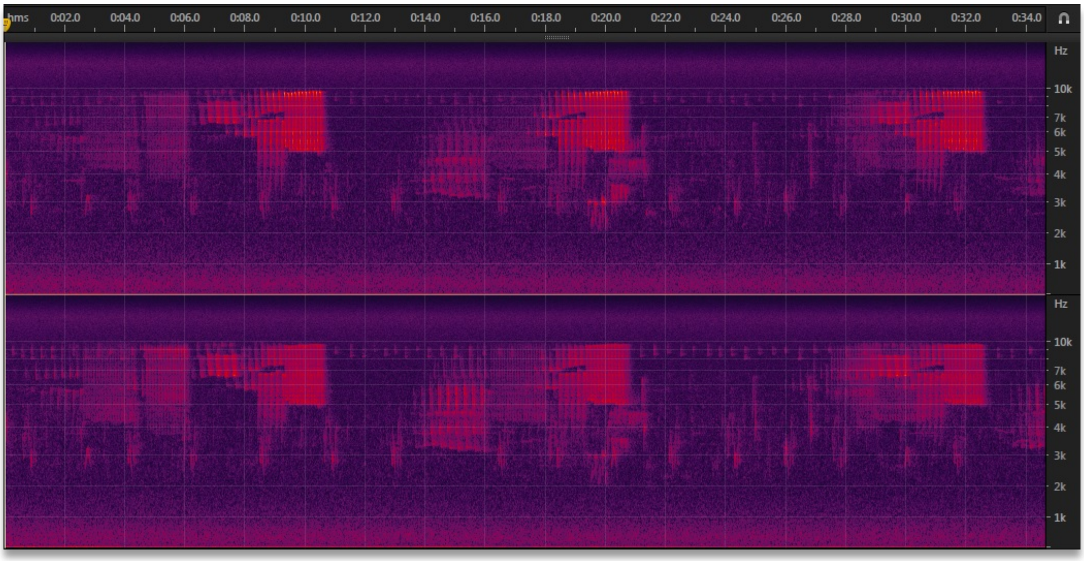


Figure A2.1 – Ideal settings for spectral display. This is a standard for most 15-17 inch screens. Important settings are timeframe (35s), frequency (scaled manually here with mostly linear but some log to eliminate high frequencies of static) and spectral resolution (Blackmann-Harris, FFT 2048, Range 132 dB).

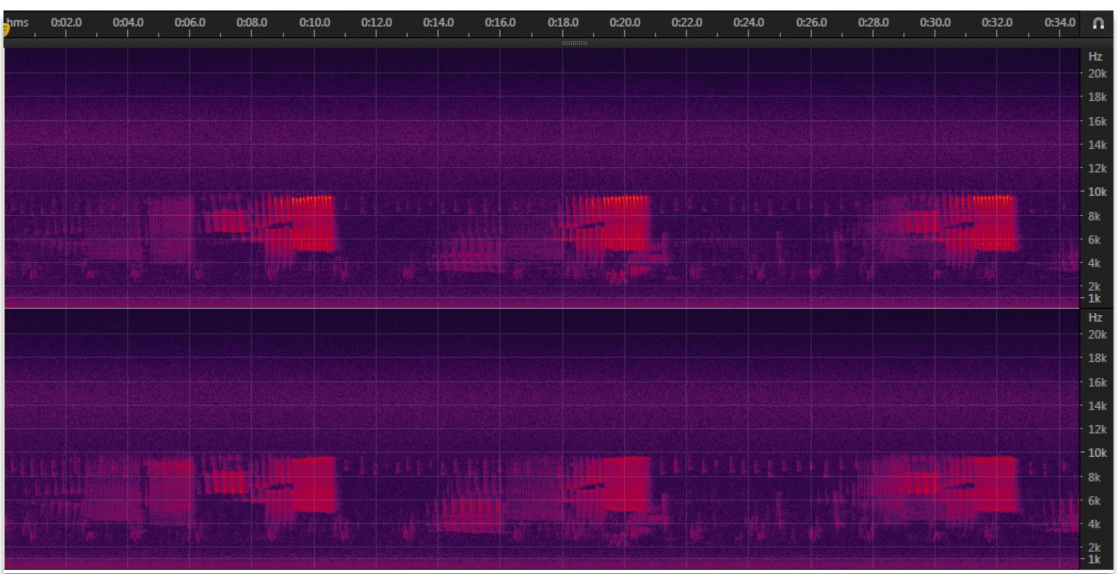


Figure A2.2 – Spectral display frequency range adjusted to a full linear scale. Here the lower frequencies and birdsongs are compressed and half of the screen is dedicated to inherent static, not ideal

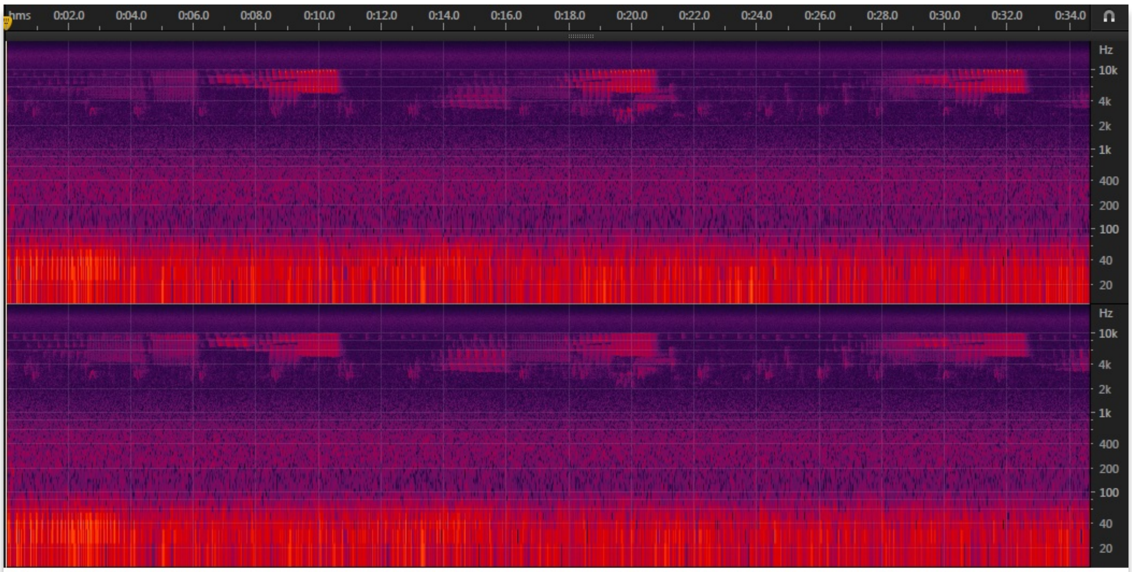


Figure A2.3 – Spectral display frequency range adjusted to a full logarithmic scale. Here, the low industrial noise takes over most of the display with the importance birdsong signatures becoming compressed in the upper parts of the spectrograph.

The second setting is the time display: depending on the width of a computer screen, a shorter or longer timeframe may be more appropriate for displaying spectral signatures. Generally, most screens used are between 15”-17” and therefore a timeframe between 15-45 seconds is the scale best fit for these screen sizes (see corresponding figures below for inappropriate timeframes). Naturally, the wider your screen, the longer you can display a spectrogram without compromising quality (i.e. on a 27” screen, 35-50 seconds can be used). Time can be adjusted by using the “Zoom In” and “Zoom Out” icons as well as simply scrolling with the mouse wheel.

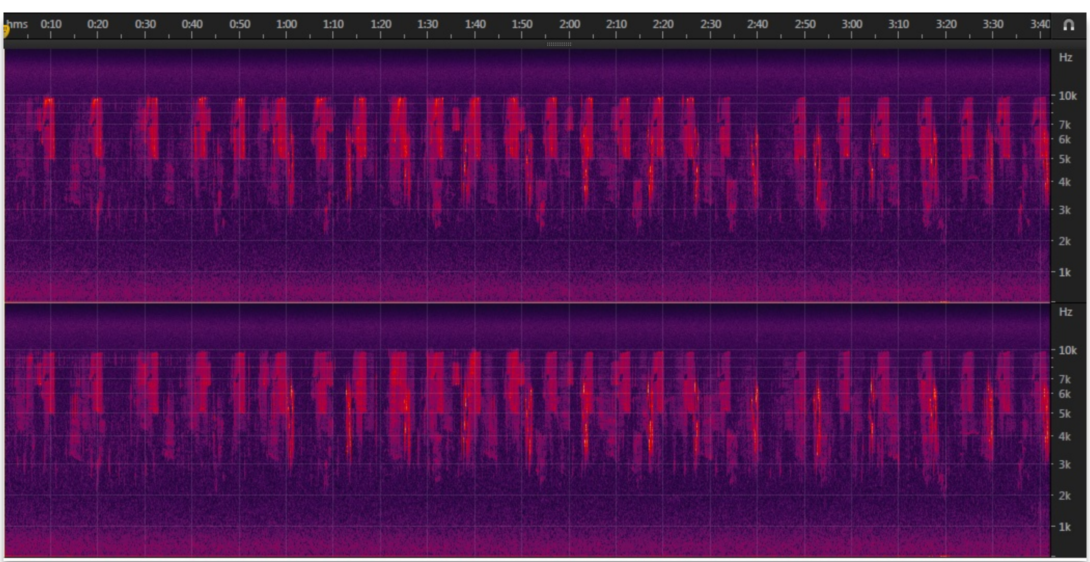


Figure A2.4 – Spectral display with a long timeframe. The birdsong here are laterally highly compressed and difficult to identify visually. Ambiguous and fainter birds may be visually obscured by these settings.

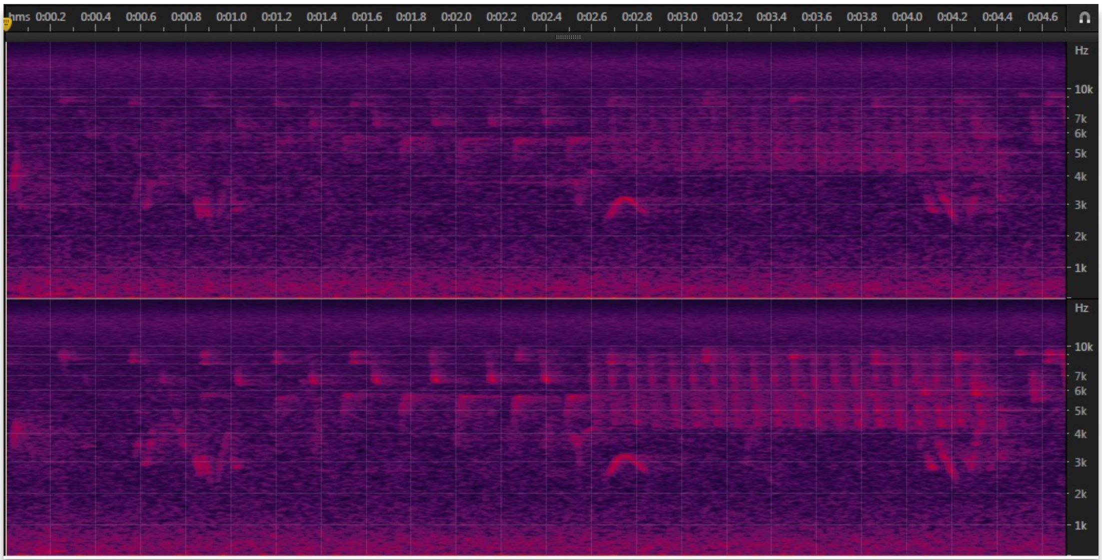


Figure A2.5 – Spectral display with a short timeframe. The birdsongs here are still visible, however, are lacking general context. Some songs may be truncated and resolution is sacrificed making the whole display much coarser.

The last setting is the spectral resolution of the display. The resolution refers to two components: FFT (Fast-Fourier Transform) function and effective spectral resolution. Together, these two functions will differentially display acoustic information. The following path can modify spectral resolution settings:
EDIT → PREFERENCES → SPECTRAL DISPLAYS
As with timeframe, spectral resolution can be adjusted to meet the needs of the user's screen resolution, such as, a higher resolution can favour a deeper resolution screen (e.g. 4096 for a 1920 x 1080 screen).

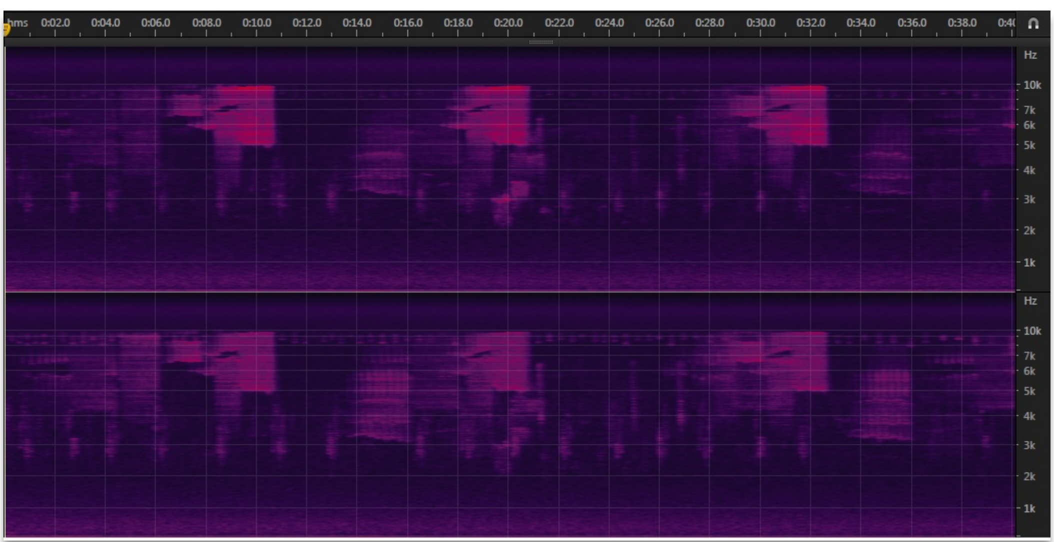


Figure A2.6 – In this example, the spectral resolution was increased to an FFT size of 16384. Birds that did not carry enough spectral information begin to fade out and even birds close to the recording begin to "fizzle" due to the high refining of the display.

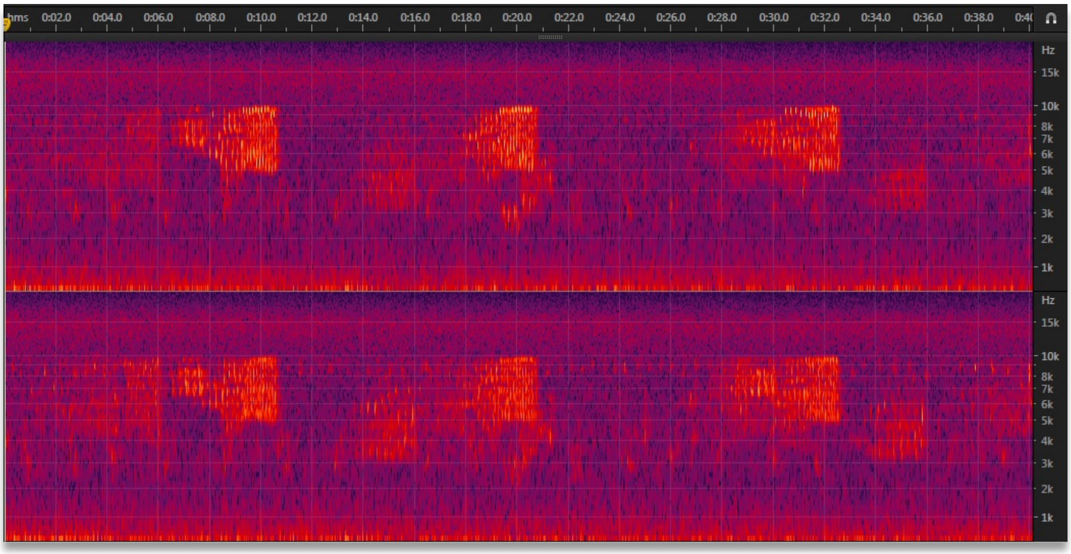


Figure A2.7 – In this example, we adjusted the spectral resolution of the display. This was done by using a coarser FFT size of 128. We can see that the display is highly pixelated and that signatures are difficult to identify.

Table A2.1 - Spectral display settings in Audition for various study species

Study	Size	Window Type	Scale	Decibel Range (dB)	Length Min (s)	Length Max (s)
Owls	4096	Blackmann-Harris	Logarithmic; +3 linear	126	30	90
Songbirds/ Amphibs	2048	Blackmann-Harris OR Hann	Logarithmic; +6-7 linear	132	15	30-45
Bats	2048	Blackmann-Harris	Full Linear	132	15	30-45

Calibrating spectral displays in Audacity

Unlike Audition, the frequency axis in Audacity is manually adjustable and thus can be tailored to focus on a specific frequency range. It is also possible to zoom in “live” even further on desired sections of recordings. Timeframe settings are the same as Audition – simply by zooming in and out, a user can restrict or expand the amount of the recording they are looking at in the window. Spectral resolutions settings are also similar, allowing the use of various FFT sizes and manipulations. The links provided by Xeno-Canto (see below) illustrates the ideal settings while using Audacity – experienced observers have been found that are essential identical with Audition settings and emulate what users need to interpret acoustic data. The end of the document provides a detailed list of the spectral display settings calibrated specially for different focus species.

https://dl.dropboxusercontent.com/u/62295188/audacity/usingaudacity.pdf
http://www.xeno-canto.org/forum/topic/3042

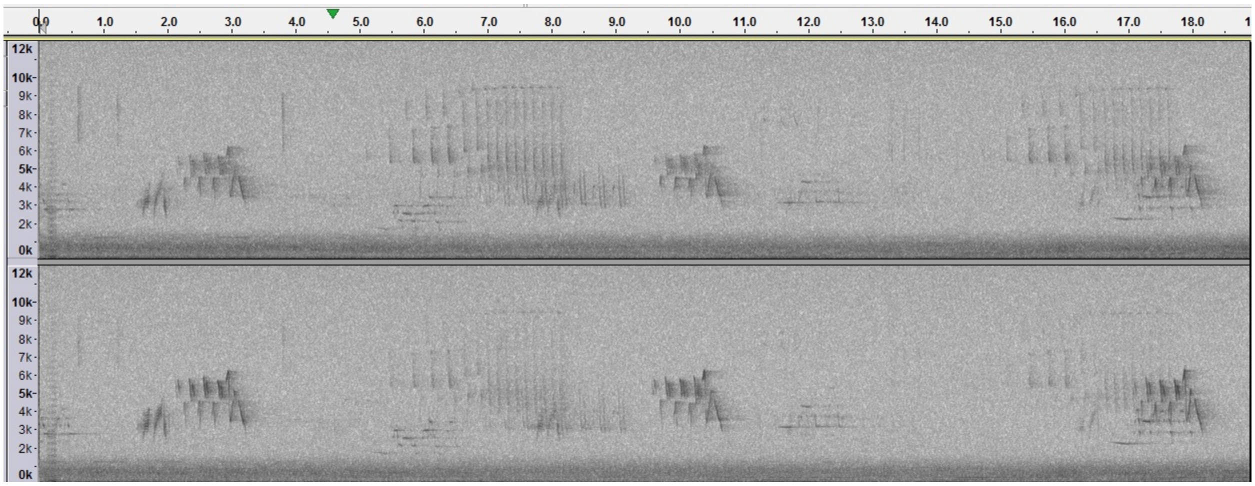


Figure A2.8 – Ideal settings for spectral displays in Audacity for songbirds. This is a standard for most 15-17” laptop screens. Important settings are timeframe (20s), frequency range (100-12000 Hz) and spectral resolution (Blackmann-Harris; FFT 2048).

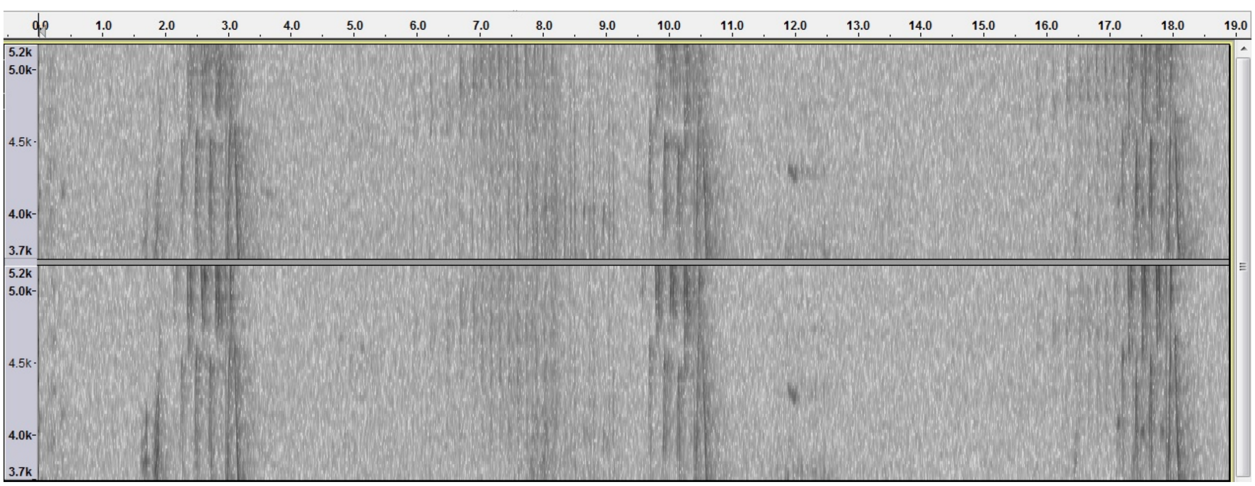


Figure A2.9 – Here the frequency range has been modified (100-6000 Hz) and zoom in to cut the bottom section of the frequency range (100-3500 Hz eliminated). The birdsongs are distorted and sections are missing because they fall into frequencies that were excluded from the display.

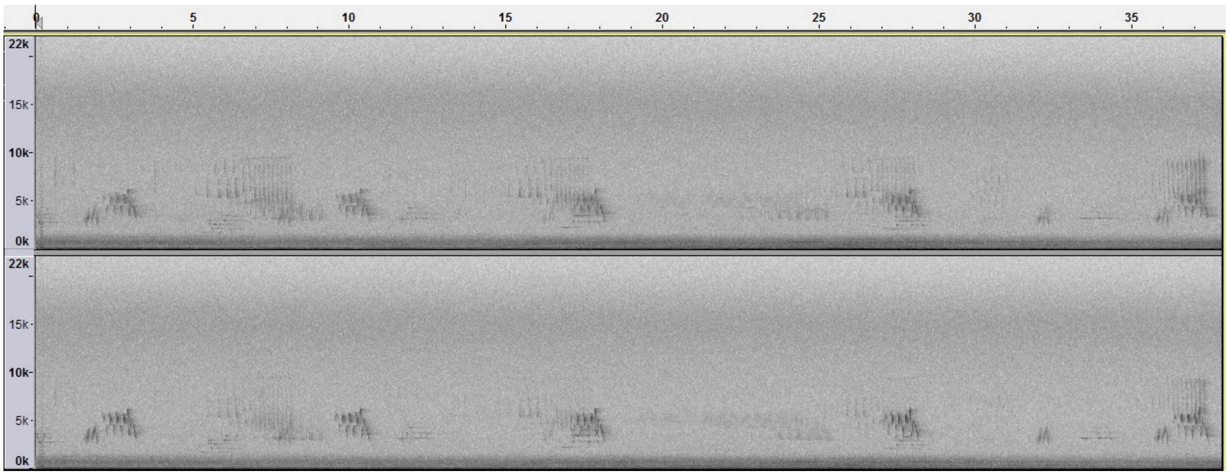


Figure A2.10 – Here the frequency range has been modified to be too broad (100-22000 Hz). At least half of the spectral display is static – we can improve the display of the birdsong by eliminating these frequencies (~10000-22000 Hz).

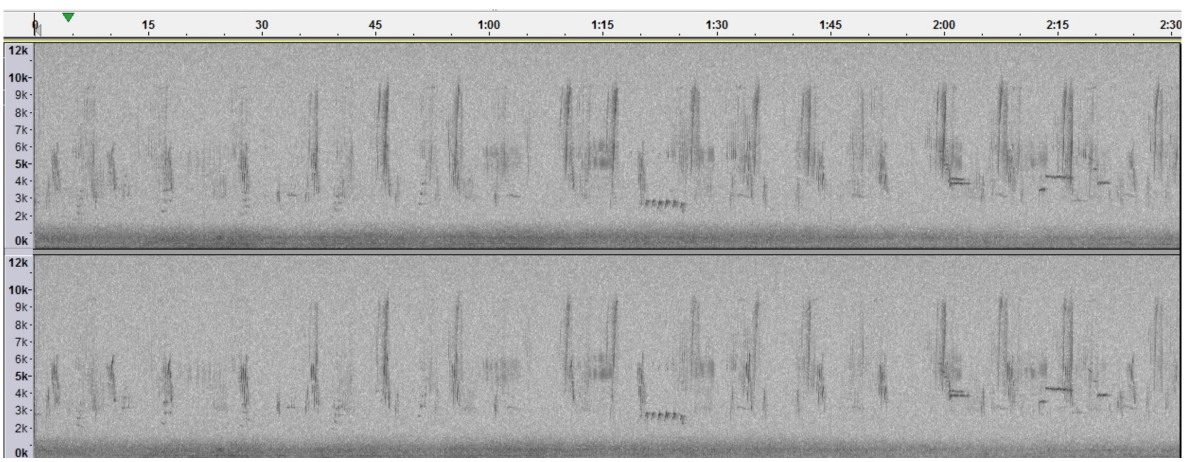


Figure A2.11 – Here we have modified only the timeframe. With a longer timeframe, we can still see the spectral signatures but the birdsongs are laterally compressed and their visual characteristics are not as apparent.

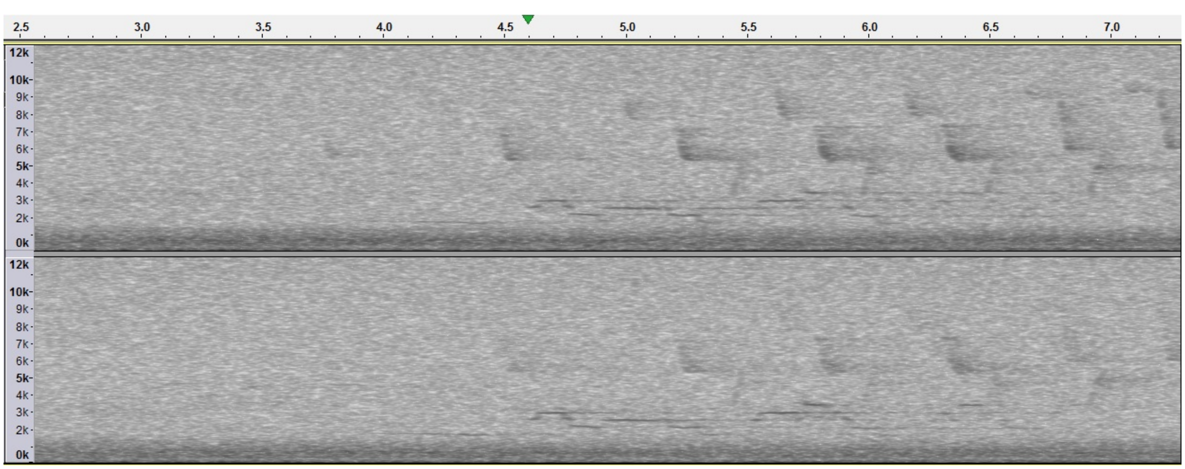


Figure A2.12 – A modified timeframe that is too short will surely eliminate sections of the birdsong and overly expand their spectral signatures.

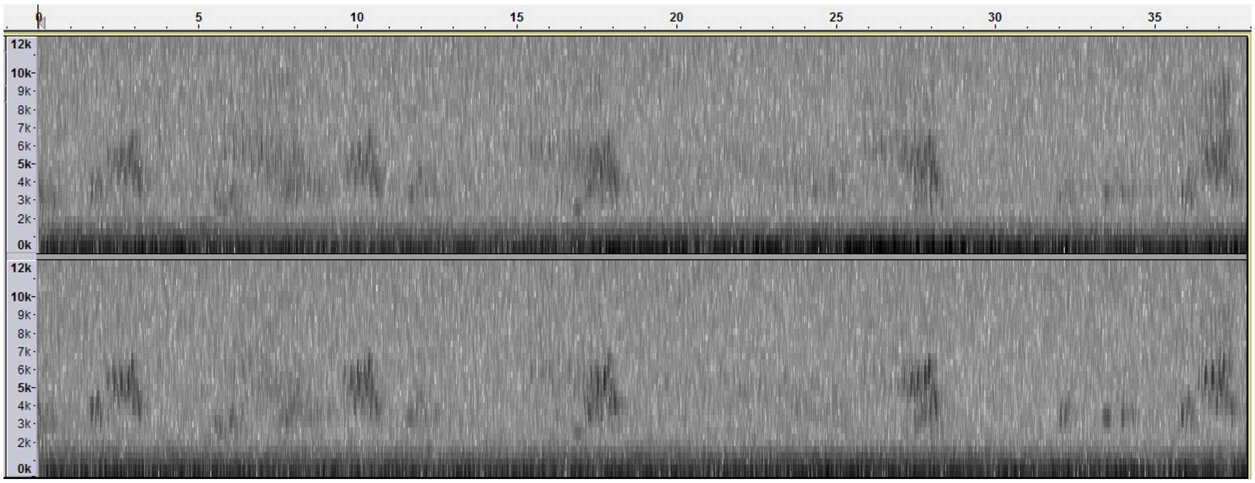


Figure A2.13 – In this example, we adjusted the spectral resolution of the display. This was done by using a coarser FFT size of 128. We can see that the display is highly pixelated and that signatures are difficult to identify.

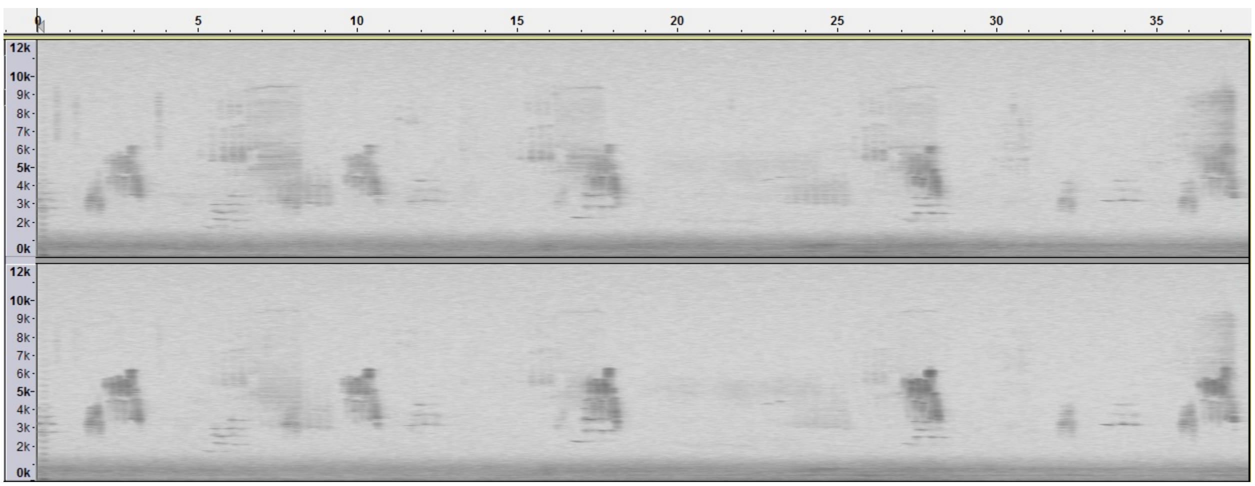


Figure A2.14 – In this example, the spectral resolution was increased to an FFT size of 16384. Birds that did not carry enough spectral information begin to fade out and even birds close to the recording begin to "fizzle" due to the high refining of the display.

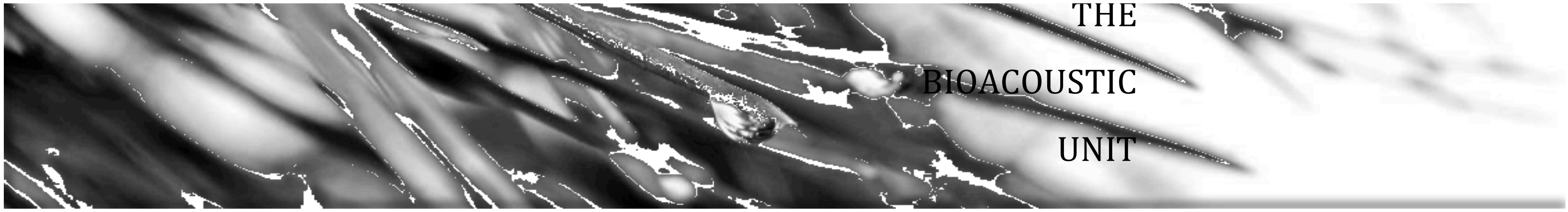
EDIT → PREFERENCES

PLAYBACK **:** **Length of Preview:** 20 seconds
QUALITY**:** **Sample Rate:** 44100 Hz, **Bit rate:** 32-bit float
INTERFACE**:** **Show track name in waveform display**
TRACKS**:** **Update display while playing**
Automatically fit frames vertically zoomed
Default View Mode: Spectrogram

Table A2.2 – Spectral display settings in Audacity for various study species

Study	Size	Window Type	Min Freq (Hz)	Max Freq (Hz)	Gain (dB)	Range (dB)	Freq Gain (dB/dec)	Length Min (s)	Length Max (s)
Owls	4096	Blackmann-Harris OR Gaussian (α=4.5)	0	8000	15 (or 1)*	80 (or 126)*	15 (or 0)*	30	90
Songbirds/Amphibs	2048	Blackmann-Harris OR Gaussian (α=4.5)	100	12000	15 (or 1)*	80 (or 126)*	15 (or 0)*	15	30-45
Bats	2048	Blackmann-Harris	6000	22000	15	80	15	15	30-45

*If setting gain and range, must follow 15-80-15 rule or 1-126-0 for optimal display



APPENDIX 3 – SUMMARY TABLES

Table 1 – List of possible species data entry scenarios

Situation	Details	Species ID	INDIV_ID	Detections/min (only first 3 min shown)			TMTC (too many to count)	VT (vocalization type)	TBC (To be checked)	Comments
				1	2	3				
Single Individual known	sings >1/recording	**LCSP**	**1**	30		5	**1**	**Song**	**0**	
	sings once	**LCSP**	**1**	30			**1**	**SS**	**0**	
	calls >1/recording	**LCSP**	**1**			7	**1**	**Call**	**0**	
	calls once	**LCSP**	**1**		8		**1**	**SC**	**0**	
	Non-vocal sound – 1 or many times *NV is recorded when there are both calls and NV, except for CONI	**WISN**	**1**			10	**1**	**NV**	**0**	Also called *note if the individual also called
	Detected in 1st sec of minute	LCSP	1	1	5		1	Song	0	
Species Unknown	Clear sound	UNKN	1	45		5	1	Song	1	0230_unkn. Squeaky call.
	Faint / brief / masked sound	UNKN	1	50	5	8	1	Song	5	Faint trill only heard once
Multiple individuals of same species	Second (or third, etc) individual	LCSP	2	5	9		1	Song	0	
	Too many to count accurately	LCSP	1	1	5	1	2	Song	0	At least 4 or 5
Amphibians detected	Calls do not overlap	BCFR	1	3			3	Song	0	
	Calls overlap but have periods of no calls	BCFR	1	1			4	Song	0	
	Constant call overlap	BCFR	1	1			5	Song	0	
Abiotic detection		Abiotic	1		36		-9	-9	0 (or 1 if unsure)	
No biotic detections in listening period		NONE	0	Leave blank			-9	-9	0 (or 1 if unsure)	

Table 2 - Abiotic sounds

Rain		LIRA	1	affects the ability to hear distant/faint species, drops seldom hit microphones
		MORA	2	affects the ability to hear nearby species, drops often hit microphones
		HERA	3	significantly affects the ability to detect species, drops almost always hit microphones
Wind		LIWI	1	rustling leaves/trees creaking (background noise), affects ability to detect distant/faint species
		MOWI	2	begins to muffle microphones (frequency and decibel rates begin to spike), occasionally affects ability to detect nearby species
		HEWI	3	always muffles microphones, frequency and decibel graphs spike constantly (sometimes cuts out due to noise threshold)
Industrial noise	compressor noise, vehicles passing, construction sounds, cannons, airplanes, trains, anything else with an engine	LINO	1	affects distant/faint species detection (generally <500 Hz)
		MONO	2	begins to affect species detection (generally between 500-2000 Hz)
		HENO	3	significantly affects ability to detect close-range species (generally >2000 Hz begins to affect species detection)
Background noise	flowing water, mosquitos, people making noises	LIBA	1	(e.g. running water not close to recorder) – affects detection of distant/faint species
		MOBA	2	(e.g. moderately loud water) – begins to affect detection of closer species
		HEBA	3	(e.g. running water or rapids very close to recorder) – species difficult to detect even if present

Table 3 - Unknown Categories. Species codes are in brackets.

Unknown (UNKN)	Unknown bird	Unknown passerine (UNPA)	Corvid (UNCR), Flycatcher (UNFL), Sparrow (UNSP), Swallow (UNSW), Thrush (UNTH), passerine trill (UNTRLL), Vireo (UNVI), Warbler (UNWA)
		Other	Accipiter (UNAC), Buteo (UNBUTEO), Duck (UNDU), Gull (UNGU), Owl (UNOW), Black-backed or Three-toed woodpecker (UNTTBB), Shorebird (UNSH), Tern (UNTERN), Woodpecker (UNWO), Yellowlegs (UNYE), domestic duck (DUCC)
	Other unknown	Mammal (UNMA)	
		Amphibian (UNFR)	