

Amphibian Monitoring in the Great Lakes Inventory and Monitoring Network: 2013 Annual Report

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The National Park Service Great Lakes Inventory and Monitoring Network (Network) is implementing an amphibian monitoring protocol at national park units across the Great Lakes region based on automated acoustic monitoring (Casper and Beever 2013). Implementation began in 2013 with three parks participating by selecting 10 sites and deploying an Automated Recording Unit (ARS) at each site per the approved protocol (*op. cit.*). ARSs were Song Meters manufactured by Wildlife Acoustics, Inc. (970 Sudbury Road, Concord, MA 01742-4939). This report provides the first annual summary results for the program.

1. Methods

1.1 Site Selection and Equipment Deployment

ARSs and pre-programmed SD cards were provided by the Network to Indiana Dunes National Park (INDU), Sleeping Bear Dunes National Lakeshore (SLBE) and Pictured Rocks National Lakeshore (PIRO) in early 2013. Up to 30 sites were pre-selected by the Network in a stratified random design per the Protocol (Casper and Beever 2013) and associated Standard Operating Procedures. ARSs were tested for quality control by the Network or the participating park before field deployment, and each site was ground truthed by the principal investigator (GC) for qualifying as suitable habitat and to assign its wetland category (temporary, semi-permanent, permanent). Ten ARSs were then deployed with three in each of three qualifying wetland ranks and the tenth unit placed at a final qualifying site at each park's discretion. Units were field checked mid-season to confirm continuing operation by park staff, and removed after the calling season. Upon return of ARSs to the office, SD cards were removed, backed up, and sent to the Network for archival and analyses. Each park will inspect and test ARS equipment again prior to redeployment in 2014, with repairs and replacements as needed. Forms detailing ARS deployment and retrieval, as well as subsequent equipment checks and retrieval, are on file with each park and the Network office.

1.2 Recognizer Development

We continued developing recognizers utilizing species recordings obtained from ARSs deployed on this and other western Great Lakes area projects. This process is described in the Song Scope software manual. Currently we have four species recognizers sufficiently developed for automated sampling of recordings: Spring Peeper (*Pseudacris crucifer*), Gray Treefrog (*Hyla versicolor*), American Toad (*Anaxyrus americanus*), and Green Frog (*Lithobates clamitans*). Recognizer specifications are provided in Table 1.

Table 1: Recognizers

Parameters	PSCR2 Spring Peeper	HYVEa Gray Treefrog	ANAM3a Am. Toad	RACLa Green Frog
Sample Rate (Hz)	16000	16000	16000	8000
FFT Size	256	256	128	256
FFT Overlap	1/2	7/8	1/2	1/2
Frequency Minimum	40	11	12	9
Frequency Range	16	36	8	94
Background Filter	1s	1s	1s	1s
Maximum Syllable	336	600	1008	16
Maximum Gap	144	920	156	224
Maximum Song	400	2288	6844	832
Dynamic Range	25	20	15	20
Maximum Complexity	44	43	32	32
Maximum Resolution	27	9	6	6
Cross Training	78.17 ± 9.37%	74.15 ± 4.38%	77.48 ± 5.03%	76.24 ± 6.42%
Total Training	83.58 ± 8.22%	74.06 ± 4.83%	77.39 ± 4.17%	75.88 ± 5.67%
Training Files	2 files from Ottawa National Forest (ONF); 30 annotations.	4 files from ONF; 38 annotations.	3 files from ONF; 17 annotations.	3 files from ONF; 63 annotations.
Training Notes	Annotated a single peep between 2000 & 4000 Hz; training files from evening samples (10 PM - 2 AM) only.	Annotated a 0.2 to 0.7 sec trill between 600 & 3000 Hz; training files from evening samples (10 PM - 2 AM) only.	Annotated a 5 - 9 sec trill between 1600 - 2250 Hz; training files from evening samples (10 PM - 2 AM) only. Requires additional post-processing filtering in Excel (limit call duration to > 5 sec).	Annotated a 1 - 1.4 sec call between 300 - 2000 Hz; training files from evening samples (10 PM - 2 AM) only.

1.3 Data Analysis

Digital audio recordings are site, time and date stamped in file names. For each site we received varying numbers of samples (a sample is a 5-minute digital audio recording), along with a TXT file containing date and time stamped temperature logger data. These data are summarized in Table 2 and Appendix D. The logger data included both internal and external temperature sensors per the Protocol.

1.3.1 Analyzing Species With Recognizers

For each site we performed a stepwise process to reduce raw data to subsets of samples for analysis. This procedure applies a sampling protocol that maximizes detection probabilities, and defines the sample size, as follows.

1. Subset raw files by time of day, selecting 5 samples per evening with the first sample being the first post-sunset. We chose 5 samples because sampling is conducted hourly and calling activity gradually declines after sunset as temperatures drop. Also, under the current protocol, sampling ends at 2 a.m. and starts again the following afternoon.
2. Run selected files through the available species recognizers.
3. For output from the American Toad recognizer, eliminate results less than 5 seconds in duration using Excel. It is currently not possible to automate this step within Song Scope, and it improves results by eliminating many false presences.
4. Verify first and last calling dates for each species by manually scanning the first and last recognizer detections using Song Scope (see below for manual scanning procedure) until first and last detections are confirmed. Eliminate samples outside these bounding dates.
5. The reduced recognizer output now lists all samples that contained one or more putative detections between the bounding dates and within the time of day constraints. Calculate the sample size as the number of samples (5-minute recordings) remaining in this reduced output. This can be accomplished within Excel through manipulation of files to eliminate duplicates with the same date/time stamp in the file name.

Note that the resultant *number of samples* will be fewer than the *number of detections*, as there are often many detections within a single sample (see Table 3). Also, the time of day constraints (Step 1) may be adjusted in the future if it is determined that daytime samples are better for detecting some species (e.g., Wood Frog, Chorus Frog).

Table 2: Data Summary

Site	Dates	Valid Samples	Temp Data?	Temp Data Notes	Midseason Check Notes	Recovery Form Notes	Sample Notes	File statistics	Other Notes
INDU01	3/25/13 - 3/30/13	3/29/13 - 3/30/13	Y	Temp data through 3/29/13		Light test failed	Files prior to 0329_12 are empty	505 MB, 56 files	All data collected from noon to midnight only
INDU02	3/25/13 - 3/30/13	3/29/13 - 3/30/13	Y	Temp data through 3/29/13		Light test passed; wildlife damage to mic	Files prior to 0329_12 are empty	597 MB, 66 files	All SET files included
INDU03	3/25/13 - 4/25/13	3/29/13 - 4/25/13	Y	Temp data through 4/24/13		Light test failed	Files prior to 0329_13 are empty	3.59 GB, 403 files	All of the sites are noisier than other parks; many have loud train noises in the background
INDU04	3/25/13 - 3/31/13	None	Y	Temp dates same as data range		12 files on SD card from 3/26/13 that were unreadable; no recovery form	All files appear to be empty	624 MB, 69 files	
INDU05	3/25/13 - 4/6/13	3/27/13 - 4/6/13	Y	Temp data through 4/5/13		Light test failed, wildlife damage to mic	First few files recorded in office, files prior to 3/27/13 are empty	1.28 GB, 144 files	
INDU06	3/25/13 - 4/8/13	3/29/13 - 4/8/13	Y	Temp data through 4/7/13		Light test failed	First few files recorded in office, files prior to 0329_12 are empty	1.6 GB, 180 files	
INDU07	3/25/13, 3/28/13 - 4/4/13	3/28/13 - 4/4/13	Y	Temp dates same as data range		Light test failed, wildlife damage to mic		827 MB, 96 files	
INDU08	3/29/13 - 4/4/13	3/29/13 - 4/4/13	N			Light test failed	Samples contain sounds, but very quiet - mic not working properly?	716 MB, 78 files	
INDU09	3/29/13 - 4/4/13	3/29/13 - 4/4/13	Y	Temp data through 4/3/13		Light test passed	All samples good; heavy background noise	799 MB, 68 files	
INDU10	3/29/13 - 4/4/13	3/29/13 - 4/4/13	Y	Temp data through 4/3/13		Light test passed	All samples are good	716 MB, 79 files	
PIRO01	5/9/2013 - 6/14/13	5/15/2013 - 6/14/13	Y	Temp dates to 6/14 with error occurring on 6/13	Light test failed; meter in water	Songmeter had not be redeployed	Files before 0515_17 are empty	5.14 GB, 576 files	
PIRO02	5/9/13 - 8/15/13	5/15/13 - 8/15/13	Y	Temp dates the same OK as data range		OK	Files before 0515_14 are empty	14 GB, 1571 files	

Table 2: Data Summary

Site	Dates	Valid Samples	Temp Data?	Temp Data Notes	Midseason Check Notes	Recovery Form Notes	Sample Notes	File statistics	Other Notes
PIRO03	5/9/13 - 5/17/13, 7/19/13 - 7/20/13	5/14/13 - 5/17/13, 7/19/13 - 7/20/13	Y	Temp dates the same as data range	OK	OK	Files before 0514_14 are empty	1.27 GB, 143 files	
PIRO04	5/9/13 - 5/19/13, 7/25/13 - 7/27/13	5/15/13 - 5/19/13, 7/25/13 - 7/27/13	Y	Temp dates the same as data range	OK	OK	Files before 0515_12 are empty	1.71 GB, 192 files	
PIRO05	5/9/13 - 5/19/13, 7/18/13 - 7/21/13	5/14/13 - 5/19/13, 7/18/13 - 7/21/13	Y	Temp dates same for May, extend through 7/24 for July	light test failed; restored w/ new batteries	OK; sensor cord snapped upon removal	Files before 0514_16 are empty	1.89 GB, 212 files	
PIRO06	5/9/13 - 5/20/13, 7/19/13 - 8/15/13	5/15/13 - 5/20/13, 7/19/13 - 8/15/13	Y	Temp dates the same as data range	OK	OK	Files before 0515_16 are empty	5.45 GB, 610 files	
PIRO07	5/9/13 - 5/22/13, 7/19/13 - 8/6/13	5/16/13 - 5/22/13, 7/19/13 - 8/6/13	Y	Temp dates the same as data range; Water sensor did not work properly	light test passed; error w/ SD card; R microphone gone	OK	Files before 0516_12 are empty	3.97 GB, 444 files	
PIRO08	5/9/13 - 5/31/13, 7/24/13	5/16/13 - 5/31/13, 7/24/13	Y	Temp dates the same as data range	OK	OK; temp probe out of water	Files prior to 0516_13 are empty	3.2 GB, 360 files	
PIRO09	5/11/13 - 5/26/13, 7/19/13 - 8/15/13	5/16/13 - 5/26/13, 7/19/13 - 8/15/13	N	PIRO06 folder contains temp data that is different from the file - labeled incorrectly?	OK; right mic dangling	OK, but logger tipped over	Data from 5/9/13 - 5/11/13 labeled as PIRO06; Files prior to 0516_14 are empty	6.31 GB, 705 files (43 files labeled as PIRO06)	
PIRO10	5/9/13 - 6/30/13, 7/24/13 - 8/2/13	5/18/13 - 6/30/13, 7/24/13 - 8/2/13	Y	Temp dates the same as data range; Water sensor did not work properly	OK	OK	Files prior to 0518_21 are empty	8.71 GB, 972 files	
SLBE03	5/1/13, 5/2/13 & 5/4/13 (few samples); 5/5/13 - 5/17/13	5/13/13 - 5/17/13	Y	Temp data missing for 5/2/13		None provided	Data prior to 5/4/13 recorded in office? Files 5/4/13 to 0513_12 are empty	1.38 GB, 179 files	Data collected from noon to midnight only

Table 2: Data Summary

Site	Dates	Valid Samples	Temp Data?	Temp Data Notes	Midseason Check Notes	Recovery Form Notes	Sample Notes	File statistics	Other Notes
SLBE04	5/2/13, 5/3/13, 5/6/13 - 5/29/13, 6/8/13 - 6/21/13	6/8/13 - 6/21/13	Y	Temp data missing for 5/2/13		None provided	Early dates contain only a few samples, files prior to 6/8/13 do not work properly	4.21 GB, 490 files	All SET files included
SLBE08	5/1/13, 5/2/13, 5/6/13 - 5/21/13	5/17/13 - 5/21/13	Y			None provided	Files prior to 5/6/13 appear to have been recorded in office; two additional sound files provided for 5/3/13, labeled GLKN402; files between 5/6 & 5/15 are empty	1.59 GB, 221 files	
SLBE09	5/1/2013; 5/6/13 - 6/7/13	5/15/13 - 6/7/13	Y			None provided	Files prior to 5/6/13 recorded in office? 6 additional sound files provided for 5/3/13, labeled GLKN401; Files between 5/6 and 0515_12 are empty	3.67 GB, 432 files	

Additional Notes:

- INDU Sites - (1) All data collected from noon to midnight only. (2) All SET files are included. (3) All of the sites are noisier than other parks; many have loud train noises in the background.
- PIRO Sites - (1) All data collected from noon to 3 A.M. (2) SET files were not included.
- SLBE Sites - (1) All data collected from noon to midnight only. (2) All SET files are included.

Table 3: Summary of Recognizer Detections

Park Site Number	Recognizer	Initial No. Detections ¹	No. Samples with Any Detection ²	No. Days with Any Detection ³
INDU01	Spring Peeper	0	0	0
INDU02	Spring Peeper	0	0	0
INDU03	Spring Peeper	369	62	8
INDU04	Spring Peeper	0	0	0
INDU05	Spring Peeper	102	29	10
INDU06	Spring Peeper	217	12	3
INDU07	Spring Peeper	763	26	6
INDU08	Spring Peeper	13	4	1
INDU09	Spring Peeper	693	27	7
INDU10	Spring Peeper	340	26	7
PIRO01	Spring Peeper	2897	147	31
PIRO02	Spring Peeper	15246	319	68
PIRO03	Spring Peeper	483	18	6
PIRO04	Spring Peeper	250	19	5
PIRO05	Spring Peeper	301	25	6
PIRO06	Spring Peeper	567	28	8
PIRO07	Spring Peeper	481	45	15
PIRO08	Spring Peeper	1851	72	16
PIRO09	Spring Peeper	464	35	10
PIRO10	Spring Peeper	8272	202	52
SLBE03	Spring Peeper	369	62	4
SLBE04	Spring Peeper	17	0	0
SLBE08	Spring Peeper	138	9	5
SLBE09	Spring Peeper	1314	77	20
INDU01	Gray Treefrog	0	0	0
INDU02	Gray Treefrog	0	0	0
INDU03	Gray Treefrog	0	0	0
INDU04	Gray Treefrog	0	0	0
INDU05	Gray Treefrog	0	0	0
INDU06	Gray Treefrog	0	0	0
INDU07	Gray Treefrog	0	0	0
INDU08	Gray Treefrog	0	0	0
INDU09	Gray Treefrog	0	0	0
INDU10	Gray Treefrog	0	0	0
PIRO01	Gray Treefrog	0	0	0
PIRO02	Gray Treefrog	1	0	0
PIRO03	Gray Treefrog	20	3	1
PIRO04	Gray Treefrog	0	0	0
PIRO05	Gray Treefrog	0	0	0
PIRO06	Gray Treefrog	1	0	0

Table 3: Summary of Recognizer Detections

Park Site Number	Recognizer	Initial No. Detections ¹	No. Samples with Any Detection ²	No. Days with Any Detection ³
PIRO07	Gray Treefrog	29	7	5
PIRO08	Gray Treefrog	1	1	1
PIRO09	Gray Treefrog	120	3	2
PIRO10	Gray Treefrog	109	6	5
SLBE03	Gray Treefrog	23	2	2
SLBE04	Gray Treefrog	1	0	0
SLBE08	Gray Treefrog	0	0	0
SLBE09	Gray Treefrog	9	4	4
INDU01	Am. Toad	0	0	0
INDU02	Am. Toad	1	0	0
INDU03	Am. Toad	165	0	0
INDU04	Am. Toad	0	0	0
INDU05	Am. Toad	4	0	0
INDU06	Am. Toad	12	0	0
INDU07	Am. Toad	111	0	0
INDU08	Am. Toad	1	0	0
INDU09	Am. Toad	291	0	0
INDU10	Am. Toad	66	0	0
PIRO01	Am. Toad	686	30	10
PIRO02	Am. Toad	1509	55	17
PIRO03	Am. Toad	0	0	0
PIRO04	Am. Toad	0	0	0
PIRO05	Am. Toad	267	13	5
PIRO06	Am. Toad	17	0	0
PIRO07	Am. Toad	13	0	0
PIRO08	Am. Toad	903	36	11
PIRO09	Am. Toad	71	6	4
PIRO10	Am. Toad	359	21	9
SLBE03	Am. Toad	56	0	0
SLBE04	Am. Toad	6	0	0
SLBE08	Am. Toad	108	9	4
SLBE09	Am. Toad	597	4	2
INDU01	Green Frog	4	0	0
INDU02	Green Frog	4	0	0
INDU03	Green Frog	229	0	0
INDU04	Green Frog	5	0	0
INDU05	Green Frog	7	0	0
INDU06	Green Frog	59	0	0
INDU07	Green Frog	41	0	0
INDU08	Green Frog	173	0	0

Table 3: Summary of Recognizer Detections

Park Site Number	Recognizer	Initial No. Detections ¹	No. Samples with Any Detection ²	No. Days with Any Detection ³
INDU09	Green Frog	10	0	0
INDU10	Green Frog	16	0	0
PIRO01	Green Frog	5	0	0
PIRO02	Green Frog	5864	255	62
PIRO03	Green Frog	7	0	0
PIRO04	Green Frog	3	0	0
PIRO05	Green Frog	257	14	4
PIRO06	Green Frog	576	0	0
PIRO07	Green Frog	2859	74	17
PIRO08	Green Frog	6	0	0
PIRO09	Green Frog	3532	109	26
PIRO10	Green Frog	1178	107	30
SLBE03	Green Frog	6	0	0
SLBE04	Green Frog	103	17	8
SLBE08	Green Frog	18	2	2
SLBE09	Green Frog	2090	74	22

1 - after filtering by time of day. 2 - after filtering by first and last accurate detection, and removing duplicate detections per sample. 3 - after filtering by first and last accurate detection (including August).

1.3.2 Determining False Presence Rates

Anticipating data needed for occupancy modeling after 5 years, we provide two more analyses that can be used in new models developed by Miller et al. (2011, 2013; Pillay et al. 2014) that account for both false presences and false absences. 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. For example, one suggestion is to use call index values and assume that high index values are more "certain" detections than low index values. Such techniques will require more assumptions and more complexity in the modeling and interpretation of results.

We first determined false presence rates by choosing a random sample of up to 10 detections per site (some sites had <10 detections) and confirming each detection by manual scanning (see procedure below). The random samples were selected from the reduced data set resulting from Section 1.3.1, where same-date duplicates were removed. This returns a false presence rate that could be treated as a constant and applied in occupancy modeling. It also quantifies the efficacy of the recognizers in this regard. This same data set could also be treated as a second kind of survey or sampling technique (manual scanning of auditory files in Song Scope), which has higher "certainty" than the automated recognizer detection technique. In fact, we consider the false presence rate to be zero utilizing this technique. In this second treatment we can let Miller's models determine the likelihood of false presences by inputting data from both sampling techniques. Which treatment proves more efficacious and returns data closer to

reality remains to be seen. We fully expect that by the time we analyze data for occupancy at the 5-year mark, these models will be revised again.

1.3.3 Analyzing Species Without Recognizers

We constructed a presence/absence table for species we have not developed recognizers for by manually scanning samples for each site. The species to be potentially evaluated by this method are currently (in phenological calling order): Wood Frog, Chorus Frogs (both species are treated together), Leopard Frog, Pickerel Frog, Fowler's Toad, Cope's Gray Treefrog, Mink Frog, and American Bullfrog. If and when recognizer files are developed for any of these species, they will be eliminated from this list and evaluated per the automated process. Note that manual scanning is only assigned to species that are otherwise known to occur in each park (Table 4) and do not have recognizers developed. For species with recognizers the automated system is preferred.

Table 4: Species Confirmed by Park

Species	Recognizer File Developed?	APIS	GRPO	INDU	ISRO	MISS	PIRO	SACN	SLBE	VOYA
American Toad	Yes	X	X	X	X	X	X	X	X	X
Fowler's Toad	No			X						
Blanchard's Cricket Frog	No			X						
Cope's Gray Treefrog	No	X		X		X		X		
Gray Treefrog	Yes	X	X	X	X	X	X	X	X	X
Spring Peeper	Yes	X	X	X	X	X	X	X	X	X
Western Chorus Frog	No			X					X	
Boreal Chorus Frog	No	X	X		X	X	X	X		X
American Bullfrog	No	X		X		X	X	X	X	
Green Frog	Yes	X	X	X	X	X	X	X	X	X
Mink Frog	No	X	X		X		X	X		
Pickerel Frog	No			X				X	X	
Northern Leopard Frog	No	X	X	X		X	X	X	X	X
Wood Frog	No	X	X	X	X	X	X	X	X	X

How to Perform Manual Scanning

- 1) Open the folder of samples from a site and open the first file (*.WAV) to be scanned in Song Scope software (File ➤ Open). Adjust settings as follows for Song Scope version 3.4:
 - 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.
 - c) Spectrogram Tab: FFT Size 256, FFT Overlap ., Frequency Range 128, Background Filter 1s, all other sliders at 0.
 - d) Detector tab: Max Syllable and Max Syllable Gap at 50, Max Song at 30, Dynamic Range at 20, Algorithm at 2.0.
 - e) Recognizers tab: leave at defaults.
- 2) Review the example sonograms in Appendix A to aid in visual scanning. Refer to these examples each time you evaluate a new species.
- 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 record the species(s) heard in the Manual Scan Data Sheet (Appendix B). Then 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 data. 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) Note: 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.

Manual Scanning Sample Selection and Study Design

1. Determine the start date for each site. This Step discovers "empty" or blank samples (considered invalid) and a valid start date. These are also discovered in Step 4 of 1.3.1, so this Step may already be completed as part of the automated scanning process. "Empty" samples are those that are silent and do not contain any background noise or frogs, and are assumed to result from equipment failure. These are not valid samples and will be eliminated (as they are from the automated scanning results). Start by scanning one sample per day. Choose the first sample at least 30-minutes post-sunset (see 2013 Sunset Tables), which should have the highest sound level if equipment is functioning. Scan one file per day until you find a viable sample (there is recorded sound), then work backwards scanning each file sequentially until you find the beginning of the viable recordings. This is the start date for Step 2. Repeat this process to obtain valid start dates for each site to be analyzed.
2. Perform Species 1 sampling. Choose a site and start date from Step 1 and fill in the *Evaluator Name* and *Park and Site* on the Manual Scan Data Sheet (Appendix B). Begin scanning for the first species to be evaluated (currently Wood Frog) per the How to Manually Scan instructions above. Scan only the first sample on each day recorded at least

30 minutes after sunset (one sample per day, see provided sunset tables), until the target species is found or the end of the assumed breeding period is reached. The assumed breeding periods are given in Table 5 and provided on the Manual Scan Data Sheet. These are based on traditional calling periods for the species at each park and may be refined based on ongoing data collection, but currently dates outside of these periods are considered to be invalid samples. Use the Manual Scan Data Sheet to record the file name where the scanning begins (*Start File Name*), and the file name where the target species is first detected (*First Detection File Name*). As you proceed, if species other than the target species are detected, start a new species section on the Manual Scan Data Sheet and enter the appropriate *Species Evaluated* and *First Detection File Name* (you will complete data entry for that species in the next step). As soon as the target species is found, presence has been determined and no more files need to be scanned (following a removal sampling design). However, if the species is not found, continue scanning one file per day until the end of the assumed breeding period is reached, and record the *End File Name*. Note that the *End File Name* will be the same as the *First Detection File Name* if a detection is made. If no detection is made, leave *First Detection File Name* blank. Finally, calculate and record the *Number of Samples*, by counting the number of days scanned between the *Start File Name* and the *End File Name*. This is the number of files scanned to reach the presence/absence conclusion at each site. The file names have site and date stamps. Be sure to count days correctly using a calendar, including the first and last dates.

- a. Note: If there are periods when the samples reveal total silence, indicating additional equipment failure that was not eliminated in Step 1, scan forwards and backwards until these failure bounding dates are determined and eliminate those days from all sampling - they are invalid samples. Make sure to note any such discoveries on the data sheet and list the invalid dates. Then make sure sample sizes recorded account for any such invalid dates.
3. Move on to the next target species - Chorus Frogs (both species are treated together), Leopard Frog, Pickerel Frog, Fowler's Toad, Cope's Gray Treefrog, Mink frog, and American Bullfrog in that order (the order accounts for phenology and will be the most efficient way to proceed). Only scan additional dates *beyond what have already been scanned* (species presence has already been determined in previously scanned samples) AND that fall within the remaining assumed breeding period for the species. Record data as for Step 2, but the sample size will be the number of samples already examined from the first date in this species assumed breeding period, PLUS any new samples scanned for this species to the end of its assumed breeding period.
4. Continue as per Step 3 until all target species are completed for that site. Check Table 5 to determine the species list, evaluating only those species present in the park and without developed recognizers.
5. Repeat for the next site. Please start a new tab in the Manual Scan Data Sheet for each site evaluated, labeling the tabs with the site name (e.g., PIRO01, PIRO02, etc.). You can copy the first site tab to retain the species and dates, then edit as needed for the current site files names, dates and results.

Table 5: Assumed Breeding Periods by Park

Species	APIS	GRPO	INDU	ISRO	MISS	PIRO	SACN	SLBE	VOYA
Wood	3/25 - 5/ 10	4/1 - 5/10	3/1 - 4/15	4/1 - 5/10	3/20 - 5/10	3/25 - 5/15	3/20 - 5/10	4/1 - 5/15	4/1 - 5/10
W. Chorus	absent	absent	3/1 - 5/25	absent	absent	absent	absent	3/20 - 5/15	absent
Boreal Chorus	3/25 - 5/15	4/1 - 5/15	absent	4/1 - 5/15	3/20 - 5/15	4/1 - 5/15	3/20 - 5/15	absent	4/1 - 5/15
Spring Peeper	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis
No. Leopard	4/10 - 6/10	4/1 - 6/10	3/25 - 5/10	absent	3/20 - 5/31	4/10 - 6/5	4/1 - 5/25	4/1 - 5/25	4/1 - 6/10
Pickereel	absent	absent	4/ 5 - 5/15	absent	absent	absent	4/10 - 5/25	4/10 - 5/25	absent
Am. Toad	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis
Fowler's Toad	absent	absent	4/15 - 6/1	absent	absent	absent	absent	absent	absent
Gray Treefrog	automate analysis	automated automate	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis
Cope's Treefrog	4/25 - 7/15	absent	4/15 - 7/1	absent	4/20 - 7/15	absent	4/20 - 7/15	absent	absent
Cricket	absent	absent	5/15 - 8/10	absent	absent	absent	absent	absent	absent
Green	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis	automate analysis
Mink	6/1 - 8/15	6/5 - 8/15	absent	6/5 - 8/15	6/1 - 8/15	absent	6/1 - 8/15	absent	absent
Am. Bullfrog	6/1 - 8/15	absent	5/20 - 8/15	absent	5/25 - 8/15	6/1 - 8/15	5/25 - 8/15	5/25 - 8/15	absent

Note: These dates are based on Michigan, Minnesota and Wisconsin calling frog survey program phenology charts, and local knowledge. They will be revised as data are collected and analyzed. We did not analyze any files for Bullfrogs past July 31, as calling rates decline significantly after July.

2013 Sunset Tables

We obtained sunset times from (http://aa.usno.navy.mil/data/docs/RS_OneYear.php), with tables provided in Appendix C. Note that Song Meters do not automatically adjust for daylight savings time, but this shift occurs in early March and early November (<http://www.day-finder.com/daylight-savings.php>), so Song Meters calibrated to local Daylight Time when deployed will correctly log in local Daylight Time throughout the sampling period. Sunset tables in Appendix C, however, are in Standard Time, so one hour must be added to the time to account for Daylight Time. The Protocol currently instructs parks to program Song Meters to current local Daylight Time. If Song Meters were calibrated to local Standard Time instead of local Daylight Time, then this adjustment for sunset times would not be needed.

Park	Place	Date	Sunset	Sample to Use
PIRO	Munising, MI	5/9/2013	2006 EDT	2200h
PIRO	Munising, MI	5/31/2013	2031 EDT	2300h
PIRO	Munising, MI	7/21/2013	2030 EDT	2200h
PIRO	Munising, MI	8/30/2013	2029 EDT	2100h
INDU	Porter, IN	3/25/2013	1906 CDT	2000h
INDU	Porter, IN	4/17/2013	1931 CDT	2100h
SLBE	Traverse City, MI	5/1/2013	2048 EDT	2200h
SLBE	Traverse City, MI	6/16/2013	2131 EDT	2300h

2. Results

2.1 Site Selection, Equipment Deployment and Retrieval, Data Collection

These data forms are archived at each park and the Network office, pending database development and data entry. Initial site selection from the remote sensing randomized site list went fairly smoothly (weather issues aside), but there was some difficulty in distinguishing between ephemeral and semi-permanent wetland classifications based on only one site visit. These rankings should be periodically re-evaluated based on hydroperiod data. Equipment deployment was performed as best as possible in this pilot year, and improvements in materials and fastening of posts, cords and sensors may be realized as the program progresses.

Equipment and data retrieval were handled by park and Network staff. Data contained on SD cards from each ARS unit were delivered to the investigators in November 2013 and examined for completeness, including scanning of files to determine "empty" files indicating equipment failures. Results are presented in Table 2.

Data collection success is presented in Table 6 with sampling success rates. Since deployment dates vary each year with phenology and staff logistics, sampling start dates are not static. Once deployed the pilot protocol assumed 13 samples recorded each day (1200h to 0000h), at the top of each hour, until units are retrieved. The protocol intent is to continue sampling through

July 31 to allow for analyses of late calling species (e.g., American Bullfrog). Therefore, the expected number of samples is calculated from the actual deployment date of each unit through July 31. See Table 2 for actual sampling dates. In 2013, INDU and SLBE Song Meters were recording 13 samples per day 1200h to 0000h), while PIRO Song Meters were recording 16 samples per day 1200h to 0300h).

Table 6: Data Collection Results

Site	First Recording Date	N Expected Sample Days (to July 31)	N Expected Samples (days X 13)	N Actual Sample Days	N Actual Samples (to July 31)	Success Rate Days	Success Rate Samples
INDU01	3/25	128	1664	6	55	0.05	0.03
INDU02	3/25	128	1664	6	65	0.05	0.04
INDU03	3/25	128	1664	32	402	0.25	0.24
INDU04	3/25	128	1664	7	68	0.05	0.04
INDU05	3/25	128	1664	13	143	0.10	0.09
INDU06	3/25	128	1664	15	179	0.12	0.11
INDU07	3/25	128	1664	9	95	0.07	0.06
INDU08	3/29	125	1625	7	78	0.05	0.05
INDU09	3/29	125	1625	7	67	0.06	0.04
INDU10	3/29	125	1625	7	78	0.06	0.05
PIRO01	5/9	84	1092	37	575	0.44	0.53
PIRO02	5/9	84	1092	84	1346	1.00	1.23
PIRO03	5/9	84	1092	11	142	0.13	0.13
PIRO04	5/9	84	1092	14	191	0.17	0.17
PIRO05	5/9	84	1092	15	211	0.18	0.19
PIRO06	5/9	84	1092	25	609	0.30	0.56
PIRO07	5/9	84	1092	27	443	0.32	0.41
PIRO08	5/9	84	1092	24	359	0.29	0.33
PIRO09	5/11	82	1066	29	705	0.35	0.66
PIRO10	5/9	84	1066	61	971	0.73	0.91
SLBE01	None						
SLBE02	None						
SLBE03	5/1	92	1196	16	154	0.17	0.13
SLBE04	5/2	91	1183	40	470	0.44	0.40
SLBE05	None						
SLBE06	None						
SLBE07	None						
SLBE08	5/1	92	1196	18	220	0.20	0.18
SLBE09	5/1	92	1196	34	409	0.37	0.34
SLBE10	None						

2.2 Recognizer File Development

Our current recognizers are sufficient for automated sampling for four species provided both false presences and false absences are accounted for in subsequent analyses. Our Spring Peeper recognizer works very well overall, but will return some false presences identifying some birds and Chorus Frogs as Spring Peepers, and it does not identify Spring Peeper choruses. In selecting samples for analyses, filtering recognizer output by time of day and time of year can help reduce false presences. Reducing false presences of Spring Peepers from misidentified Chorus Frog calls may be difficult but we continue to evaluate this. The American Toad recognizer works well once calls less than 5 seconds are filtered out post-processing. We do not yet have training files for Fowler's Toad so have not examined how well this recognizer can differentiate between these two species, although a frequency filter may achieve this as Fowler's Toad calls are a higher frequency (and this species is currently known only from INDU, and possible in SLBE). The Gray Treefrog recognizer works well and additional development will be assessed as more data and Cope's Gray Treefrog recordings are evaluated. The Green Frog recognizer returns few false absences, but incorrectly detects a lot of background noise (false presences). We continue to evaluate additional filtering to reduce false presences in this recognizer.

The status of recognizer development for the remaining species in the Network is variable. For Wood Frog, we have not yet incorporated enough training samples, but probably now have enough samples in hand to begin development. The call is fairly distinct and occurs throughout the day and night, so we anticipate being able to develop a quality recognizer, possibly improved by selecting daytime samples. For Western Chorus Frog we have not yet incorporated enough training samples, but probably now have enough in hand to begin development. The call is very distinct and occurs throughout the day and night, so we anticipate being able to develop a quality recognizer, possibly improved by selecting daytime samples. For Boreal Chorus Frog, we have not yet incorporated enough training samples, and the samples currently in hand show a difference in frequency range from the Western Chorus Frog. We may be able to develop a quality recognizer if we can obtain more training data. For Northern Leopard Frog we also lack sufficient training samples. However, the call is fairly distinct, so we anticipate being able to develop a recognizer once we obtain more data. For Mink Frog, the call is very weak and not well differentiated from Green Frog calls and background noises. Its visual signature in a sonogram, however, is distinct enough for a human to pick it out visually, giving us confidence that our manual scanning protocol will allow for analyzing this species if automation fails. Current recognizers do well at detecting Mink Frogs (low false absences), but have a very high false positive rate in our informal testing. We continue to work on recognizer development for this species. For American Bullfrog, we have not yet obtained sufficient training samples. However, the call is fairly distinct, so we anticipate being able to develop a recognizer once we have more data. This species call is also visually detectable in sonograms and our manual scanning protocol will allow for analyzing this species if automation fails. For the remaining species (Fowler's Toad, Blanchard's Cricket Frog, Pickerel Frog and Cope's Gray Treefrog) we have no training samples and the prospects for recognizer development remain

unknown. However, as mentioned above, we expect to be able to develop a Fowler's Toad recognizer by restricting our American Toad recognizer to only higher frequencies. The same technique may succeed to differentiate Pickerel and Northern Leopard frog calls. How well Blanchard's Cricket Frog and Cope's Gray Treefrog calls can be differentiated from similar species and background noise remains to be determined. We are working with Trout Unlimited to obtain Blanchard's Cricket Frog samples from southwestern Wisconsin in 2014. In summary, any species for which adequate recognizers are not available still have strong potential for being adequately sampled by our manual scanning protocol.

2.3 Data Analysis

Species detected at each site by each method are detailed in Table 7, along a metric for evaluating detection success at each sampling site (detection rate). Note that the detection rate assumes that any species known to occur in a park could be present in any wetland, regardless of wetland type. In future, detection rates should be evaluated by wetland type, so that, for example, American Bullfrog is not assumed to breed in ephemeral wetlands.

2.3.1 Species With Recognizers

Appendix D provides recognizer outputs.

2.3.2 False Presence Rates

False presence rates for the automated recognizer detections are presented in Table 8. These values can be used to select false presence constants for modeling. Note that these detections were from the reduced data set as described in Section 1.3.1. False presences would be higher if data were not reduced to ensure the highest detection probabilities (best sampling protocol). Since the data reduction also removed same-date duplicates, this resulted in lower sample size for this exercise in some instances. We may add more detections by using additional same-date duplicates and confirm these as well to increase confidence in a false presence constant (e.g., for Gray Treefrog). However, these numbers are also expected to become more robust with next year's data, assuming equipment failures are resolved.

The confirmed data set, which was produced by our manual scanning procedure, can also be used as a second high "certainty" survey sample set with false presences being zero. Used in this manner a false presence constant need not be used and the model can determine occupancy probability adjusted for false presence likelihood (Miller et al. 2013).

2.3.3 Species Without Recognizers

The results of our manual scanning are provided in Table 7 and Appendix B. In general, this exercise went quite smoothly and quickly, and we have high confidence in it. Visual recognition of call patterns is quickly learned and files can be processed in very little time (roughly <2 min. per sample). The technique returns no false presences, as every first or questionable detection is verified by a second observer. Manual scanning is feasible as a technique for monitoring species where automated detection is not yet developed.

Table 8: False presence rates

Park	Species	N Sites With Detections	N Random Detections Evaluated	N Correct	False Presence Rate
INDU	Spring Peeper	7	64	62	0.031
PIRO	Spring Peeper	10	100	98	0.020
PIRO	Gray Treefrog	5	20	19	0.050
PIRO	Am. Toad	7	57	55	0.035
PIRO	Green Frog	5	50	38	0.240
SLBE	Spring Peeper	3	29	27	0.069
SLBE	Gray Treefrog	2	6	6	0.000
SLBE	Am. Toad	2	13	11	0.154
SLBE	Green Frog	3	22	15	0.318
Combined	Spring Peeper	20	193	187	0.031
Combined	Gray Treefrog	7	26	25	0.038
Combined	Am. Toad	9	70	66	0.057
Combined	Green Frog	8	72	53	0.264

Table 7: Detection Results by Site

Site	N Days	N	WF	WCF	BCF	SP	NLF	PF	AT	FT	GT	CGT	BCF	GF	MF	AB	N Sp. Possible	N Sp. Detected	Detection Rate
INDU01	2	10			A			X	X	X	X	X	X	X	A	X	12	0	0
INDU02	2	10			A			X	X	X	X	X	X	X	A	X	12	0	0
INDU03	28	140		M	A	R							X	X	A	X	12	2	0.17
INDU04	0	0	X	X	A	X	X	X	X	X	X	X	X	X	A	X	12	0	NA
INDU05	11	55			A	R				X	X	X	X	X	A	X	12	1	0.08
INDU06	11	55			A	R				X	X	X	X	X	A	X	12	1	0.08
INDU07	8	40		M	A	R				X	X	X	X	X	A	X	12	2	0.17
INDU08	7	35			A	R				X	X	X	X	X	A	X	12	1	0.08
INDU09	7	35		M	A	R				X	X	X	X	X	A	X	12	2	0.17
INDU10	7	35		M	A	R				X	X	X	X	X	A	X	12	2	0.17
PIRO01	34	170	X	A	X	R		A	R	A		A	A		A		8	2	0.25
PIRO02	73	365	X	A	X	R		A	R	A		A	A	R	A		8	3	0.38
PIRO03	5	25	M	A	X	R		A		A		A	A		A		8	2	0.25
PIRO04	8	40	M	A	X	R		A		A		A	A		A		8	2	0.25
PIRO05	10	50	X	A	X	R		A	R	A		A	A	R	A		8	3	0.38
PIRO06	22	110	M	A	X	R		A		A		A	A		A		8	2	0.25
PIRO07	32	160	X	A	X	R		A		A	R	A	A	R	A		8	3	0.38
PIRO08	17	85	X	A	X	R		A	R	A	R	A	A	R	A		8	4	0.50
PIRO09	27	135	X	A	X	R		A	R	A	R	A	A	R	A		8	4	0.50
PIRO10	65	325	X	A	X	R		A	R	A	R	A	A	R	A		8	4	0.50
SLBE01	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA
SLBE02	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA
SLBE03	5	25	X	X	A	R				A	R	A	A	X	A	X	9	2	0.22
SLBE04	14	70	X	X	A		X	X	X	A	X	A	A	R	A		9	1	0.11
SLBE05	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA
SLBE06	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA
SLBE07	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA
SLBE08	5	25	X	X	A	R			R	A		A	A	R	A	X	9	3	0.33
SLBE09	26	130	X	X	A	R			R	A	R	A	A	R	A		9	4	0.44

Table 7: Detection Results by Site

Site	N Days	N	WF	WCF	BCF	SP	NLF	PF	AT	FT	GT	CGT	BCF	GF	MF	AB	N Sp. Possible	N Sp. Detected	Detection Rate
SLBE10	0	0	X	X	A	X	X	X	X	A	X	A	A	X	A	X	9	0	NA

Grayed out cells (Category X) are non-meaningful results and should be ignored. Blank cells mean that no detections were obtained by any method. WF = Wood Frog, WCF = Western Chorus Frog, BCF = Boreal Chorus Frog, SP = Spring Peeper, NLF = Northern Leopard Frog, PF = Pickerel Frog, AT = American Toad, FT = Fowler's Toad, GT = Gray Treefrog, CGT = Cope's Gray Treefrog, BCF = Blanchard's Cricket Frog, GF = Green Frog, MF = Mink Frog, AB = American Bullfrog. R = Detected by recognizers, M = Detected by manual scan, X = No valid samples were obtained during species breeding season, A = Considered absent from park and not detected by any method, N Days = Total number of valid days sampled, N = Total number of valid samples for site in 2013 (N days X 5 samples per day and no later than July 31). Note that N Species Possible does not account for wetland type and assumes all species known from a park could be present in any wetland

3. Discussion

Data collection issues were encountered in 2013, and sample sizes obtained were lower than planned (Table 6). At SLBE some Song Meters failed to start at all. At INDU many units stopped recording prematurely, which may also be related to incompatible SD cards and/or battery failures. At PIRO the higher sampling rate was probably the result of different programming on the SET files uploaded to the units, while units that stopped recording prematurely most likely experienced battery failures. These equipment problems are under investigation by the Network and hopefully will be resolved for 2014 sampling. We recommend programming SET files to record from 1200h to 0300h, to extend the after sunset sampling somewhat.

To speed up manual scanning, we may consider eliminating scanning of ephemeral wetlands for late season callers that only breed in wetlands/lakes with long hydroperiods (Green Frog, Mink Frog, American Bullfrog). Equipment failures experienced in 2013 need to be resolved. Currently, incompatible SD cards are suspected. We suggest investigating whether or not the INDU programming can be adjusted to avoid train schedules, to avoid train noise that reduced the quality of recordings. We also recommend that a botanical description of each permanent sampling site be completed, at minimum describing dominant plant species and communities, and photo documenting conditions, every 5-10 years. A wetland monitoring SOP is currently in development under the Amphibian Monitoring Protocol to address this recommendation.

Song Scope version 4 has been released and has a new capability termed "Sound Scape". This is described in the manual as follows.

"A Song Scape can be described as a spectrogram on a large time scale. Instead of looking at individual vocalizations as they appear in small time scales measured in seconds, a Song Scape lets you view the frequency spectrum over a large time scale measured in days, months, and even years at time. This powerful visualization makes it possible to observe phenological events, such as what time of year specific frog species begin to vocalize, and what time of night they are most active. A Song Scape can also help locate interesting acoustic events, such as a change in the composition of the dawn chorus, by looking at thousands of recordings simultaneously. You can then zoom in on an individual recording and observe the specific vocalizations that contributed to the change. Song Scapes are embodied by a Song Scape Summary (.sss) file and are organized into discrete time periods (e.g. hourly). For each time period, the summary file contains spectral information such as minimum, maximum, average, and the standard deviation of power levels for each of several frequency bands."

We suspect that USGS is planning to utilize a Song Scape analysis in some capacity at SACN and VOYA. However, how it will be used for monitoring (what parameters are monitored and how) remains unclear. Nevertheless, as we purchase new licenses for our use of Song Scope, this capability will become available for our sampling, and may yield additional insights worth pursuing.

A new version of the Song Meter (SM3) has been released as of this writing. These units have improved battery life and programming capabilities, and significant design improvements for durability and ease of mounting. They also have built in microphones which may require less frequent maintenance and replacement. We may recommend transitioning to the SM3 platform in the future, as replacement units are needed. However, the SM3 platform will require new programming files to be developed (they cannot read SET files developed for the SM2 platform), and SOP revisions to address the SM3 platform specifics (particularly SOP 4 Automated Recording Systems).

4. Literature Cited

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5. Appendices

- Appendix A - Example sonograms to aid in visual scanning
- Appendix B - Manual Scan Data Sheets (Excel files)
- Appendix C - Sunset times (PDF files)
- Appendix D - Provides recognizer outputs (Excel files)