

Standard Operating Procedure #7: Data Analysis

Version 2.0

In GLKN Amphibian Monitoring Protocol

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Revision History Log

The following table lists all edits and amendments to this document since the original publication date. Information entered in the log must be complete and concise. Users of this standard operating procedure will promptly notify the program manager and/or the Great Lakes Network (GLKN) data manager about recommended and required changes. The program manager must review and incorporate all changes, complete the revision history log, and change the date and version number on the title page and in the header of the document file. For complete instructions, please refer to Revising the Protocol, SOP #10.

Previous Version #	Revision Date	Author (with title and affiliation)	Location in Document and Concise Description of Revision	Reason for Change	New Version #
1.0	April 2016	Gary S. Casper (GLES)	Title version number, date, authors, citation and Literature Cited updated.	revisions	2.0
1.0	May 2016	Gary S. Casper (GLES)	Remaining sections completely re-written.	Success of pilot studies potentially reduces the need for PAO modeling, therefore a complete re-write was needed to describe alternative methodology.	2.0
1.0	Sept 2016	Gary S. Casper (GLES)	Added Sec. 7.1, re-numbered subsequent sections, additional edits based on reviews throughout.	Added programming documentation and response to reviewer comments.	2.0
Add rows as needed for each change or set of changes tied to an updated version number					

7.0 Introduction

Original program objectives were to periodically assess the percent area occupied (PAO) over time to determine if the distribution or number of occupied sites of any monitored species changes significantly, and compare these results with results from other national and state programs. The PAO (MacKenzie et al. 2002a,b; MacKenzie et al. 2003) was to be the principal metric to quantify occupancy of sites for targeted species across parks. In the development and testing of the protocol, however, it became clear that for most species, the methodology is able to determine occupancy for each species at each sampling site in each year with >95% confidence, potentially making occupancy modeling unnecessary (a PAO model would not increase confidence). However, interpretation of data for up to 5 species may benefit from modeling, due to under-sampling, and measures of environmental conditions should also be used to test whether trends in occupancy thus determined are associated with environmental parameters. For example, precipitation, drought index, habitat fragmentation, temperature, ice duration, snow cover, frost depth, and water chemistry are metrics that could be analyzed. At this time modeling is still recommended, with review after a 10-year mark to determine which procedures should remain going forward.

See SOP #5 for additional information on data management.

7.1 Programming

The Network will provide programming for the Acoustic Recording Systems (ARS) and deliver these program files with instructions for loading into the ARS to each Park annually, well before ARS deployments begin. Since ARS technology continues to rapidly evolve, programming will need to remain current with changing hardware. Currently, the SM2 models in use have been discontinued by the manufacturer and replaced with SM3 and SM4 models. The Network is currently experimenting with these new units and is likely to upgrade to SM4 units as older SM2 units are decommissioned and replaced due to normal wear and tear, or accidental damage. During this transition programming parameters may be changed to take advantage of longer battery life in SM4 models. Such new programming should retain the schedule detailed below for SM2 models, but may add to it by increasing the number of samples, and/or by increasing the sample rate (which includes higher frequency sounds but increases file sizes). Any programming changes should consider effects on data management and analysis, including storage requirements, analysis time, and, in the case of increased sample rates that expand the frequency range of recordings, possible effects on the accuracy of the software recognizer results.

7.1.1 Programming for model SM2 Song Meters

An example SM2 program is illustrated in Appendix A. Programs for each park will differ in the Location tab, where a unique acronym is assigned for a prefix for each park, the correct time zone is entered, and the latitude and longitude is assigned. Values for remaining tabs should be identical for all parks, unless unique reasons exist for changing SD card capacity (must be at least 32 GB cards in

slots A and B) or power source. When available, a sample SM4 program will be appended to this SOP. All program files will be archived each year with the data for each site.

The program will schedule 5-minute recording sessions at the top of each hour from 5:00 p.m. to 3:00 a.m. daily (in local time), starting when the ARS is turned on at deployment, and ending 1 August, for up to 21 weeks of sampling (or simply allow the program to run until batteries fail or the unit is retrieved and turned off). To increase sampling during the primary detection time (after sunset), three additional samples will be programmed for 7:30 p.m., 8:30 p.m., and 9:30 p.m. at INDU and APIS, and at 8:30 p.m., 9:30 p.m. and 10:30 p.m. at MISS, GRPO, SLBE, PIRO, and ISRO.

NOTE: The ARS units are typically deployed shortly after ice-out (ice-out dates will vary annually by Park). Where travel during the ice-out period is problematic, some parks may prefer to deploy units before ice-out with a delayed start programmed, in which case the network should be consulted for appropriate programming and power choices (external batteries and solar charging may be considered).

7.2 Data Analysis Roles and Responsibilities

The program manager will supervise data collection, provide project oversight, direct on-the-ground data collections, and provide cohesive links among data collection, analysis, synthesis, interpretation, and reporting. Assignment of data analysis tasks will remain flexible, and may be performed by park and Network staff, and/or contractors. Data analyses will provide the tables needed for annual and in-depth reports (SOP #8), as outlined below.

7.3 Data Analysis

The program manager will collect and organize data from all parks to be analyzed (digital acoustic files, digital logger output, digital photos, scanned data forms), and provide to the data analysis team in an organized manner (e.g., organized by park and site folders). Digital acoustic recordings (*.WAV) are site, time and date stamped in file names by the ARS. For each site varying numbers of samples (5-minute digital acoustic recording), along with two *.TXT files containing date and time stamped temperature logger data, will be supplied (note that HOBO logger output contains metadata with the logger serial number, this identifies an external data log that should match the serial recorded on Song Meter deployment forms). The data analysis team will refer to the supplied digital photos and scanned data forms for error checking and quality control. Both an internal temperature log (recorded by the ARS) and an external air temperature log (recorded by external loggers) will be supplied. In future, a third water temperature log may be considered. Data analysis will then proceed as follows.

7.3.1 Automated Analyses

For each site a stepwise process is performed to reduce raw data to subsets of samples for analysis. This procedure applies a sampling protocol that maximizes detection probabilities, and defines the sample subsets to be used for both automated and manual scanning. For automated scanning, sample batch files will be run through recognizers, with one auto-detection per species per site manually confirmed. For manual scanning, 30 samples will be selected and scored for species occupancy and phenology. This process is detailed as follows.

1. Determine deployment and retrieval dates. Open a copy of the network-provided data folder for a Site (changes will be made so keeping a backup of original files is mandatory). Open a copy of SOP 7 Form 1 from the prior year, begin a new row for the Site being analyzed, and fill in the Site name and year in Columns A (*Site*) and B (*Year*) (e.g., APIS01, 2016). Note: alternatively, copy and paste all Site names down and then add the current year. Fill in Column C (*File Statistics*) with values for size and file count (e.g., 3.95 GB, 445 files). Referring to the provided *.PDF scans of the Deployment and Retrieval Forms, record the Deployment and Retrieval date / time in Columns D and E respectively.
2. Delete extraneous recordings. Examine the acoustic data sample files (*.WAV) in the Site folder sorted on file name. Compare the date/time of the first sample file with the ARS deployment date/time recorded on the Deployment Form. Delete any samples that occurred prior to deployment. Similarly delete any samples recorded after the ARS retrieval date/time on the Retrieval Form. Be sure to use the date in the sample file name (recording date), not in the file attributes (the attribute date may be when it was copied) for this process. If files are not on scheduled program times (usually due to a programming error, software bug, or hardware fault), consult with the Network to determine the range and times of files that should be analyzed.
3. Delete blank files. This Step discovers “empty” or blank samples (considered invalid). Empty samples are those that are silent and do not contain any background noise at all, indicating equipment failure or that the ARS started recording before microphones were attached. The equipment failures discovered here are those that result in either no recording made at all (typically due to battery failure, water damage, or physical damage from animals or tree fall), or an empty recording resulting from microphone detachment or failure. To begin, make sure the folder view is displaying file details and size, sort by file size, and look for any sample files where file size = 0. In Form 1 Column F (*Invalid samples (i.e., empty)*) record the number of empty samples, followed by a description of any pattern to them (e.g., 1,203 files empty; prior to 0530_1200; 610_1500, 611_1400, & 611_1700). If no sample files are empty, enter "none". When finished entering findings to Form 1, delete the empty sample files from the work folder.
4. Document annual data collection. Re-sort the remaining files on file name, which, being date and time stamped, will sort chronologically. Scroll through to find any missing dates or times, indicating the ARS stopped recording but then re-started (such as when batteries failed but were then replaced on a mid-season check), or a programming error. Selecting all the

WAV files in the folder and looking at the file count, minus the noted number from #3, should be a good check against this scan to see if there are files missing. In Form 1 Column G (*Date range(s) of valid files*) enter the sampling date range(s). If no date gaps exist then enter the first and last dates (e.g., 3/1/2016 - 8/15/2016). If there are gaps, indicating the ARS stopped recording for a period then re-started, enter each contiguous date range (e.g., 3/1/2016 - 5/10/2016; 6/3/2016 - 8/15/2016).

5. Verify channel functionality. ARS recordings are in stereo with left (Channel 1) and right (Channel 2) microphones. [NOTE: The Song Meter manual (p. 42) states "For stereo recordings, the left channel is number zero and the right channel is number one." However, the Mixer tab in Song Scope 4.1.3A displays Channels 1 and 2, which numbering is used here.] Analyses default to Channel 1, with Channel 2 as a backup if Channel 1 malfunctions. This step confirms proper recordings were made on selected samples, assuming that channel malfunctions will be consistent across an entire multi-day recording session. In each date range documented in Step 4, open and verify (view spectrogram and playback audio) the first and last sample files in Song Scope to confirm that both channels were properly recording (channel selection is on the Mixer tab). If both channels in a sample contain either "garbage" (see Step 14) or blank recordings, the samples should be deleted as invalid, and date ranges from the previous step adjusted accordingly to accurately reflect only valid samples. If such invalid samples are discovered, work forwards and backwards to eliminate the entire range of bad recordings. If only one channel is blank or bad, but the other is good, keep the sample. In Column H (*Active Channels*) enter the properly recording channels (e.g., 1,2) — subsequent automated and manual scans will use Channel 1 unless otherwise indicated here. If the "good" channel changes in different date ranges describe how.
6. Delete sample files recorded after the night of 31 July. To increase detectability and minimize false positives, and maintain consistency in analyses, no samples after 1 August 0300h will be used for either automated or manual scanning. Frog calling activity greatly decreases after 1 August, and interference from increased insect noise can interfere with the Cricket Frog recognizer.
7. Determine number of nights sampled. Using a calendar and the date ranges in Form 1 Column G, count the number of nights sampled up to the night of July 31, and enter value in Column I (*Number of nights sampled before Aug. 1*).
8. Delete sample files prior to sunset. Referring to sunset tables for the site location (see below), delete all sample files remaining from Step 6 recorded prior to sunset, making sure to properly account for daylight savings time. Various sorting and filtering options can be used to select and delete files at the non-valid times of day stamped into the file names (analysis personnel should be proficient in computer use). This process increases detection probabilities as calling activity gradually declines after sunset as temperatures drop, automated recognition improves with fewer frogs calling, and there is less bird call interference after dark (reducing the number of false positives in the results). Under the current protocol, sampling occurs hourly from 5 p.m. to 3 a.m. with additional samples at

7:30 or 8:30 p.m., 8:30 or 9:30 p.m., and 9:30 or 10:30 p.m. (see Section 7.1), so the number of samples analyzed each night will vary depending on sunset time.

- *Selecting samples post-sunset while accounting for Daylight Savings Time:* Obtain sunset times from (http://aa.usno.navy.mil/data/docs/RS_OneYear.php). The ARS's do not automatically adjust for Daylight Savings Time, but because this shift occurs in early March and early November (<http://www.day-finder.com/daylight-savings.php>), ARS's are calibrated to log in local Daylight Time throughout the sampling period (file time stamps are in local time). However, sunset tables from the aforementioned website are in Standard Time, so when determining sunset time one hour must be added to account for Daylight Savings Time (Table 1).

Table 1. Examples of proper sample selection based on sunset tables.

Park	Place	Date	Sunset	First Sample for Analysis
APIS	Bayfield, WI	5/28/2016	1947 CDT	2100h
ISRO/GRPO	Grand Marais, MN	5/28/2016	1948 CDT	2100h
MISS	St. Paul, MN	5/28/2016	1949 CDT	2100h
PIRO	Munising, MI	5/28/2016	2028 EDT	2200h
INDU	Porter, IN	5/28/2016	1913 CDT	2100h
SLBE	Traverse City, MI	5/28/2016	2018 EDT	2200h

9. Record the number of samples analyzed. Count the number of samples left from Step 8, this is the sample size for the automated survey (should equal the number of *.WAV files left in the work folder). Enter this number in Form 1 Column J (*N Samples Analyzed*).
10. Finish Form 1 data entry. Enter data in Columns K–S as follows from examining forms and data to this point. Columns K–Q: enter Y (Yes) or N (No) indicating if the form or data were provided. Column R (*Logger notes*): describe any problems noted with external loggers (e.g., missing, damaged, under water, etc.). Column S (*ARS notes*): describe any problems noted with acoustic recordings or hardware (e.g., mic damaged, Channel 1 blank, submerged, missing, etc.).
11. Run the file subset from Step 8 through the available species recognizers. Determine which species recognizers should be run for each site by referring to Table 2, which identifies species to be scanned for in each park. Where listed as “absent”, data need not be run through that species recognizer (note this value might change in future if species range limits change). See Song Scope manual for instructions on batch processing with recognizers. Before starting batch processing for Chorus Frogs, American Bullfrog, or Green Frog, apply these additional filters to further reduce false positives for these species:

- a. Recognizer PSMA (Chorus Frogs): Set Minimum Score to 65.
- b. Recognizer LICA (American Bullfrog): Set Minimum Score to 55.
- c. Recognizer LICL (Green Frog): Set Minimum Quality to 30, and Minimum Score to 60.

When completed, save the text file in a subfolder "Auto-Detections" within the Site data folder, with the file named as follows: [SiteName]_[Year]_[Recognizer], example "APIS05_2016_HYVE". Open the text file in Excel and save in spreadsheet format using the same naming format. Add a header row with the column names as follows: File Name, Time Offset, Duration, Level, Quality, Score, Recognizer. Add a last Column with the header Comments.

12. Filter recognizer output further for American Toad and American Bullfrog. The output from the American Toad and American Bullfrog recognizers should be further reduced to minimize false presences. For American Toad, sort the recognizer output in Excel by Duration. Delete any detections where duration <5.0 s. For American Bullfrog, similarly delete any detections where duration <4.5 s. It is currently not possible to automate this step within Song Scope. If all of the detections for a site are less than these values for either species, then retain all detections for manually scanning.
13. Confirm earliest auto-detections for each species. This step eliminates any possible false presence scores for Site occupancy in the recognizer output, and provides phenology data, by confirming the earliest valid detection. It does not eliminate all false presences in every sample, but rather confirms that at least one detection is real for the Site in the sampling year. Using the recognizer output from Steps 11 and 12, for each species and Site, manually verify the earliest auto-detection following the manual scanning procedure detailed below. Begin with examining the first auto-detection, and continue forward in time until an auto-detection is confirmed. As you proceed, comment in the Comment field on reasons for false presences encountered (e.g., what did the recognizer falsely identify as a frog). When a good detection is found, enter "first detection" in the Comment field of the recognizer output file, and then enter results in Form 2 as follows (read Step 14 before beginning):
 - a. Site: enter site name (i.e., APIS05).
 - b. Year: enter year.
 - c. Species: Enter species acronym (from second tab "Species Codes").
 - i. For generic Chorus Frog auto-detections, identify the correct species by geography, entering PSTR for any INDU or SLBE detections, and PSMA for all other parks. Note: the correct species for PIRO detections is currently uncertain, but they have not yet been detected there.

- ii. For generic Treefrog auto-detections, identify and enter the correct species by call (HYVE or HYCH), and geography (refer to the Table 2 to eliminate some species by geography). If both species are calling in the sample, enter both in separate rows.
 - d. Score (0,1): enter 0 (no detection confirmed) or 1 (detection confirmed).
 - e. Verified File Name: copy the file name of the confirmed sample into this column. If no auto-detection can be manually confirmed, enter "none".
 - f. N Early False Presences: enter the number of false detections that preceded the earliest confirmed detection.
 - g. Count: enter the total number of auto-detections in the recognizer output for the Site in this year.
 - h. Sample Count: determine the number of samples in which the species was auto-detected and enter this number (it should be less than the total count due to multiple auto-detections within each 5-minute sample). This can be accomplished by copying the output data into a blank spreadsheet and using the "remove duplicates" function on the Data tab.
14. Review the recognizer output results for anomalies. This Step overlaps with the previous step where these data were being examined. If there were no detections for any species for a site, manually examine a few samples for potential "garbage" recordings indicating malfunctioning equipment. These typically have consistent white noise with no variation (if they recorded nothing at all they should have been eliminated in Step 3). If a "garbage" recording is found, then check Channel 2 (in the Mixer tab in Song Scope). If good data is present on Channel 2, then the sample should be re-run through all appropriate recognizers with Channel 2 selected (and Form 1 Column H (*Active Channels*) corrected to direct manual scanning to use Channel 2). If neither of the channels contain valid data, then delete samples as invalid in the earlier calculations for sample size, revising Forms 1 and 2 as needed.
- Note: No detections may also result from actual absence of frogs calling, sometimes resulting from cold temperatures or strong storms. If birds, wind, thunder, or other animal or anthropogenic sounds are recorded, the sample is good. For the current objective of scoring occupancy auto-detection across an entire season, samples are valid regardless of temperature, although temperature may be treated as a covariate or used for sample filtering in subsequent more detailed analyses of calling data.
15. Prepare and deliver samples for manual scanning. Select a Site and copy the sample file subset from Step 8 (the same samples that were run through the recognizers) into a new folder, using a naming convention such as "ParkNameSite_manual_scan_samples." If needed, further reduce this subset by eliminating any "garbage" files identified through Step

14. Open the external air temperature log for the site (if not available, use the temperature log from the next nearest available site or weather station). The logs (*.hobo) can be viewed and converted (e.g., to a spreadsheet) with freeware (HOBOWare) from Onset Computer Corporation (<http://www.onsetcomp.com>). Using the start and end dates of the acoustic data files in this sample subset, a calendar, and the temperature log, select 30 samples as follows.

- a. Eliminate samples <40F. Open a copy of the folder containing the acoustic data sample files (*.WAV) from Step 8. These samples have already been selected to begin with the first sample post-sunset on each night (the sample time to be used for manual scan selection). Each acoustic data folder should have up to 140 nights of samples from March or April through July. In the external temperature log, select and display all entries with temperatures <40F (sorted by date/time). You may wish to copy these to a second tab for ease of use. Comparing these temperature log entries to the acoustic data sample files, delete any acoustic samples where the temperature was <40F.
- b. Calculate number of samples and spacing to apply. From this reduced sample subset, and considering only the first sample on each night, count the number of nights samples are available from. This should equal the value from Form 1 Column I (*Number of nights sampled before Aug 1*) minus the number of nights where samples were <40F. Divide by 30, and round up to the next whole number = X. X should range between 3 and 5 (typically 4), and represents the spacing to apply between the 30 samples.
- c. Select the 30 samples. Select 30 samples (1 per night) using the first sample post-sunset and spaced X nights apart, from the remaining sample files. Copy the file names into Form 3 Column D (*Sample File Name*), and then pre-fill Form 3 as follows:
- d. Pre-fill Form 3. Open Form 3 and fill in as follows:
 - i. Site, Year and Sample: Enter each site name for a park, the year, and each sample number (1–30) into 30 rows (e.g., APIS01, 2016, 1; APIS01, 2016, 2; ...; APIS01, 2016, 30; APIS02, 2016, 1; APIS02, 2016, 2; etc.). Use drag and copy or drag and auto-increment to avoid a lot of typing.
 - ii. Sample File Name: For each site, copy the names of the 30 files selected in Step 15c. Note there are utilities to copy file names from a folder view so typing each file name is unnecessary.
 - iii. Temp. Source: Enter the source of the temperature log used to eliminate samples <40F as "on ARS", "[Site Name] ARS ca. [XX] km distant", or "[other source named] ca. [XX] km distant".
 - iv. Temp.(F): Enter the temperature.

- e. Package and deliver manual scan materials. Deliver all necessary materials to the person(s) designated for manual scanning, organized into site folders. Include:
 - i. Prefilled Form 3 spreadsheet.
 - ii. Subfolder with the acoustic data files (*.WAV) from Step 15a. Note these are not just the reduced set of 30 samples, the full data set is needed for performing possible substitutions.
 - iii. Subfolder with ancillary data (temperature logs, photos, scanned forms, any special notes such as a direction to use Channel 2).

7.3.2 Manual Analyses

This process performs a survey independent of the automated analysis, and covering all possible species, including those for which automated recognizers have not been developed. It also contributes data for phenological analysis (e.g., tracking trends in first calling dates). Personnel performing these scans should be experienced in the methodology, and be familiar with Song Scope software and the spectrograms and audio calls of all anuran species in the network parks.

1. Open the first file (*.WAV) to be scanned in Song Scope software (File B> Open). Adjust settings as follows for Song Scope version 3.4 (Note that these are the default settings except for the Background Filter on the Spectrogram Tab):
 - a. Display tab: all sliders on 0 except Saturation on 255 and Luminosity on 128.
 - b. Mixer tab: Sample Rate to 8000, Playback Speed Normal, Max Sample Delay 64, all other sliders at 0. *NOTE: If the default Channel 1 appears blank, try Channel 2 and note this problem in comments.*
 - c. Spectrogram Tab: FFT Size 256, FFT Overlap 1/2, Frequency Range 128, Background Filter 1s, all other sliders at 0.
 - d. Detector tab: Max Syllable and Max Syllable Gap at 500, Max Song at 300, Dynamic Range at 20, Algorithm at 2.0.
 - e. Recognizers tab: leave alone, as this does not change the view of the sonogram.
2. Review the example sonograms in Appendix B to aid in visual scanning. Refer to these examples as needed.
3. Grabbing the slider with the mouse pointer, scroll slowly to the right until a sound wave is observed. Release the slider and click the Play button (triangle) to listen to confirm the species calling (headphones are recommended). Click the Pause button and enter the Call Index Value (CIV) of the species(s) heard in the Manual Scan Data Sheet (Form 3). The CIV score is described in the Call Index Value tab, and the species codes are in the Species Code tab, of the Form 3 spreadsheet. Next grab the slider again with your mouse pointer and

continue scrolling to the right until you see another (different) sound pattern. Play again to confirm, then Pause and record the CIV. Continue to the end of the file. After a little experience you should be able to visually recognize species call patterns almost instantly, but always confirm the first instance by audio verification.

- a. Tip: After adjusting settings, always keep one file open in a Song Scope window, opening a new file from it using File → Open (it will open in a new window). This will save your settings. If you close all open Song Scope file windows, the settings will return to default when you again open a new file.
 - b. Tip: If you are having trouble confirming a call because of low frequency background noise interfering, this can be filtered out. On the Spectrogram Tab, move the Frequency Minimum slider to the right. The suppressed frequencies will no longer be visible on the spectrogram, nor will they be audible on playback.
 - c. Note: For Chorus Frog detections, identify the correct species by geography, entering PSTR for any INDU or SLBE detections, and PSMA for all other parks. The correct species for PIRO detections is currently uncertain, but they have not yet been detected there.
 - d. Note: For Treefrog detections, identify and enter the correct species by call and spectrogram (HYVE or HYCH).
4. Occasionally samples may be found where the recordings are so noisy that they should be considered invalid samples. Both anthropogenic (traffic, airplanes, etc.) and natural (wind and waves from storms) noise can violate protocol, which requires that the species be detectable during the survey. If such samples are encountered, follow this protocol to substitute for new samples. Exceptionally noisy ARS sites may have to be relocated.
 - a. First examine the available samples later that night. If still too noisy then b.
 - b. Examine the available samples for the night before and the night after, until a suitable sample is found.
 - c. Explain substitution in comments Column U (*File Substitution Notes*).
5. Upon reaching the end of the acoustic sample, scroll back and for each species detected, find the highest call intensity and adjust the CIV previously entered to the maximum level encountered. Enter your name in Form 3 Column F (*Surveyor Name*), and any comments in Column T (*Surveyor Comments*). Comments may include anything relevant to your data entry, such as uncertainties for identifications or CIVs. If there is only a visual or audible confirmation for a species, but not both, make a note in the comments regarding the call location in the sample, and record “?” in the species data cell rather than a CIV. Any questionable calls should be noted in the comments and will be examined by a second observer.

- a. Tip: For noisy samples, visually scan for calls first, and verify them second. You don't need to “listen through the noise” to find potential calls because both a visual and audible confirmation are required to assure presence.
 - b. Note: If “garbage” samples are found (see Section 7.2.1 Step 14 above) indicating additional equipment malfunction that was not previously eliminated, follow the substitution process from Step 4 above and notify the personnel who performed the auto-detections (they may need to adjust data in Forms 1 and 2).
6. Repeat for each of the 30 samples, then move on to the next Site.
7. Return the Form 3 spreadsheet and a qualified second observer will verify every first and questionable detection for each species at each Site.

7.4 Annual Reporting

Annual reporting will provide completed Forms and additional summary analysis. The following should be prepared and delivered to the Network.

1. Proof Form 3. When manual verifications are complete Form 3 will be proofed. Enter second observer name in Form 3 Column V (Observer 2 Name), and verify every first and questionable detection for each species at each Site following the Manual Scan procedure above. All data cell values should be normalized to 0-3, removing any “?” with decisions made. Consult with other project personnel as needed to resolve any questionable detections. As a rule, only score species as detected (1) if there is no doubt. Explain any changes made in Column W (*Second Observer Comments*), if no changes (original survey data accepted) enter “OK”.
2. Update Table 2 (Assumed Breeding Periods by Park). This table provides assumed breeding periods within which sampling achieved should be evaluated, and keeps a record of the earliest and latest confirmed calling dates for each species in each park. As climate change progress these dates may need periodic adjustment. Examine data from Forms 2 and 3 and adjust any early or late dates in Table 2 as needed.
3. Complete Form 4. This provides a cumulative occupancy record, from which changes in occupancy will be tracked. It also identifies inadequate sampling. Begin with a copy from the prior year, and add new entries. Using Forms 1, 2 and 3, fill in Form 4 as follows:
 - a. Populate Site and Year rows for each Site from which data are available. Note: If the ARS for any Site was not deployed or entirely malfunctioned returning no data, or data were otherwise lost or are unavailable, do not enter a row for the Site.
 - b. Populate Valid Sample Range column by copying data for each Site from Form 1 Column G (*Date range(s) of valid files*).
 - c. Enter a Score value for each species (O, A, M, AM, or X), see Scores tab for definitions. Refer to Species Codes tab if needed.
 - i. If no A or M detection is recorded in Forms 1 or 2, determine if the value should be 0 (no detections) or X (inadequate sampling) as follows. Compare the Valid Sample Range with the Assumed Breeding Periods in Table 2, and data in Form 1. If at least 30 samples (Form 1, Column J (*N Samples Analyzed*)) on at least 10 separate nights (Form 1, Column I (*Number of nights sampled before Aug 1*)) were obtained, then enter 0 (sampling was adequate for the species). Otherwise enter X (sampling was inadequate). Unless there were malfunctions resulting in sampling gaps, adequate sampling should only need to be determined for early breeding species (e.g.,

Wood, Chorus, Pickerel, and Northern Leopard frogs), to determine if ARS recordings began early enough.

- d. Count species detected by any method and enter value in Total Sp. row.
4. Deliver the following:
- a. Final completed Excel Forms 1, 2, 3 and 4.
 - b. All raw data analysis files (i.e., recognizer outputs and progressively filtered results).
 - c. Complete a report addressing the following:
 - i. From Form 4, include a table of results for the year being analyzed.
 - ii. From Form 4, extract a list of Sites where "X" was entered for the year being analyzed, identifying inadequate sampling for the year, and present as a table. If relevant, discuss reasons for insufficient data collection (e.g., ARS deployed too late, equipment failure, etc.).
 - iii. From Form 4, extract a list of only A and M entries for the year being analyzed. Discuss as appropriate possible reasons why the species was missed by the second method (from notes in Form 2 or 3 data, or by re-examining files).

Table 2. Assumed breeding periods by park.

Species	APIS	GRPO	INDU	ISRO	MISS	PIRO	SACN	SLBE	VOYA
Blanchard's Cricket Frog	absent	absent	5/15 - 8/15*	absent	5/15 - 8/15	absent	absent	absent	absent
Am. Toad	4/15 - 7/15	4/15 - 7/15	3/15 - 6/30	4/15 - 7/15	4/15 - 7/15	4/15 - 7/15	4/15 - 7/15	4/15 - 7/15	4/15 - 7/15
Fowler's Toad	absent	absent	3/15 - 6/30	absent	absent	absent	absent	4/15 - 7/15*	absent
Spring Peeper	3/15 - 6/30	4/1 - 6/30	3/1 - 5/31	4/1 - 6/30	3/15 - 5/31	4/1 - 6/30	3/15 - 6/15	3/15 - 6/15	4/1 - 6/30
Boreal Chorus Frog	3/15 - 5/31	4/1 - 5/31	absent	4/1 - 5/31	3/1 - 5/31	3/15 - 5/31*	3/15 - 5/31	absent	4/1 - 5/31
W. Chorus Frog	absent	absent	3/1 - 5/15	absent	absent	3/15 - 5/31*	absent	3/15 - 5/31	absent
Cope's Gray Treefrog	5/1 - 7/15	absent	4/15 - 7/15	absent	4/15 - 7/15	5/1 - 7/15*	4/15 - 7/15	5/1 - 7/15*	5/1 - 7/15*
Gray Treefrog	5/1 - 7/15	5/1 - 7/15	4/15 - 7/15	5/1 - 7/15	4/15 - 7/15	5/1 - 7/15	4/15 - 7/15	5/1 - 7/15	5/1 - 7/15
Am. Bullfrog	5/15 - 8/15*	absent	5/15 - 8/15	absent	5/15 - 8/15*	5/15 - 8/15*	5/15 - 8/15	5/15 - 8/15	absent
Green Frog	5/15 - 8/15	5/15 - 8/15	5/1 - 8/15	5/15 - 8/15	5/1 - 8/15	5/15 - 8/15	5/1 - 8/15	5/15 - 8/15	5/15 - 8/15
Pickereel Frog	absent	absent	absent	absent	absent	absent	4/1 - 5/31	4/1 - 5/31	absent
No. Leopard Frog	4/1 - 5/31	4/1 - 5/31	3/1 - 5/31	3/1 - 5/31*	3/15 - 5/31	4/1 - 5/31	4/1 - 5/31	4/1 - 5/31	4/1 - 5/31
Mink Frog	6/1 - 8/15	6/1 - 8/15	absent	6/1 - 8/15	absent	6/1 - 8/15	6/1 - 8/15	absent	6/1 - 8/15*
Wood Frog	3/15 - 5/15	4/1 - 6/1	3/1 - 5/15	4/1 - 6/1	3/1 - 5/15	3/15 - 5/15	3/15 - 5/15	3/15 - 5/15	4/1 - 6/1

Note: These dates are based on Michigan, Minnesota, and Wisconsin calling frog survey program phenology charts, and local knowledge. They can be revised as new empirical data are acquired. * - Indicates species currently presumed absent in park but could potentially colonize in future from nearby populations.

7.5 Long-term Analyses

Every five years additional analyses will be performed to assess phenology, call intensity, and trends in species occupancy through time. Data will be graphed or charted for easy reference. For many species the methodology achieves 95% confidence and modeling with confidence intervals is unnecessary (see Protocol). However, sample size is expected to remain low for some species in some years, which may not meet 95% confidence in detection, due to logistical issues and/or equipment failure. This is most notably a concern with early breeding species (e.g., Wood, Chorus, Pickerel and Leopard frogs). Occupancy trends in many of these under-sampled species may be modeled to account for imperfect detection. This may be performed at longer intervals (e.g., 10 years), and/or include occupancy modeling for all data for all species, at the Network's discretion.

For 95% confidence in detecting a species if it is there, 29 samples are required for species with a detection probability of 0.10 (see Protocol). Determine and summarize which species are consistently under-sampled, and why, by examining Form 4 data (X values). Discuss with the Network whether occupancy modeling is desired for any of these species, or all species pooled.

7.5.1 Trends in Near Perfectly Sampled Species

This analysis uses pooled data from two independent surveys (auto- and manual), and should provide >95% confidence in detectability for most species (see Protocol). Produce an occupancy table from cumulative Form 4 data, depicting occupancy for only adequately sampled species. The table should be equivalent to Form 4 with A, M and AM values converted to "1". Add any additional Site covariates desired (e.g., habitat or weather parameters), but in particular a Wetland Type covariate classifying wetlands as ephemeral, semi-permanent, or permanent (see site documentation).

From this master table, analyze each species as follows. Preliminary to analysis or charting, delete any "X" samples, as these are invalid (do not change to "0", remove these sample years from analysis for that year as data collection was insufficient to assure 95% confidence in determining occupancy). The data analyzed should consist solely of 0s and 1s. Note that data for SACN and VOYA may or may not be available.

1. For each species, produce a table and chart of the number of sites occupied in each year for each park, for each of the three wetland classes, and for all wetland classes.
2. Produce the same for the following regions, pooling data: Eastern (INDU-SLBE-PIRO), Western (MISS-SACN-APIS), and Northern (ISRO, GRPO, VOYA).
3. Produce the same for all parks combined.

Discuss as appropriate any patterns observed in occupancy changes. If desired, perform association tests to determine if occupancy is explained by any habitat, climate, or other covariates.

7.5.2 Phenology

This analysis will present phenology results. Open Form 5 and copy cumulative Form 2 data where Score = 1. This contains the earliest verified auto-detection for each species at each site in each year.

Compare this to cumulative Form 3 data. This can be accomplished by filtering Form 3 data for each species to display only detections, then for each site/year examine the earliest date (in the Sample File Name). If any manual detection dates are earlier than the auto-detection dates, adjust the date as follows.

1. From the manual scan data set (from 7.2.1 Step 15) determine if the species was calling in any unscanned samples between the earliest manual detection date and the next earliest manually scanned date, following the manual scan procedure (there should be no more than 5 samples to check).
2. Replace the earliest auto-detection date with the newly determined earliest manually verified date.

Add temperature data for each entry in Form 5 from appropriate temperature logs. Determine and enter a Julian date for each entry. When complete, analyze each species as follows. For each Park, chart the earliest calling date for each species each year, with year on the X axis and species on the Y axis. Each chart should have up to 12 species graphed. Next, pooling all data for each species, produce a histogram of first calling dates and temperature class, showing the proportion of events in each temperature range. The ranges will be determined during the first analysis based on how the histogram bins are best divided, and subsequent analyses should retain these bin increments for year-to-year comparisons. Discuss as appropriate, summarizing any patterns observed in phenology. If desired, association tests or other analyses may be performed to compare first calling dates to climate or other variables.

7.5.3 Call Index Value Analysis

This analysis will provide a reduced table of the maximum Call Index Value (CIV) for each species at each Site in each year, and analysis similar to the phenology analysis. From the cumulative proofed Form 3 data produce a separate table for each species, retaining only the maximum CIV for each site in each year. For each species chart the maximum CIV for each Site in each year, with year on the X axis and CIV on the Y axis. Each chart should have all Sites at a Park graphed (up to 10) for easy comparison. Discuss as appropriate, summarizing any patterns observed in CIV. If desired, association tests or other analyses may be performed to compare CIVs to climate or other variables.

7.5.4 Modeling

To this point, analyses have utilized site occupancy determined at >95% confidence. At the Network's discretion, modeling may be performed on the full data sets to analyze under-sampled species, and/or for comparison against the unmodeled results. In these analyses, PAO statistics will be produced that account for both false presences and false absences. At this time we anticipate using models developed by Miller et al. (2011, 2013; Pillay et al. 2014), but as this is an evolving field, methods may be updated in the future. In these models, false presence rates are determined by comparing samples from the same locations and dates (with all other covariates presumably the same) by two different methods, one of which has more "certainty" than the other. In these data sets, manually verified samples can be treated as a second survey which has higher "certainty" than the auto-detections (false presence rates should be zero with manual scanning). In this second treatment

Miller's models determine the likelihood of false presences by inputting data from both sampling techniques. Similarly, within the auto-detection results alone, the subset of manually verified samples for determining first calling date (from Form 2) could be treated as nested survey results with higher "certainty" in a hierarchical model design. Models may be restricted to only inadequately sampled species, or include all species (recommended at this time). Over time, at the network's discretion, some analyses may be discontinued if results support alternatives. Models may be revised at any time to keep abreast of the most modern techniques.

For this analysis cumulative Form 3 manual survey data may be input as the second survey of high certainty (assume no false presences; 30 samples per site per year). The Sample File Name will need to match exactly the sample identifier for the auto-detection survey set, prepared as follows. We recommend that the personnel who performed the auto-detection analysis prepare these files through Step 4, as they will be most familiar with the data and the needed manipulations.

1. Prepare auto-detection sample data set. Begin with the reduced sample file sets for each Site used to run through the recognizers (results of Step 8 of 7.2.1). These are the auto-detection sample files for each Site in each year. Prepare a table of these sample file names (which include the Site name and date/time stamp), using the same table structure as prior year analyses.
 - At this point, the statistician may choose to have data moved into a database, rather than continue working in Excel, given the number of samples which may accumulate (ca. 600 per year per site). He/she may also choose to parse out separate Site, Date, and Time fields from the file names if desired. Personnel should consult with the statistician and the Network to determine the needed formats.
2. Obtain auto-detection results and reduce for earliest verified detection. Begin with the output from Step 13 of 7.2.1 (the filtered recognizer output files including all unverified auto-detections with false presences and absences included), and with the first verified auto-detection identified. Reduce these data further by deleting all auto-detections before the first verified auto-detection (listed in Form 2). These are considered invalid samples, as the species was likely not present to be detected. Delete samples prior to the earliest verified detection from the data table produced in Step 1 as well.
3. Reduce further for latest verified detection. Re-visit data from each Site and determine the latest verified auto-detection for each Site. Note that for efficiency, data analysis personnel may determine this during Step 13 of 7.2.1 (when earliest auto-detections are being identified). Follow the same procedure as for confirming earliest auto-detections, but in reverse, working back in time from the last auto-detection. When found, enter "last detection" in Comments column of the recognizer output file, and copy the identified Sample File Name into the Last Detection column of Form 2. Then delete all auto-detections after the latest verified auto-detection. Delete samples after the latest verified detection from the data table produced in Step 1 as well. The remaining auto-detections in the sample data file are

now bounded by dates within which it is assumed the species was present to be detected. This temporal bounding greatly reduces false presences in the auto-detection data prior to analysis.

4. Reduce data to samples. To this point, all auto-detections are listed, but a “sample” for analysis is a 5-minute acoustic recording. The score present (1) or absent (0) must be provided for each sample. From the sample data file from Step 3 above, select only the auto-detections labeled “first detection”, and copy them to a new file (or spreadsheet tab). This reduced data set now lists only the samples for which at least one detection was confirmed (the “1” values for the model input).
5. Add auto-detection data to sample data set from Step 1. For each remaining auto-detection from Step 4, populate the appropriate cells in the analysis table prepared in Step 1 (file names of all samples run and now reduced for a valid sampling period bounded by first and last detection dates) with “1” by matching the Sample File Name (or Site-Date-Time). Score all other sample values as 0 (for no detection). Provide this file to the statistician for modeling. Note: the statistician or Network may request that covariates be added at this point.
6. Perform PAO modeling. The two input tables are now prepared: auto-detection survey and manual survey. Append the new data to prior year data if needed (from the last analysis). Add any covariables intended for analysis before running models (e.g., wetland class, sample temperature, etc.).

Produce a report of results. As appropriate, address changes in site occupancy, variables which most strongly affect detectability and/or occupancy of each amphibian species, the assumption that the combined manual and auto-detection dataset meets 95% confidence in occupancy for each species, and differences between results from manual vs. auto-detection surveys. Figures may include trend charts for PAO, maps of sites, annual temperature and precipitation of the current and last 25 yrs at nearby weather stations, and GIS coverage of any other spatially explicit stressor (e.g., roads). Narrative may also include noteworthy anecdotes or observations.

7.6 Literature Cited

- MacKenzie, D. I., and W. L. Kendall. 2002. How should detection probability be incorporated into estimates of relative abundance? *Ecology* 83:2387–2393.
- MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83:2248–2255.
- Mackenzie, D. I., J. D. Nichols, J. E. Hines, M. G. Knutson, and A. B. Franklin. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. *Ecology* 84:2200–2207.
- Miller, D. A., J. D. Nichols, B. T. McClintock, E. H. Campbell Grant, L. L. Bailey, and L. A. Weir. 2011. Improving occupancy estimation when two types of observational error occur: Non-detection and species misidentification. *Ecology* 92(7):1422–1428.
- Miller D. A., J. D. Nichols, J. A. Gude, L. N. Rich, K. M. Podrutzny, J. E. Hines, and M. S. Mitchell. 2013. Determining occurrence dynamics when false positives occur: Estimating the range dynamics of wolves from public survey data. *PLOS ONE* 8(6): e65808. Available at: <https://doi.org/10.1371/journal.pone.0065808>.
- Pillay, R., D. A. W. Miller, J. E. Hines, A. A. Joshi, and M. D. Madhusudan. 2014. Accounting for false positives improves estimates of occupancy from key informant interviews. *Diversity and Distributions* 20:223–235.

Appendix 1. SM2 Program Parameters.

File Help

Song Meter Configuration Utility 3.2.4

General Audio Advanced Location Sensors Capacity

Model: SM2 Schedule: Advanced

Start time (for display purposes only)
mm/dd/yyyy hh:mm:ss
05/01/2017 08:15:47

01 AT TIME 17:00:00
Delete

02 RECORD 00:05:00
Delete

03 PAUSE 00:55:00
Delete

04 GOTO LINE 02 01X
Delete

05 RECORD 00:05:00
Delete

06 PAUSE 00:25:00
Delete

07 GOTO LINE 05 05X
Delete

08 RECORD 00:05:00
Delete

09 PAUSE 00:55:00
Delete

10 GOTO LINE 08 05X
Delete

11 GOTO LINE 01 00X
Delete

New Line: Command
12 -Choose Command-- Insert

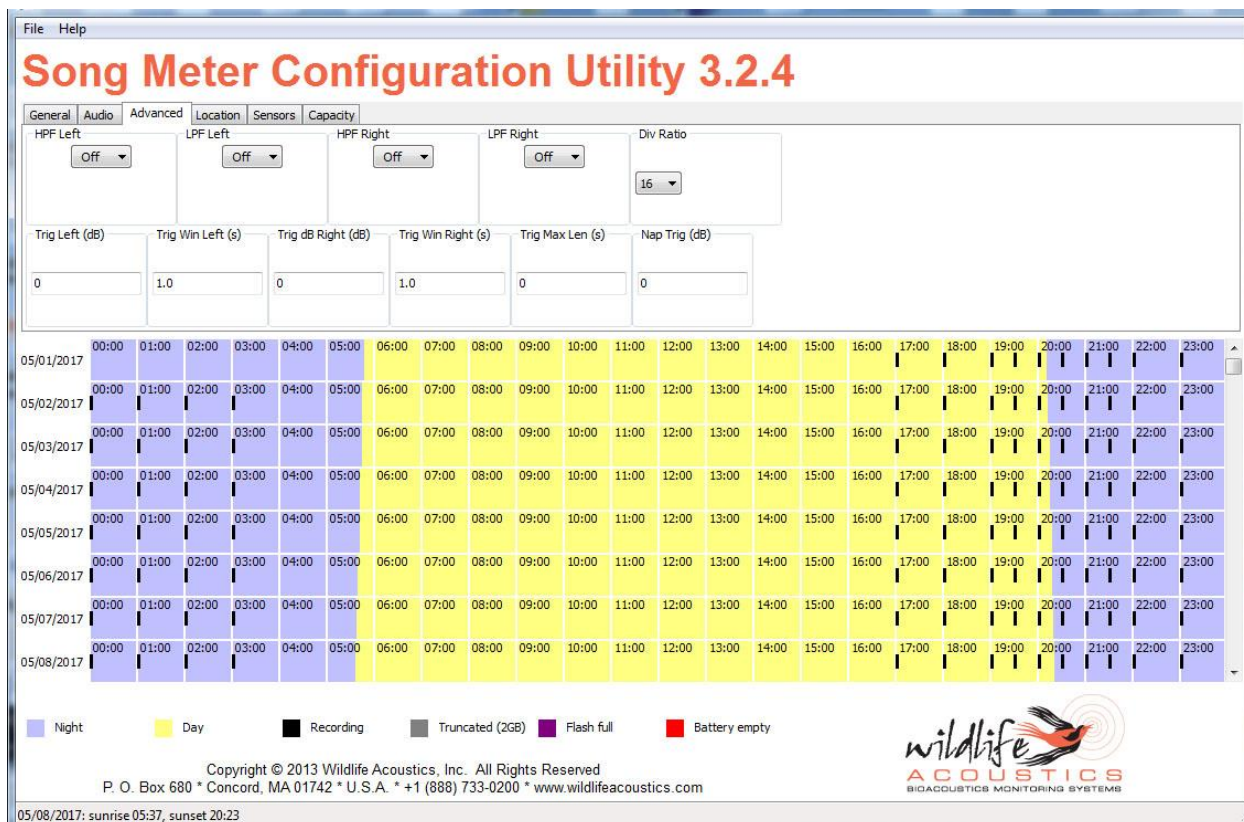
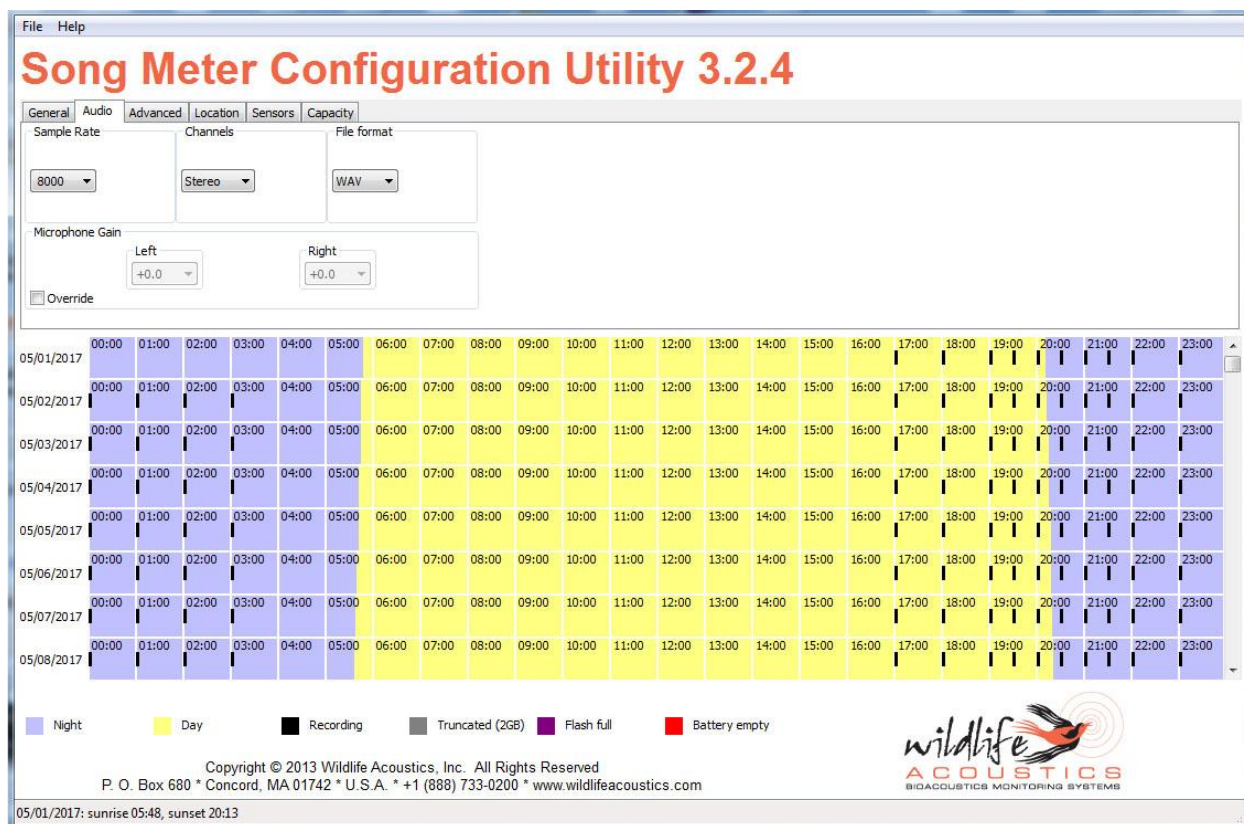
	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
05/01/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/02/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/03/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/04/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/05/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/06/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/07/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/08/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/09/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/10/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day

Night
 Day
 Recording
 Truncated (2GB)
 Flash full
 Battery empty

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File Help

Song Meter Configuration Utility 3.2.4

General Audio Advanced Location Sensors Capacity

Prefix: APIS10 Solar mode: Sunrise/set

☒ Override

Timezone: -05 :00 Latitude: 46.80 N Longitude: 90.80 W

Date	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
05/01/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/02/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/03/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/04/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/05/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/06/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/07/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/08/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day

Legend: Night (Blue), Day (Yellow), Recording (Black), Truncated (2GB) (Grey), Flash full (Purple), Battery empty (Red)

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File Help

Song Meter Configuration Utility 3.2.4

General Audio Advanced Location Sensors Capacity

Internal Type: Linear Zero: 400.00 Unit: 19.50 Digits: 1

External Type: Linear Zero: 400.00 Unit: 19.50 Digits: 1

☒ Override

Date	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
05/01/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/02/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/03/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/04/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/05/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/06/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/07/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
05/08/2017	Night	Night	Night	Night	Night	Night	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day

Legend: Night (Blue), Day (Yellow), Recording (Black), Truncated (2GB) (Grey), Flash full (Purple), Battery empty (Red)

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File
Help

Song Meter Configuration Utility 3.2.4

General
Audio
Advanced
Location
Sensors
Capacity

Flash Card Capacities

32GB
32GB
None
None
% compress
100

Power consumption

Power Source: Internal
Battery Type: Alkaline
mAh capacity: 12000
%/mo discharge: 1

05/01/2017	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
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Night
Day
Recording
Truncated (2GB)
Flash full
Battery empty

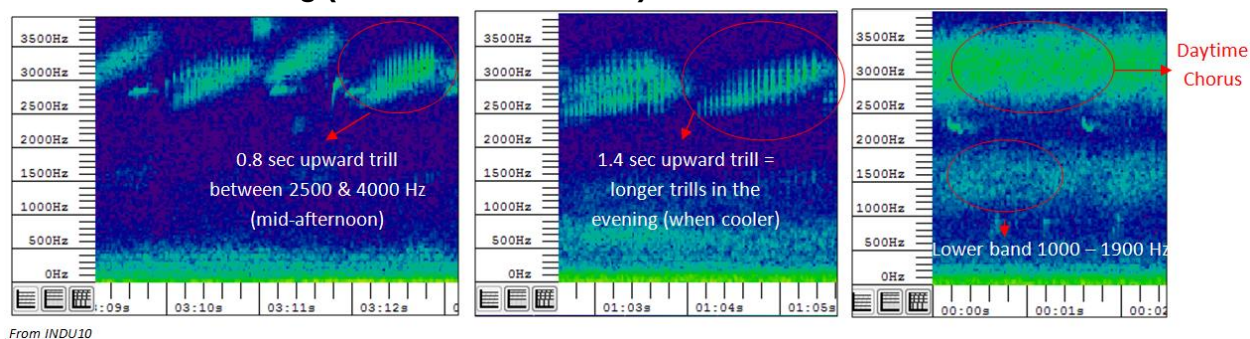
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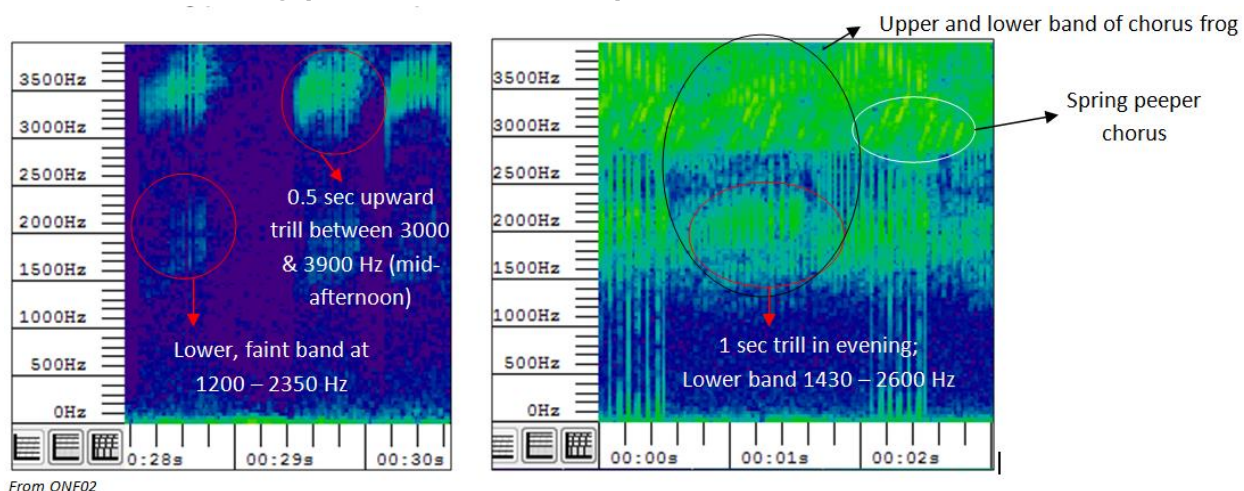


Appendix 2. Spectrogram Examples.

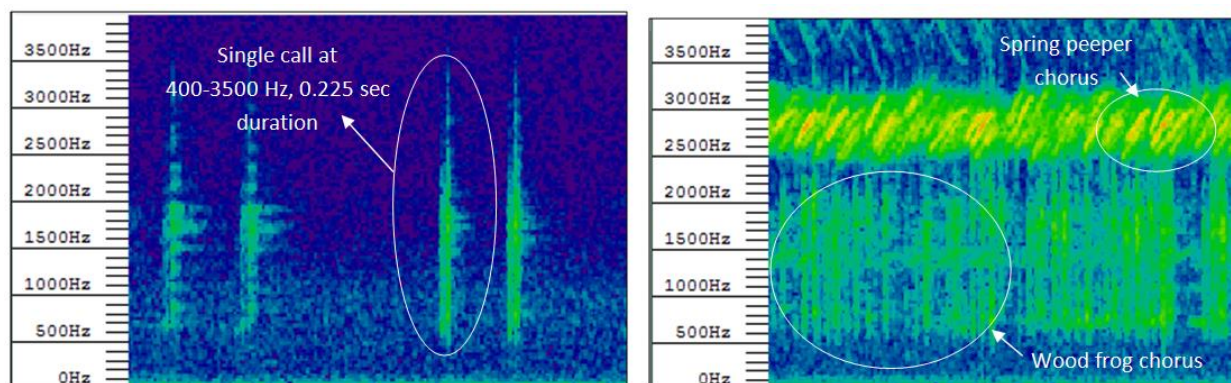
Western Chorus Frog (*Pseudacris triseriata*)



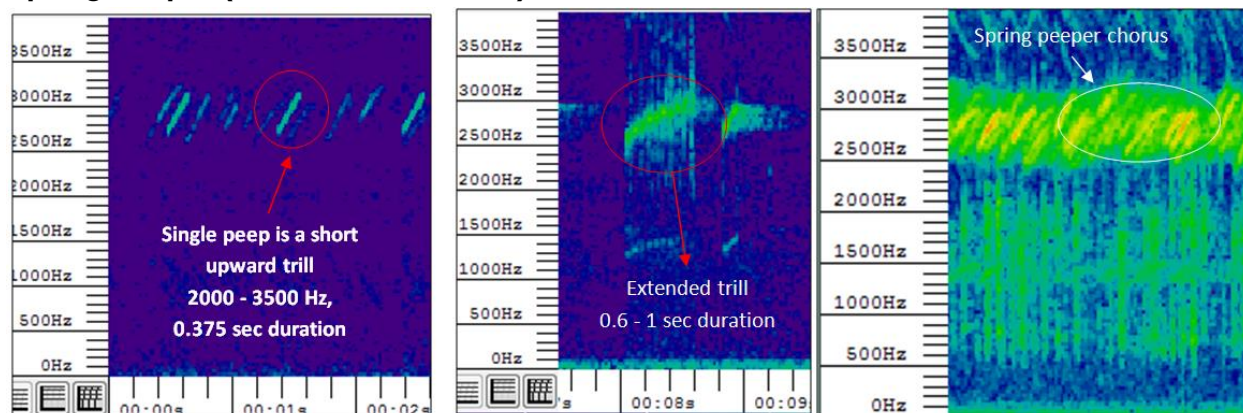
Boreal Chorus Frog (*Pseudacris maculata*)



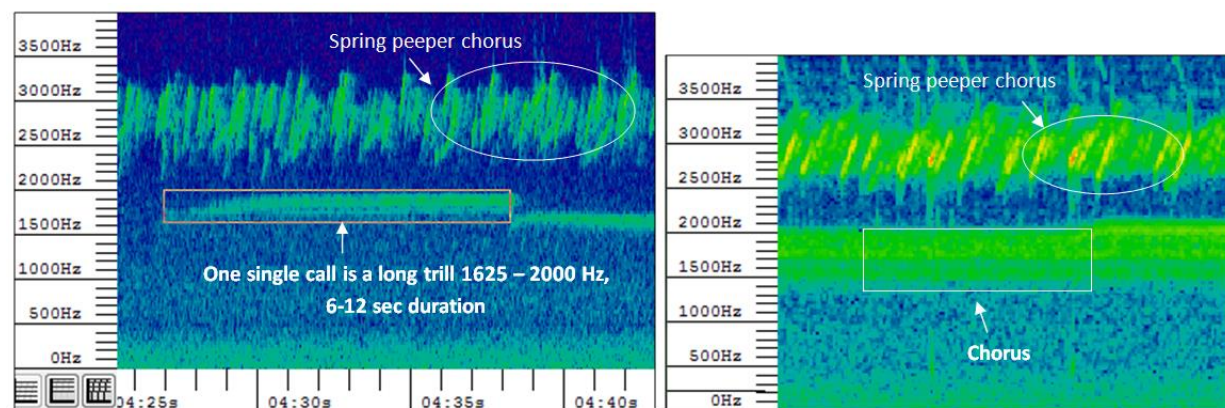
Wood Frog (*Lithobates sylvaticus*)



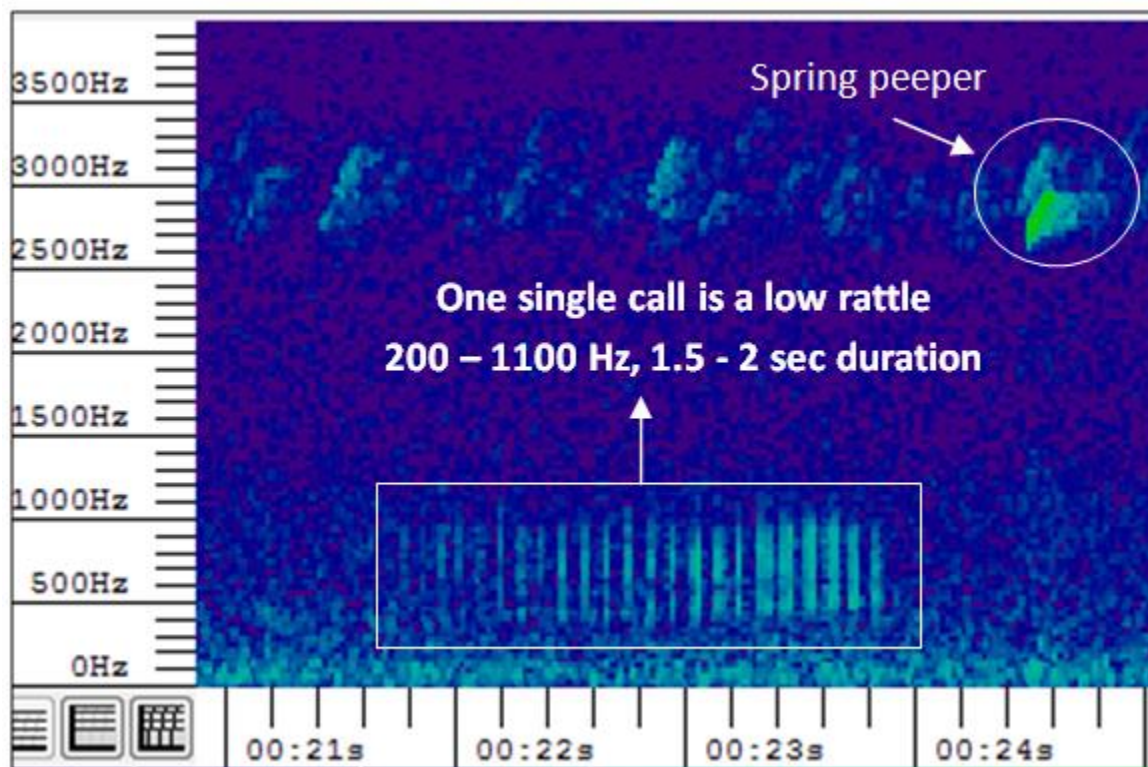
Spring Peeper (*Pseudacris crucifer*)



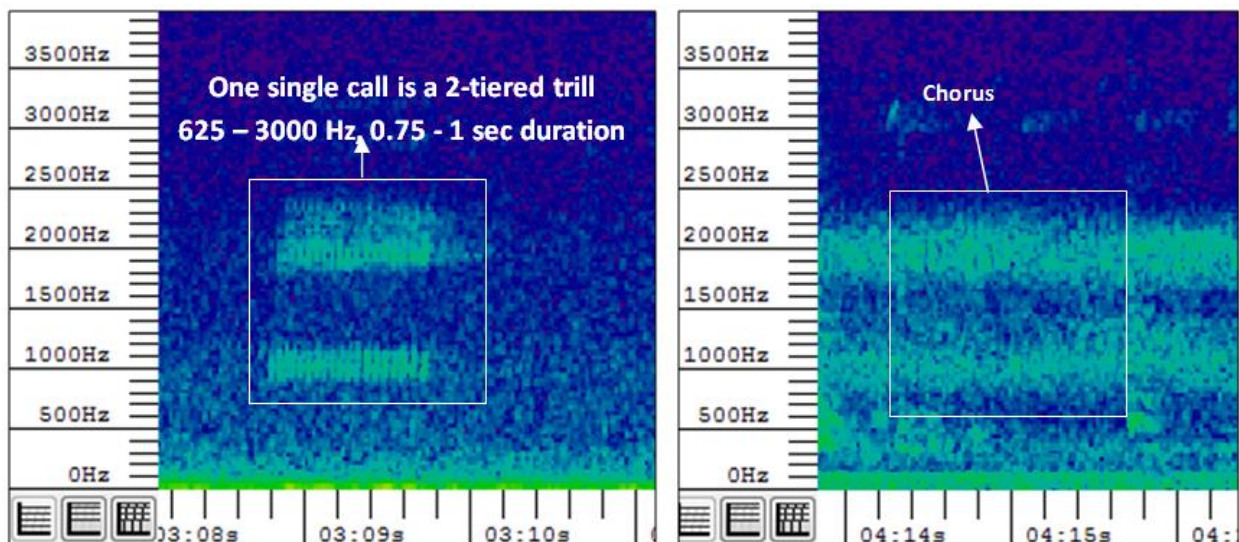
American Toad (*Anaxyrus americanus*)



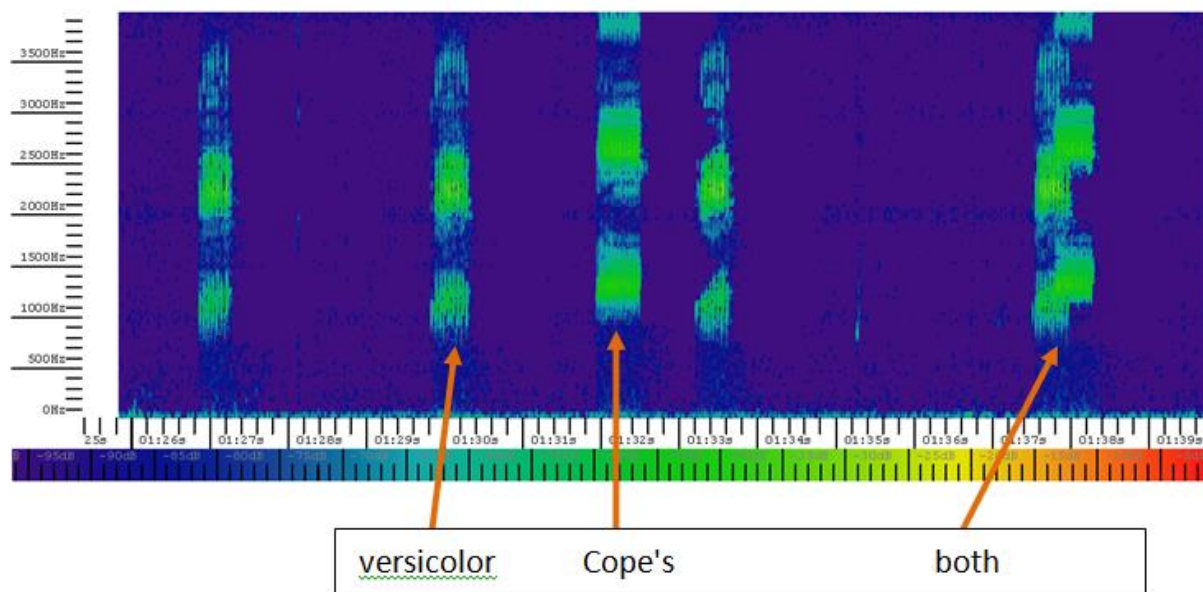
Northern Leopard Frog (*Lithobates pipiens*)



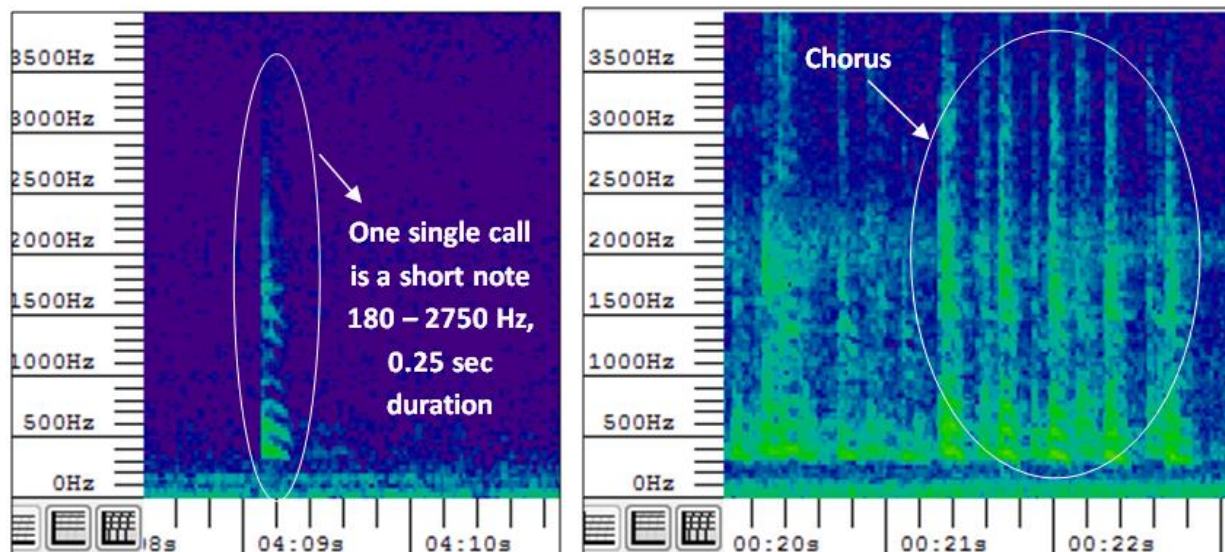
Gray Treefrog (*Hyla versicolor*)



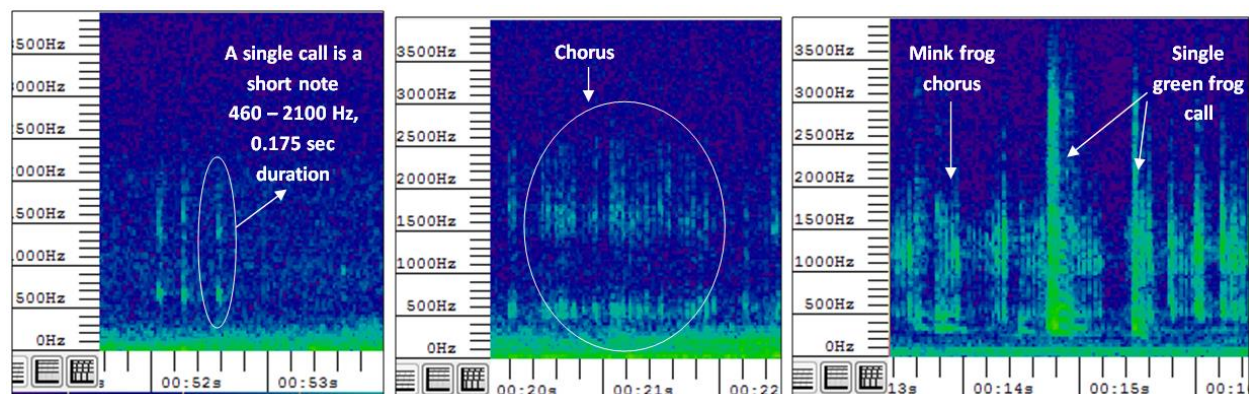
Cope's Gray Treefrog (*Hyla chrysoscelis*)



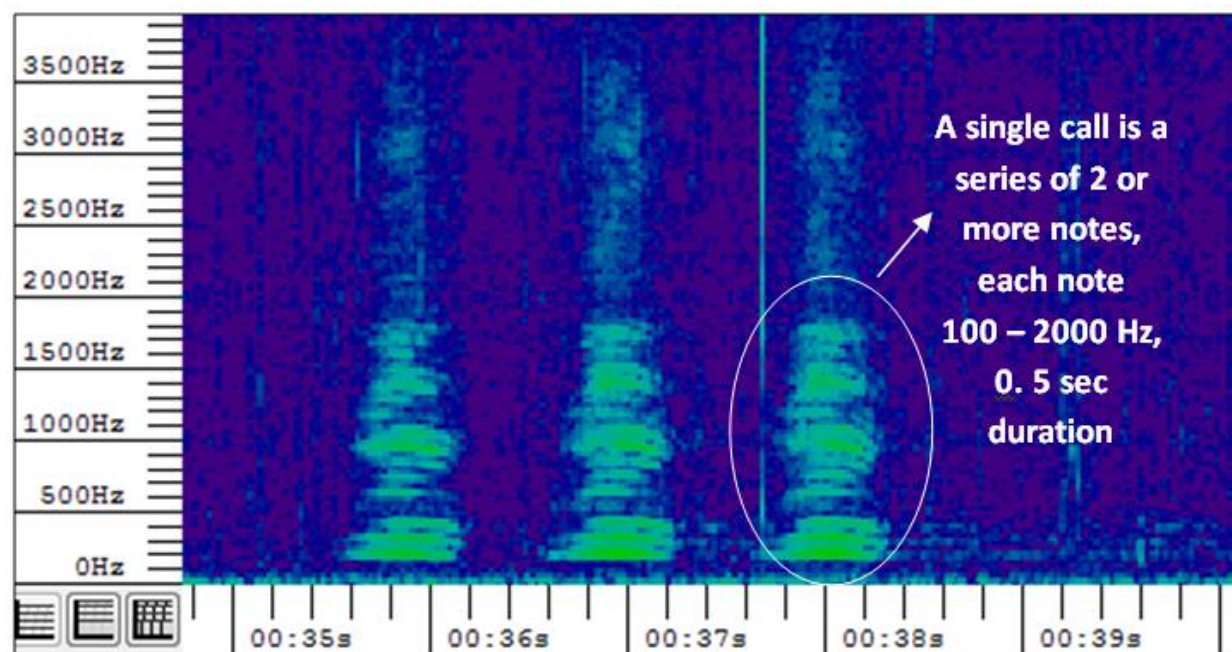
Green Frog (*Lithobates clamitans*)



Mink Frog (*Lithobates septentrionalis*)



American Bullfrog (*Lithobates catesbeianus*)



Blanchard's Cricket Frog (*Acris blanchardi*)

