WildResearch Nightjar Survey ARU Data Processing Protocol

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1. INTRODUCTION

1.1. Autonomous Recording Units (ARUs)

Autonomous Recording Units are weatherproof, programmable devices that can be set out for long periods of time to collect audio recordings according to a pre-determined schedule. This method of surveying is particularly useful for studies where time-intensive or difficult monitoring is required, and ARUs are commonly used for studies of nocturnal species such as nightjars. The ARUs deployed by WildResearch were SM2+ and SM3 units made by Wildlife Acoustics. You can read more about the units at http://www.wildlifeacoustics.com.

1.2. WildResearch Nightjar Survey ARU Data

In 2015, the WildResearch Nightjar Survey deployed ARUs during road-side citizen science surveys to conduct a comparison of the two survey methods. Comparison of these two methods will allow us to understand the pros and cons of each and develop solutions for integrating the two datasets in large scale analyses. ARUs were deployed at various locations in central and south-central British Columbia, as well as the boreal forest of northern Alberta. Each recording was made concurrent with a survey that was conducted by a human observer following WildResearch's citizen science survey protocols.

1.3. Spectrograms

A spectrogram is a visual representation of sound frequencies over time. The main properties of a spectrogram are the frequency and amplitude, which, when viewed together create a unique sound signature for each nightjar species. Using a spectrogram to identify visual signals at the same time as the auditory component will greatly improve your ability to identify a species. As you become more familiar with the visual signature of Common Nighthawks and Common Poorwills, you will be able to pre-scan your audio files to look for species detections prior to listening.

2. EQUIPMENT

You will need the following equipment to process ARU data:

- Set of six-minute audio files obtained from WildResearch
- Computer
- Audacity audio software available free for PC or Mac computers from http://audacity.sourceforge.net/.
- Data entry spreadsheet obtained from WildResearch
- Good quality headphones
    - Circumaural (enclosing the ear)
    - Stereo
    - No bass boost

3. GETTING READY

3.1. Learn Your Nightjars (Common Nighthawk and Common Poorwill)

3.1.1. Listen

Before you get started, we ask that you familiarize yourself with the sounds of the two nightjar species that you may hear on the ARU recordings. We recommend the following:

- Dendroica: an interactive website designed to help learn bird identification. Listen to recordings and look at photos of potential species: http://www.natureinstruct.org/dendroica/
- Xeno-canto: an online database of birds from volunteers across the world.
    - Common Nighthawk (make sure to listen to some recordings with wing-booms): http://www.xeno-canto.org/species/Chordeiles-minor
    - Common Poorwill: http://www.xeno-canto.org/species/Phalaenoptilus-nuttallii
- MacAuley Library: an online database of bird recordings and videos: http://macaulaylibrary.org/

3.1.2. Look

Because ARU data processing will be done using visual cues on a spectrogram in addition to listening, it is important to also know what the visual sound signature for each species looks like. The following spectrograms are all viewed in Audacity using the recommended settings (see Section 3.2).

- Common Nighthawk call ("peent")

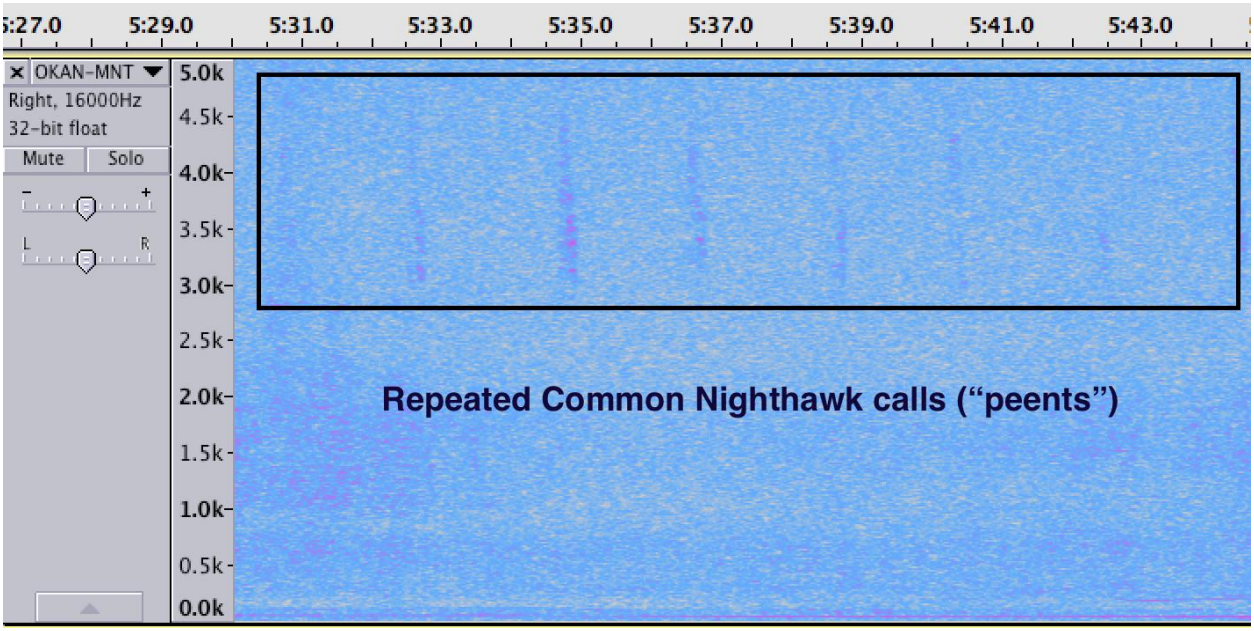

Figure 1. Spectrogram of Common Nighthawk calls.

- Common Nighthawk wing-boom

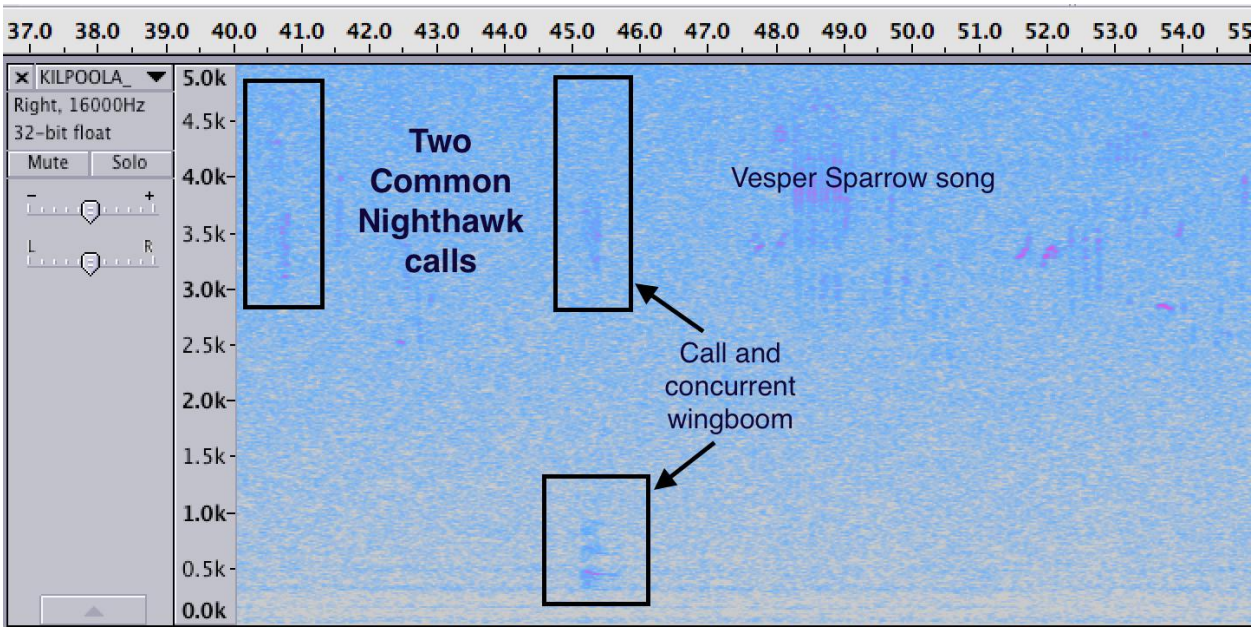

Figure 2. Spectrogram of Common Nighthawk wingboom and calls. Note that wingbooms are not always concurrent with a call.

- Common Poorwill call ("poor-will")

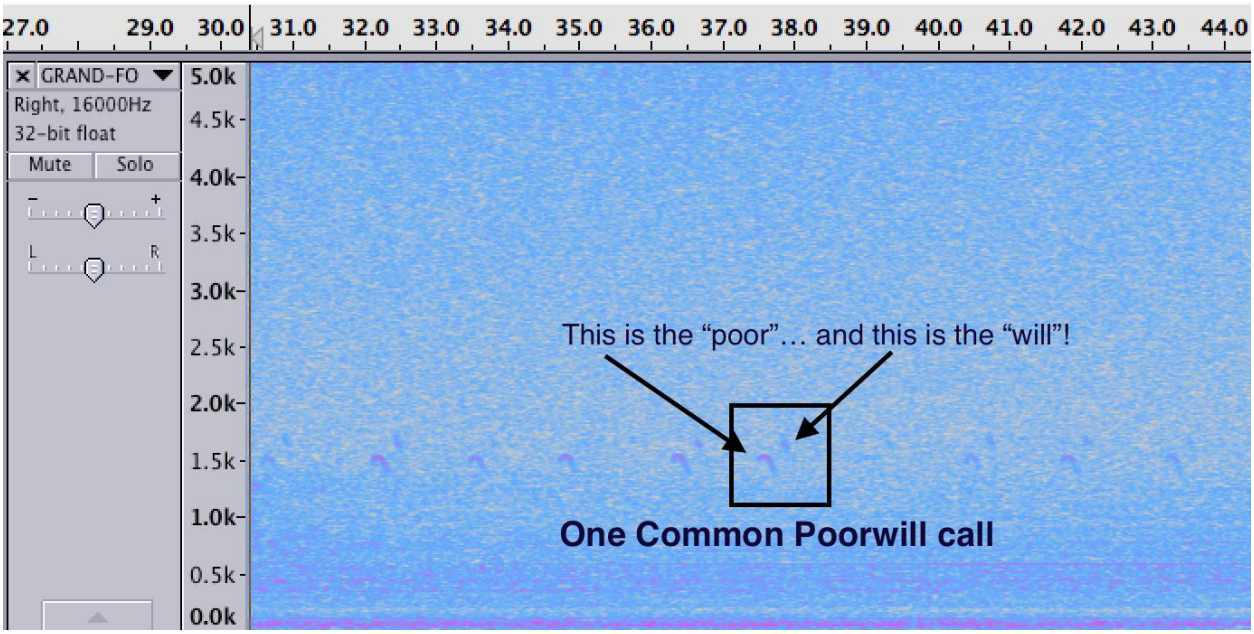

Figure 3. Common Poorwill audio spectrogram.

3.2. Set Up Audacity

Audacity provides the use of a spectrogram to facilitate your ARU data processing. It is important to set up Audacity with standardized settings in order to optimize your ability to detect nightjars on the ARU recordings, and to standardize with other volunteers. The objective is to have the most detailed image of birdsong without compromising the efficiency of interpreting and annotating a recording. To set up:

1. Change your settings by going to Edit → Preferences. We recommend the following display settings when using Audacity.

- **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
- **Spectrograms:**
  - Window Size: 4096 or 2048
  - Window Type: Blackman-Harris
  - Minimum Frequency (Hz): 0
  - Maximum Frequency (Hz): 5000
  - Gain (dB): 15
  - Range (dB): 80
  - Frequency Gain (dB/decibel): 15

2. When you open a file, set your window length to between 15 and 45 seconds long. Do this by highlighting a selection and choosing View → Zoom to Selection.

4. PROCESSING

4.1. Excel Spreadsheet

Open up the Excel template provided to you in Microsoft Excel. Save your worksheet by appending your first and last name to the file name (e.g., "WildResearch Nightjar Survey ARU data entry – Elly Knight.xlsx"). Fill in your information in the first worksheet, "Observer Info".

4.2. Volume

The volume in headphones can reach levels that are damaging to human hearing, so it is important to ensure your volume does not exceed an amplitude that could damage your hearing. A good rule of thumb is to always start listening to each recording at a lower level and turn it up as needed. It is important to note that the number of birds detected will be lower if your volume is too low, so make sure you choose a volume where you can hear far away birds, but are still comfortable. Note that it may be necessary to temporarily turn down the volume to protect your hearing when cars pass by on the recording.

4.3. Interpreting

Start listening to and viewing the spectrogram for your audio recording from the beginning of the recording. If you see and/or hear a Common Nighthawk or Common Poorwill on the recording, pause your recording briefly in order to note the detection in the "Nightjar Detections" worksheet of your Excel spreadsheet (described in Section 5.3). Return to listening and viewing. Listen to the entire audio recording from start to finish once. Fill out the "Recording Info" worksheet once you have completed listening to the whole recording.

5. ENTERING YOUR DATA

Your data can be entered in the Excel template provided to you, which is similar to the data entry template for the WildResearch Nightjar Survey roadside surveys.

5.1. Observer Info

Please fill out your name and contact information.

5.2. Recording Info

For each recording processed, please fill out the following fields:

1. **Observer:** your full name.
2. **Exact File Name:** the full name of the .wav file as obtained from WildResearch.
3. **Computer:** the type of computer you are using to process the audio files (e.g., MacBook Pro).
4. **Volume:** the volume on your computer that you are listening to the audio files at (percentage on a PC or a value from 1 – 16 on a Mac).
5. Headphone type: circumaural, supra-aural, or earbuds.
6. **Wind:** enter the level of wind heard on the recording using the following codes:
   - 0: no wind heard.
   - 1: light wind - usually heard by means of rustling leaves/trees creaking, affects ability to detect distant/faint species.
   - 2: moderate wind - begins to muffle microphones (frequency and decibel rates begin to spike), occasionally affects ability to detect nearby species.

- 3: heavy wind - always muffles microphones, frequency and decibel graphs spike constantly (sometimes cuts out due to noise threshold).

7. **Rain:** enter the level of rain heard on the recording using the following codes:
   - 0: no rain heard.
   - 1: light rain - affects the ability to hear distant/faint species, drops seldom hit microphones.
   - 2: moderate rain – affects the ability to hear nearby species, drops often hit microphones.
   - 3: heavy rain – significantly affects the ability to detect species, drops almost always hit microphones.
8. **Number of Cars:** enter the number of cars that passed by during the recording. Cars are easy to identify by sound and on the spectrogram. The signature of the car on the spectrogram will vary, but is generally a thick, dark band across all frequencies that is wider (i.e., a longer-lasting sound) at the lower frequencies (Figure 4).

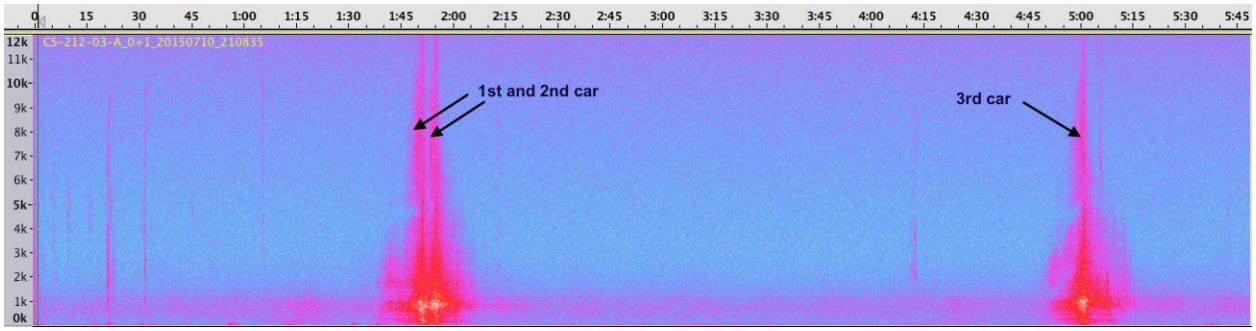

Figure 4. Six-minute spectrogram with three cars.

9. **Observer Noise:** because each recording was made concurrent with a survey by a human observer, there are sounds on each recording made by the observer (e.g., papers shuffling). Rate observer noise using the following codes:
   - 0: no noise heard.
   - 1: affects the ability to hear distant/faint species.
   - 2: affects the ability to hear nearby species.
   - 3: significantly affects the ability to detect species.
10. **Other Noise:** provide details if there are other background noises heard on the recording (e.g., frogs, industrial noise, air traffic etc.). Rate using the same codes as Observer Noise (#9 above).
11. **Time to Process:** the number of minutes it took you to complete processing the recording, including data entry.

5.3. Nightjar Detections

1. **Record each bird detected on a separate line in the spreadsheet.** Each line in the spreadsheet represents an individual bird's detection history (Figure 5). Use a new line for each new bird detected in a recording.

TIPS FOR IDENTIFYING MULTIPLE INDIVIDUALS

It can be very difficult to tell multiple individuals apart on a recording, particularly for nighthawks, which fly around while vocalizing and wing-booming. If you are unsure of how many individuals you can tell apart, use the more conservative number. It is relatively easy to keep track of three individuals, but can very difficult if there are more. Use the following methods to try and track multiple individuals throughout the six one-minute intervals of the recording.

Directionality: ARUs record in stereo, so individuals have different intensities on the left and right sides of the spectrogram, and can be heard more strongly on one side or the other of headphones while listening.

Intensity: If there are two individuals on the same side of the recorder but at different distances, individuals will be heard at different volumes and the spectrogram will be more intense for the individual closer to the recorder.

Timing/Overlap: Multiple individuals can be confirmed by hearing two or three individuals can be heard calling at the same time. Note that Common Nighthawks generally require set-up time in between wing-booms (i.e., at least 3 – 5 seconds), and so back-to-back wing-booms is strong evidence of multiple individuals.

Get a second opinion: Leave a note in the comments that if you are unsure of the number of individuals.

Check out a couple videos on YouTube if you aren't familiar with CONI behaviour in flight and how the wing-boom is performed.

2. **Record the detection history (detected or not detected) of each individual nightjar detected for each minute of the survey.** The survey period is broken into six one-minute listening periods on the spreadsheet. **If you cannot accurately count the number of individuals by sight or by concurrent calls, please make a note in the comment column of your data sheet.** Enter the following abbreviations for each species on the data sheet:
    - CONI = Common Nighthawk
    - COPO = Common Poorwill
3. **For each bird, indicate the type of detection heard for each listening period:**
    - **Call (C):** if you heard the bird call ("poor-will" for Common Poorwill; "peent" for Common Nighthawk)

- **Wing-boom (W):** if you heard the sound of the territorial wing-boom display. It is particularly important to distinguish between calls and wing booms of Common Nighthawks because this information tells us a lot about the habitat associations of that individual bird. Wing-booms are often performed only near nesting sites, while vocalizations are made kilometers away from the nest site on foraging trips. Enter 0 in this field for Common Poorwill detections.

4. **On a separate line in bold, count the total number of Common Nighthawk calls and wing-booms heard during each minute of the recording (Figure 5).** Do this only for recordings where CONI were detected. This will help us learn about calling frequency and potentially develop an index of abundance for recordings with many individuals.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Year	Exact File Name	Species	1C	1W	2C	2W	3C	3W	4C	4W	5C	5W	6C	6W	Detection Comments
2	2015	CS-207-04-B_0+1_20150701_224644.wav	CONI	1	1	1	1	1	1	1	1	1	1	0	1	
3	2015	CS-207-04-B_0+1_20150701_224644.wav	COPO	1	0	1	0	0	0	0	0	0	0	0	0	More distant than 1st CONI at this station
4	2015	CS-207-04-B_0+1_20150701_224644.wav	CONI	0	1	0	0	0	1	1	1	1	1	1	1	
5	2015	CS-207-04-B_0+1_20150701_224644.wav	CONI	0	0	0	0	0	0	0	0	0	1	0	1	Can tell is 3 CONI because concurrent booms at 3:48
6	**2015**	**CS-207-04-B_0+1_20150701_224644.wav**	**TOTAL**	**2**	**4**	**1**	**4**	**2**	**3**	**7**	**4**	**13**	**3**	**2**	**3**	
7	2015	CS-206-01-A_0+1_20150703_205235.wav	COPO	0	0	0	0	1	0	0	0	0	0	0	0	Double-check COPO at 2:43
8	2015	CS-007-01_20150623_220116_000.wav	CONI	1	1	1	1	1	1	1	1	1	1	1	1	Nearby - loud peents and booms
9	2015	CS-007-01_20150623_220116_000.wav	CONI	0	0	0	0	0	0	1	0	1	1	1	1	Heard concurrent with 1st CONI starting at 3:53. Potentially 3 birds.
10	**2015**	**CS-007-01_20150623_220116_000.wav**	**TOTAL**	**3**	**1**	**5**	**2**	**2**	**3**	**9**	**2**	**12**	**6**	**8**	**2**	

Figure 5. Sample data entry for WildResearch Nightjar Survey ARU data processing.

6. SUBMITTING YOUR DATA

Email Elly your completed Excel spreadsheet at nightjars@wildresearch.ca.

THANK YOU!

Photo: Warren Lee