



Great Lakes Network Amphibian Monitoring

Initial Synthesis Report, 2013–2016

Natural Resource Report NPS/GLKN/NRR—2019/1955



ON THE COVER

Gray Treefrog, Pictured Rocks National Lakeshore.

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Abstract

- The probability models for all amphibian species from 2013 through 2016 indicate that species' occupancy of monitored wetlands was stable or increasing, with relatively low turnover among sites. We caution however that these are currently relatively short-term data, with only two years of data available for some parks.
- The program meets its primary objective by achieving near perfect detection for most species in the Great Lakes Inventory and Monitoring Network. The high detection probabilities strongly suggest that there are very few false absences in the data. False presence rates by the automated recognition process varied across species but were overall very low, and were zero for site occupancy (due to manual proofing). Similarly, false positives for site occupancy are eliminated in the double-observer manual surveys.
- Success of automated recognition varied by species, but was successful for most species and allows for the efficient analysis of very large data sets (>150 samples per site per year).
- A protocol for manual surveys of spectrograms was developed that allows for efficient and accurate sampling of a 5-minute recording in approximately 2 minutes. This protocol provides robust data on 30 samples per site per year, including scoring of call index values (CIV) as a proxy for tracking population size.
- There is potential to increase the program sensitivity by utilizing CIV ranks in proportional trend analyses. This will allow for discovery of site-specific ongoing declines (or increases), whereas occupancy trend analyses only detect declines when species have already disappeared from multiple sites.
- An amphibian occupancy record for each monitored site is now established (Appendix C), and will continue to grow in value with annual additions.
- The State Endangered Blanchard's Cricket Frog was discovered at MISS and represents three new county records and an opportunity to better manage for this species. Interesting absences of Spring Peeper at MISS and Northern Leopard Frog at ISRO and PIRO are reported. Other species that appear rare or absent at specific parks are discussed in Appendix C.
- We strongly recommend that ARS be deployed in autumn on delayed start programs for the following spring, in most parks where early spring visits are logistically difficult or impossible due to weather. This will eliminate a persistent problem of deployments too late to track early calling species. This should greatly improve several aspects of data analysis and better meet program goals. We also recommend that early morning sampling be implemented at four parks, (APIS, GRPO, ISRO, PIRO), to improve Mink Frog detection. This is simply a programming upgrade, with some extra effort for data analyses, but a pilot study suggests this will double Mink Frog detection rates.

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Introduction

This report synthesizes results for the first four years of amphibian monitoring by the National Park Service, Great Lakes Inventory and Monitoring Network (GLKN). A written protocol documents methods (Casper et al. 2018) and annual reports provide additional detail on program development. The GLKN selected permanent monitoring stations at 10 wetlands in each of six national parks, and six stations in a seventh park, for acoustic monitoring using Automated Recording Systems (ARS) beginning in 2013 (see Casper et al. 2018 for brand and model information). Monitoring at parks was established in a staggered fashion over three years, per the schedule below, for a total of 66 sites established in 2015.

We analyzed the acoustic data by two methods. First, data were “auto-scanned” by passing through “recognizers” (customized software algorithms developed to recognize acoustic signatures for most species) and output was proofed to produce auto-detection results (proofing involves manually verifying auto-detection results by examining spectrograms with audio playback). Second, data were “manually scanned” by selecting 30 samples from each site for an observer to visually and acoustically examine and determine the species detected, with results proofed by a second observer. We began recording Call Index Values in 2016 (defined below). These combined analyses allow us to detect the amphibian species that call at each site in each year with high confidence.

Establishment Schedule

2013 – 30 sites established: Ten each at Indiana Dunes National Park (INDU), Pictured Rocks National Lakeshore (PIRO), and Sleeping Bear Dunes National Lakeshore (SLBE).

2014 – 20 sites established: Ten each at Apostle Islands National Lakeshore (APIS) and Mississippi National River and Recreation Area (MISS).

2015 – 16 sites established: Ten at Isle Royale National Park (ISRO) and six at Grand Portage National Monument (GRPO).

As discussed in Casper et al. (2018) Standard Operating Procedure (SOP) 7, annual occupancy data should be analyzed at least every five years to assess trends in species metrics through time. 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 undergo statistically significant change. Environmental parameters such as precipitation, snow cover, or frost depth may also be used as covariates in occupancy analyses. These covariate analyses will require additional years of amphibian occupancy data (and covariate data) and are not addressed in this pilot analysis with so few years of data available.

SOP #7 was revised in 2016 to add goals for assessing phenology and Call Index Values (CIV; Mossman et al. 1998). For phenology, the goal is to track if the date of species’ first calling activity changes over time. It is expected that this metric will be associated with changing climate conditions, and may be informative in explaining any changes in occupancy trend over time. CIV is a measure of calling activity (a rank estimate of the number of calling males). The goal of tracking CIV is to assess

variation in the number of calling males over time as a proxy for changes in population size trends across years, or among sites. This is accomplished by tracking the maximum call intensity determined in each year (this metric aligns with state amphibian call survey objectives). Because this is the first year of analysis of this metric, Appendix A provides descriptive and exploratory statistics to evaluate the feasibility of this metric.

In this synthesis, we provide an analysis of the first four years of data, from 2013 through 2016. Because this period represents the establishment of the monitoring program, the number of sites and consistency of the data varied among years with full implementation in all seven parks not achieved until 2015. Since trends over only a few years are not likely to be very meaningful, this initial report is intended as a demonstration of how data can be analyzed for trends in site occupancy over time, and to demonstrate how phenology and call index values can be tracked. We recommend that covariate analyses begin after 10 years of data are accumulated, as this period of time represents a typical drought cycle in the region, thought to affect natural amphibian population variation (Lannoo 1998).

Methods

See Casper et al. (2018) for details on site selection and field data collection procedures. Below we present the analytical procedures for examining the resulting data.

Phenology

To document amphibian calling phenology we examined all auto-detection and manual scan results from 2013 through 2016, and identified the first detection of each species at each site in each year. We transformed calendar dates to Julian dates for analyses, expressed as the number of days from 1 January. At some sites/dates, ambient air temperature data were also collected with data loggers and are included where available.

Call Index Value Analysis

Call Index Values (CIV) are categorical estimates of the number of calling frogs as determined by observers performing manual scans. As described in SOP 7, a set of 30 samples are selected from each site and spectrograms examined for call activity. When calls are observed, they are played back acoustically and the observer assigns the maximum CIV for each species in the sample. A second observer then verifies the species determination and CIV and consults with first observer on any differences for concurrence (if the two observers cannot agree, a third observer breaks the tie). Call Index Values are only available for the 2016 manual scans.

CIVs are defined as follows:

0 = No calls detected.

1 = Individuals of the species can be counted; there is silence between calls.

2 = Calls of individuals can be distinguished, but there is some overlapping of calls.

3 = Full chorus for the species. Calls are constant, continuous, and overlapping.

Detection and Occupancy Modeling

We analyzed the detection–non-detection data from automated audio recorders and a manually-validated subset of these recordings to account for imperfect detection (false negatives) and false positives from the automated recognizer software using a modification of the methods of Chambert et al. (2017). Our modifications were based on Chambert et al.’s (2017) model S1 (which consists of only the first two processes of model *G*, the occupancy process and the binomial detection process), and included: 1) expanding the model from a static occupancy to a dynamic occupancy model to account for changes in occupancy across years; 2) expanding the model to a multi-species occupancy model to allow sharing of occupancy and detection (though not false positive) information across species, improving inference for rarely detected species; 3) adding a hierarchical occupancy process that accounted for regional patterns in occupancy, whereby occurrence at a site was conditional on a species occurring in the park; 4) adding effects of site type (ephemeral, semi-permanent, and permanent) on initial conditional probability of occurrence (ψ_1 ; probability that a breeding site was occupied in 2013, given that the species was present in the park containing the breeding site), persistence probability (ϕ ; probability that a site occupied in year $t - 1$ remains occupied in year t) and colonization probability (γ ; probability that a site unoccupied in year $t - 1$ becomes occupied in

year t); and 5) adding effects of time of year as a covariate to allow for variability in the seasonality of calling of different species. As in Chambert et al. (2017), we pooled detections by week (7 days) to increase the efficiency of the analysis. We are currently developing Chambert et al.'s (2017) model G into a dynamic multi-species occupancy model as above, which we intend to use for inference in future analyses as it makes better use of combined automated detections and manually validated data at the sample level, rather than the site level.

In our current model structure, the detection of species X does not affect detection of species Y. Instead, the probability of detection of species X can inform the probability of detection of species Y based on the assumption that the detection probability of all pond-breeding amphibians in the analysis are distributed normally with a mean and variance estimated across all species. If data are rich for species Y (high occurrence and detectability), species X (and all other species) will have little to no effect on the estimates for species Y. If data are sparse for species Y (few detections), then information from all other species inform the distribution from which the detection of species Y is a sample, and the estimate will be pulled slightly toward the mean (this is called shrinkage). This does two things: 1) allows the estimation of parameters that otherwise couldn't be estimated, and 2) constrains these parameter estimates to realistic values.

We conducted the analysis of model S1 using Markov-chain Monte Carlo (MCMC) methods typical for Bayesian inference. We selected all priors to be uninformative, with $\text{beta}(1, 1)$ priors for probabilities, normal (mean = 0, sd = 3.2) priors for model coefficients, and half-Cauchy(1) priors for standard deviations describing the logit-scale variation among species in mean probability of occurrence, colonization probability, probability of persistence, variation in the linear and quadratic effects of date, and the effect of year on detection probability. We analyzed the model by calling JAGS 4.3.0 (Plummer 2015) from R 3.4.0 (R Core Team 2016) using the package “runjags” (Denwood 2016). We ran the model on five independent chains of 20,000 iterations each after a burn-in of 5,000 iterations, then thinned the output by a factor of 10 so posterior inference was based on 10,000 samples. Unless otherwise indicated, we summarize posterior distributions as median (95% credible interval).

Results

Phenology

Phenology data are presented in Appendix B. For each park the earliest calling date for each species in each year is provided along with ambient air temperature for that sample (if available).

Deployment dates for each ARS are also provided. For early calling species (Wood Frog, Spring Peeper, Chorus Frog spp., and Northern Leopard Frog) first detections were often the same or within a few days of when the ARS was deployed. Since any site had at most only four years of data, no further analysis was performed as no statistical significance is expected with these sample sizes.

Table 1 provides the minimum air temperature for which calling was confirmed for each species/species group.

Table 1. Minimum air temperature recorded for verified calls of 11 species or species group.

Common Name	Scientific Name	Temp(F)
Spring Peeper	<i>Pseudacris crucifer</i>	21.7
Northern Leopard Frog	<i>Lithobates pipiens</i>	25.4
Western Chorus Frog	<i>Pseudacris triseriata</i>	26.7
Wood Frog	<i>Lithobates sylvaticus</i>	27.1
Eastern American Toad	<i>Anaxyrus americanus</i>	27.5
Green Frog	<i>Lithobates clamitans</i>	29.2
Chorus Frog spp.	<i>Pseudacris maculata/triseriata</i>	32.2
Treefrog spp.	<i>Hyla spp.</i>	40.9
Gray Treefrog	<i>Hyla versicolor</i>	43.6
American Bullfrog	<i>Lithobates catesbeianus</i>	53.6
Blanchard's Cricket Frog	<i>Acris blanchardi</i>	58.5

Call Index Value Analysis

Appendix A provides an analysis of results for CIV scoring. In sum, the probability of detecting the maximum CIV in 30 samples varied considerably among sites and species, and is influenced by weather conditions and population size. The proportion of sites in each CIV rank, and how that proportion changes within a site across years, were developed as metrics for tracking trends in population size. The distribution of CIV scores for all species analyzed in 2016 is shown in Table 2.

Table 2. Summary of maximum CIV for occupied sites sampled in 2016.

Parameter	Species ¹											
	ACBL	ANAM	HYCH	HYVE	LICA	LICL	LIPI	LISE	LISY	PSCR	PSMA	PSTR
CIV=1	0	10	2	10	3	17	3	3	5	6	3	1
CIV=2	0	19	2	11	1	22	4	0	3	5	1	1
CIV=3	1	8	0	20	1	8	2	1	10	40	2	0
N Sites	1	37	4	41	5	47	9	4	18	51	6	2
Percent CIV=1	0.00%	27.03%	50.00%	24.39%	60.00%	36.17%	33.33%	75.00%	27.78%	11.76%	50.00%	50.00%
Percent CIV=2	0.00%	51.35%	50.00%	26.83%	20.00%	46.81%	44.44%	0.00%	16.67%	9.80%	16.67%	50.00%
Percent CIV=3	100.00%	21.62%	0.00%	48.78%	20.00%	17.02%	22.22%	25.00%	55.56%	78.43%	33.33%	0.00%

¹ Species Codes: ACBL – Blanchard's Cricket Frog (*Acris blanchardi*), ANAM – American Toad (*Anaxyrus americanus*), HYCH – Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE – Gray Treefrog (*Hyla versicolor*), LICA – American Bullfrog (*Lithobates catesbeianus*), LICL – Green Frog (*Lithobates clamitans*), LIPI – Northern Leopard Frog (*Lithobates pipiens*), LISE – Mink Frog (*Lithobates septentrionalis*), LISY – Wood Frog (*Lithobates sylvaticus*), PSCR – Spring Peeper (*Pseudacris crucifer*), PSMA – Boreal Chorus Frog (*Pseudacris maculata*), PSTR – Western Chorus Frog (*Pseudacris triseriata*).

Modeling

Considering all seven parks combined, the probability of occurrence varied greatly among species, but nearly all species increased in their conditional probability of occurrence from 2013 through 2016 (Figure 1). This is most likely a result of increasing sample size and better adherence to protocol as the program got up and running over this period. American Toad and Green Frog were estimated to occur in all parks, with conditional probabilities of occurrence of 0.83 (0.74–0.90) and 0.78 (0.68–0.86), respectively, in 2016. Within the six parks where they occurred, Spring Peeper was also very widespread, occurring at 96% (90%–99%) of breeding sites within these parks in 2016. The least widespread species were Blanchard’s Cricket Frog—estimated to occur in one park (MISS) and found only at 17% (3%–43%) of sites within that park in 2016—and American Bullfrog, estimated to occur in one park (INDU) and found at 41% (16%–66%) of sites within that park in 2016.

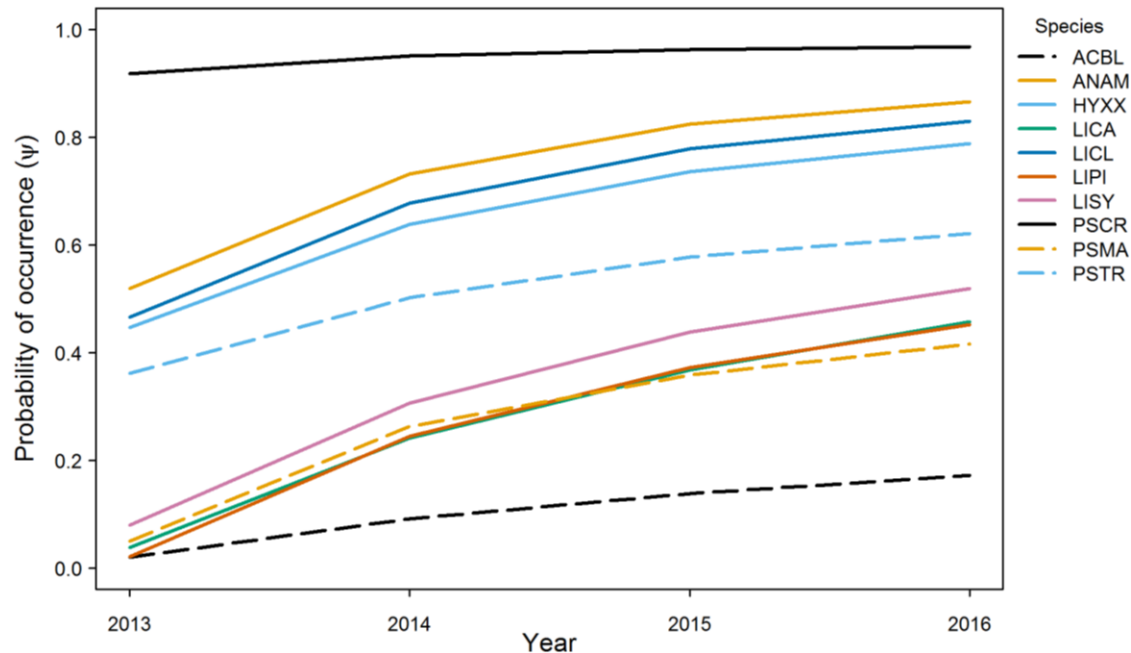


Figure 1. Probability of occurrence (ψ) of anurans at breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016, conditional on a park being occupied by the species. Lines indicate posterior medians; credible intervals are omitted for clarity. ACBL = Blanchard’s Cricket Frog, ANAM = American Toad, HYCH = Cope’s Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

Conditional initial probability of occurrence of the “average” anuran did not vary among ephemeral, semi-permanent, and permanent sites, and although species varied in their initial probability of occurrence at sites with different hydroperiods, most differences were not significant at the 95% credible level (Figure 2). Nonetheless, the probability that Wood Frog was more likely to occur in ephemeral than permanent sites was 0.97, whereas the probabilities that American Toad, Green Frog, and Western Chorus Frog were more likely to occur in permanent than ephemeral sites were >0.99 ,

0.97, and 0.95, respectively (Figure 2). Initial probability of occurrence did not differ between semi-permanent and ephemeral or permanent sites for any species.

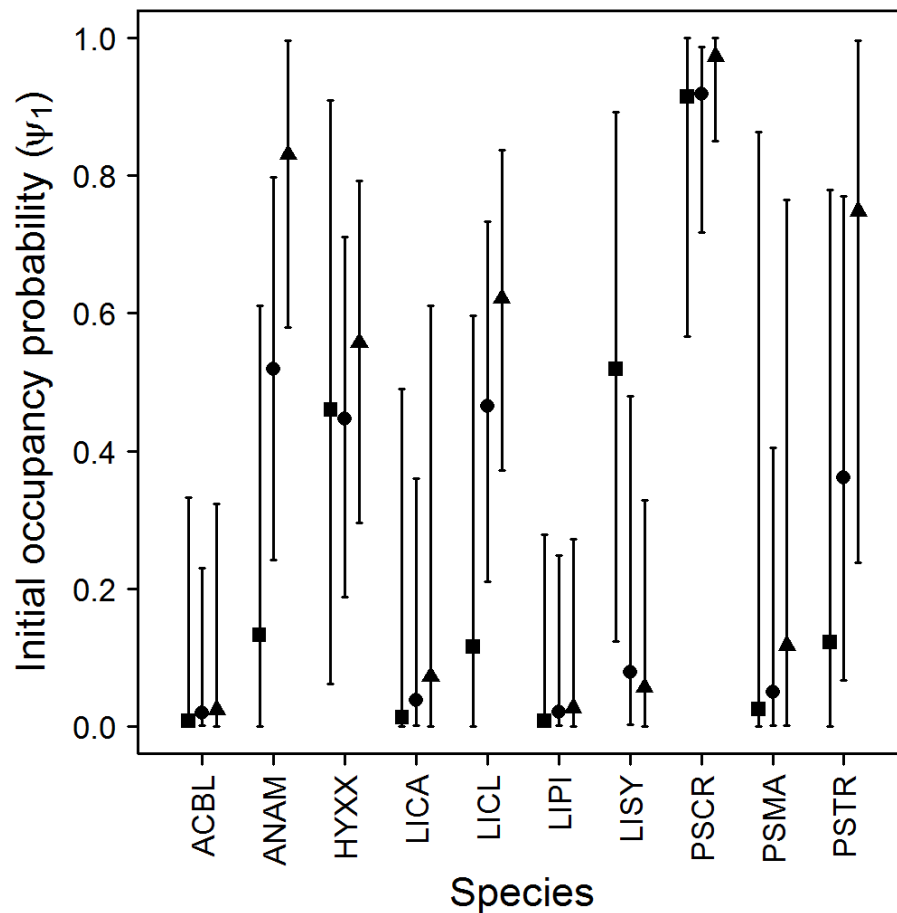


Figure 2. Initial conditional probability of occurrence (ψ_1 ; probability that a breeding site was occupied in 2013, given that the species was present in the park containing the breeding site) of anurans at ephemeral (squares), semi-permanent (circles), and permanent (triangles) breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013. Symbols indicate posterior medians; error bars indicate 95% credible intervals. ACBL = Blanchard's Cricket Frog, ANAM = American Toad, HYCH = Cope's Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

All species persisted at occupied sites with high probability (all >0.8 ; Figure 3). Stated another way, we estimated a 20% chance that a species known to occur at a site became extirpated from that site over the four year period. Hydroperiod had little effect on probabilities of persistence (Figure 3). Median probability of colonizing a new site was <0.5 for all species combined (Figure 4). As with persistence probabilities, hydroperiod had little effect on probabilities of colonization (Figure 4). Combining the persistence and colonization analyses suggests the probability of occurrence from 2013 through 2016 remained stable or increased for most species, with relatively little turnover.

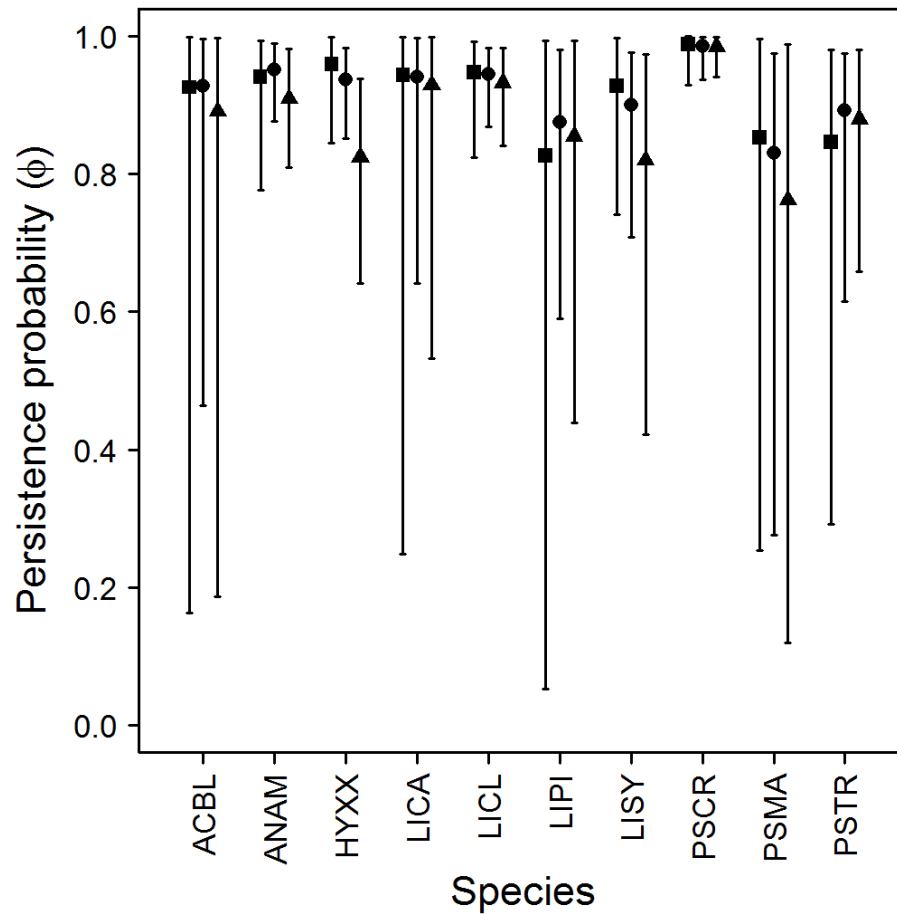


Figure 3. Persistence probability (ϕ ; probability that a site occupied in year $t - 1$ remains occupied in year t) of anurans at ephemeral (squares), semi-permanent (circles), and permanent (triangles) breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016. Symbols indicate posterior medians; error bars indicate 95% credible intervals. ACBL = Blanchard's Cricket Frog, ANAM = American Toad, HYCH = Cope's Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

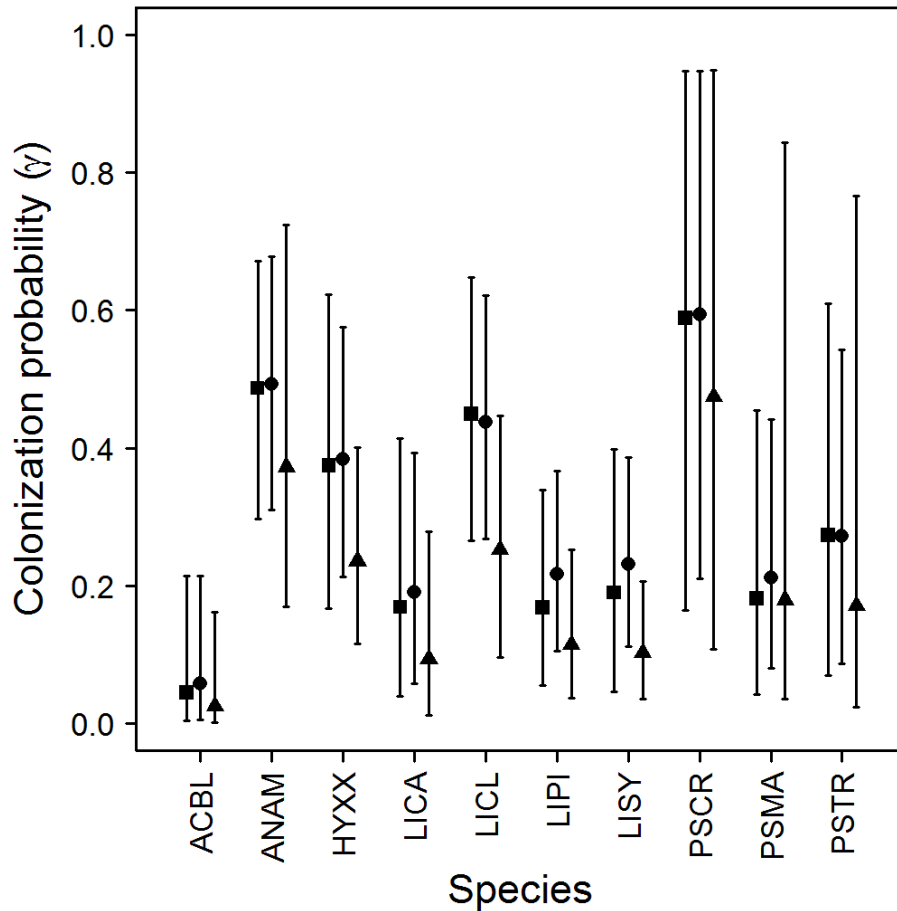


Figure 4. Colonization probability (γ ; probability that a site unoccupied in year $t - 1$ becomes occupied in year t) of anurans at ephemeral (squares), semi-permanent (circles), and permanent (triangles) breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016. Symbols indicate posterior medians; error bars indicate 95% credible intervals. ACBL = Blanchard’s Cricket Frog, ANAM = American Toad, HYCH = Cope’s Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

Patterns in the seasonality of detection probability were as expected (Figure 5). Wood Frog detection probabilities peaked earliest in the year (around late March), and Green Frog, American Bullfrog, and Blanchard’s Cricket Frog detection probabilities peaked latest in the year (around early July). Peak weekly detection probabilities were highest for Spring Peeper (0.93 [0.91–0.94]) and lowest for Northern Leopard Frog (0.44 [0.32–0.56]; Figure 5). Cumulative detection probabilities (the chance of at least one detection across the entire annual sampling period) were >0.99 for all species except Northern Leopard Frog, which had a cumulative detection probability of 0.96 (0.89–0.99; Figure 6). This high detection probability strongly suggests that there are very few false absences in trend data collected in this monitoring effort.

Site-level false positive detection rates by the automated recognition process varied across species, but were very low (all posterior medians <0.002 ; all upper credible limits <0.01 ; Figure 7). Sample-

level false positive probabilities were undoubtedly higher, but will require a different model for estimation, which we have not yet constructed.

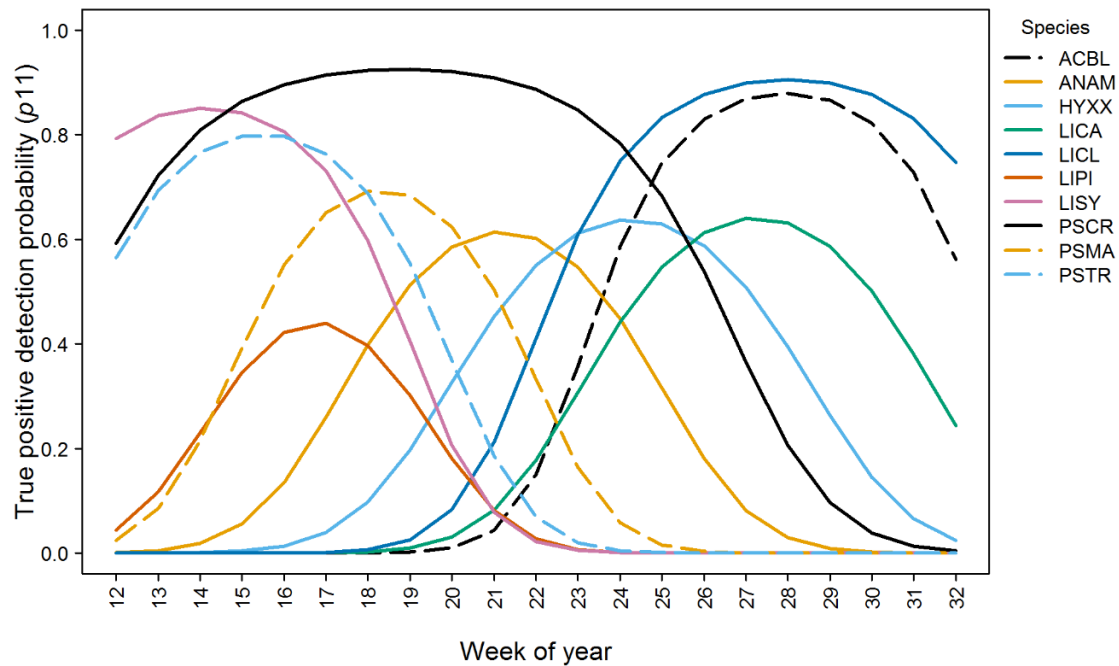


Figure 5. True positive weekly probability of detection (p_{11}) of anurans at breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016. Lines indicate posterior medians; credible intervals are omitted for clarity. ACBL = Blanchard's Cricket Frog, ANAM = American Toad, HYCH = Cope's Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

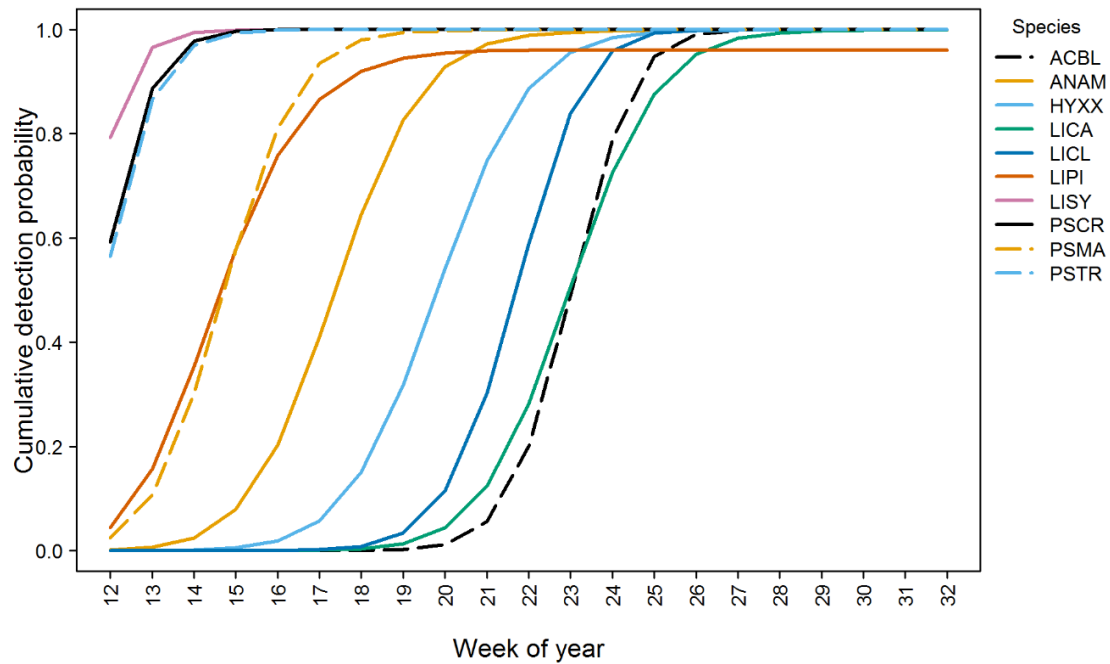


Figure 6. Cumulative probability of detection of anurans at breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016. Lines indicate posterior medians; credible intervals are omitted for clarity. ACBL = Blanchard's Cricket Frog, ANAM = American Toad, HYCH = Cope's Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

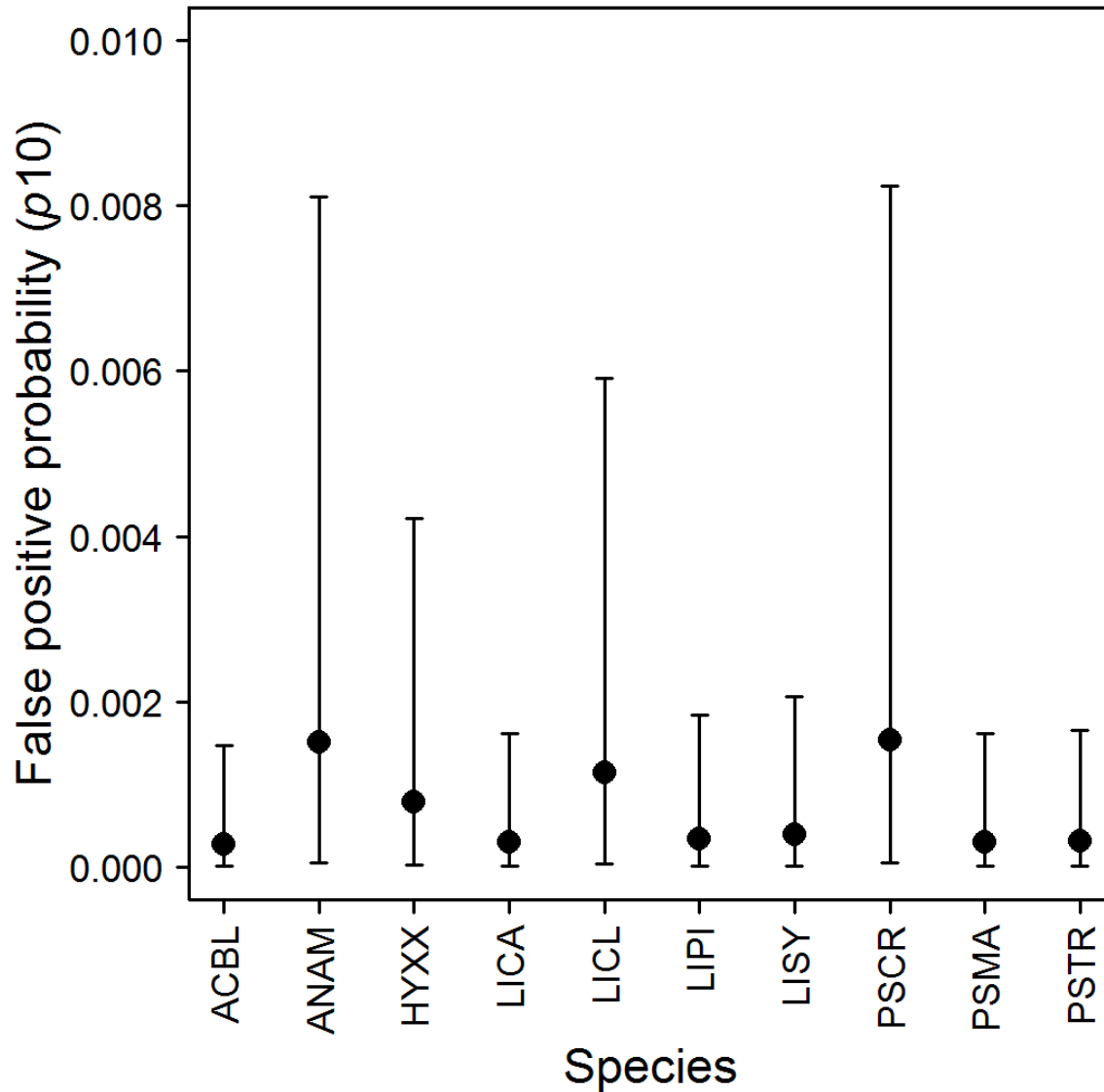


Figure 7. Probability of false positive detections (p_{10}) at the site level for anurans at breeding sites in Great Lakes Inventory and Monitoring Network parks, 2013–2016. Dots indicate posterior medians; error bars indicate 95% credible intervals. ACBL = Blanchard's Cricket Frog, ANAM = American Toad, HYCH = Cope's Gray Treefrog, HYVE = Gray Treefrog, LICA = American Bullfrog, LICL = Green Frog, LIPI = Northern Leopard Frog, LISE = Mink Frog, LISY = Wood Frog, PSCR = Spring Peeper, PSMA = Boreal Chorus Frog, PSTR = Western Chorus Frog.

Discussion

Phenology

Phenology data may become an informative metric of change over time, especially if recommendations for improving data collection are adopted. Appendix B can be updated annually and used for future analysis. When a longer duration dataset is available, these data may also be compared to other phenology data sets such as State frog call surveys, plant phenology data, and weather data.

We report some surprisingly low ambient air temperatures for species calling (i.e., 29.2°F for Green Frog), although little has been reported on minimum calling temperatures. At this time we suspect many of the temperatures reported in Table 1 are outliers, resulting from temperature differences between the temperature logger, which is exposed to the air and shaded, and the aquatic microhabitat calling frogs actually occupy. In particular, sun warmed surface waters can create temperature conditions many degrees warmer than the shaded air temperature. Currently we eliminate recordings below 40°F from analyses, which may be re-assessed in the future with more robust temperature data. Water temperature may also be informative but was ruled out as logistically infeasible for automated monitoring, due to both complexity of the equipment, and wide variation in the water temperatures within the same water body due to shading and wave action.

Call Index Value Analysis

This metric has potential for providing a more sensitive means of informing how populations are changing, as opposed to simply tracking occupancy without knowing if a population decline is underway. To assess this, we analyzed how the frequency of maximum CIVs (CIV^{max}) varies across years for each species, and we provide descriptive statistics on the probability of detecting the CIV^{max} , which is critical to the value of using CIV rank as a metric (see Appendix A). CIV rank has been used in some trend analyses of State-run calling frog programs to assess population trends (i.e., Mossman et al. 1998). Table 2 illustrates the frequency of sites occupied by populations in each CIV rank in 2016. How these proportions change across years is recommended as a metric for tracking trends in abundance. For example, the proportion of CIV=3 may significantly increase or decrease over time among occupied sites, which would suggest a decline in population levels. CIV analysis should be a useful supplement, and be related to, the site occupancy analysis results. Appendix A Table A4 summarizes the potential for using proportional CIV trends as a proxy for population change, with nine species considered to have potential for this metric at this time (Blanchard's Cricket Frog, American Toad, Cope's Gray Treefrog, Gray Treefrog, Green Frog, Wood Frog, Spring Peeper, Boreal Chorus Frog, and Western Chorus Frog). Additionally Mink Frog may have potential if detection rates improve with the recommended early morning sampling.

Modeling

Results from the dynamic multi-species occupancy model accounting for the possibility of false-positives at the site level were consistent with expectations. The probability of a false positive at the site level (i.e., a species detected at a site where it did not occur) was very low across all species; therefore, false positives likely had little effect on inferences about amphibian occurrence in the

parks and sites we analyzed. Weekly detection probabilities varied seasonally and differed among species as expected, but the probability of detecting most species over the course of the monitoring year was near 1.0. Species with less robust data that may be poorly modeled are Wood Frog, Northern Leopard Frog, and Mink Frog. For Wood Frog, this data deficiency is mainly due to ARS being deployed too late in the season, after Wood Frog calling has peaked (especially in logistically challenging parks). This problem is likely to be alleviated if parks switch to autumn deployment with a delayed start, in which case Wood Frog modeling should substantially improve.

For Northern Leopard Frog and Mink Frog, we suspect that data deficiencies are due to poor detection, with many false negatives (i.e., the species is there but we cannot easily detect it). For Northern Leopard Frog, automated detection does work but calls are frequently drowned out by other acoustic interference in this low frequency band (especially at urban parks), and their calling may be more frequent during daylight hours which are not analyzed owing to bird call interference.

For Mink Frog, the development of automated detection was not successful owing to the call signature being a subset of the Green Frog call. Its typically low volume and amplitude were also factors impeding automated detection. Mink Frog is limited in known occurrence to only four parks (APIS, GRPO, ISRO, PIRO), and calling may be more frequent during early morning and/or afternoon hours. Currently, samples are not taken during these hours; however, in analyzing early morning samples for bird song for another investigation at APIS, we did encounter Mink Frogs at much higher detection rates than were obtained from nighttime sampling (Casper, unpublished 2017 data). We therefore suspect that Mink Frog can be adequately monitored by manual surveys of acoustic samples between 02:00 and 06:00, and recommend that this additional effort be implemented at those four parks.

The probability of occurrence for all species from 2013 through 2016 suggest occupancy was stable or increasing, but these probabilities varied widely by species. Species near their range limits, such as American Bullfrog and Blanchard's Cricket Frog, were found in few parks and had low probabilities of occurrence, even within these parks. Other species, such as American Toad, Green Frog, and Spring Peeper, occurred in many parks and at a high proportion of sites within these parks. High persistence probabilities combined with relatively low colonization probabilities resulted in stable or slightly increasing probability of occurrence and relatively low turnover among sites. Stable or increasing trends were expected within protected habitats of these national parks over this short time period, during which precipitation, a variable positively associated with reproductive success, has been increasing (NOAA 2016).

Hydroperiod rank (ephemeral, semi-permanent, permanent) comparisons so far show little effect on probabilities of site persistence or colonization, with significant associations only in four species to date (Wood Frog, American Toad, Green Frog, and Western Chorus Frog). This is likely due to data deficiencies (most early calling species are poorly sampled to date), wetland habitat complexity poorly conforming to the ranks (with multiple hydroperiod microhabitats present at a single site), and possibly an effect of dispersion. In these large natural areas, with large amphibian populations, a saturation effect could be operating, where dispersing males may be calling at sites that are not actually suitable hydrologically for successful breeding. Calling males do not necessarily equate with

successful reproduction, and dispersing males may be attempting to colonize but failing. These are still recorded as present in the monitoring program, which cannot distinguish between successful and unsuccessful males. Hydroperiod as a covariate may become more informative as more data accumulate, especially if data collection begins earlier, and any questionable site ranks are corrected or verified.

Examining automated results only, in Table 3 we provide a matrix of probability of occurrence by park and species (proportion of iterations that the park indicator variable for each species was 1), as well as summaries (number of parks estimated to be occupied by each species, probability of occurrence at parks in the GLKN, and species richness by park). If any site is occupied, the park is considered occupied. Values <1.00 indicate the probability that the species might occur in the park, but is as yet undetected. This matrix can be compared to previous species by park matrices (in annual reporting) where only known occurrences were tabulated. Note that this analysis combines the two treefrog species and does not evaluate Mink Frog.

Table 3. Probability of occurrence by park (Psi; automated results only, confirmed occupancy bolded).

Park	Species ¹										Species Richness
	ACBL	ANAM	HYXX	LICA	LICL	LIPI	LISY	PSCR	PSMA	PSTR	
APIS	0.16	1.00	1.00	0.01	1.00	0.09	1.00	1.00	0.00	0.00	5.26
GRPO	0.22	1.00	1.00	0.03	1.00	0.47	0.54	1.00	0.03	0.04	5.32
INDU	0.17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	8.17
ISRO	0.18	1.00	0.00	0.01	1.00	0.52	0.67	1.00	1.00	0.15	5.53
MISS	1.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	6.01
PIRO	0.16	1.00	1.00	0.01	1.00	0.07	1.00	1.00	0.00	0.00	5.24
SLBE	0.16	1.00	1.00	0.01	1.00	1.00	1.00	1.00	0.00	0.00	6.17
N Occupied Parks	2.05	7.00	6.00	1.07	7.00	4.14	5.21	6.00	2.04	1.19	–
Psi_park	0.34	0.91	0.81	0.23	0.91	0.60	0.73	0.82	0.34	0.24	–

¹Species Codes: ACBL – Blanchard's Cricket Frog (*Acris blanchardi*), ANAM – American Toad (*Anaxyrus americanus*), HYXX – Gray Treefrog species (*Hyla* spp.), LICA – American Bullfrog (*Lithobates catesbeianus*), LICL – Green Frog (*Lithobates clamitans*), LIPI – Northern Leopard Frog (*Lithobates pipiens*), LISY – Wood Frog (*Lithobates sylvaticus*), PSCR – Spring Peeper (*Pseudacris crucifer*), PSMA – Boreal Chorus Frog (*Pseudacris maculata*), PSTR – Western Chorus Frog (*Pseudacris triseriata*).

Although the model was generally successful for describing patterns in site occupancy and detection of anurans, further model development is recommended. For example, the current model does not account for differences in abundance or other factors that could affect detection probabilities, but this could easily be added to the current model. Another simple extension would be to add effects of

additional covariates on the probability of occurrence or detection probability, such as precipitation or frost depth. The covariate data will need to be provided. Perhaps most importantly, expanding the model to mimic the structure of model G of Chambert et al. (2017) would make better use of the sample-level validation of data by expert listeners. In simulations, this model performed better at distinguishing true positive detections from false positive detections (Chambert et al. 2017).

Park Specific Findings

Summaries of site occupancy for each park are provided in Appendix C. In most parks a few early calling species are currently poorly detected, and a recommendation is made to implement a delayed start ARS deployment in autumn to improve detection of these species (Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog). Similarly, Mink Frog detection can be improved in several parks by implementing early morning sampling (APIS, ISRO, GRPO, PIRO). Most other species are being detected at excellent rates and the program will achieve goals. Rare species detected were Blanchard's Cricket Frog (MISS) and Cope's Gray Treefrog (APIS). Species not detected that are of interest are Blanchard's Cricket Frog and Fowler's Toad at INDU, Spring Peeper at MISS, Gray Treefrog at ISRO, and Northern Leopard Frog at ISRO and PIRO. Detection rates for Northern Leopard Frog should improve with delayed start ARS deployment in autumn. More years of sampling will better define if these species are declining. Adding additional ARS at MISS for Blanchard's Cricket Frog and at INDU for Fowler's Toad should also be considered to track these rare species at known sites.

Recommendations

Fall ARS Deployment

We recommend ARS be deployed in autumn or late winter on delayed start triggers in most parks, to ensure that early calling species are adequately monitored for phenology and better tracked in occupancy and CIV analyses. This will greatly improve metrics for Wood Frog, Spring Peeper, Chorus Frog spp., and Northern Leopard Frog. Urban parks such as INDU and MISS may not fit this recommendation as sites are more accessible and there are more security concerns.

Mink Frog Sampling

Based on success at doubling detection rates for Mink Frog through early morning sampling (Casper 2018), we recommend extending sampling at APIS, GRPO, ISRO, and PIRO to include samples at 4 a.m., 5 a.m., and 6 a.m., and adding these samples to analyses in June and July (with appropriate Protocol and SOP revision). Better tracking of this species is important, as it is expected to retract its range northward with ongoing climate change.

Consistent Temperature Logging

Consistency in collecting ambient air temperatures with Onset™ data loggers will improve the ability to assess this temperature as a covariate to calling phenology, and how it affects calling frequency across the season. We also recommend considering using degree-days data that are available from NOAA weather stations around each park ([ClimateAnalyzer.org](https://climateanalyzer.org)). While this is not site-specific, it would be interesting to see if these data would be more informative than ambient temperature in explaining phenology. All loggers should continue to be shielded from solar exposure.

CIV Analyses

We recommend continuing to score CIV values in manual surveys, and utilizing proportional trend analyses to assess site-specific population level trends when multiple years of data become available. How interpretation of CIV scores may vary by species should be addressed as well (i.e., CIV=3 is not directly comparable between species as an index of population abundance, but can be an indicator of population trend within species).

Model Development

As indicated above, we recommend further developing models, and incorporating CIV trends into analyses for the next synthesis.

Additional Site Monitoring

Establishing additional ARS should be considered to track Blanchard's Cricket Frog at MISS and Fowler's Toad at INDU at known occupied sites. These rare species sites were not selected in the stratified random site selection design, and better tracking of how these rare species are faring at the few sites they are known to occur can be important for park management objectives.

Hydroperiod Rankings

We recommend that hydroperiod rankings be reviewed/proofed for each site and adjusted if indicated. Where the ARS is within acoustic range of more than one hydroperiod additional rankings

should be considered (i.e., score each type as present or not at each site). The occupancy record may assist with this review, where obligate permanent or obligate ephemeral species are being consistently reported.

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Appendix A. Call Index Value analysis

Methods

Results for CIV scoring were obtained from 2016 manual surveys (Casper and Nadeau 2017), and Supplement A1 (see end of this appendix) provides the maximum values for 2016 call intensity (CIV^{max}) at each site monitored. To assess the value of this metric the probability of detecting CIV^{max} was calculated for the robustly sampled species at each occupied site (Table A1, Supplement A2 – available upon request). These data inform the discussion over how to proceed with CIV analysis, and are presented in two ways. First is the probability of recording CIV^{max} on all 30 surveys. Second, the number of samples between and including the first and last detections at each site was calculated as the sample size within a confirmed calling period, and the probability of recording CIV^{max} on that number of surveys is presented (when the species is assumed to be available for detection). Results for the less well detected are summarized for data deficient species in the following narrative, and the distribution of CIV^{max} is summarized for all species in Tables A2–A3, illustrating the variation in CIV^{max} among all sites, and among only occupied sites, respectively.

Table A1. CIV^{max} detection probabilities (DP) in 2016.

Species	N Occupied Sites	Average CIV^{max} DP with 30 samples	Average N Samples within Calling Period	Average CIV^{max} DP within Calling Period	Range CIV^{max} DP with 30 samples	Range CIV^{max} DP within Calling Period
American Toad	39	0.063	7.923	0.417	0.033–0.200	0.059–1.000
Gray Treefrog	43	0.108	11.279	0.395	0.033–0.333	0.043–1.000
Green Frog	49	0.141	16.592	0.315	0.033–0.500	0.033–1.000
No. Leopard Frog	8	0.046	3.250	0.646	0.033–0.067	0.167–1.000
Wood Frog	17	0.049	3.059	0.676	0.033–0.133	0.200–1.000
Spring Peeper	54	0.277	16.333	0.540	0.033–0.567	0.083–1.000

The remaining species were found at too few sites for robust analysis, but are summarized below. Many had results biased by a large proportion of sites having detections only on a single sample.

Results

Blanchard's Cricket Frog was detected in 2016 at only one site (MISS07), where the probability of CIV^{max} detection in all 30 samples was 0.267. Within the actual calling period (18 samples, 24 May to 28 July) the probability of CIV^{max} detection was 0.444. Detections were made on 18 of 30 manual surveys (60%) spanning the entire season, and on 100% of surveys conducted after the first detection date of 24 May. The frequency distribution of each CIV is illustrated in Figure A1 showing the 2016 data with detections for 18 samples. For comparison, 2015 data from this site was scored as well, where Blanchard's Cricket Frog was detected on 10 of 30 manual surveys (33%), again on 100% of

surveys conducted after the first detection date of 15 June. In 2014 it was detected at MISS04A on 2 of 30 manual surveys spanning the entire season (6.7%), and 50% of surveys conducted after the first detection date of 16 June. MISS04A appeared to have only a single calling male present, and independent sampling by ARS in 2015 found no Blanchard's Cricket Frogs there (the site was discontinued after 2014 as a GLKN site).

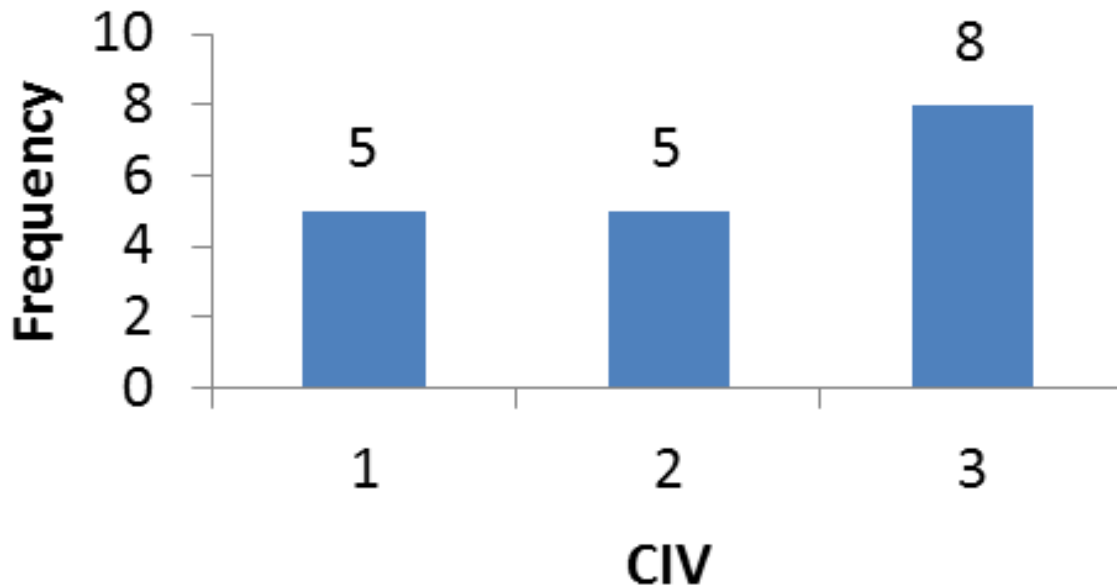


Figure A1. Blanchard's Cricket Frog CIV histogram showing how often CIV=3 was scored on 18 samples (MISS07, 2016).

Cope's Gray Treefrog was detected in 2016 at only two sites (MISS01, MISS09), where the probability of CIV^{max} detection in all 30 samples was 0.067 and 0.033, respectively. Within the actual calling periods (2 and 10 samples, 13 to 17 June and 20 May to 25 June, respectively) the probability of CIV^{max} detection was 1.000 and 0.100, respectively.

American Bullfrog was detected in 2016 at only four sites in one park (INDU03, INDU08, INDU09, INDU10), two of which had detections on only a single night (INDU03, INDU10). At INDU08 (CIV^{max} was 2) and INDU09 (CIV^{max} was 1), the probability of CIV^{max} detection in all 30 samples was 0.033 and 0.433, respectively; the actual calling period included 14 and 18 samples (5 June to 19 July, and 26 May to 29 July), respectively; and the probability of CIV^{max} detection was 0.071 and 0.722 during these calling periods, respectively.

Mink Frog was detected in 2016 at only three sites in two parks (GRPO01, ISRO02, ISRO03), two of which (ISRO02, ISRO03) had detections on only a single night. At GRPO01 (CIV^{max} was 1) the probability of CIV^{max} detection in all 30 samples was 0.133; the actual calling period included only 6 samples (6 to 16 July), within which the probability of CIV^{max} detection was much higher (0.667).

Boreal Chorus Frog was detected in 2016 at only five sites in one park (MISS03, MISS05, MISS06, MISS07, MISS08), three of which (MISS03, MISS06, MISS08) had detections on only a single

night; the probability of CIV^{max} detection in all 30 samples was 0.033. At MISS05 (CIV^{max} was 3) the probability of CIV^{max} detection in all 30 samples was 0.067; and was 0.182 during the actual calling period (11 samples, 31 March to 11 May). At MISS07 (CIV^{max} was 2) the probability of CIV^{max} detection in all 30 samples was 0.100; and was 1.00 during the actual calling period (3 samples, 30 April to 8 May).

Western Chorus Frog was detected in 2016 at only two sites in one park (INDU01, INDU04), one of which (INDU01) had detections on only a single night (probability of CIV^{max} detection in all 30 samples = 0.033). At INDU04 (CIV^{max} was 2) the probability of CIV^{max} detection in all 30 samples was 0.067; and was 0.143 during the actual calling period (14 samples, 10 April to 11 May).

Discussion

CIV has been used in some trend analyses of State-run calling frog programs (i.e., Mossman et al. 1998). From the data reviewed here, we recommend that how the frequency of maximum CIVs (CIV^{max}; i.e., the proportion of times the highest CIV is recorded among all samples at a site in a year) varies across years be utilized as a metric of change as additional years of data become available. We provide here descriptive statistics on the probability of detecting the CIV^{max}, in order to better assess this value as a metric. Table A2 illustrates the frequency of sites occupied by populations in each CIV rank in 2016. How these proportions change across years should be related to occupancy trends, with CIV frequencies declining in the lead up to non-occupancy. For example, if the proportion of CIV=3 significantly increases or decreases over time among occupied sites, this would suggest a change in population level, and would be a more sensitive metric for discovering population decline than waiting for non-occupancy to trigger a concern. Such apparent decline would need to be evaluated in the context of natural, climate related, population variation, which associations should emerge over time as long term datasets are analyzed for covariate effects (such as drought cycles).

We also examined the effect of sample size on obtaining CIV^{max}. Frog calling intensity varies each night, influenced by temperature, wind, and the presence of other calling frogs. Hence, if CIV^{max} scores are infrequently encountered, trend analyses utilizing this metric will underestimate the population unless taking into account CIV^{max} detection probabilities, especially with small sample sizes. Encounter probabilities are provided in Supplement A2, and here we assess how these descriptive statistics inform the feasibility of a monitoring program based on trends in CIV^{max}.

For the rare Blanchard's Cricket Frog, which calls regularly over a medium duration calling period, few data are available. At MISS07 in 2016 the probability of encountering CIV^{max} on 30 surveys was 0.267, and the probability of encountering CIV^{max} on surveys within the calling period was 0.444. The suitability of this species for CIV^{max} trend analysis should be evaluated with data from more sites (MISS is starting to accumulate more data from non-GLKN sites), but it appears that this species may be a good candidate for using CIV^{max} as an index to population abundance, given its regular calling activity and high detection rates when calling, especially if modeling can delineate a calling period for analyses utilizing first and last dates of detection to increase confidence.

Table A2. Summary of maximum CIV for 65 sites sampled in 2016.

Parameter	ACBL	ANAM	HYCH	HYVE	LICA	LICL	LIPI	LISE	LISY	PSCR	PSMA	PSTR
CIV=0	64	26	62	22	61	16	57	62	48	11	60	63
CIV=1	0	10	2	10	3	17	3	3	5	6	3	1
CIV=2	0	21	1	13	1	24	4	0	3	5	1	1
CIV=3	1	8	0	20	0	8	1	0	9	43	1	0
N Sites	65	65	65	65	65	65	65	65	65	65	65	65
Percent CIV=0	98.46%	40.00%	95.38%	33.85%	93.85%	24.62%	87.69%	95.38%	73.85%	16.92%	92.31%	96.92%
Percent CIV=1	0.00%	15.38%	3.08%	15.38%	4.62%	26.15%	4.62%	4.62%	7.69%	9.23%	4.62%	1.54%
Percent CIV=2	0.00%	32.31%	1.54%	20.00%	1.54%	36.92%	6.15%	0.00%	4.62%	7.69%	1.54%	1.54%
Percent CIV=3	1.54%	12.31%	0.00%	30.77%	0.00%	12.31%	1.54%	0.00%	13.85%	66.15%	1.54%	0.00%

Table A3. Summary of maximum CIV for only occupied sites sampled in 2016.

Parameter	ACBL	ANAM	HYCH	HYVE	LICA	LICL	LIPI	LISE	LISY	PSCR	PSMA	PSTR
CIV=1	0	10	2	10	3	17	3	3	5	6	3	1
CIV=2	0	21	1	13	1	24	4	0	3	5	1	1
CIV=3	1	8	0	20	0	8	1	0	9	43	1	0
N Sites	1	39	3	43	4	49	8	3	17	54	5	2
Percent CIV=1	0.00%	25.64%	66.67%	23.26%	75.00%	34.69%	37.50%	100.00%	29.41%	11.11%	60.00%	50.00%
Percent CIV=2	0.00%	53.85%	33.33%	30.23%	25.00%	48.98%	50.00%	0.00%	17.65%	9.26%	20.00%	50.00%
Percent CIV=3	100.00%	20.51%	0.00%	46.51%	0.00%	16.33%	12.50%	0.00%	52.94%	79.63%	20.00%	0.00%

American Toad, a species that calls infrequently within a long duration calling period, was detected at 39 sites in 2016. The probability of encountering CIV^{max} on 30 surveys ranged from 0.03 to 0.20 (average 0.063). The number of samples falling within the actual calling period ranged from 1–18 (average 8), and at 11 sites calls were detected in three or fewer samples. The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.59 to 1.00 (average 0.417). Therefore, for infrequent callers such as American Toad, the chance of detecting a significant trend in CIV^{max} appears low even with 30 samples per year, unless modeling can delineate a calling period for analyses utilizing first and last dates of detection.

For the uncommon Cope's Gray Treefrog, which calls regularly over a long duration calling period, data from only three sites are available (MISS01, MISS09, MISS10). The probability of encountering CIV^{max} over 30 surveys ranged from 0.033–0.167, and the probability of encountering CIV^{max} on surveys within the calling period ranged from 0.100–1.000. The suitability of this species for CIV^{max} trend analysis should be evaluated with data from more sites, but it appears that it may be a fair candidate for using CIV^{max} as an index to population abundance if modeling can delineate a calling period for analyses utilizing first and last dates of detection to increase confidence.

Gray Treefrog, with a long duration calling period and regular calling pattern, was detected at 43 sites in 2016, and the probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.333 (average 0.108). The number of samples falling within the actual calling period ranged from 1–26 (average 11), and at 8 sites calls were detected on 3 or fewer samples. The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.043–1.000 (average 0.395). For this species, it appears that the chance of detecting a significant trend in CIV^{max} with 30 samples per year may be informative if the analysis is constrained to the calling period (where probabilities are generally >0.3).

For the uncommon American Bullfrog, which calls irregularly over a moderate duration calling period, data from only four sites are available (INDU03, INDU08, INDU09, INDU10). The probability of encountering CIV^{max} over 30 surveys ranged from 0.033–0.433 (average 0.233), and the probability of encountering CIV^{max} on surveys within the calling period ranged from 0.071–0.722 (average 0.397). The suitability of this species for CIV^{max} trend analysis should be evaluated with data from more sites, but it appears that it may be a poor candidate for using CIV^{max} as an index to population abundance, given the low chance of detecting the true CIV^{max} . If used, modeling should delineate a calling period for analyses utilizing first and last dates of detection to increase confidence.

Green Frog, with a long duration calling period, high detection rate, and fairly regular calling pattern, was detected at 49 sites in 2016. The probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.500 (average 0.141). The number of samples falling within the actual calling period ranged from 1–30 (average 17), and at two sites calls were detected on only one sample. The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.033–1.000 (average 0.315). For this species, it appears that the chance of detecting a significant trend in CIV^{max} with 30 samples per year may be informative if analysis is constrained to the calling period (where probabilities are generally >0.3).

Northern Leopard Frog, calling irregularly and over a medium duration calling period, was detected at only 8 sites in one park in 2016 (MISS). The probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.067 (average 0.046). The number of samples falling within the actual calling period ranged from 1–6 (average 3), and at five sites calls were detected on only 1–2 samples. The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.167–1.000 (average 0.646) – a result biased by the uniformly low number of samples in the defined calling periods. For this species we suspect that false absences are high in acoustic data sets owing to low volume and the distance calls can be heard, as well as calls being masked by other noise. This species may be a poor candidate for CIV^{max} trend analysis, given that the weakness of the calls probably compromises obtaining a true CIV^{max} , and the chance of detecting a significant trend will be informative only if analysis is constrained to the calling period (where probabilities are generally >0.3).

Mink Frog was detected at only three sites in two parks, and maximum CIV encounter probabilities could be biased by the low number of samples (six) in the defined calling period at the one site where it was detected on more than one night. This species call is also weak (low volume and carrying distance) and it calls for short periods, hence we suspect false absences are high in acoustic data sets. It is therefore not a promising candidate for CIV trend analysis. However, recent success with detection in the early morning hours (Casper unpublished data) may improve results as more of these data are acquired.

Wood Frog, a highly sporadic caller within a brief calling period, was detected at 17 sites in four parks in 2016. The probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.133 (average 0.049). The number of samples falling within the actual calling period ranged from 1–8 (average 3). At seven sites calls were detected on only one sample, and at three sites on only two samples (this deficiency should improve if ARS are deployed earlier as recommended). The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.200–1.000 (average 0.676)—a result biased by the uniformly low number of samples in the defined calling periods. This species calls for short periods in early spring, and never on more than eight samples in 2016. This species is probably a promising candidate for CIV^{max} trend analysis if ARS are deployed earlier so detection statistics improve, and analysis is constrained to the calling period to increase confidence (this should eliminate samples after the early calling period).

Spring Peeper, a very regular caller with a very long calling season, was detected at 54 sites in six parks in 2016. The probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.567 (average 0.277). The number of samples falling within the actual calling period ranged from 1–29 (average 18), and the number of samples in which the species called in any site was consistently high, with only one site detecting the species in only one sample. The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.083–1.000 (average 0.540). This species appears to be a promising candidate for CIV trend analysis if the analysis is constrained to the calling period (where probabilities are generally >0.3).

Boreal Chorus Frog was detected in 2016 at only five sites, all at MISS. With this low encounter rate statistics on the probabilities of correctly scoring CIV^{max} should be considered preliminary. The

probability of encountering CIV^{max} on 30 surveys ranged from 0.033–0.100 (average 0.053). The probability of encountering CIV^{max} on surveys within the calling period ranged from 0.182–1.000 (average 0.836). This species, like Wood Frog, calls early, sporadically, and often for short periods. However, the detection deficiencies should improve if ARS are deployed earlier as recommended. Therefore, this species is probably a promising candidate for CIV^{max} trend analysis if ARS are deployed earlier so detection statistics improve, and analysis is constrained to the calling period to increase confidence (this should eliminate samples after the early calling period).

Western Chorus Frog was detected in 2016 at only two sites, both at INDU. With this low encounter rate statistics on the probabilities of correctly scoring CIV^{max} should be considered preliminary. The probability of encountering CIV^{max} on 30 surveys ranged was 0.033 and 0.067, and the probability of encountering CIV^{max} on surveys within the calling period ranged was 0.143 and 1.000. Chorus Frogs call early, sporadically, and often for short periods. However, the detection deficiencies should improve if ARS are deployed earlier as recommended. Therefore, this species is probably a promising candidate for CIV^{max} trend analysis if ARS are deployed earlier so detection statistics improve, and analysis is constrained to the calling period to increase confidence (this should eliminate samples after the early calling period).

In sum, the descriptive statistics provided here utilizing 2016 data demonstrate that anuran calling intensity is highly variable within a single season, both within and among sites, and in most cases the chance of detecting the true CIV^{max} is low, hence modeling trends in CIV will need to account for this. Constraining analyses to within the calling season (bounding by first and last detection dates at each site) improves statistics considerably. Across all species the chance of encountering CIV^{max} ranged from 0.033–0.567 in 30 samples, but was higher within calling periods (range 0.033–1.00). In Table A4 summarizes recommendations for each species' suitability for CIV^{max} trend analysis. Further investigation should be pursued for data deficient species, and this metric should be re-evaluated after five years of CIV data are analyzed.

Table A4. CIV index potential.

Species	Index Potential	Based On
Blanchard's Cricket Frog	Good	High detection rates when present in moderate to high abundance. Modeling should delineate calling period for analysis, which typically would eliminate samples before mid-May.
American Toad	Moderate	Infrequent caller but high detection rates when present. Modeling should delineate calling period for analysis.
Cope's Gray Treefrog	Moderate	Variable detection rates when present, data deficient. Modeling should delineate calling period for analysis.
Gray Treefrog	Good	High detection rates when present in low to high abundance. Modeling should delineate calling period for analysis.

Table A4 (continued). CIV index potential.

Species	Index Potential	Based On
American Bullfrog	Poor-Moderate	Low detection rates, data deficient. Modeling should delineate calling period for analysis.
Green Frog	Moderate	Low detection rates for CIVmax (although high detection for occupancy). Modeling should delineate calling period for analysis to improve confidence.
Northern Leopard Frog	Poor	Low detection rates, weak call, data deficient. Not recommended for CIV trend analysis.
Mink Frog	Poor	Low detection rates, weak call, data deficient. Not recommended for CIV trend analysis unless detection rates improve with recommended early morning sampling.
Wood Frog	Moderate	Early episodic caller but with good detection rates when present (for both occupancy and CIVmax). Currently data deficient but earlier ARS deployment should resolve this issue. Modeling should delineate calling period for analysis.
Spring Peeper	Good	High detection rates. Modeling should delineate calling period for analysis.
Boreal Chorus Frog	Moderate	Early episodic caller but with good detection rates when present (for both occupancy and CIVmax). Currently data deficient but earlier ARS deployment should resolve this issue. Modeling should delineate calling period for analysis.
Western Chorus Frog	Moderate	Early episodic caller but with good detection rates when present (for both occupancy and CIVmax). Currently data deficient but earlier ARS deployment should resolve this issue. Modeling should delineate calling period for analysis.

The ability to detect the true CIV^{max} is a function of sample size. At a detection probability of 0.033 (the lowest detection rate in the 2016 data set), conducting 30 samples achieves a 63% chance of returning the CIV^{max} , and 90 samples are needed to meet 95% confidence in detection of CIV^{max} (see formulae in Table 1 in Casper et al. 2018). While in many cases limiting sampling to only the actual calling period returns higher confidence in detection, in practice the calling period cannot be known a priori. Actual confidence levels will of course vary with effective sample size in each season and for each species. We therefore recommend continuing with the current sampling design of 30 samples for analyzing trends in CIV^{max} , that modeling be constrained to samples within confirmed calling periods, and that models utilize the frequency (proportion) of each CIV score at each site as a trend metric, whereby trends in the CIV values over time will be assumed to reflect actual population trends. For example, if for Species A the proportion of CIV=3 is 30% in Year 1, 25% in Year 2, and 20% in Year 3, the population would be assumed to be decreasing (fewer calling males every year). In this example we would expect to see the proportion of CIV=1 and CIV=2 values increasing at this

site, and possibly the number of sites occupied in the region declining as well if the decline is not isolated to the one site (for example, a trend resulting from multi-year drought conditions).

We also caution that CIV scores should not be directly compared across species in the context of a proxy for population size, as they may mean different things for different species. For example, a CIV of 3 for American Toad likely represents fewer males than would a CIV of 3 for Spring Peeper or treefrogs.

Supplemental Material

CIV^{max} Detection Probabilities

An Excel spreadsheet with detection probability calculations for each species and site is available from the Great Lakes Network Office by request (Supplement A2).

Maximum Call Index Values (CIV)

Table starts on next page (Supplement A1).

Supplement A1. Maximum Call Index Values (CIV).

Site	Year	Sample	ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	PSTR
APIS01	2016	Max	0	2	0	0	2	0	2	0	0	0	0	3	0	0
APIS02	2016	Max	0	2	0	0	2	0	2	0	0	0	0	3	0	0
APIS03	2016	Max	0	2	0	0	1	0	2	0	0	0	0	3	0	0
APIS04	2016	Max	0	3	0	0	1	0	2	0	0	0	3	3	0	0
APIS05	2016	Max	0	1	0	0	3	0	1	0	0	0	1	3	0	0
APIS06	2016	Max	0	1	0	0	3	0	0	0	0	0	2	3	0	0
APIS07	2016	Max	0	2	0	0	2	0	3	0	0	0	1	3	0	0
APIS08	2016	Max	0	0	0	0	0	0	0	0	0	0	3	3	0	0
APIS10	2016	Max	0	2	0	0	1	0	2	0	0	0	3	3	0	0
APIS11	2016	Max	0	2	0	0	0	0	2	0	0	0	0	3	0	0
GRPO01	2016	Max	0	2	0	0	2	0	1	0	0	1	0	3	0	0
GRPO03	2016	Max	0	0	0	0	1	0	2	0	0	0	0	3	0	0
GRPO04	2016	Max	0	1	0	0	1	0	0	0	0	0	0	3	0	0
GRPO05	2016	Max	0	0	0	0	2	0	1	0	0	0	0	3	0	0
GRPO06	2016	Max	0	2	0	0	1	0	1	0	0	0	0	3	0	0
GRPO07	2016	Max	0	0	0	0	0	0	0	0	0	0	0	1	0	0
INDU01	2016	Max	0	0	0	0	2	0	0	0	0	0	0	3	0	1
INDU02	2016	Max	0	2	0	0	3	0	2	0	0	0	0	1	0	0
INDU03	2016	Max	0	1	0	0	3	1	1	0	0	0	0	3	0	0

Supplement A1 (continued). Maximum Call Index Values (CIV).

Site	Year	Sample	ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	PSTR
INDU04	2016	Max	0	2	0	0	3	0	0	0	0	0	0	3	0	2
INDU05	2016	Max	0	2	0	0	2	0	0	0	0	0	0	3	0	0
INDU07	2016	Max	0	1	0	0	3	0	1	0	0	0	0	3	0	0
INDU08	2016	Max	0	1	0	0	3	2	3	0	0	0	0	3	0	0
INDU09	2016	Max	0	0	0	0	3	1	3	0	0	0	0	3	0	0
INDU10	2016	Max	0	0	0	0	3	1	2	0	0	0	0	3	0	0
ISRO01	2016	Max	0	0	0	0	0	0	2	0	0	0	0	1	0	0
ISRO02	2016	Max	0	0	0	0	0	0	2	0	0	1	0	1	0	0
ISRO03	2016	Max	0	0	0	0	0	0	2	0	0	1	0	1	0	0
ISRO04	2016	Max	0	1	0	0	0	0	2	0	0	0	0	3	0	0
ISRO05	2016	Max	0	0	0	0	0	0	1	0	0	0	0	2	0	0
ISRO06	2016	Max	0	0	0	0	0	0	2	0	0	0	0	2	0	0
ISRO07	2016	Max	0	0	0	0	0	0	1	0	0	0	0	2	0	0
ISRO08	2016	Max	0	0	0	0	0	0	2	0	0	0	0	2	0	0
ISRO09	2016	Max	0	2	0	0	0	0	0	0	0	0	0	2	0	0
ISRO10	2016	Max	0	0	0	0	0	0	0	0	0	0	0	1	0	0
MISS01	2016	Max	0	3	0	1	2	0	3	0	2	0	0	0	0	0
MISS02	2016	Max	0	2	0	0	1	0	0	0	0	0	0	0	0	0
MISS03	2016	Max	0	1	0	0	3	0	1	0	1	0	0	0	1	0

Supplement A1 (continued). Maximum Call Index Values (CIV).

Site	Year	Sample	ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	PSTR
MISS04	2016	Max	0	3	0	0	3	0	2	0	2	0	0	0	0	0
MISS05	2016	Max	0	2	0	0	3	0	0	0	2	0	2	0	3	0
MISS06	2016	Max	0	3	0	0	0	0	3	0	2	0	0	0	1	0
MISS07	2016	Max	3	2	0	0	3	0	1	0	1	0	0	0	2	0
MISS08	2016	Max	0	2	0	0	3	0	1	0	3	0	0	0	1	0
MISS09	2016	Max	0	3	0	2	0	0	2	0	1	0	0	0	0	0
MISS10	2016	Max	0	0	0	1	0	0	0	0	0	0	0	0	0	0
PIRO01	2016	Max	0	2	0	0	0	0	2	0	0	0	0	3	0	0
PIRO02	2016	Max	0	3	0	0	0	0	2	0	0	0	0	3	0	0
PIRO03	2016	Max	0	2	0	0	2	0	1	0	0	0	3	3	0	0
PIRO04	2016	Max	0	0	0	0	2	0	2	0	0	0	1	3	0	0
PIRO05	2016	Max	0	0	0	0	0	0	0	0	0	0	1	3	0	0
PIRO06	2016	Max	0	3	0	0	0	0	2	0	0	0	0	3	0	0
PIRO07	2016	Max	0	0	0	0	3	0	1	0	0	0	3	3	0	0
PIRO08	2016	Max	0	2	0	0	2	0	2	0	0	0	1	3	0	0
PIRO09	2016	Max	0	2	0	0	3	0	1	0	0	0	0	3	0	0
PIRO10	2016	Max	0	0	0	0	1	0	2	0	0	0	0	3	0	0
SLBE01	2016	Max	0	0	0	0	1	0	0	0	0	0	2	3	0	0
SLBE02	2016	Max	0	0	0	0	3	0	1	0	0	0	3	3	0	0

Supplement A1 (continued). Maximum Call Index Values (CIV).

Site	Year	Sample	ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	PSTR
SLBE03	2016	Max	0	0	0	0	3	0	1	0	0	0	3	3	0	0
SLBE04	2016	Max	0	0	0	0	1	0	0	0	0	0	0	3	0	0
SLBE05	2016	Max	0	0	0	0	3	0	3	0	0	0	3	3	0	0
SLBE06	2016	Max	0	0	0	0	3	0	3	0	0	0	3	3	0	0
SLBE07	2016	Max	0	2	0	0	2	0	3	0	0	0	0	3	0	0
SLBE08	2016	Max	0	1	0	0	0	0	1	0	0	0	0	0	0	0
SLBE09	2016	Max	0	1	0	0	2	0	2	0	0	0	0	3	0	0
SLBE11	2016	Max	0	3	0	0	0	0	0	0	0	0	0	3	0	0

Appendix B. Cumulative phenology.

Table B1. Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
APIS01	APIS	2013	Deploy	5/9/2013	–	129	129
APIS01	APIS	2013	PSCR	5/15/2013	–	135	135
APIS01	APIS	2013	ANAM	6/11/2013	–	162	162
APIS01	APIS	2013	HYXX	6/11/2013	–	162	162
APIS01	APIS	2014	Deploy	5/30/2014	–	150	150
APIS01	APIS	2014	PSCR	5/30/2014	–	150	150
APIS01	APIS	2014	HYXX	6/3/2014	–	154	154
APIS01	APIS	2014	ANAM	6/6/2014	–	157	157
APIS01	APIS	2014	LICL	7/7/2014	–	188	188
APIS01	APIS	2015	Deploy	4/16/2015	–	106	106
APIS01	APIS	2015	PSCR	4/19/2015	36.53	109	109
APIS01	APIS	2015	ANAM	5/23/2015	56.06	143	143
APIS01	APIS	2015	LICL	5/30/2015	37.49	150	150
APIS01	APIS	2015	HYXX	6/21/2015	61.57	172	172
APIS01	APIS	2016	Deploy	4/14/2016	–	105	105
APIS01	APIS	2016	PSCR	4/20/2016	–	111	111
APIS01	APIS	2016	ANAM	5/19/2016	–	140	140
APIS01	APIS	2016	LICL	6/8/2016	–	160	160
APIS01	APIS	2016	HYXX	6/16/2016	–	168	168

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
APIS02	APIS	2013	Deploy	5/9/2013	–	129	129
APIS02	APIS	2013	PSCR	5/12/2013	–	132	132
APIS02	APIS	2014	Deploy	5/30/2014	–	150	150
APIS02	APIS	2014	PSCR	5/30/2014	–	150	150
APIS02	APIS	2014	ANAM	6/3/2014	–	154	154
APIS02	APIS	2014	LICL	6/3/2014	–	154	154
APIS02	APIS	2015	Deploy	4/16/2015	–	106	106
APIS02	APIS	2015	PSCR	4/17/2015	52.58	107	107
APIS02	APIS	2015	LISY	5/8/2015	–	128	128
APIS02	APIS	2015	LICL	6/10/2015	–	161	161
APIS02	APIS	2015	ANAM	6/19/2015	–	170	170
APIS02	APIS	2015	HYXX	6/19/2015	61.91	170	170
APIS02	APIS	2016	Deploy	4/14/2016	–	105	105
APIS02	APIS	2016	PSCR	4/15/2016	67.05	106	106
APIS02	APIS	2016	ANAM	5/13/2016	–	134	134
APIS02	APIS	2016	LICL	5/29/2016	–	150	150
APIS02	APIS	2016	HYXX	6/11/2016	–	163	163
APIS03	APIS	2013	Deploy	5/17/2013	–	137	137
APIS03	APIS	2013	LICL	6/6/2013	–	157	157
APIS03	APIS	2013	ANAM	6/7/2013	–	158	158
APIS03	APIS	2013	PSCR	6/7/2013	–	158	158
APIS03	APIS	2013	HYXX	6/26/2013	–	177	177

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
APIS03	APIS	2014	ANAM	5/28/2014	–	148	148
APIS03	APIS	2014	Deploy	5/28/2014	–	148	148
APIS03	APIS	2014	PSCR	5/28/2014	–	148	148
APIS03	APIS	2014	LICL	6/11/2014	–	162	162
APIS03	APIS	2014	HYXX	6/13/2014	–	164	164
APIS03	APIS	2015	Deploy	4/27/2015	–	117	117
APIS03	APIS	2015	PSCR	4/27/2015	42.55	117	117
APIS03	APIS	2015	ANAM	5/20/2015	47.98	140	140
APIS03	APIS	2015	LICL	6/8/2015	–	159	159
APIS03	APIS	2016	Deploy	4/15/2016	–	106	106
APIS03	APIS	2016	PSCR	4/16/2016	47.09	107	107
APIS03	APIS	2016	ANAM	5/18/2016	43.83	139	139
APIS03	APIS	2016	LICL	6/8/2016	45.29	160	160
APIS03	APIS	2016	HYXX	6/19/2016	61.40	171	171
APIS04	APIS	2014	Deploy	5/28/2014	–	148	148
APIS04	APIS	2014	PSCR	5/28/2014	–	148	148
APIS04	APIS	2014	LICL	7/2/2014	–	183	183
APIS04	APIS	2015	Deploy	4/28/2015	–	118	118
APIS04	APIS	2015	LISY	4/28/2015	44.38	118	118
APIS04	APIS	2015	PSCR	4/28/2015	44.38	118	118
APIS04	APIS	2015	ANAM	5/7/2015	–	127	127
APIS04	APIS	2015	LICL	6/11/2015	56.06	162	162

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
APIS04	APIS	2016	LISY	4/15/2016	–	106	106
APIS04	APIS	2016	PSCR	4/15/2016	61.40	106	106
APIS04	APIS	2016	ANAM	5/6/2016	–	127	127
APIS04	APIS	2016	HYXX	6/18/2016	–	170	170
APIS04	APIS	2016	LICL	6/24/2016	–	176	176
APIS05	APIS	2013	Deploy	5/17/2013	–	137	137
APIS05	APIS	2013	PSCR	5/30/2013	–	150	150
APIS05	APIS	2014	Deploy	5/29/2014	–	149	149
APIS05	APIS	2014	PSCR	5/29/2014	–	149	149
APIS05	APIS	2014	ANAM	6/1/2014	–	152	152
APIS05	APIS	2014	LICL	6/5/2014	–	156	156
APIS05	APIS	2014	HYXX	6/16/2014	–	167	167
APIS05	APIS	2015	Deploy	4/17/2015	–	107	107
APIS05	APIS	2015	PSCR	4/17/2015	–	107	107
APIS05	APIS	2015	LICL	6/2/2015	–	153	153
APIS05	APIS	2015	ANAM	6/7/2015	–	158	158
APIS05	APIS	2015	HYXX	6/7/2015	–	158	158
APIS05	APIS	2016	Deploy	4/15/2016	–	106	106
APIS05	APIS	2016	PSCR	4/15/2016	50.64	106	106
APIS05	APIS	2016	LISY	4/16/2016	–	107	107
APIS05	APIS	2016	ANAM	5/8/2016	41.99	129	129
APIS05	APIS	2016	HYXX	6/7/2016	–	159	159
APIS05	APIS	2016	LICL	6/12/2016	47.98	164	164

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
APIS06	APIS	2014	Deploy	5/29/2014	–	149	149
APIS06	APIS	2014	PSCR	5/29/2014	–	149	149
APIS06	APIS	2014	HYXX	6/6/2014	–	157	157
APIS06	APIS	2015	Deploy	4/18/2015	–	108	108
APIS06	APIS	2015	PSCR	4/19/2015	36.15	109	109
APIS06	APIS	2015	LISY	4/28/2015	–	118	118
APIS06	APIS	2015	HYXX	6/9/2015	65.34	160	160
APIS06	APIS	2015	ANAM	6/18/2015	45.10	169	169
APIS06	APIS	2015	LICL	6/27/2015	–	178	178
APIS06	APIS	2016	Deploy	4/15/2016	–	106	106
APIS06	APIS	2016	PSCR	4/15/2016	41.81	106	106
APIS06	APIS	2016	LISY	5/6/2016	–	127	127
APIS06	APIS	2016	ANAM	5/20/2016	49.94	141	141
APIS06	APIS	2016	HYXX	6/16/2016	–	168	168
APIS07	APIS	2013	Deploy	5/17/2013	–	137	137
APIS07	APIS	2013	PSCR	5/17/2013	–	137	137
APIS07	APIS	2013	ANAM	5/31/2013	–	151	151
APIS07	APIS	2013	HYXX	6/19/2013	–	170	170
APIS07	APIS	2013	LICL	6/25/2013	–	176	176
APIS07	APIS	2014	Deploy	5/28/2014	–	148	148
APIS07	APIS	2014	PSCR	5/28/2014	–	148	148
APIS07	APIS	2014	ANAM	5/31/2014	–	151	151

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
APIS07	APIS	2014	LICL	6/3/2014	–	154	154
APIS07	APIS	2014	HYXX	6/19/2014	–	170	170
APIS07	APIS	2015	LISY	4/18/2015	–	108	108
APIS07	APIS	2015	PSCR	4/18/2015	42.55	108	108
APIS07	APIS	2015	Deploy	4/28/2015	–	118	118
APIS07	APIS	2015	ANAM	5/22/2015	48.52	142	142
APIS07	APIS	2015	LICL	5/24/2015	–	144	144
APIS07	APIS	2015	HYXX	6/3/2015	–	154	154
APIS07	APIS	2016	Deploy	4/15/2016	–	106	106
APIS07	APIS	2016	PSCR	4/15/2016	–	106	106
APIS07	APIS	2016	LISY	4/19/2016	41.81	110	110
APIS07	APIS	2016	ANAM	5/22/2016	50.11	143	143
APIS07	APIS	2016	LICL	6/8/2016	44.01	160	160
APIS07	APIS	2016	HYXX	6/17/2016	–	169	169
APIS08	APIS	2013	Deploy	5/17/2013	–	137	137
APIS08	APIS	2013	ANAM	6/11/2013	–	162	162
APIS08	APIS	2013	PSCR	6/11/2013	–	162	162
APIS08	APIS	2014	Deploy	5/29/2014	–	149	149
APIS08	APIS	2014	PSCR	5/29/2014	–	149	149
APIS08	APIS	2014	ANAM	6/3/2014	–	154	154
APIS08	APIS	2015	Deploy	4/28/2015	–	118	118
APIS08	APIS	2015	LISY	4/28/2015	44.74	118	118

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
APIS08	APIS	2015	PSCR	4/28/2015	45.83	118	118
APIS08	APIS	2015	ANAM	5/22/2015	–	142	142
APIS08	APIS	2016	Deploy	4/15/2016	–	106	106
APIS08	APIS	2016	LISY	4/15/2016	–	106	106
APIS08	APIS	2016	PSCR	4/15/2016	51.52	106	106
APIS08	APIS	2016	ANAM	5/30/2016	52.23	151	151
APIS10	APIS	2014	Deploy	5/29/2014	–	149	149
APIS10	APIS	2014	PSCR	5/29/2014	–	149	149
APIS10	APIS	2014	ANAM	6/2/2014	–	153	153
APIS10	APIS	2014	LICL	6/20/2014	–	171	171
APIS10	APIS	2015	Deploy	4/28/2015	–	118	118
APIS10	APIS	2015	LISY	4/28/2015	48.52	118	118
APIS10	APIS	2015	PSCR	4/28/2015	48.52	118	118
APIS10	APIS	2015	ANAM	5/7/2015	54.50	127	127
APIS10	APIS	2015	HYXX	6/2/2015	57.96	153	153
APIS10	APIS	2015	LICL	6/9/2015	67.56	160	160
APIS10	APIS	2016	Deploy	4/15/2016	–	106	106
APIS10	APIS	2016	LISY	4/15/2016	55.19	106	106
APIS10	APIS	2016	PSCR	4/15/2016	57.10	106	106
APIS10	APIS	2016	ANAM	5/6/2016	55.19	127	127
APIS10	APIS	2016	LICL	6/17/2016	53.27	169	169
APIS10	APIS	2016	HYXX	6/18/2016	65.00	170	170

Table B1 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Apostle Islands National Lakeshore (Wisconsin). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
APIS11	APIS	2014	Deploy	5/28/2014	–	148	148
APIS11	APIS	2014	PSCR	5/28/2014	–	148	148
APIS11	APIS	2014	ANAM	5/29/2014	–	149	149
APIS11	APIS	2014	LICL	6/4/2014	–	155	155
APIS11	APIS	2015	Deploy	4/27/2015	–	117	117
APIS11	APIS	2015	PSCR	4/27/2015	39.57	117	117
APIS11	APIS	2015	ANAM	5/18/2015	53.27	138	138
APIS11	APIS	2015	LICL	5/31/2015	41.25	151	151
APIS11	APIS	2016	Deploy	4/15/2016	–	106	106
APIS11	APIS	2016	PSCR	4/15/2016	52.05	106	106
APIS11	APIS	2016	ANAM	5/7/2016	48.16	128	128
APIS11	APIS	2016	LICL	6/3/2016	49.94	155	155

Table B2. Phenology of frog calling, including earliest date, temperature, and Julian Day for Grand Portage National Monument (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
GRPO01	GRPO	2016	Deploy	5/19/2016	–	140	140
GRPO01	GRPO	2016	PSCR	5/19/2016	52.58	140	140
GRPO01	GRPO	2016	ANAM	5/20/2016	–	141	141
GRPO01	GRPO	2016	HYXX	5/23/2016	–	144	144
GRPO01	GRPO	2016	LICL	6/12/2016	43.47	164	164
GRPO01	GRPO	2016	LISE	7/6/2016	–	188	188
GRPO03	GRPO	2015	Deploy	5/13/2015	–	133	133
GRPO03	GRPO	2015	PSCR	5/15/2015	43.83	135	135
GRPO03	GRPO	2015	HYXX	6/9/2015	–	160	160
GRPO03	GRPO	2016	Deploy	5/18/2016	–	139	139
GRPO03	GRPO	2016	PSCR	5/18/2016	49.40	139	139
GRPO03	GRPO	2016	ANAM	5/22/2016	49.76	143	143
GRPO03	GRPO	2016	HYXX	6/17/2016	–	169	169
GRPO03	GRPO	2016	LICL	6/20/2016	–	172	172
GRPO04	GRPO	2015	Deploy	5/13/2015	–	133	133
GRPO04	GRPO	2015	PSCR	5/13/2015	–	133	133
GRPO04	GRPO	2015	ANAM	5/27/2015	–	147	147
GRPO04	GRPO	2015	HYXX	6/12/2015	54.67	163	163
GRPO04	GRPO	2016	Deploy	5/18/2016	–	139	139
GRPO04	GRPO	2016	PSCR	5/18/2016	50.11	139	139
GRPO04	GRPO	2016	ANAM	5/22/2016	50.82	143	143
GRPO04	GRPO	2016	HYXX	6/17/2016	–	169	169
GRPO04	GRPO	2016	LICL	6/24/2016	63.11	176	176

Table B2 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Grand Portage National Monument (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
GRPO05	GRPO	2015	Deploy	5/13/2015	–	133	133
GRPO05	GRPO	2015	PSCR	5/16/2015	51.00	136	136
GRPO05	GRPO	2015	HYXX	5/24/2015	–	144	144
GRPO05	GRPO	2015	ANAM	5/27/2015	–	147	147
GRPO05	GRPO	2015	LICL	6/13/2015	51.52	164	164
GRPO05	GRPO	2016	Deploy	5/18/2016	–	139	139
GRPO05	GRPO	2016	PSCR	5/18/2016	46.91	139	139
GRPO05	GRPO	2016	ANAM	5/21/2016	–	142	142
GRPO05	GRPO	2016	HYXX	6/9/2016	–	161	161
GRPO05	GRPO	2016	LICL	7/5/2016	–	187	187
GRPO06	GRPO	2015	Deploy	5/13/2015	–	133	133
GRPO06	GRPO	2015	PSCR	5/13/2015	43.65	133	133
GRPO06	GRPO	2015	ANAM	5/27/2015	53.97	147	147
GRPO06	GRPO	2015	LICL	6/6/2015	51.52	157	157
GRPO06	GRPO	2015	HYXX	6/9/2015	–	160	160
GRPO06	GRPO	2016	Deploy	5/18/2016	–	139	139
GRPO06	GRPO	2016	PSCR	5/18/2016	51.00	139	139
GRPO06	GRPO	2016	ANAM	5/20/2016	49.05	141	141
GRPO06	GRPO	2016	HYXX	6/10/2016	–	162	162
GRPO06	GRPO	2016	LICL	6/17/2016	–	169	169

Table B2 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Grand Portage National Monument (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
GRPO07	GRPO	2015	Deploy	5/14/2015	–	134	134
GRPO07	GRPO	2015	PSCR	5/27/2015	–	147	147
GRPO07	GRPO	2016	Deploy	5/19/2016	–	140	140
GRPO07	GRPO	2016	PSCR	5/20/2016	52.05	141	141

Table B3. Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU01	INDU	2014	Deploy	4/24/2014	–	114	114
INDU01	INDU	2014	PSTR	4/26/2014	–	116	116
INDU01	INDU	2014	PSCR	5/9/2014	–	129	129
INDU01	INDU	2014	HYXX	5/12/2014	–	132	132
INDU01	INDU	2015	Deploy	4/1/2015	–	091	91
INDU01	INDU	2015	PSCR	4/3/2015	–	093	93
INDU01	INDU	2015	PSTR	4/11/2015	–	101	101
INDU01	INDU	2015	ANAM	4/18/2015	–	108	108
INDU01	INDU	2015	HYXX	5/6/2015	–	126	126
INDU01	INDU	2016	Deploy	4/7/2016	–	098	98
INDU01	INDU	2016	PSCR	4/7/2016	37.49	098	98
INDU01	INDU	2016	PSTR	4/10/2016	47.45	101	101
INDU01	INDU	2016	ANAM	4/21/2016	52.05	112	112
INDU01	INDU	2016	HYXX	5/12/2016	57.96	133	133
INDU02	INDU	2014	Deploy	4/25/2014	–	115	115
INDU02	INDU	2014	PSCR	4/25/2014	–	115	115
INDU02	INDU	2014	PSTR	4/26/2014	–	116	116
INDU02	INDU	2014	HYXX	5/7/2014	–	127	127
INDU02	INDU	2014	LICL	7/18/2014	–	199	199
INDU02	INDU	2015	Deploy	4/2/2015	–	092	92
INDU02	INDU	2015	PSCR	4/2/2015	–	092	92
INDU02	INDU	2015	LIPI	4/11/2015	–	101	101

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU02	INDU	2015	ANAM	5/2/2015	–	122	122
INDU02	INDU	2015	PSTR	5/2/2015	–	122	122
INDU02	INDU	2015	HYXX	5/7/2015	–	127	127
INDU02	INDU	2015	LICL	5/26/2015	–	146	146
INDU02	INDU	2016	Deploy	4/11/2016	–	102	102
INDU02	INDU	2016	PSCR	4/11/2016	–	102	102
INDU02	INDU	2016	ANAM	4/21/2016	–	112	112
INDU02	INDU	2016	HYXX	5/11/2016	–	132	132
INDU02	INDU	2016	LICL	5/29/2016	–	150	150
INDU03	INDU	2013	Deploy	3/29/2013	–	088	88
INDU03	INDU	2013	PSCR	4/4/2013	–	094	94
INDU03	INDU	2014	PSCR	4/21/2014	–	111	111
INDU03	INDU	2014	Deploy	4/22/2014	–	112	112
INDU03	INDU	2014	ANAM	5/8/2014	–	128	128
INDU03	INDU	2014	HYXX	5/8/2014	–	128	128
INDU03	INDU	2014	LICL	6/1/2014	–	152	152
INDU03	INDU	2015	Deploy	4/2/2015	–	092	92
INDU03	INDU	2015	PSCR	4/2/2015	–	092	92
INDU03	INDU	2015	PSTR	4/2/2015	–	092	92
INDU03	INDU	2015	ANAM	5/5/2015	–	125	125
INDU03	INDU	2015	HYXX	5/8/2015	–	128	128
INDU03	INDU	2015	LICL	5/8/2015	–	128	128

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
INDU03	INDU	2015	LICA	6/13/2015	–	164	164
INDU03	INDU	2016	Deploy	4/11/2016	–	102	102
INDU03	INDU	2016	PSCR	4/11/2016	36.34	102	102
INDU03	INDU	2016	PSTR	4/16/2016	50.29	107	107
INDU03	INDU	2016	ANAM	4/19/2016	56.06	110	110
INDU03	INDU	2016	HYXX	4/25/2016	73.58	116	116
INDU03	INDU	2016	LICL	6/12/2016	59.51	164	164
INDU03	INDU	2016	LICA	6/22/2016	66.88	174	174
INDU04	INDU	2014	Deploy	4/25/2014	–	115	115
INDU04	INDU	2014	PSCR	4/25/2014	–	115	115
INDU04	INDU	2014	PSTR	4/25/2014	–	115	115
INDU04	INDU	2014	ANAM	4/29/2014	–	119	119
INDU04	INDU	2014	HYXX	5/7/2014	–	127	127
INDU04	INDU	2014	LICL	6/12/2014	–	163	163
INDU04	INDU	2015	Deploy	3/18/2015	–	077	77
INDU04	INDU	2015	PSTR	3/25/2015	–	084	84
INDU04	INDU	2015	PSCR	4/1/2015	–	091	91
INDU04	INDU	2015	ANAM	4/16/2015	–	106	106
INDU04	INDU	2015	HYXX	5/7/2015	–	127	127
INDU04	INDU	2016	Deploy	4/7/2016	–	098	98
INDU04	INDU	2016	PSCR	4/10/2016	49.94	101	101
INDU04	INDU	2016	PSTR	4/10/2016	49.94	101	101

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
INDU04	INDU	2016	ANAM	4/15/2016	40.32	106	106
INDU04	INDU	2016	HYXX	5/11/2016	64.31	132	132
INDU05	INDU	2013	Deploy	3/27/2013	–	086	86
INDU05	INDU	2013	PSCR	3/28/2013	–	087	87
INDU05	INDU	2014	Deploy	4/24/2014	–	114	114
INDU05	INDU	2014	PSCR	4/24/2014	–	114	114
INDU05	INDU	2014	HYXX	5/13/2014	–	133	133
INDU05	INDU	2014	LICL	5/16/2014	–	136	136
INDU05	INDU	2015	Deploy	4/1/2015	–	091	91
INDU05	INDU	2015	PSCR	4/1/2015	–	091	91
INDU05	INDU	2015	PSTR	4/1/2015	–	091	91
INDU05	INDU	2015	LISY	4/5/2015	–	095	95
INDU05	INDU	2015	ANAM	4/17/2015	–	107	107
INDU05	INDU	2015	HYXX	5/4/2015	–	124	124
INDU05	INDU	2015	LICL	5/24/2015	–	144	144
INDU05	INDU	2016	Deploy	4/7/2016	–	098	98
INDU05	INDU	2016	PSCR	4/10/2016	–	101	101
INDU05	INDU	2016	ANAM	4/18/2016	–	109	109
INDU05	INDU	2016	HYXX	5/11/2016	–	132	132
INDU06	INDU	2013	Deploy	3/29/2013	–	088	88
INDU06	INDU	2013	PSCR	4/4/2013	–	094	94
INDU06	INDU	2014	Deploy	4/25/2014	–	115	115

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU06	INDU	2014	PSCR	4/25/2014	–	115	115
INDU06	INDU	2014	HYXX	5/7/2014	–	127	127
INDU06	INDU	2014	ANAM	5/10/2014	–	130	130
INDU06	INDU	2014	LICL	5/25/2014	–	145	145
INDU06	INDU	2014	LICA	6/7/2014	–	158	158
INDU06	INDU	2015	Deploy	4/2/2015	–	092	92
INDU06	INDU	2015	PSCR	4/2/2015	–	092	92
INDU06	INDU	2015	ANAM	5/7/2015	–	127	127
INDU06	INDU	2015	HYXX	5/7/2015	–	127	127
INDU06	INDU	2015	LICL	5/17/2015	–	137	137
INDU07	INDU	2013	Deploy	3/28/2013	–	087	87
INDU07	INDU	2013	PSTR	3/28/2013	–	087	87
INDU07	INDU	2013	PSCR	3/30/2013	–	089	89
INDU07	INDU	2014	ANAM	4/23/2014	–	113	113
INDU07	INDU	2014	Deploy	4/23/2014	–	113	113
INDU07	INDU	2014	LIPI	4/23/2014	–	113	113
INDU07	INDU	2014	PSCR	4/23/2014	–	113	113
INDU07	INDU	2014	PSTR	4/23/2014	–	113	113
INDU07	INDU	2014	HYXX	4/29/2014	–	119	119
INDU07	INDU	2014	LICL	5/11/2014	–	131	131
INDU07	INDU	2015	Deploy	4/1/2015	–	091	91
INDU07	INDU	2015	PSCR	4/1/2015	–	091	91

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU07	INDU	2015	PSTR	4/1/2015	–	091	91
INDU07	INDU	2015	LISY	4/4/2015	–	094	94
INDU07	INDU	2015	LIPI	4/7/2015	–	097	97
INDU07	INDU	2015	ANAM	4/17/2015	–	107	107
INDU07	INDU	2015	HYXX	5/6/2015	–	126	126
INDU07	INDU	2015	LICL	5/16/2015	–	136	136
INDU07	INDU	2016	Deploy	4/1/2016	–	092	92
INDU07	INDU	2016	PSCR	4/1/2016	41.44	092	92
INDU07	INDU	2016	PSTR	4/2/2016	37.11	093	93
INDU07	INDU	2016	LIPI	4/7/2016	40.51	098	98
INDU07	INDU	2016	ANAM	4/16/2016	49.23	107	107
INDU07	INDU	2016	HYXX	4/24/2016	60.71	115	115
INDU07	INDU	2016	LICL	5/3/2016	–	124	124
INDU08	INDU	2013	Deploy	3/29/2013	–	088	88
INDU08	INDU	2013	PSCR	3/31/2013	–	090	90
INDU08	INDU	2014	Deploy	4/24/2014	–	114	114
INDU08	INDU	2014	PSCR	4/24/2014	–	114	114
INDU08	INDU	2014	LIPI	4/25/2014	–	115	115
INDU08	INDU	2014	ANAM	5/7/2014	–	127	127
INDU08	INDU	2014	HYXX	5/7/2014	–	127	127
INDU08	INDU	2014	LICL	5/13/2014	–	133	133
INDU08	INDU	2015	Deploy	4/1/2015	–	091	91

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
INDU08	INDU	2015	PSCR	4/1/2015	–	091	91
INDU08	INDU	2015	LIPI	4/13/2015	–	103	103
INDU08	INDU	2015	ANAM	4/17/2015	–	107	107
INDU08	INDU	2015	HYXX	5/4/2015	–	124	124
INDU08	INDU	2015	LICL	5/16/2015	–	136	136
INDU08	INDU	2016	Deploy	4/1/2016	–	092	92
INDU08	INDU	2016	PSCR	4/1/2016	–	092	92
INDU08	INDU	2016	ANAM	4/18/2016	–	109	109
INDU08	INDU	2016	HYXX	5/8/2016	–	129	129
INDU08	INDU	2016	LICL	5/21/2016	–	142	142
INDU08	INDU	2016	LICA	5/29/2016	–	150	150
INDU09	INDU	2013	Deploy	3/29/2013	–	088	88
INDU09	INDU	2013	PSCR	3/29/2013	–	088	88
INDU09	INDU	2013	PSTR	3/29/2013	–	088	88
INDU09	INDU	2014	Deploy	4/24/2014	–	114	114
INDU09	INDU	2014	PSCR	4/24/2014	–	114	114
INDU09	INDU	2014	LIPI	4/25/2014	–	115	115
INDU09	INDU	2014	PSTR	4/25/2014	–	115	115
INDU09	INDU	2014	ANAM	5/1/2014	–	121	121
INDU09	INDU	2014	HYXX	5/6/2014	–	126	126
INDU09	INDU	2014	LICL	5/9/2014	–	129	129
INDU09	INDU	2014	LICA	7/5/2014	–	186	186

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU09	INDU	2015	Deploy	4/1/2015	–	091	91
INDU09	INDU	2015	LISY	4/1/2015	–	091	91
INDU09	INDU	2015	PSCR	4/1/2015	–	091	91
INDU09	INDU	2015	PSTR	4/1/2015	–	091	91
INDU09	INDU	2015	LIPI	4/6/2015	–	096	96
INDU09	INDU	2015	ANAM	4/17/2015	–	107	107
INDU09	INDU	2015	HYXX	5/3/2015	–	123	123
INDU09	INDU	2015	LICL	5/3/2015	–	123	123
INDU09	INDU	2015	LICA	6/10/2015	–	161	161
INDU09	INDU	2016	Deploy	4/8/2016	–	099	99
INDU09	INDU	2016	PSCR	4/8/2016	35.18	099	99
INDU09	INDU	2016	LIPI	4/15/2016	45.65	106	106
INDU09	INDU	2016	ANAM	4/17/2016	59.16	108	108
INDU09	INDU	2016	HYXX	4/24/2016	67.56	115	115
INDU09	INDU	2016	LICL	5/12/2016	53.10	133	133
INDU09	INDU	2016	LICA	5/24/2016	74.10	145	145
INDU10	INDU	2013	Deploy	3/29/2013	–	088	88
INDU10	INDU	2013	PSCR	3/29/2013	–	088	88
INDU10	INDU	2013	PSTR	3/29/2013	–	088	88
INDU10	INDU	2014	Deploy	4/23/2014	–	113	113
INDU10	INDU	2014	PSCR	4/23/2014	–	113	113
INDU10	INDU	2014	PSTR	4/23/2014	–	113	113

Table B3 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Indiana Dunes National Park (Indiana). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
INDU10	INDU	2014	LIPI	4/26/2014	–	116	116
INDU10	INDU	2014	HYXX	4/29/2014	–	119	119
INDU10	INDU	2014	LICL	5/5/2014	–	125	125
INDU10	INDU	2015	Deploy	4/1/2015	–	091	91
INDU10	INDU	2015	LISY	4/1/2015	–	091	91
INDU10	INDU	2015	PSCR	4/1/2015	–	091	91
INDU10	INDU	2015	PSTR	4/1/2015	–	091	91
INDU10	INDU	2015	LIPI	4/6/2015	–	096	96
INDU10	INDU	2015	ANAM	4/17/2015	–	107	107
INDU10	INDU	2015	HYXX	5/2/2015	–	122	122
INDU10	INDU	2015	LICL	5/7/2015	–	127	127
INDU10	INDU	2015	LICA	6/29/2015	–	180	180
INDU10	INDU	2016	Deploy	4/1/2016	–	092	92
INDU10	INDU	2016	PSCR	4/1/2016	–	092	92
INDU10	INDU	2016	LISY	4/11/2016	–	102	102
INDU10	INDU	2016	PSTR	4/13/2016	–	104	104
INDU10	INDU	2016	LIPI	4/17/2016	–	108	108
INDU10	INDU	2016	ANAM	4/18/2016	–	109	109
INDU10	INDU	2016	HYXX	4/18/2016	–	109	109
INDU10	INDU	2016	LICL	5/8/2016	–	129	129
INDU10	INDU	2016	LICA	5/26/2016	–	147	147

Table B4. Phenology of frog calling, including earliest date, temperature, and Julian Day for Isle Royale National Park (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
ISRO01	ISRO	2015	Deploy	5/17/2015	–	137	137
ISRO01	ISRO	2015	PSCR	5/17/2015	53.10	137	137
ISRO01	ISRO	2015	ANAM	5/26/2015	–	146	146
ISRO01	ISRO	2015	LICL	5/28/2015	42.92	148	148
ISRO01	ISRO	2016	Deploy	5/31/2016	–	152	152
ISRO01	ISRO	2016	PSCR	5/31/2016	–	152	152
ISRO01	ISRO	2016	LICL	6/5/2016	–	157	157
ISRO01	ISRO	2016	ANAM	6/18/2016	–	170	170
ISRO02	ISRO	2015	Deploy	5/19/2015	–	139	139
ISRO02	ISRO	2015	PSCR	5/20/2015	44.74	140	140
ISRO02	ISRO	2015	LICL	6/4/2015	–	155	155
ISRO02	ISRO	2015	ANAM	6/29/2015	51.35	180	180
ISRO02	ISRO	2016	Deploy	6/16/2016	–	168	168
ISRO02	ISRO	2016	LICL	6/16/2016	–	168	168
ISRO02	ISRO	2016	LISE	6/16/2016	–	168	168
ISRO02	ISRO	2016	PSCR	6/16/2016	–	168	168
ISRO03	ISRO	2015	Deploy	5/19/2015	–	139	139
ISRO03	ISRO	2015	PSCR	5/20/2015	46.73	140	140
ISRO03	ISRO	2015	LICL	5/24/2015	–	144	144
ISRO03	ISRO	2015	ANAM	6/4/2015	–	155	155
ISRO03	ISRO	2016	Deploy	6/16/2016	–	168	168
ISRO03	ISRO	2016	LICL	6/16/2016	–	168	168

Table B4 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Isle Royale National Park (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
ISRO03	ISRO	2016	PSCR	6/16/2016	–	168	168
ISRO03	ISRO	2016	ANAM	6/18/2016	–	170	170
ISRO03	ISRO	2016	LISE	6/20/2016	–	172	172
ISRO04	ISRO	2015	Deploy	5/17/2015	–	137	137
ISRO04	ISRO	2015	PSCR	5/17/2015	51.00	137	137
ISRO04	ISRO	2015	LICL	7/14/2015	53.62	195	195
ISRO04	ISRO	2016	Deploy	5/27/2016	–	148	148
ISRO04	ISRO	2016	PSCR	5/27/2016	–	148	148
ISRO04	ISRO	2016	LICL	6/2/2016	–	154	154
ISRO04	ISRO	2016	ANAM	6/18/2016	–	170	170
ISRO05	ISRO	2015	Deploy	6/23/2015	–	174	174
ISRO05	ISRO	2015	LICL	6/24/2015	51.35	175	175
ISRO05	ISRO	2015	PSCR	6/24/2015	50.82	175	175
ISRO05	ISRO	2016	Deploy	6/3/2016	–	155	155
ISRO05	ISRO	2016	PSCR	6/3/2016	–	155	155
ISRO05	ISRO	2016	LICL	6/7/2016	–	159	159
ISRO06	ISRO	2015	Deploy	5/19/2015	–	139	139
ISRO06	ISRO	2015	PSCR	5/19/2015	38.63	139	139
ISRO06	ISRO	2015	LICL	6/9/2015	50.82	160	160
ISRO06	ISRO	2016	Deploy	6/16/2016	–	168	168
ISRO06	ISRO	2016	LICL	6/16/2016	–	168	168
ISRO06	ISRO	2016	PSCR	6/16/2016	–	168	168

Table B4 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Isle Royale National Park (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
ISRO07	ISRO	2015	Deploy	6/4/2015	–	155	155
ISRO07	ISRO	2015	PSCR	6/5/2015	43.47	156	156
ISRO07	ISRO	2015	LICL	6/8/2015	–	159	159
ISRO07	ISRO	2016	Deploy	6/3/2016	–	155	155
ISRO07	ISRO	2016	LICL	6/3/2016	–	155	155
ISRO07	ISRO	2016	PSCR	6/3/2016	–	155	155
ISRO08	ISRO	2015	Deploy	5/17/2015	–	137	137
ISRO08	ISRO	2015	PSCR	5/17/2015	52.75	137	137
ISRO08	ISRO	2015	ANAM	5/24/2015	59.34	144	144
ISRO08	ISRO	2015	LICL	5/30/2015	40.70	150	150
ISRO08	ISRO	2016	Deploy	5/27/2016	–	148	148
ISRO08	ISRO	2016	PSCR	5/27/2016	–	148	148
ISRO08	ISRO	2016	LICL	5/31/2016	–	152	152
ISRO09	ISRO	2015	ANAM	6/4/2015	–	155	155
ISRO09	ISRO	2015	Deploy	6/4/2015	–	155	155
ISRO09	ISRO	2015	PSCR	6/4/2015	49.23	155	155
ISRO09	ISRO	2015	LICL	6/28/2015	–	179	179
ISRO09	ISRO	2016	Deploy	6/3/2016	–	155	155
ISRO09	ISRO	2016	PSCR	6/3/2016	–	155	155
ISRO09	ISRO	2016	ANAM	6/18/2016	–	170	170
ISRO10	ISRO	2015	Deploy	5/16/2015	–	136	136
ISRO10	ISRO	2015	PSCR	5/16/2015	38.82	136	136

Table B4 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Isle Royale National Park (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
ISRO10	ISRO	2015	PSMA	5/16/2015	38.44	136	136
ISRO10	ISRO	2016	Deploy	6/3/2016	–	155	155
ISRO10	ISRO	2016	PSCR	6/3/2016	–	155	155

Table B5. Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
MISS01	MISS	2013	Deploy	4/25/2013	–	115	115
MISS01	MISS	2013	ANAM	5/8/2013	–	128	128
MISS01	MISS	2014	ANAM	5/7/2014	–	127	127
MISS01	MISS	2014	Deploy	5/7/2014	–	127	127
MISS01	MISS	2014	LIPI	5/7/2014	–	127	127
MISS01	MISS	2014	LICL	5/28/2014	–	148	148
MISS01	MISS	2015	Deploy	4/18/2015	–	108	108
MISS01	MISS	2015	LIPI	4/18/2015	56.92	108	108
MISS01	MISS	2015	ANAM	5/2/2015	73.06	122	122
MISS01	MISS	2015	PSMA	5/11/2015	53.97	131	131
MISS01	MISS	2015	LICL	5/28/2015	60.20	148	148
MISS01	MISS	2015	HYXX	6/5/2015	–	156	156
MISS01	MISS	2016	Deploy	4/6/2016	–	097	97
MISS01	MISS	2016	LIPI	4/14/2016	–	105	105
MISS01	MISS	2016	ANAM	4/17/2016	–	108	108
MISS01	MISS	2016	LICL	5/24/2016	–	145	145
MISS01	MISS	2016	HYXX	5/26/2016	–	147	147
MISS01A	MISS	2013	ANAM	5/17/2013	–	137	137
MISS02	MISS	2015	Deploy	4/9/2015	–	099	99
MISS02	MISS	2015	ANAM	5/3/2015	57.79	123	123
MISS02	MISS	2015	HYXX	5/26/2015	–	146	146
MISS02	MISS	2016	Deploy	3/29/2016	–	089	89

Table B5 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
MISS02	MISS	2016	ANAM	4/19/2016	57.27	110	110
MISS02	MISS	2016	HYXX	5/20/2016	–	141	141
MISS02A	MISS	2013	Deploy	4/25/2013	–	115	115
MISS02A	MISS	2013	ANAM	5/16/2013	–	136	136
MISS02A	MISS	2013	LICL	6/3/2013	–	154	154
MISS02A	MISS	2014	Deploy	5/6/2014	–	126	126
MISS02A	MISS	2014	ANAM	5/12/2014	–	132	132
MISS02A	MISS	2014	LICL	5/27/2014	–	147	147
MISS03	MISS	2015	Deploy	4/8/2015	–	098	98
MISS03	MISS	2015	LIPI	4/11/2015	–	101	101
MISS03	MISS	2015	ANAM	5/3/2015	57.96	123	123
MISS03	MISS	2015	HYXX	5/6/2015	66.37	126	126
MISS03	MISS	2015	LICL	6/18/2015	55.71	169	169
MISS03	MISS	2016	Deploy	4/2/2016	–	093	93
MISS03	MISS	2016	ANAM	4/17/2016	62.77	108	108
MISS03	MISS	2016	LIPI	4/17/2016	62.77	108	108
MISS03	MISS	2016	PSMA	4/23/2016	–	114	114
MISS03	MISS	2016	HYXX	5/6/2016	–	127	127
MISS03	MISS	2016	LICL	5/19/2016	–	140	140
MISS03A	MISS	2014	ANAM	5/7/2014	–	127	127
MISS03A	MISS	2014	Deploy	5/7/2014	–	127	127
MISS03A	MISS	2014	LIPI	5/7/2014	–	127	127
MISS03A	MISS	2014	PSMA	5/13/2014	–	133	133

Table B5 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
MISS04	MISS	2015	Deploy	4/9/2015	–	099	99
MISS04	MISS	2015	LIPI	4/17/2015	61.57	107	107
MISS04	MISS	2015	ANAM	5/2/2015	71.68	122	122
MISS04	MISS	2015	HYXX	5/27/2015	65.51	147	147
MISS04	MISS	2015	LICL	6/1/2015	58.13	152	152
MISS04	MISS	2016	Deploy	3/29/2016	–	089	89
MISS04	MISS	2016	LIPI	4/13/2016	54.50	104	104
MISS04	MISS	2016	HYXX	4/23/2016	–	114	114
MISS04	MISS	2016	ANAM	5/1/2016	–	122	122
MISS04	MISS	2016	LICL	6/4/2016	61.05	156	156
MISS04A	MISS	2014	Deploy	4/25/2014	–	115	115
MISS04A	MISS	2014	PSMA	4/25/2014	–	115	115
MISS04A	MISS	2014	HYXX	5/11/2014	–	131	131
MISS04A	MISS	2014	LIPI	5/15/2014	–	135	135
MISS04A	MISS	2014	ANAM	5/17/2014	–	137	137
MISS04A	MISS	2014	ACBL	6/16/2014	–	167	167
MISS05	MISS	2015	Deploy	4/16/2015	–	106	106
MISS05	MISS	2015	LIPI	4/16/2015	–	106	106
MISS05	MISS	2015	PSMA	4/16/2015	–	106	106
MISS05	MISS	2015	HYXX	5/2/2015	–	122	122
MISS05	MISS	2015	ANAM	5/8/2015	–	128	128
MISS05	MISS	2015	LICL	7/19/2015	–	200	200

Table B5 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
MISS05	MISS	2016	Deploy	3/31/2016	–	091	91
MISS05	MISS	2016	LISY	3/31/2016	–	091	91
MISS05	MISS	2016	PSMA	3/31/2016	–	091	91
MISS05	MISS	2016	LIPI	4/16/2016	–	107	107
MISS05	MISS	2016	HYXX	5/5/2016	65.17	126	126
MISS05	MISS	2016	ANAM	5/7/2016	62.43	128	128
MISS05	MISS	2016	LICL	6/18/2016	74.79	170	170
MISS06	MISS	2015	Deploy	4/11/2015	–	101	101
MISS06	MISS	2015	LIPI	4/13/2015	–	103	103
MISS06	MISS	2015	ANAM	5/2/2015	69.62	122	122
MISS06	MISS	2015	LICL	6/5/2015	–	156	156
MISS06	MISS	2016	Deploy	3/30/2016	–	090	90
MISS06	MISS	2016	LIPI	4/13/2016	55.19	104	104
MISS06	MISS	2016	ANAM	4/16/2016	66.37	107	107
MISS06	MISS	2016	PSMA	4/21/2016	–	112	112
MISS06	MISS	2016	LICL	5/19/2016	50.11	140	140
MISS06	MISS	2016	HYXX	5/22/2016	–	143	143
MISS07	MISS	2015	Deploy	4/16/2015	–	106	106
MISS07	MISS	2015	LIPI	4/16/2015	–	106	106
MISS07	MISS	2015	PSMA	4/16/2015	68.42	106	106
MISS07	MISS	2015	ANAM	5/2/2015	68.93	122	122
MISS07	MISS	2015	HYXX	5/2/2015	71.17	122	122

Table B5 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
MISS07	MISS	2015	ACBL	6/15/2015	–	166	166
MISS07	MISS	2016	Deploy	3/31/2016	–	091	91
MISS07	MISS	2016	PSMA	4/13/2016	60.37	104	104
MISS07	MISS	2016	ANAM	4/16/2016	66.37	107	107
MISS07	MISS	2016	LIPI	4/18/2016	–	109	109
MISS07	MISS	2016	HYXX	5/5/2016	61.40	126	126
MISS07	MISS	2016	ACBL	6/5/2016	58.48	157	157
MISS07	MISS	2016	LICL	6/19/2016	–	171	171
MISS08	MISS	2015	Deploy	4/9/2015	–	099	99
MISS08	MISS	2015	LIPI	4/13/2015	–	103	103
MISS08	MISS	2015	ANAM	5/2/2015	–	122	122
MISS08	MISS	2015	HYXX	5/2/2015	–	122	122
MISS08	MISS	2015	LICL	5/30/2015	–	150	150
MISS08	MISS	2016	Deploy	4/1/2016	–	092	92
MISS08	MISS	2016	LIPI	4/13/2016	–	104	104
MISS08	MISS	2016	ANAM	4/17/2016	–	108	108
MISS08	MISS	2016	PSMA	4/21/2016	–	112	112
MISS08	MISS	2016	HYXX	5/6/2016	–	127	127
MISS08	MISS	2016	LICL	6/16/2016	–	168	168
MISS08A	MISS	2014	Deploy	6/13/2014	–	164	164
MISS08A	MISS	2014	ANAM	6/17/2014	–	168	168
MISS08A	MISS	2014	LICL	6/18/2014	–	169	169

Table B5 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Mississippi National River and Recreation Area (Minnesota). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
MISS09	MISS	2015	Deploy	4/10/2015	–	100	100
MISS09	MISS	2015	LIPI	4/15/2015	–	105	105
MISS09	MISS	2016	Deploy	3/30/2016	–	090	90
MISS09	MISS	2016	LIPI	4/17/2016	–	108	108
MISS09	MISS	2016	ANAM	4/20/2016	55.36	111	111
MISS09	MISS	2016	HYXX	5/20/2016	–	141	141
MISS09	MISS	2016	LICL	6/15/2016	64.31	167	167
MISS09A	MISS	2014	HYXX	5/24/2014	–	144	144
MISS09A	MISS	2014	Deploy	6/11/2014	–	162	162
MISS09A	MISS	2014	ANAM	6/12/2014	–	163	163
MISS09A	MISS	2014	LICL	6/26/2014	–	177	177
MISS10	MISS	2015	Deploy	4/10/2015	–	100	100
MISS10	MISS	2015	ANAM	5/7/2015	–	127	127
MISS10	MISS	2015	LIPI	5/7/2015	–	127	127
MISS10	MISS	2015	HYXX	5/16/2015	–	136	136
MISS10	MISS	2016	Deploy	3/30/2016	–	090	90
MISS10	MISS	2016	HYXX	5/6/2016	–	127	127

Table B6. Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
PIRO01	PIRO	2013	Deploy	5/15/2013	–	135	135
PIRO01	PIRO	2013	PSCR	5/15/2013	–	135	135
PIRO01	PIRO	2013	ANAM	5/19/2013	–	139	139
PIRO01	PIRO	2014	Deploy	5/27/2014	–	147	147
PIRO01	PIRO	2014	PSCR	5/27/2014	–	147	147
PIRO01	PIRO	2014	HYXX	5/29/2014	–	149	149
PIRO01	PIRO	2014	LICL	6/6/2014	–	157	157
PIRO01	PIRO	2016	Deploy	5/4/2016	–	125	125
PIRO01	PIRO	2016	PSCR	5/4/2016	–	125	125
PIRO01	PIRO	2016	ANAM	5/12/2016	46.37	133	133
PIRO01	PIRO	2016	LICL	5/29/2016	–	150	150
PIRO02	PIRO	2013	ANAM	5/15/2013	–	135	135
PIRO02	PIRO	2013	Deploy	5/15/2013	–	135	135
PIRO02	PIRO	2013	PSCR	5/15/2013	–	135	135
PIRO02	PIRO	2013	LICL	5/27/2013	–	147	147
PIRO02	PIRO	2014	Deploy	5/22/2014	–	142	142
PIRO02	PIRO	2014	PSCR	5/22/2014	–	142	142
PIRO02	PIRO	2014	ANAM	5/24/2014	–	144	144
PIRO02	PIRO	2014	HYXX	5/26/2014	–	146	146
PIRO02	PIRO	2014	LICL	5/27/2014	–	147	147
PIRO02	PIRO	2016	Deploy	4/26/2016	–	117	117
PIRO02	PIRO	2016	ANAM	5/2/2016	33.01	123	123

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
PIRO02	PIRO	2016	PSCR	5/3/2016	40.51	124	124
PIRO02	PIRO	2016	LICL	5/12/2016	57.96	133	133
PIRO03	PIRO	2013	Deploy	5/14/2013	–	134	134
PIRO03	PIRO	2013	LISY	5/14/2013	–	134	134
PIRO03	PIRO	2013	PSCR	5/14/2013	–	134	134
PIRO03	PIRO	2013	HYXX	5/26/2013	–	146	146
PIRO03	PIRO	2014	Deploy	5/21/2014	–	141	141
PIRO03	PIRO	2014	LISY	5/21/2014	–	141	141
PIRO03	PIRO	2014	PSCR	5/21/2014	–	141	141
PIRO03	PIRO	2014	HYXX	6/15/2014	–	166	166
PIRO03	PIRO	2014	LICL	6/17/2014	–	168	168
PIRO03	PIRO	2015	Deploy	4/28/2015	–	118	118
PIRO03	PIRO	2015	LISY	4/28/2015	–	118	118
PIRO03	PIRO	2015	PSCR	4/30/2015	–	120	120
PIRO03	PIRO	2015	ANAM	5/7/2015	–	127	127
PIRO03	PIRO	2015	HYXX	5/24/2015	–	144	144
PIRO03	PIRO	2015	LICL	6/13/2015	–	164	164
PIRO03	PIRO	2016	Deploy	4/22/2016	–	113	113
PIRO03	PIRO	2016	PSCR	4/22/2016	32.22	113	113
PIRO03	PIRO	2016	LISY	4/23/2016	40.32	114	114
PIRO03	PIRO	2016	ANAM	5/6/2016	–	127	127
PIRO03	PIRO	2016	HYXX	5/26/2016	–	147	147
PIRO03	PIRO	2016	LICL	6/4/2016	55.54	156	156

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
PIRO04	PIRO	2013	Deploy	5/15/2013	–	135	135
PIRO04	PIRO	2013	LISY	5/15/2013	–	135	135
PIRO04	PIRO	2013	PSCR	5/15/2013	–	135	135
PIRO04	PIRO	2014	Deploy	5/22/2014	–	142	142
PIRO04	PIRO	2014	PSCR	5/22/2014	–	142	142
PIRO04	PIRO	2014	HYXX	5/24/2014	–	144	144
PIRO04	PIRO	2014	LICL	6/15/2014	–	166	166
PIRO04	PIRO	2015	Deploy	5/5/2015	–	125	125
PIRO04	PIRO	2015	PSCR	5/5/2015	58.99	125	125
PIRO04	PIRO	2015	HYXX	5/17/2015	–	137	137
PIRO04	PIRO	2015	LICL	6/10/2015	62.25	161	161
PIRO04	PIRO	2016	Deploy	4/26/2016	–	117	117
PIRO04	PIRO	2016	PSCR	4/26/2016	30.61	117	117
PIRO04	PIRO	2016	LISY	5/5/2016	–	126	126
PIRO04	PIRO	2016	HYXX	5/24/2016	60.54	145	145
PIRO04	PIRO	2016	LICL	5/31/2016	44.56	152	152
PIRO05	PIRO	2013	Deploy	5/14/2013	–	134	134
PIRO05	PIRO	2013	PSCR	5/14/2013	–	134	134
PIRO05	PIRO	2013	ANAM	5/15/2013	–	135	135
PIRO05	PIRO	2013	LICL	7/18/2013	–	199	199
PIRO05	PIRO	2014	ANAM	5/21/2014	–	141	141
PIRO05	PIRO	2014	Deploy	5/21/2014	–	141	141

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
PIRO05	PIRO	2014	PSCR	5/21/2014	–	141	141
PIRO05	PIRO	2014	LICL	6/6/2014	–	157	157
PIRO05	PIRO	2015	Deploy	4/27/2015	–	117	117
PIRO05	PIRO	2015	PSCR	4/28/2015	38.44	118	118
PIRO05	PIRO	2015	ANAM	5/7/2015	53.62	127	127
PIRO05	PIRO	2015	LICL	5/28/2015	–	148	148
PIRO05	PIRO	2016	Deploy	4/27/2016	–	118	118
PIRO05	PIRO	2016	LISY	4/27/2016	31.21	118	118
PIRO05	PIRO	2016	PSCR	4/28/2016	–	119	119
PIRO05	PIRO	2016	ANAM	5/28/2016	63.11	149	149
PIRO06	PIRO	2013	Deploy	5/15/2013	–	135	135
PIRO06	PIRO	2013	LISY	5/15/2013	–	135	135
PIRO06	PIRO	2013	PSCR	5/15/2013	–	135	135
PIRO06	PIRO	2014	Deploy	5/19/2014	–	139	139
PIRO06	PIRO	2014	LISY	5/19/2014	–	139	139
PIRO06	PIRO	2014	PSCR	5/19/2014	–	139	139
PIRO06	PIRO	2014	LICL	5/25/2014	–	145	145
PIRO06	PIRO	2015	Deploy	4/30/2015	–	120	120
PIRO06	PIRO	2015	LISY	4/30/2015	–	120	120
PIRO06	PIRO	2015	PSCR	4/30/2015	–	120	120
PIRO06	PIRO	2015	LICL	6/26/2015	–	177	177
PIRO06	PIRO	2016	Deploy	4/27/2016	–	118	118

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
PIRO06	PIRO	2016	LISY	4/27/2016	–	118	118
PIRO06	PIRO	2016	PSCR	4/28/2016	–	119	119
PIRO06	PIRO	2016	ANAM	5/11/2016	53.97	132	132
PIRO06	PIRO	2016	HYXX	5/27/2016	60.71	148	148
PIRO06	PIRO	2016	LICL	5/28/2016	62.25	149	149
PIRO07	PIRO	2013	Deploy	5/16/2013	–	136	136
PIRO07	PIRO	2013	PSCR	5/16/2013	–	136	136
PIRO07	PIRO	2013	HYXX	5/20/2013	–	140	140
PIRO07	PIRO	2013	LICL	7/19/2013	–	200	200
PIRO07	PIRO	2014	Deploy	5/22/2014	–	142	142
PIRO07	PIRO	2014	PSCR	5/22/2014	–	142	142
PIRO07	PIRO	2014	HYXX	5/23/2014	–	143	143
PIRO07	PIRO	2015	Deploy	4/30/2015	–	120	120
PIRO07	PIRO	2015	LISY	4/30/2015	33.21	120	120
PIRO07	PIRO	2015	PSCR	4/30/2015	34.00	120	120
PIRO07	PIRO	2015	HYXX	5/6/2015	–	126	126
PIRO07	PIRO	2015	LICL	6/4/2015	53.97	155	155
PIRO07	PIRO	2016	Deploy	4/21/2016	–	112	112
PIRO07	PIRO	2016	PSCR	4/21/2016	38.44	112	112
PIRO07	PIRO	2016	LISY	4/22/2016	30.00	113	113
PIRO07	PIRO	2016	HYXX	5/20/2016	–	141	141
PIRO07	PIRO	2016	LICL	5/30/2016	57.79	151	151

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
PIRO08	PIRO	2013	Deploy	5/16/2013	–	136	136
PIRO08	PIRO	2013	PSCR	5/16/2013	–	136	136
PIRO08	PIRO	2013	ANAM	5/17/2013	–	137	137
PIRO08	PIRO	2013	HYXX	5/31/2013	–	151	151
PIRO08	PIRO	2014	ANAM	5/21/2014	–	141	141
PIRO08	PIRO	2014	Deploy	5/21/2014	–	141	141
PIRO08	PIRO	2014	PSCR	5/21/2014	–	141	141
PIRO08	PIRO	2015	Deploy	4/30/2015	–	120	120
PIRO08	PIRO	2015	PSCR	4/30/2015	30.00	120	120
PIRO08	PIRO	2015	ANAM	5/3/2015	–	123	123
PIRO08	PIRO	2015	HYXX	5/18/2015	61.91	138	138
PIRO08	PIRO	2015	LICL	5/27/2015	42.36	147	147
PIRO08	PIRO	2016	Deploy	4/22/2016	–	113	113
PIRO08	PIRO	2016	PSCR	4/22/2016	28.35	113	113
PIRO08	PIRO	2016	LISY	4/23/2016	–	114	114
PIRO08	PIRO	2016	ANAM	5/5/2016	52.40	126	126
PIRO08	PIRO	2016	HYXX	5/28/2016	63.46	149	149
PIRO08	PIRO	2016	LICL	5/30/2016	59.16	151	151
PIRO09	PIRO	2013	Deploy	5/16/2013	–	136	136
PIRO09	PIRO	2013	PSCR	5/17/2013	–	137	137
PIRO09	PIRO	2013	ANAM	5/18/2013	–	138	138
PIRO09	PIRO	2013	HYXX	7/19/2013	–	200	200

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
PIRO09	PIRO	2013	LICL	7/19/2013	–	200	200
PIRO09	PIRO	2015	Deploy	4/29/2015	–	119	119
PIRO09	PIRO	2015	LISY	4/30/2015	31.82	120	120
PIRO09	PIRO	2015	PSCR	4/30/2015	31.82	120	120
PIRO09	PIRO	2015	ANAM	5/1/2015	49.94	121	121
PIRO09	PIRO	2015	HYXX	5/6/2015	–	126	126
PIRO09	PIRO	2015	LICL	6/11/2015	41.99	162	162
PIRO09	PIRO	2016	Deploy	4/22/2016	–	113	113
PIRO09	PIRO	2016	PSCR	4/22/2016	26.88	113	113
PIRO09	PIRO	2016	ANAM	5/7/2016	–	128	128
PIRO09	PIRO	2016	HYXX	5/19/2016	–	140	140
PIRO09	PIRO	2016	LICL	6/27/2016	61.40	179	179
PIRO10	PIRO	2013	PSCR	5/14/2013	–	134	134
PIRO10	PIRO	2013	Deploy	5/18/2013	–	138	138
PIRO10	PIRO	2013	ANAM	5/20/2013	–	140	140
PIRO10	PIRO	2013	HYXX	5/30/2013	–	150	150
PIRO10	PIRO	2013	LICL	6/10/2013	–	161	161
PIRO10	PIRO	2014	Deploy	5/21/2014	–	141	141
PIRO10	PIRO	2014	PSCR	5/21/2014	–	141	141
PIRO10	PIRO	2014	ANAM	5/23/2014	–	143	143
PIRO10	PIRO	2014	LICL	6/23/2014	–	174	174
PIRO10	PIRO	2015	Deploy	4/29/2015	–	119	119

Table B6 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Pictured Rocks National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
PIRO10	PIRO	2015	PSCR	4/29/2015	37.11	119	119
PIRO10	PIRO	2015	ANAM	5/4/2015	55.19	124	124
PIRO10	PIRO	2015	HYXX	5/23/2015	–	143	143
PIRO10	PIRO	2015	LICL	6/6/2015	56.92	157	157
PIRO10	PIRO	2016	Deploy	4/25/2016	–	116	116
PIRO10	PIRO	2016	PSCR	4/25/2016	34.79	116	116
PIRO10	PIRO	2016	LICL	4/26/2016	29.17	117	117
PIRO10	PIRO	2016	ANAM	5/9/2016	28.97	130	130
PIRO10	PIRO	2016	HYXX	5/29/2016	–	150	150

Table B7. Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
SLBE01	SLBE	2014	Deploy	5/6/2014	–	126	126
SLBE01	SLBE	2014	PSCR	5/6/2014	–	126	126
SLBE01	SLBE	2014	LISY	5/8/2014	–	128	128
SLBE01	SLBE	2014	ANAM	5/10/2014	–	130	130
SLBE01	SLBE	2014	HYXX	5/21/2014	–	141	141
SLBE01	SLBE	2015	Deploy	4/20/2015	–	110	110
SLBE01	SLBE	2015	PSCR	5/2/2015	–	122	122
SLBE01	SLBE	2015	ANAM	5/6/2015	–	126	126
SLBE01	SLBE	2015	HYXX	5/8/2015	–	128	128
SLBE01	SLBE	2015	LICL	6/10/2015	–	161	161
SLBE01	SLBE	2016	Deploy	3/23/2016	–	083	83
SLBE01	SLBE	2016	LISY	3/27/2016	38.25	087	87
SLBE01	SLBE	2016	PSCR	4/15/2016	–	106	106
SLBE01	SLBE	2016	ANAM	5/13/2016	–	134	134
SLBE01	SLBE	2016	HYXX	5/26/2016	–	147	147
SLBE02	SLBE	2014	Deploy	5/6/2014	–	126	126
SLBE02	SLBE	2014	LISY	5/6/2014	–	126	126
SLBE02	SLBE	2014	PSCR	5/6/2014	–	126	126
SLBE02	SLBE	2014	ANAM	5/8/2014	–	128	128
SLBE02	SLBE	2014	HYXX	5/25/2014	–	145	145
SLBE02	SLBE	2014	LICL	7/22/2014	–	203	203
SLBE02	SLBE	2015	Deploy	4/18/2015	–	108	108

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
SLBE02	SLBE	2015	LISY	4/18/2015	–	108	108
SLBE02	SLBE	2015	PSCR	4/18/2015	–	108	108
SLBE02	SLBE	2015	HYXX	5/3/2015	–	123	123
SLBE02	SLBE	2015	ANAM	5/4/2015	–	124	124
SLBE02	SLBE	2015	LICL	7/14/2015	–	195	195
SLBE02	SLBE	2016	Deploy	3/23/2016	–	083	83
SLBE02	SLBE	2016	LISY	3/25/2016	28.56	085	85
SLBE02	SLBE	2016	PSCR	4/13/2016	–	104	104
SLBE02	SLBE	2016	ANAM	5/3/2016	48.34	124	124
SLBE02	SLBE	2016	LICL	5/21/2016	46.37	142	142
SLBE02	SLBE	2016	HYXX	5/23/2016	–	144	144
SLBE03	SLBE	2013	Deploy	5/13/2013	–	133	133
SLBE03	SLBE	2013	PSCR	5/13/2013	–	133	133
SLBE03	SLBE	2014	Deploy	4/16/2014	–	106	106
SLBE03	SLBE	2014	LISY	4/17/2014	–	107	107
SLBE03	SLBE	2014	PSCR	4/17/2014	–	107	107
SLBE03	SLBE	2014	HYXX	5/24/2014	–	144	144
SLBE03	SLBE	2014	LICL	6/28/2014	–	179	179
SLBE03	SLBE	2015	Deploy	4/19/2015	–	109	109
SLBE03	SLBE	2015	LISY	4/19/2015	–	109	109
SLBE03	SLBE	2015	PSCR	4/19/2015	–	109	109
SLBE03	SLBE	2015	HYXX	5/7/2015	–	127	127
SLBE03	SLBE	2015	LICL	6/2/2015	–	153	153

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
SLBE03	SLBE	2016	Deploy	3/29/2016	–	089	89
SLBE03	SLBE	2016	PSCR	3/29/2016	39.20	089	89
SLBE03	SLBE	2016	LISY	3/30/2016	41.99	090	90
SLBE03	SLBE	2016	LICL	4/30/2016	38.82	121	121
SLBE03	SLBE	2016	ANAM	5/9/2016	50.47	130	130
SLBE03	SLBE	2016	HYXX	5/20/2016	51.70	141	141
SLBE04	SLBE	2013	Deploy	6/8/2013	–	159	159
SLBE04	SLBE	2013	LICL	6/10/2013	–	161	161
SLBE04	SLBE	2014	Deploy	4/24/2014	–	114	114
SLBE04	SLBE	2014	LISY	4/24/2014	–	114	114
SLBE04	SLBE	2014	PSCR	4/24/2014	–	114	114
SLBE04	SLBE	2014	LIPI	4/25/2014	–	115	115
SLBE04	SLBE	2014	ANAM	5/11/2014	–	131	131
SLBE04	SLBE	2014	HYXX	5/26/2014	–	146	146
SLBE04	SLBE	2014	LICL	6/14/2014	–	165	165
SLBE04	SLBE	2015	Deploy	4/21/2015	–	111	111
SLBE04	SLBE	2015	PSCR	4/21/2015	–	111	111
SLBE04	SLBE	2015	ANAM	5/7/2015	–	127	127
SLBE04	SLBE	2015	HYXX	6/3/2015	–	154	154
SLBE04	SLBE	2015	LICL	6/17/2015	–	168	168
SLBE04	SLBE	2016	Deploy	3/29/2016	–	089	89
SLBE04	SLBE	2016	PSCR	4/1/2016	34.59	092	92
SLBE04	SLBE	2016	ANAM	5/22/2016	47.45	143	143

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
SLBE04	SLBE	2016	HYXX	5/25/2016	54.15	146	146
SLBE04	SLBE	2016	LICL	6/6/2016	55.36	158	158
SLBE05	SLBE	2014	Deploy	5/6/2014	–	126	126
SLBE05	SLBE	2014	PSCR	5/6/2014	–	126	126
SLBE05	SLBE	2014	HYXX	5/18/2014	–	138	138
SLBE05	SLBE	2014	LICL	6/17/2014	–	168	168
SLBE05	SLBE	2015	Deploy	4/17/2015	–	107	107
SLBE05	SLBE	2015	LISY	4/17/2015	–	107	107
SLBE05	SLBE	2015	PSCR	4/17/2015	–	107	107
SLBE05	SLBE	2015	HYXX	5/8/2015	–	128	128
SLBE05	SLBE	2015	LICL	5/26/2015	–	146	146
SLBE05	SLBE	2016	Deploy	3/24/2016	–	084	84
SLBE05	SLBE	2016	LISY	3/26/2016	36.72	086	86
SLBE05	SLBE	2016	PSCR	3/28/2016	35.37	088	88
SLBE05	SLBE	2016	HYXX	5/6/2016		127	127
SLBE05	SLBE	2016	LICL	5/12/2016	–	133	133
SLBE05	SLBE	2016	ANAM	5/20/2016	–	141	141
SLBE06	SLBE	2014	Deploy	4/16/2014	–	106	106
SLBE06	SLBE	2014	LISY	4/16/2014	–	106	106
SLBE06	SLBE	2014	PSCR	4/16/2014	–	106	106
SLBE06	SLBE	2014	ANAM	5/8/2014	–	128	128
SLBE06	SLBE	2014	HYXX	5/10/2014	–	130	130
SLBE06	SLBE	2014	LICL	5/25/2014	–	145	145

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
SLBE06	SLBE	2015	Deploy	4/18/2015	–	108	108
SLBE06	SLBE	2015	LISY	4/18/2015	–	108	108
SLBE06	SLBE	2015	PSCR	4/18/2015	–	108	108
SLBE06	SLBE	2015	HYXX	5/3/2015	–	123	123
SLBE06	SLBE	2015	ANAM	5/4/2015	–	124	124
SLBE06	SLBE	2015	LICL	5/18/2015	–	138	138
SLBE06	SLBE	2016	Deploy	3/30/2016	–	090	90
SLBE06	SLBE	2016	LISY	3/30/2016	41.81	090	90
SLBE06	SLBE	2016	PSCR	3/30/2016	41.81	090	90
SLBE06	SLBE	2016	ANAM	5/12/2016	54.84	133	133
SLBE06	SLBE	2016	HYXX	5/12/2016	55.70	133	133
SLBE06	SLBE	2016	LICL	5/28/2016	–	149	149
SLBE07	SLBE	2014	Deploy	5/8/2014	–	128	128
SLBE07	SLBE	2014	PSCR	5/8/2014	–	128	128
SLBE07	SLBE	2014	ANAM	5/10/2014	–	130	130
SLBE07	SLBE	2014	LICL	5/11/2014	–	131	131
SLBE07	SLBE	2014	HYXX	5/26/2014	–	146	146
SLBE07	SLBE	2015	PSCR	4/18/2015	–	108	108
SLBE07	SLBE	2015	Deploy	4/21/2015	–	111	111
SLBE07	SLBE	2015	ANAM	5/4/2015	–	124	124
SLBE07	SLBE	2015	HYXX	5/8/2015	–	128	128
SLBE07	SLBE	2015	LICL	5/18/2015	–	138	138
SLBE07	SLBE	2016	Deploy	3/24/2016	–	084	84

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as N days from January 1)	Julian Day
SLBE07	SLBE	2016	PSCR	3/31/2016	35.37	091	91
SLBE07	SLBE	2016	ANAM	5/9/2016	39.20	130	130
SLBE07	SLBE	2016	LICL	5/22/2016	51.17	143	143
SLBE07	SLBE	2016	HYXX	5/25/2016	66.00	146	146
SLBE08	SLBE	2013	ANAM	5/17/2013	–	137	137
SLBE08	SLBE	2013	Deploy	5/17/2013	–	137	137
SLBE08	SLBE	2013	PSCR	5/17/2013	–	137	137
SLBE08	SLBE	2014	Deploy	4/24/2014	–	114	114
SLBE08	SLBE	2014	PSCR	4/29/2014	–	119	119
SLBE08	SLBE	2014	ANAM	5/10/2014	–	130	130
SLBE08	SLBE	2014	HYXX	5/21/2014	–	141	141
SLBE08	SLBE	2014	LICL	5/30/2014	–	150	150
SLBE08	SLBE	2015	Deploy	4/26/2015	–	116	116
SLBE08	SLBE	2015	PSCR	4/29/2015	–	119	119
SLBE08	SLBE	2015	ANAM	5/4/2015	–	124	124
SLBE08	SLBE	2015	HYXX	5/17/2015	–	137	137
SLBE08	SLBE	2015	LICL	6/3/2015	–	154	154
SLBE08	SLBE	2016	Deploy	3/30/2016	–	090	90
SLBE08	SLBE	2016	PSCR	4/17/2016	48.52	108	108
SLBE08	SLBE	2016	ANAM	5/4/2016	44.38	125	125
SLBE08	SLBE	2016	LICL	5/27/2016	70.14	148	148
SLBE09	SLBE	2013	Deploy	5/15/2013	–	135	135
SLBE09	SLBE	2013	PSCR	5/15/2013	–	135	135

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
SLBE09	SLBE	2013	ANAM	5/19/2013	–	139	139
SLBE09	SLBE	2013	LICL	5/19/2013	–	139	139
SLBE09	SLBE	2013	HYXX	5/27/2013	–	147	147
SLBE09	SLBE	2014	Deploy	5/8/2014	–	128	128
SLBE09	SLBE	2014	PSCR	5/8/2014	–	128	128
SLBE09	SLBE	2014	ANAM	5/9/2014	–	129	129
SLBE09	SLBE	2014	LICL	5/11/2014	–	131	131
SLBE09	SLBE	2014	HYXX	5/23/2014	–	143	143
SLBE09	SLBE	2015	Deploy	4/18/2015	–	108	108
SLBE09	SLBE	2015	PSCR	4/18/2015	–	108	108
SLBE09	SLBE	2015	ANAM	5/3/2015	–	123	123
SLBE09	SLBE	2015	HYXX	5/3/2015	–	123	123
SLBE09	SLBE	2015	LICL	5/6/2015	–	126	126
SLBE09	SLBE	2016	Deploy	3/24/2016	–	084	84
SLBE09	SLBE	2016	PSCR	3/29/2016	39.76	089	89
SLBE09	SLBE	2016	ANAM	5/1/2016	45.65	122	122
SLBE09	SLBE	2016	LICL	5/18/2016	38.06	139	139
SLBE09	SLBE	2016	HYXX	5/21/2016	55.90	142	142
SLBE11	SLBE	2014	ANAM	5/28/2014	–	148	148
SLBE11	SLBE	2014	Deploy	5/28/2014	–	148	148
SLBE11	SLBE	2014	PSCR	5/28/2014	–	148	148
SLBE11	SLBE	2015	Deploy	4/28/2015	–	118	118
SLBE11	SLBE	2015	PSCR	4/28/2015	–	118	118

Table B7 (continued). Phenology of frog calling, including earliest date, temperature, and Julian Day for Sleeping Bear Dunes National Lakeshore (Michigan). Species Codes: ACBL - Blanchard's Cricket Frog (*Acris blanchardi*), ANAM - American Toad (*Anaxyrus americanus*), ANFO - Fowler's Toad (*Anaxyrus fowleri*), HYCH - Cope's Gray Treefrog (*Hyla chrysoscelis*), HYVE - Gray Treefrog (*Hyla versicolor*), HYXX – Treefrog species (*Hyla* sp.) LICA - American Bullfrog (*Lithobates catesbeianus*), LICL - Green Frog (*Lithobates clamitans*), LIPA - Pickerel Frog (*Lithobates palustris*), LIPI - Northern Leopard Frog (*Lithobates pipiens*), LISE - Mink Frog (*Lithobates septentrionalis*), LISY - Wood Frog (*Lithobates sylvaticus*), PSCR - Spring Peeper (*Pseudacris crucifer*), PSMA - Boreal Chorus Frog (*Pseudacris maculata*), PSTR - Western Chorus Frog (*Pseudacris triseriata*).

Site	Park	Year	Species	Earliest Date	Temp(F)	Julian Day Formula (as	
						N days from January 1)	Julian Day
SLBE11	SLBE	2015	ANAM	5/3/2015	–	123	123
SLBE11	SLBE	2016	Deploy	4/13/2016	–	104	104
SLBE11	SLBE	2016	PSCR	4/15/2016	39.38	106	106
SLBE11	SLBE	2016	ANAM	5/11/2016	56.40	132	132

Appendix C. Park summaries.

Table C1. Four-letter codes based on Latin names used to identify amphibian species in the following park summaries.

Code	Latin Name	Common Name
ACBL	<i>Acris blanchardi</i>	Blanchard's Cricket Frog
ANAM	<i>Anaxyrus americanus</i>	American Toad
HYCH	<i>Hyla chrysoscelis</i>	Cope's Gray Treefrog
HYVE	<i>Hyla versicolor</i>	Gray Treefrog
LICA	<i>Lithobates catesbeianus</i>	American Bullfrog
LICL	<i>Lithobates clamitans</i>	Green Frog
LIPI	<i>Lithobates pipiens</i>	Northern Leopard Frog
LISE	<i>Lithobates septentrionalis</i>	Mink Frog
LISY	<i>Lithobates sylvaticus</i>	Wood Frog
PSCR	<i>Pseudacris crucifer</i>	Spring Peeper
PSMA	<i>Pseudacris maculata</i>	Boreal Chorus Frog
PSTR	<i>Pseudacris triseriata</i>	Western Chorus Frog

Apostle Islands National Lakeshore

Apostle Islands National Lakeshore detection results are presented in Table C2. This displays combined results from both auto- and manual detections by the Great Lakes Inventory and Monitoring Network (GLKN) program. Six species were confirmed: American Toad, Cope's Gray Treefrog, Gray Treefrog, Green Frog, Wood Frog, and Spring Peeper. Cope's Gray Treefrog was only detected at one site (APIS10) in one year. In reviewing available acoustic data, Casper (2018) found no Treefrog spp. calling at APIS-10 in 2014, but two individual Gray Treefrogs were calling in 2015, and one Cope's Gray Treefrog called for just a few days in early July, and in 2016 and 2017 two individual Gray Treefrogs again were calling. These low numbers suggest that there is not a breeding population of either species at this quarry pond, but rather a few males are attempting to establish. Treefrogs are known to occasionally stowaway by secreting themselves within recesses of cars, boats, and other equipment during the daytime. It is therefore possible that these individuals were accidently transported to the island and will not persist.

Five species were not detected by the program: American Bullfrog, Pickerel Frog, Northern Leopard Frog, Mink Frog, and Boreal Chorus Frog. American Bullfrog, Pickerel Frog, and Boreal Chorus Frog probably do not occur in the park, but are near their northern range limits and will continue to be monitored for presence by the GLKN program (Casper 2018, Powell et al. 2016). Northern Leopard Frog and Mink Frog are known to occur in the park (Casper 2018) but have not been

detected at the monitored sites to date. Both these species have low detection probabilities and sparse distribution within the Apostle Islands National Lakeshore, and they are probably truly absent from most GLKN sites (Casper 2018). The remaining species tracked by the GLKN program—Blanchard’s Cricket Frog and Fowler’s Toad—are out of range for this park (Powell et al. 2016).

Recommendations

Implement the early morning sampling recommendation to improve Mink Frog detection. Implement the delayed start ARS deployment recommendation in autumn to improve detection of species with early calling seasons (Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog).

Table C2. Amphibian occupancy record for Apostle Islands National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
APIS01	P	2013	1	0	1	0	0	0	–	0	–	1	–	3
APIS01	P	2014	1	0	1	0	1	0	0	0	–	1	0	4
APIS01	P	2015	1	0	1	0	1	0	0	0	0	1	0	4
APIS01	P	2016	1	0	1	0	1	0	0	0	0	1	0	4
APIS02	P	2014	1	0	0	0	1	0	0	0	–	1	0	3
APIS02	P	2015	1	0	1	0	1	0	0	0	1	1	0	5
APIS02	P	2016	1	0	1	0	1	0	0	0	0	1	0	4
APIS03	P	2013	1	0	1	0	1	0	–	0	–	1	–	4
APIS03	P	2014	1	0	1	0	1	0	0	0	–	1	0	4
APIS03	P	2015	1	0	0	0	1	0	0	0	0	1	0	3
APIS03	P	2016	1	0	1	0	1	0	0	0	0	1	0	4
APIS04	S	2014	0	0	0	0	1	0	0	0	–	1	0	2
APIS04	S	2015	1	0	0	0	1	0	0	0	1	1	0	4
APIS04	S	2016	1	0	1	0	1	0	0	0	1	1	0	5
APIS05	S	2013	0	0	1	0	0	0	–	0	–	1	–	2
APIS05	S	2014	1	0	1	0	1	0	0	0	–	1	0	4

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C2 (continued). Amphibian occupancy record for Apostle Islands National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
APIS05	S	2015	1	0	1	0	1	0	0	0	0	1	0	4
APIS05	S	2016	1	0	1	0	1	0	0	0	1	1	0	5
APIS06	S	2014	0	0	1	0	0	0	0	0	–	1	0	2
APIS06	S	2015	1	0	1	0	1	0	0	0	1	1	0	5
APIS06	S	2016	1	0	1	0	0	0	0	0	1	1	0	4
APIS07	P	2013	1	0	1	0	1	0	–	0	–	1	–	4
APIS07	P	2014	1	0	1	0	1	0	0	0	–	1	0	4
APIS07	P	2015	1	0	1	0	1	0	0	0	1	1	0	5
APIS07	P	2016	1	0	1	0	1	0	0	0	1	1	0	5
APIS08	S	2013	1	0	0	0	0	0	–	0	–	1	–	2
APIS08	S	2014	1	0	0	0	0	0	0	0	–	1	0	2
APIS08	S	2015	1	0	0	0	0	0	0	0	1	1	0	3
APIS08	S	2016	1	0	0	0	0	0	0	0	1	1	0	3
APIS10	P	2014	0	0	0	0	1	0	0	0	–	1	0	2
APIS10	P	2015	1	1	1	0	1	0	0	0	1	1	0	6
APIS10	P	2016	1	0	1	0	1	0	0	0	1	1	0	5

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C2 (continued). Amphibian occupancy record for Apostle Islands National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
APIS11	P	2014	1	0	0	0	1	0	0	0	–	1	0	3
APIS11	P	2015	1	0	0	0	1	0	0	0	0	1	0	3
APIS11	P	2016	1	0	0	0	1	0	0	0	0	1	0	3
N Sites	n/a	n/a	10	1	8	0	9	0	0	0	7	10	0	6

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Grand Portage National Monument

Grand Portage National Monument detection results are presented in Table C3. This displays combined results from both auto- and manual detections by the GLKN program. Five species were confirmed with only two years of data: American Toad, Gray Treefrog, Green Frog, Mink Frog, and Spring Peeper. All except Mink Frog were well distributed and found on five or six of the six sites monitored. Mink Frog was detected only at GRPO01, but this species currently has low detection rates.

Four species were not detected by the program: Cope's Gray Treefrog, Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog. Cope's Gray Treefrog is unlikely to occur in the park, which is well outside its recognized range limits (Powell et al. 2016), but will continue to be monitored for presence by the GLKN program. The remaining three species may occur in the park but have not been detected at the monitored sites to-date by the GLKN program. These species have early calling seasons and may be missed by late ARS deployment. The remaining species tracked by the GLKN program are out of range for this park: Blanchard's Cricket Frog, American Bullfrog, Pickerel Frog, and Fowler's Toad (Powell et al. 2016).

Recommendations

Implement the early morning sampling recommendation to improve Mink Frog detection. Implement the delayed start ARS deployment recommendation in autumn to improve detection of species with early calling seasons (Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog).

Table C3. Amphibian occupancy record for Grand Portage National Monument, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²									Total Spp.
			ANAM	HYCH	HYVE	LICL	LIPI	LISE	LISY	PSCR	PSMA	
GRPO01	S	2016	1	0	1	1	0	1	0	1	0	5
GRPO03	S	2015	0	0	1	0	0	0	0	1	0	2
GRPO03	S	2016	1	0	1	1	0	0	0	1	0	4
GRPO04	E	2015	1	0	1	0	0	0	0	1	0	3
GRPO04	E	2016	1	0	1	1	0	0	0	1	0	4
GRPO05	E	2015	1	0	1	1	0	0	0	1	0	4
GRPO05	E	2016	1	0	1	1	0	0	0	1	0	4
GRPO06	P	2015	1	0	1	1	0	0	0	1	0	4
GRPO06	P	2016	1	0	1	1	0	0	0	1	0	4
GRPO07	P	2015	0	0	0	0	0	0	0	1	0	1
GRPO07	P	2016	0	0	0	0	0	0	0	1	0	1
N Sites	n/a	n/a	5	0	5	5	0	1	0	6	0	5

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Indiana Dunes National Lakeshore

Indiana Dunes National Lakeshore detection results are presented in Table C4. This displays combined results from both auto- and manual detections by the GLKN program. Nine species were confirmed: American Toad, Cope's Gray Treefrog, Gray Treefrog, American Bullfrog, Green Frog, Northern Leopard Frog, Wood Frog, Spring Peeper, and Chorus Frog spp. Chorus Frog species determination remains uncertain in this transition zone, but they are probably Boreal Chorus Frog (Powell et al. 2016). Cope's Gray Treefrog has been detected at only one site in one year (INDU07). Wood Frog has been detected at only four sites to-date, and American Bullfrog and Northern Leopard Frog at five sites each. Remaining species occupy most sites in most years. All of the latter three species have lower detection rates so there is a greater probability that they occupy more sites but have not been detected.

Three species were not detected by the program: Blanchard's Cricket Frog, Pickerel Frog, and Fowler's Toad. All may occur in the park, or did historically, but have not been detected at the monitored sites to date by the GLKN program. The remaining species tracked by the GLKN program, Mink Frog, is out of range for this park (Powell et al. 2016).

Recommendations

Consider a supplementary ARS station at the known Fowler's Toad site if security issues can be resolved (perhaps mounted high on a locking flag or martin house pole). Ensure that ARS are deployed early enough to monitor species with early calling seasons (Pickerel Frog, Northern Leopard Frog, Wood Frog, and Chorus Frog spp.).

Table C4. Amphibian occupancy record for Indiana Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
INDU01	E	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
INDU01	E	2014	0	0	0	0	1	0	0	0	0	–	1	1	3
INDU01	E	2015	0	1	0	0	1	0	0	0	0	0	1	1	4
INDU01	E	2016	0	1	0	0	1	0	0	0	0	0	1	1	4
INDU02	E	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
INDU02	E	2014	0	0	0	0	1	0	1	0	0	–	1	1	4
INDU02	E	2015	0	1	0	0	1	0	1	0	1	0	1	1	6
INDU02	E	2016	0	1	0	0	1	0	1	0	0	0	1	0	4
INDU03	P	2013	0	0	0	0	0	0	0	0	0	0	1	1	2
INDU03	P	2014	0	1	0	0	1	0	1	0	0	–	1	0	4
INDU03	P	2015	0	1	0	0	1	1	1	0	0	0	1	1	6
INDU03	P	2016	0	1	0	0	1	1	1	0	0	0	1	1	6
INDU04	S	2013	0	0	0	0	0	0	0	0	0	0	–	0	0
INDU04	S	2014	0	1	0	0	1	0	1	0	0	–	1	1	5
INDU04	S	2015	0	1	0	0	1	0	0	0	0	0	1	1	4
INDU04	S	2016	0	1	0	0	1	0	0	0	0	0	1	1	4

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C4 (continued). Amphibian occupancy record for Indiana Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
INDU05	S	2013	0	0	0	0	0	0	0	0	0	0	1	0	1
INDU05	S	2014	0	0	0	0	1	0	1	0	0	–	1	0	3
INDU05	S	2015	0	1	0	0	1	0	1	0	0	1	1	1	6
INDU05	S	2016	0	1	0	0	1	0	0	0	0	0	1	0	3
INDU06	P	2013	0	0	0	0	0	0	0	0	0	0	1	0	1
INDU06	P	2014	0	0	0	0	1	1	1	0	0	–	1	0	4
INDU06	P	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
INDU07	S	2013	0	0	0	0	0	0	0	0	0	0	1	1	2
INDU07	S	2014	0	1	0	0	1	0	1	0	1	–	1	1	6
INDU07	S	2015	0	1	0	1	1	0	1	0	1	1	1	1	8
INDU07	S	2016	0	1	0	0	1	0	1	0	1	0	1	1	6
INDU08	P	2013	0	0	0	0	0	0	0	0	0	0	1	0	1
INDU08	P	2014	0	1	0	0	1	0	1	0	1	–	1	0	5
INDU08	P	2015	0	1	0	0	1	0	1	0	1	0	1	0	5
INDU08	P	2016	0	1	0	0	1	1	1	0	0	0	1	0	5
INDU09	S	2013	0	0	0	0	0	0	0	0	0	0	1	1	2
INDU09	S	2014	0	1	0	0	1	1	1	0	1	–	1	1	7

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C4 (continued). Amphibian occupancy record for Indiana Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
INDU09	S	2015	0	1	0	0	1	1	1	0	1	1	1	1	8
INDU09	S	2016	0	1	0	0	1	1	1	0	1	0	1	0	6
INDU10	E	2013	0	0	0	0	0	0	0	0	0	0	1	1	2
INDU10	E	2014	0	0	0	0	1	0	1	0	1	–	1	1	5
INDU10	E	2015	0	0	0	0	1	0	1	0	1	1	1	1	6
INDU10	E	2016	0	1	0	0	1	1	1	0	1	1	1	1	8
N Sites	n/a	n/a	0	10	0	1	10	5	9	0	5	4	10	8	9

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Isle Royale National Park

Isle Royale National Park detection results are presented in Table C5. This displays combined results from both auto- and manual detections by the GLKN program. Five species were confirmed with only two years of data: American Toad, Green Frog, Mink Frog, Spring Peeper and Boreal Chorus Frog. Only Green Frog and Spring Peeper were well distributed (found on nine and ten sites, respectively, in all years). Mink Frog and Boreal Chorus Frog were each detected only at one site in one year, but these species are currently poorly monitored due to late ARS deployments.

Four species were not detected by the program: Cope's Gray Treefrog, Gray Treefrog, Northern Leopard Frog, and Wood Frog. Cope's Gray Treefrog is unlikely to occur in the park, which is well outside its recognized range limits (Powell et al. 2016), but will continue to be monitored for presence by the GLKN program. Gray Treefrog has previously been reported from the Windigo area, but records are rare and remain unconfirmed (Casper 2008). Treefrogs are known to occasionally stowaway by secreting themselves within recesses of watercraft, camping gear, and other equipment during the daytime. It is therefore possible that individuals are occasionally transported to the island but do not persist. Northern Leopard Frog are probably truly absent (Casper 2008), and Wood Frog is known present (Casper 2008) and considered common, but currently is poorly monitored due to late ARS deployments. The remaining species tracked by the GLKN program are out of range for this park: Blanchard's Cricket Frog, American Bullfrog, Pickerel Frog, and Fowler's Toad (Powell et al. 2016).

Recommendations

Implement the early morning sampling recommendation to improve Mink Frog detection. Implement the delayed start ARS deployment recommendation in autumn to improve detection of species with early calling seasons (Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog).

Table C5. Amphibian occupancy record for Isle Royale National Park, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²									Total Spp.
			ANAM	HYCH	HYVE	LICL	LIPI	LISE	LISY	PSCR	PSMA	
ISRO01	P	2015	1	0	0	1	0	0	0	1	0	3
ISRO01	P	2016	1	0	0	1	–	0	–	1	–	3
ISRO02	S	2015	1	0	0	1	0	0	0	1	0	3
ISRO02	S	2016	0	0	0	1	–	0	–	1	–	2
ISRO03	S	2015	1	0	0	1	0	0	0	1	0	3
ISRO03	S	2016	1	0	0	1	–	1	–	1	–	4
ISRO04	P	2015	0	0	0	1	0	0	0	1	0	2
ISRO04	P	2016	1	0	0	1	–	0	–	1	–	3
ISRO05	P	2015	0	0	0	1	–	0	–	1	–	2
ISRO05	P	2016	0	0	0	1	–	0	–	1	–	2
ISRO06	P	2015	0	0	0	1	0	0	0	1	0	2
ISRO06	P	2016	0	0	0	1	–	0	–	1	–	2
ISRO07	E	2015	0	0	0	1	–	0	–	1	–	2
ISRO07	E	2016	0	0	0	1	–	0	–	1	–	2
ISRO08	P	2015	1	0	0	1	0	0	0	1	0	3
ISRO08	P	2016	0	0	0	1	–	0	–	1	–	2

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C5 (continued). Amphibian occupancy record for Isle Royale National Park, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²									Total Spp.
			ANAM	HYCH	HYVE	LICL	LIPI	LISE	LISY	PSCR	PSMA	
ISRO09	P	2015	1	0	0	1	–	0	–	1	–	3
ISRO09	P	2016	1	0	0	0	–	0	–	1	–	2
ISRO10	S	2015	0	0	0	0	0	0	0	1	1	2
ISRO10	S	2016	0	0	0	0	–	0	–	1	–	1
N Sites	n/a	n/a	6	0	0	9	0	1	0	10	1	5

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Mississippi National River and Recreation Area

Mississippi National River and Recreation Area detection results are presented in Table C6. This displays combined results from both auto- and manual detections by the GLKN program. In this park initial site selections were problematic, due to unrealized flood extents and security issues. Therefore, some ARS units were moved to new sites in 2014 and 2015. See Table C7 for a summary of how each ARS was redeployed annually. Final sites were established in 2015, so site names for 2013 and 2014 deployments were appended with letters to indicate they were at sites since abandoned. While these sites are included in this initial synthesis, for subsequent reporting abandoned sites should be removed and considered as separate inventory data.

Eight species were confirmed: Blanchard's Cricket Frog, American Toad, Cope's Gray Treefrog, Gray Treefrog, Green Frog, Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog. Wood Frog and Blanchard's Cricket Frog were detected at only one and two sites, respectively. Cope's Gray Treefrog and Boreal Chorus Frog were found at six and seven sites, respectively. Remaining species occupy most sites in most years. The discovery of Blanchard's Cricket Frog was novel and represents three new county records to-date (Casper et al. 2017).

Four species were not detected by the program: American Bullfrog, Pickerel Frog, Mink Frog, and Spring Peeper. All may occur in the park, or did historically, but have not been detected at the monitored sites to-date by the GLKN program. These species will continue to be monitored for presence by the GLKN program. American Bullfrog, Pickerel Frog, and Mink Frog are likely truly absent from within the park boundaries, being near range limits and there being no recent or historical records (Moriarty and Hall 2014; Powell et al. 2016; J. J. Moriarty, personal communication, 2016). Spring Peeper absence is surprising given the apparently suitable habitat and the park being within its known range (Powell et al. 2016). A possible explanation is extirpation from disease such as Ranavirus (Gray and Miller 2013) or Chytrid fungus (Saenz et al. 2015) without subsequent recovery in this fragmented urban environment. Fowler's Toad, the only other species tracked by the GLKN program, is out of range for this park (Powell et al. 2016).

Recommendations

Consider supplementary ARS stations dedicated to monitoring the State Endangered Blanchard's Cricket Frog. Ensure that ARS are deployed early enough to monitor species with early calling seasons (Pickerel Frog, Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog).

Table C6. Amphibian occupancy record for Mississippi National River and Recreation Area, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ACBL	ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSMA	
MISS01A	S	2013	0	1	0	0	0	0	0	0	0	0	0	1
MISS01	P	2014	0	1	0	0	0	1	0	1	0	0	0	3
MISS01	P	2015	0	1	1	0	0	1	0	1	0	0	0	4
MISS01	P	2016	0	1	1	1	0	1	0	1	0	0	0	5
MISS02A	S	2013	0	1	0	0	0	1	0	0	0	0	0	2
MISS02A	S	2014	0	1	0	0	0	1	0	0	0	0	0	2
MISS02	S	2015	0	1	0	1	0	0	0	0	0	0	0	2
MISS02	S	2016	0	1	0	1	0	0	0	0	0	0	0	2
MISS03A	S	2013	0	1	0	0	0	0	0	0	0	0	0	1
MISS03B	S	2014	0	1	0	0	0	0	0	1	0	0	1	3
MISS03	P	2015	0	1	0	1	0	1	0	1	0	0	0	4
MISS03	P	2016	0	1	0	1	0	1	0	1	0	0	1	5
MISS04A	P	2014	1	1	0	1	0	0	0	1	0	0	1	5
MISS04	P	2015	0	1	0	1	0	1	0	1	0	0	0	4
MISS04	P	2016	0	1	0	1	0	1	0	1	0	0	0	4
MISS05	E	2015	0	1	1	1	0	1	0	1	0	0	1	6
MISS05	E	2016	0	1	0	1	0	1	0	1	1	0	1	6

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C6 (continued). Amphibian occupancy record for Mississippi National River and Recreation Area, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ACBL	ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSMA	
MISS06	P	2015	0	1	0	0	0	1	0	1	0	0	0	3
MISS06	P	2016	0	1	0	1	0	1	0	1	0	0	1	5
MISS07	S	2015	1	1	0	1	0	0	0	1	0	0	1	5
MISS07	S	2016	1	1	0	1	0	1	0	1	0	0	1	6
MISS08A	S	2014	0	1	1	0	0	1	0	–	–	0	0	3
MISS08	E	2015	0	1	0	1	0	1	0	1	0	0	0	4
MISS08	E	2016	0	1	0	1	0	1	0	1	0	0	1	5
MISS09A	S	2014	0	1	1	0	0	1	0	–	–	0	0	3
MISS09	S	2015	0	0	0	0	0	0	0	1	0	0	0	1
MISS09	S	2016	0	1	1	0	0	1	0	1	0	0	0	4
MISS10	E	2015	0	1	1	0	0	0	0	1	0	0	0	3
MISS10	E	2016	0	0	1	0	0	0	0	0	0	0	0	1
N Sites	n/a	n/a	2	17	6	9	0	11	0	11	1	0	7	8

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C7. Site change record for automated recorders (ARS) at Mississippi National River and Recreation Area.

ARS_ID	2013	2014	2015	2016
MISS01	Coldwater Miss R. slough	Coldwater North	Coldwater North	Coldwater North
MISS02	Coldwater S of spring	Coldwater S of spring	Ravenna Trail & Hwy 68	Ravenna Trail & Hwy 68
MISS03	Coldwater N	E of 35E & S of Shepard Rd.	Grey Cloud Dunes SNA (N of tracks)	Grey Cloud Dunes SNA (N of tracks)
MISS04	–	Cement plant	Hastings/Ravenna Trail (Frisbee)	Hastings/Ravenna Trail (Frisbee)
MISS05	–	–	Macalaster Ordway	Macalaster Ordway
MISS06	–	–	Pickereel Lake-St. Paul	Pickereel Lake-St. Paul
MISS07	–	–	Swing Bridge – Inver Grove Heights	Swing Bridge – Inver Grove Heights
MISS08	–	Hwy 77 Nicols Road, snake in sack	Grey Cloud Dunes SNA (S of tracks)	Grey Cloud Dunes SNA (S of tracks)
MISS09	–	494/13 Tartarian Honeysuckle	Three Rivers Park	Three Rivers Park
MISS10	–	–	Coon Rapids Dam (Anoka)	Coon Rapids Dam (Anoka)

Pictured Rocks National Lakeshore

Pictured Rocks National Lakeshore detection results are presented in Table C8. This displays combined results from both auto- and manual detections by the GLKN program. Five species were confirmed: American Toad, Gray Treefrog, Green Frog, Wood Frog, and Spring Peeper. All of these species were well distributed within the park.

Six species were not detected by the program: Cope's Gray Treefrog, American Bullfrog, Pickerel Frog, Northern Leopard Frog, Mink Frog, and Chorus Frog spp. These species will continue to be monitored for presence by the GLKN program. All except Northern Leopard Frog and Mink Frog probably do not currently occur in the park, but have reasonably close range limits (Casper 2005, Casper et al. 2015, Powell et al. 2016). Northern Leopard Frog and Mink Frog occur fairly close to park boundaries (Casper et al. 2015), but have not been detected at the monitored sites to-date by the GLKN program. Both these species have low detection probabilities, but detection may improve by implementing the recommendations below. The remaining species tracked by the GLKN program—Blanchard's Cricket Frog and Fowler's Toad—are out of range for this park (Powell et al. 2016).

Recommendations

Implement the early morning sampling recommendation to improve Mink Frog detection. Implement the delayed start ARS deployment recommendation in autumn to improve detection of species with early calling seasons (Pickerel Frog, Northern Leopard Frog, Wood Frog, and Boreal Chorus Frog).

Table C8. Amphibian occupancy record for Pictured Rocks National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro1	Year	Species2											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
PIRO01	P	2013	1	0	0	0	0	0	0	0	0	1	0	2
PIRO01	P	2014	0	0	1	0	1	0	0	0	–	1	0	3
PIRO01	P	2016	1	0	0	0	1	0	0	0	0	1	0	3
PIRO02	P	2013	1	0	0	0	1	0	0	0	0	1	0	3
PIRO02	P	2014	1	0	1	0	1	0	0	0	–	1	0	4
PIRO02	P	2016	1	0	0	0	1	0	0	0	0	1	0	3
PIRO03	E	2013	0	0	0	0	0	0	0	0	1	1	0	2
PIRO03	E	2014	0	0	1	0	1	0	0	0	1	1	0	4
PIRO03	E	2015	1	0	1	0	1	0	0	0	1	1	0	5
PIRO03	E	2016	1	0	1	0	1	0	0	0	1	1	0	5
PIRO04	E	2013	0	0	0	0	0	0	0	0	1	1	0	2
PIRO04	E	2014	0	0	1	0	1	0	0	0	–	1	0	3
PIRO04	E	2015	0	0	1	0	1	0	0	0	0	1	0	3
PIRO04	E	2016	0	0	1	0	1	0	0	0	1	1	0	4

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C8 (continued). Amphibian occupancy record for Pictured Rocks National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro1	Year	Species2											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
PIRO05	P	2013	1	0	0	0	1	0	0	0	0	1	0	3
PIRO05	P	2014	1	0	0	0	1	0	0	0	–	1	0	3
PIRO05	P	2015	1	0	0	0	1	0	0	0	0	1	0	3
PIRO05	P	2016	1	0	0	0	0	0	0	0	1	1	0	3
PIRO06	E	2013	0	0	0	0	0	0	0	0	1	1	0	2
PIRO06	E	2014	0	0	0	0	1	0	0	0	1	1	0	3
PIRO06	E	2015	0	0	0	0	1	0	0	0	1	1	0	3
PIRO06	E	2016	1	0	1	0	1	0	0	0	1	1	0	5
PIRO07	S	2013	0	0	1	0	1	0	0	0	0	1	0	3
PIRO07	S	2014	0	0	1	0	0	0	0	0	–	1	0	2
PIRO07	S	2015	0	0	1	0	1	0	0	0	1	1	0	4
PIRO07	S	2016	0	0	1	0	1	0	0	0	1	1	0	4
PIRO08	S	2013	1	0	1	0	1	0	0	0	0	1	0	4
PIRO08	S	2014	1	0	1	0	0	0	0	0	–	1	0	3
PIRO08	S	2015	1	0	1	0	1	0	0	0	0	1	0	4
PIRO08	S	2016	1	0	1	0	1	0	0	0	1	1	0	5

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C8 (continued). Amphibian occupancy record for Pictured Rocks National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²											Total Spp.
			ANAM	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISE	LISY	PSCR	PSMA	
PIRO09	S	2013	1	0	1	0	1	0	0	0	0	1	0	4
PIRO09	S	2014	–	–	–	–	–	–	–	–	–	–	–	0
PIRO09	S	2015	1	0	1	0	1	0	0	0	1	1	0	5
PIRO09	S	2016	1	0	1	0	1	0	0	0	0	1	0	4
PIRO10	P	2013	1	0	1	0	1	0	0	0	0	1	0	4
PIRO10	P	2014	1	0	0	0	1	0	0	0	0	1	0	3
PIRO10	P	2015	1	0	1	0	1	0	0	0	0	1	0	4
PIRO10	P	2016	1	0	1	0	1	0	0	0	0	1	0	4
N Sites	n/a	n/a	8	0	9	0	10	0	0	0	7	10	0	5

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Sleeping Bear Dunes National Lakeshore

Sleeping Bear Dunes National Lakeshore detection results are presented in Table C9. This displays combined results from both auto- and manual detections by the GLKN program. Six species were confirmed: American Toad, Gray Treefrog, Green Frog, Northern Leopard Frog, Wood Frog, and Spring Peeper. Northern Leopard Frog has been detected at only one site to-date, and was also rarely encountered in the inventory study (Casper and Anton 2008). Wood Frog was detected at six sites. Remaining species occupy most sites in most years. Northern Leopard Frog and Wood Frog detection rates should improve with earlier ARS deployment as recommended below.

Six species were not detected by the program: Blanchard's Cricket Frog, Fowler's Toad, Cope's Gray Treefrog, American Bullfrog, Pickerel Frog, and Western Chorus Frog. These species will continue to be monitored for presence by the GLKN program. There is no evidence that Blanchard's Cricket Frog ever occupied Benzie or Leelanau counties, which is generally considered to be outside of its range limits (Casper and Anton 2008, Powell et al. 2016). The northern range limit for Fowler's Toad is at the park, but no confirmed records are known (Casper and Anton 2008, Powell et al. 2016). It could potentially colonize in the future with ongoing climate change. Cope's Gray Treefrog appears to be either absent or rare in the park, which is just outside its presumed range limit (Casper and Anton 2008, Powell et al. 2016). American Bullfrog is apparently sparsely distributed in the park, with vouchers only from North Manitou Island (Casper and Anton 2008, Powell et al. 2016). Tadpoles of this species are often accidentally transported with bait minnows, making historic distribution difficult to evaluate. Pickerel Frog and Western Chorus Frog have not been reported from the park, but the park is within their presumed range limits (Casper and Anton 2008, Powell et al. 2016). Mink Frog, the only other species tracked by the GLKN program, is out of range for this park (Powell et al. 2016).

Recommendations

Ensure that ARS are deployed early enough to monitor species with early calling seasons (Pickerel Frog, Northern Leopard Frog, Wood Frog, and Western Chorus Frog). Where necessary implement the delayed start ARS deployment recommendation in autumn to improve detection of these species (i.e., the island site).

Table C9. Amphibian occupancy record for Sleeping Bear Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
SLBE01	E	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE01	E	2014	0	1	0	0	1	0	0	0	0	1	1	0	4
SLBE01	E	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE01	E	2016	0	1	0	0	1	0	0	0	0	1	1	0	4
SLBE02	E	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE02	E	2014	0	1	0	0	1	0	0	0	0	1	1	0	4
SLBE02	E	2015	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE02	E	2016	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE03	E	2013	0	0	0	0	1	0	0	0	0	0	1	0	2
SLBE03	E	2014	0	0	0	0	1	0	1	0	0	1	1	0	4
SLBE03	E	2015	0	0	0	0	1	0	1	0	0	1	1	0	4
SLBE03	E	2016	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE04	S	2013	0	0	0	0	0	0	1	0	0	0	0	0	1
SLBE04	S	2014	0	1	0	0	1	0	1	0	1	1	1	0	6
SLBE04	S	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE04	S	2016	0	1	0	0	1	0	1	0	0	0	1	0	4

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C9 (continued). Amphibian occupancy record for Sleeping Bear Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
SLBE05	S	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE05	S	2014	0	0	0	0	1	0	1	0	0	0	1	0	3
SLBE05	S	2015	0	0	0	0	1	0	1	0	0	1	1	0	4
SLBE05	S	2016	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE06	S	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE06	S	2014	0	0	0	0	1	0	1	0	0	1	1	0	4
SLBE06	S	2015	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE06	S	2016	0	1	0	0	1	0	1	0	0	1	1	0	5
SLBE07	P	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE07	P	2014	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE07	P	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE07	P	2016	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE08	P	2013	0	1	0	0	0	0	1	0	0	0	1	0	3
SLBE08	P	2014	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE08	P	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE08	P	2016	0	1	0	0	0	0	1	0	0	0	1	0	3

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

Table C9 (continued). Amphibian occupancy record for Sleeping Bear Dunes National Lakeshore, 2013–2016. 1 = Present, 0 = Absent, “–” = no data.

Site	Hydro ¹	Year	Species ²												Total Spp.
			ACBL	ANAM	ANFO	HYCH	HYVE	LICA	LICL	LIPA	LIPI	LISY	PSCR	PSTR	
SLBE09	P	2013	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE09	P	2014	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE09	P	2015	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE09	P	2016	0	1	0	0	1	0	1	0	0	0	1	0	4
SLBE10	P	2013	0	0	0	0	0	0	0	0	0	0	0	0	0
SLBE11	P	2014	0	1	0	0	0	0	0	–	–	–	1	0	2
SLBE11	P	2015	0	1	0	0	0	0	0	0	0	0	1	0	2
SLBE11	P	2016	0	1	0	0	0	0	0	0	0	0	1	0	2
N Sites	n/a	n/a	0	10	0	0	9	0	9	0	1	6	10	0	6

¹ Hydrology: Permanent, Semi-permanent, Ephemeral.

² ACBL=Blanchard's Cricket Frog, ANAM=American Toad, HYCH=Cope's Gray Treefrog, HYVE=Gray Treefrog, LICA=American Bullfrog, LICL=Green Frog, LIPI=Northern Leopard Frog, LISE=Mink Frog, LISY=Wood Frog, PSCR=Spring Peeper, PSMA=Boreal Chorus Frog, PSTR=Western Chorus Frog.

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