



Acoustic Monitoring for Bats at Pictured Rocks National Lakeshore

Data Summary Report for 2015–2018

Natural Resource Data Series NPS/GLKN/NRDS—2023/1397



ON THE COVER

Bat acoustic monitoring equipment at Pictured Rocks National Lakeshore.
NPS

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Data Summary Report for 2015–2018

Natural Resource Data Series NPS/GLKN/NRDS—2023/1397

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Abstract

Pictured Rocks National Lakeshore initiated an acoustic monitoring program for bats in 2015. Resulting data were provided to the Great Lakes Inventory and Monitoring Network to be processed under the same protocol as bat monitoring data from other network parks. Acoustic recordings were analyzed using the software program Kaleidoscope Pro, and a subset of files were manually reviewed to confirm species identifications. The six bat species previously documented at the park were reconfirmed: big brown bat, eastern red bat, hoary bat, silver-haired bat, little brown bat, and northern long-eared bat. All except the northern long-eared bat were verified through manual vetting (northern long-eared bat presence in the park has been separately verified by captures). A seventh species, the tricolored bat, has never been physically captured in the park. However, our acoustic data suggest it may be present based on four manually verified recordings from one site. Although the park is outside its known range, this species has been recorded in other parts of northern Michigan, which prompted us to include it in our expanded analysis. The status of tricolored bat in the park remains uncertain due to limited data, and our data are insufficient to determine activity trends for this species. For the remaining species, activity levels for hoary bat and silver-haired bat appear to be stable, while activity levels for big brown bat, eastern red bat, little brown bat, and northern long-eared bat show decreasing trends.

Acknowledgments

This work would not have been possible without all the park employees, partners, and volunteers who completed field surveys and provided logistical support, including C. Heyd, N. Holomuzki, M. Gutt, T. Oja, E. Schultz, and C. Fastiggi. We thank K. Gilland and others at Normandeau Associates for data processing and manual vetting, and R. Key for database development and assistance with data management. C. Heyd and T. Gostomski reviewed earlier drafts of this report. Funding for this monitoring effort was provided by the National Park Service's Natural Resource Stewardship and Science Directorate White-Nose Syndrome program.

Introduction

North American bat populations are threatened by a number of environmental pressures including the fungal disease white-nose syndrome (WNS), mortality from wind turbines, and changing land use and climatic conditions. Due to these conservation concerns, the National Park Service (NPS) and other federal agencies have implemented or expanded bat research and monitoring programs (Loeb et al. 2015, Rodhouse et al. 2016, Rodriguez et al. 2019). The NPS has funded over 150 bat-focused research, conservation, and education projects at 78 parks since 2013 (National Park Service 2016).

In 2015, the Great Lakes Inventory and Monitoring Network (GLKN) and Pictured Rocks National Lakeshore (PIRO) independently established bat acoustic monitoring programs focused on documenting the impacts of WNS. The original objectives of PIRO's monitoring program were to obtain baseline acoustic data prior to establishment of WNS, assess bat presence in different habitats in the park, better understand timing of the breeding season by documenting spring arrival and fall departure dates, and collect data to support environmental compliance procedures. When the GLKN and PIRO projects were initiated, the Great Lakes region was at the leading edge of the disease's spread, with WNS documented within 50 miles of most parks (U.S. Geological Survey 2019). In 2018 the PIRO dataset was merged with the GLKN program, allowing all data to be analyzed in a consistent manner. GLKN's monitoring program is helping parks to document baseline data on their bat populations and assess changes over time.

Nine species of bats are found in the Great Lakes region (Kurta 2017), detailed in Appendix A. All are insectivores belonging to the Family Vespertilionidae, the largest and most common group of bats in North America. Great Lakes bat species can be divided into two groups: tree-roosting, migratory bats and cavity-roosting, hibernating bats. The hibernating species are highly susceptible to WNS, except for big brown bats (*Eptesicus fuscus*), which show greater resistance to the disease and experience less severe infections (Frank et al. 2014, Moore et al. 2018).

The U.S. Fish and Wildlife Service lists the Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) as federally endangered under the Endangered Species Act (U.S. Fish and Wildlife Service 1967, 2022a). The agency has also proposed listing the tricolored bat (*Perimyotis subflavus*) as endangered (U.S. Fish and Wildlife Service 2022b). Furthermore, all nine Great Lakes bat species are listed by one or more states as endangered, threatened, or of special concern (Michigan Natural Features Inventory 2009, Minnesota Department of Natural Resources 2013, Wisconsin Department of Natural Resources 2021, Indiana Department of Natural Resources 2021) (Appendix A).

Prior to the initiation of the bat acoustic monitoring program in 2015, a total of six species had been documented at PIRO (Table 1). Survey work specifically targeting bats took place in 2003–2004 (Kruger and Peterson 2008, Miller 2010). This effort resulted in both captures and acoustic recordings of the little brown bat (*Myotis lucifugus*), northern long-eared bat, and eastern red bat (*Lasiurus borealis*). In addition, acoustic recordings were obtained for the big brown bat, hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). No park-specific occurrence records are available for the period before 2003. Although an early report on the vertebrate fauna of

the park described six bat species as being found in the region, it was based on other cited sources rather than on the author's own fieldwork (McCann 1975). Concurrent to our acoustic monitoring, mist-netting surveys were completed at PIRO in 2016–2017, resulting in captures of six species in the first year and four in the second (Kurta and Slider 2017).

Table 1. Bat species occurrences recorded at Pictured Rocks National Lakeshore by other survey efforts prior to or concurrent with the acoustic monitoring program, and method(s) by which the species were documented. Data sources include Kruger and Peterson (2008), Miller (2010), and Kurta and Slider (2017). Ranges are as shown in Kurta (2017).

Species Name	Prior Records	Methods Used
Big Brown Bat <i>Eptesicus fuscus</i>	Yes	Acoustic, Capture
Eastern Red Bat <i>Lasiurus borealis</i>	Yes	Acoustic, Capture
Hoary Bat <i>Lasiurus cinereus</i>	Yes	Acoustic, Capture
Silver-haired Bat <i>Lasionycteris noctivagans</i>	Yes	Acoustic, Capture
Little Brown Bat <i>Myotis lucifugus</i>	Yes	Acoustic, Capture, Genetic Voucher
Northern Long-eared Bat <i>Myotis septentrionalis</i>	Yes	Acoustic, Capture, Genetic Voucher
Indiana Bat <i>Myotis sodalis</i>	No, well outside of range	n/a
Evening Bat <i>Nycticeius humeralis</i>	No, well outside of range	n/a
Tricolored Bat <i>Perimyotis subflavus</i>	No, close to edge of range	n/a

PIRO lies near the edge of the known range for tricolored bat, but this species was not captured or recorded during the monitoring efforts conducted by Kruger and Peterson (2008) or Kurta and Slider (2017). However, acoustic surveys in 2015 on the nearby Hiawatha National Forest did document tricolored bats through a small number of manually vetted calls (Schools and Klatt 2015). The location where the tricolored bat calls were recorded is about 20 miles south of PIRO. Tricolored bats have also been observed hibernating in mines in Michigan's Upper Peninsula (Kurta and Smith 2014, 2020). The combination of both summer and winter records in relative proximity to PIRO suggests the species may possibly be present in the park. The ranges of the Indiana bat and evening bat (*Nycticeius humeralis*) lie further south, therefore these species are not expected to be present at PIRO.

Methods

Bat acoustic monitoring at PIRO was conducted according to the park's protocol (Fastiggi 2018). In 2018, some components of GLKN's protocol (Goodwin 2020) and associated standard operating procedures were added, particularly in regard to collection of site data and data management.

Site Selection

Sample sites were selected using a Generalized Random Tessellation Stratified (GRTS) cell system. GRTS is a probabilistic sample design based on the creation of a master sample, as described by Larsen et al. (2008) and Stevens and Olsen (2004). Additionally, sample sites were selected to be representative of the different habitat types present in the park (Fastiggi 2018). Each potential site was evaluated for accessibility and habitat representation to determine if it should be included. Twenty-seven sites were established under this protocol in 2015 and three more were added in 2016. These 30 sites were revisited each year with the sampling locations duplicated as closely as possible using site descriptions and GPS coordinates. Park staff selected several additional non-protocol sampling points based on management interests; those are not included in this report.

Specific sampling sites were chosen by identifying locations that were representative of the assigned habitat category (e.g., northern hardwood forest, mesic conifer forest) and had landscape openings or corridors sufficient to allow high quality sound recordings. Suitable locations for sampling bats typically include potential travel corridors (e.g., cut lines, roads, trails) and foraging areas (e.g., wetlands). As much as possible, the sample sites at PIRO were located away from active roadways, large forest clearings, dense vegetative clutter, buildings, or open water in order to optimize recording quality. Each site was assigned a Site ID in the format PIRO001. A map of PIRO sample sites is provided in Figure 1.

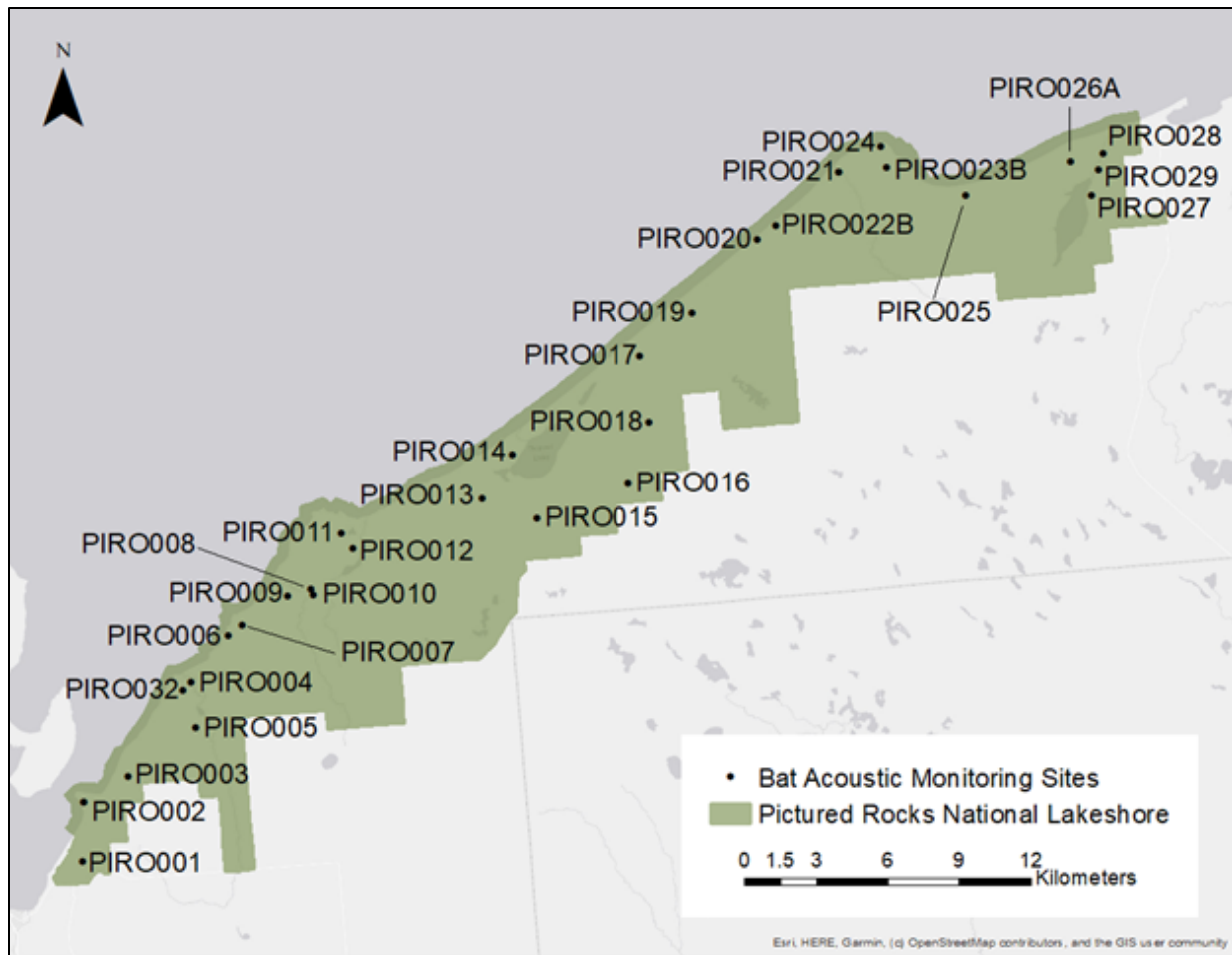


Figure 1. Bat monitoring sites at Pictured Rocks National Lakeshore, Michigan. Sites shown were established in 2015 ($n = 27$) and 2016 ($n = 3$) and used each year since, with the exception of the following: PIRO011, PIRO015, PIRO017, PIRO021, PIRO023, PIRO026, and PIRO032 were not sampled in 2017. PIRO022 was moved to the “B” site in 2017 and PIRO023 was moved to the “B” site in 2018.

Data Collection

Acoustic monitoring is conducted during the summer, from 1 June–15 August. The same sites are monitored each year in approximately the same order and at approximately the same time of year to facilitate estimation of long-term trends. Each site is sampled once per year for a period of 7–8 consecutive nights. Detectors are programmed to record every night from 30 minutes before sunset to 15 minutes after sunrise.

One acoustic detector with an external ultrasonic microphone is deployed at each survey site to passively record bat echolocation calls. The equipment used at PIRO includes a Pettersson D500X detector powered by an external battery, and a unidirectional Pettersson microphone. Recordings are collected in full-spectrum format and stored as WAV files on compact flash cards mounted in the detector. Field technicians record a site description including habitat type, microphone direction, detector settings, GPS coordinates, and weather information. Site photos were taken in 2015 and

2018. In 2018 a GLKN field datasheet was also completed for each site. After retrieving equipment, the WAV files and detector status files are downloaded.

Data Management and Analysis

The PIRO wildlife biologist and field technicians are responsible for data organization and securely storing data at the PIRO office. At the conclusion of the field season, all data are submitted to GLKN for quality assurance/quality control, entry into the bat monitoring database, data analysis, and data archiving.

For 2015–2018 data, GLKN contracted with an outside consultant (Normandeau Associates) to process acoustic files and obtain species classifications. Each deployment was categorized as valid or not valid. Valid deployments were those that had at least four nights of successful recording during the protocol sampling period (1 June–15 August). In some cases, there was more than one valid deployment per year at a particular site. When this occurred, the first valid deployment was categorized as “valid” and the remaining were categorized as “valid (duplicate).” A deployment categorized as “failed” indicates it was unsuccessful due to equipment malfunction, improper programming, and/or vandalism. “Failed (short)” indicates the deployment was unsuccessful only because the minimum required four nights of recording were not completed. “Early” and “late” categories designate deployments that occurred either before 1 June or after 15 August, respectively, and thus were outside the protocol sampling period. Finally, “non-protocol” indicates deployments that were completed for park-specific monitoring goals or points of management interest. These “non-protocol” locations were selected intentionally, rather than following the GRTS sample design. Non-valid deployments (including those categorized as “valid (duplicate)”) were excluded from all further analyses.

Normandeau Associates used an automated acoustic analysis software program to filter out noise and assign species classifications to audio files. The specific program used was Wildlife Acoustics Kaleidoscope Pro Version 4.0.0 with the Bats of North America Classifier Version 3.1.0 and the “–1 More Sensitive” setting. During Kaleidoscope processing, the software assigned each audio file a species-level classification where possible. Files not classified to a particular species were labeled “No ID” if they contained unknown bat calls; otherwise, they were labeled “Noise.” The software did not process files that were corrupt or unreadable. Files from incomplete recording nights (less than six hours of recording) were also excluded from processing.

Kaleidoscope Pro allows the user to customize a list of possible bat species that will be considered during the classification process. This allows for the exclusion of any species not found in the study area, reducing the chance of obtaining false positive results. GLKN determined which species have known ranges within the boundaries of PIRO based on published range maps (Harvey et al. 2011, Rodhouse et al. 2016, Kurta 2017). These species were considered the “baseline” species list. We also created an “expanded” list, adding species that are documented relatively close to the park and may possibly be present. All audio files were run through Kaleidoscope Pro twice, once using the baseline list and once using the expanded list. The baseline and expanded species lists for PIRO are provided in Appendix B. Analysis settings used in Kaleidoscope Pro are provided in Appendix C.

Kaleidoscope Pro and other similar acoustic analysis programs are not 100% accurate. Software classification results are expected to include some errors due to the similarity of echolocation calls among different species, variation of calls within the same species, poor quality or truncated calls, clutter effects, or multiple bats recorded simultaneously (Britzke et al. 2013, Reichert et al. 2018). Therefore, manual review (manual vetting) of call files by a qualified biologist is an important secondary step to verify the results produced by the software.

Due to the enormous quantity of data collected by the GLKN monitoring program, it is not feasible to manually review all files. From each year's dataset, Normandeau Associates randomly selected approximately 1% of the files that Kaleidoscope Pro identified to the species level (i.e., excluding noise and unknown bats). To ensure all species were proportionally represented, this consisted of 1% of the files identified to each species at each park, with a required minimum of 10 files per species per park unless there were fewer than 10 files available. This procedure was used for the baseline analysis; for the expanded analysis, additional files were selected only for the new species not already represented by the baseline analysis.

Files selected for manual vetting were chosen and prepared by a different individual than the biologist doing the reviewing. Any information that could identify the sample site such as site location and date were removed from the file name. Manual vetting was performed by a qualified biologist from Normandeau Associates, who was provided with a list of possible species to consider (equivalent to the baseline or expanded species list, Appendix B). However, to ensure an independent assessment, the manual reviewer did not know how the Kaleidoscope software had identified each file. Manual identifications were based on call characteristics such as shape, frequency, and duration, using published reference materials and call libraries. The manual reviewer assigned a species or species group (e.g., unknown high frequency or unknown low frequency) to each audio file, assuming it contained bat calls of sufficient quality. The reviewer could also determine that a file did not contain bat echolocation calls and contained only noise. Following processing, results of both automated software classification and manual vetting were incorporated into GLKN's bat monitoring database.

Acoustic monitoring by these methods does not allow estimation of population size or number of individual bats detected. Instead, results of the Kaleidoscope Pro analysis are presented in terms of species composition (percent of total files assigned to each species), activity levels (call files per recording night), and spatial and temporal distribution (percent of sites and percent of recording nights with positive detections). Manual vetting results are presented in terms of the number of vetted calls that were verified. For simplicity, results for vetted calls that were not verified are not broken down by species in this report, but those data are available if needed for future analyses. Misclassification rates, as derived from the manual vetting process, have not been applied to the Kaleidoscope Pro results; data presented reflect the original outputs from the software.

Results

Survey Effort

Acoustic monitoring took place at PIRO during the years 2015 through 2018. There were 20 to 29 valid deployments per year. This report provides results only for the sites that had valid deployments. No data from non-protocol sites (points of management interest) are included in this report.

Monitoring occurred over a total of 142 to 215 nights of recording per year. The number of audio files collected per year ranged from 60,880 to 301,671. Yearly survey effort and deployment information are summarized in Figure 2 and Appendix D.

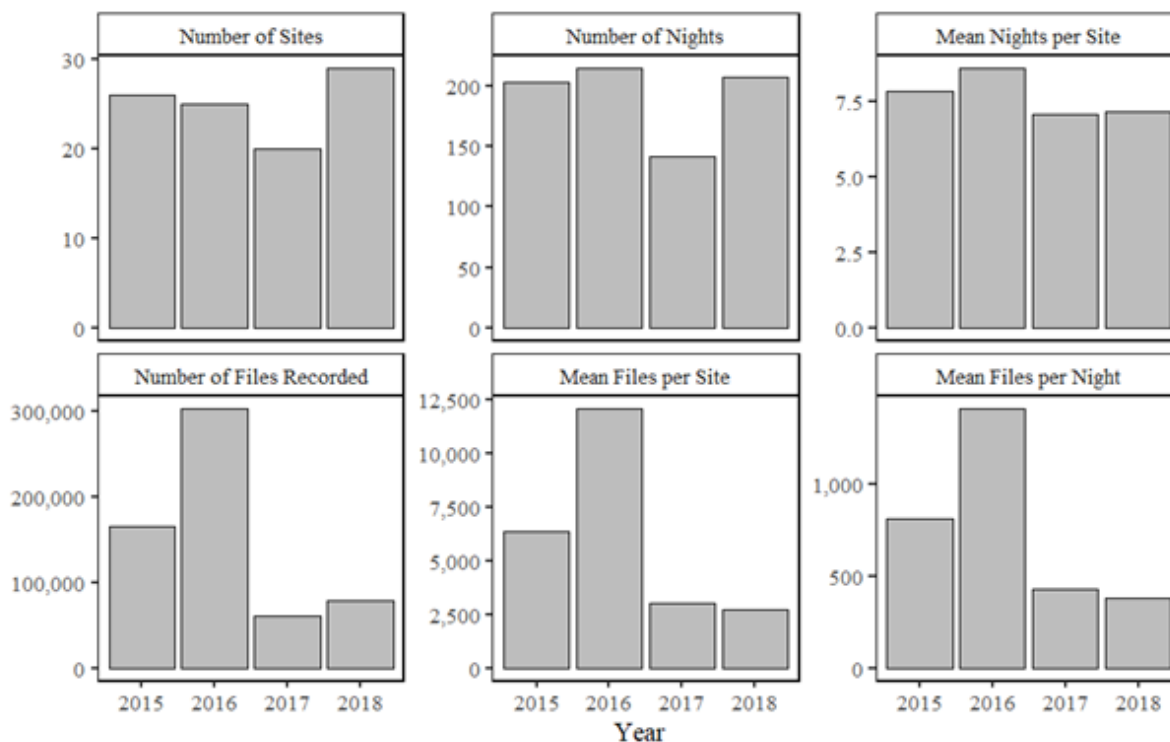


Figure 2. Yearly survey effort at Pictured Rocks National Lakeshore, 2015–2018. *Top, left to right:* Number of sites, number of nights, and mean nights per site. *Bottom, left to right:* total number of audio files recorded, mean files per site, and mean files per night. Number of files is prior to classification (i.e., includes noise).

Automated Classification

The proportion of files identified to the species level each year ranged from 3% to 12%, while the proportion of files categorized as noise was consistently higher than 85% (Figure 3, Appendix E). However, noisiness varied somewhat by site and by year (Appendix F). The proportion of files assigned to a species versus noise or unknown was similar for the baseline and expanded analyses.

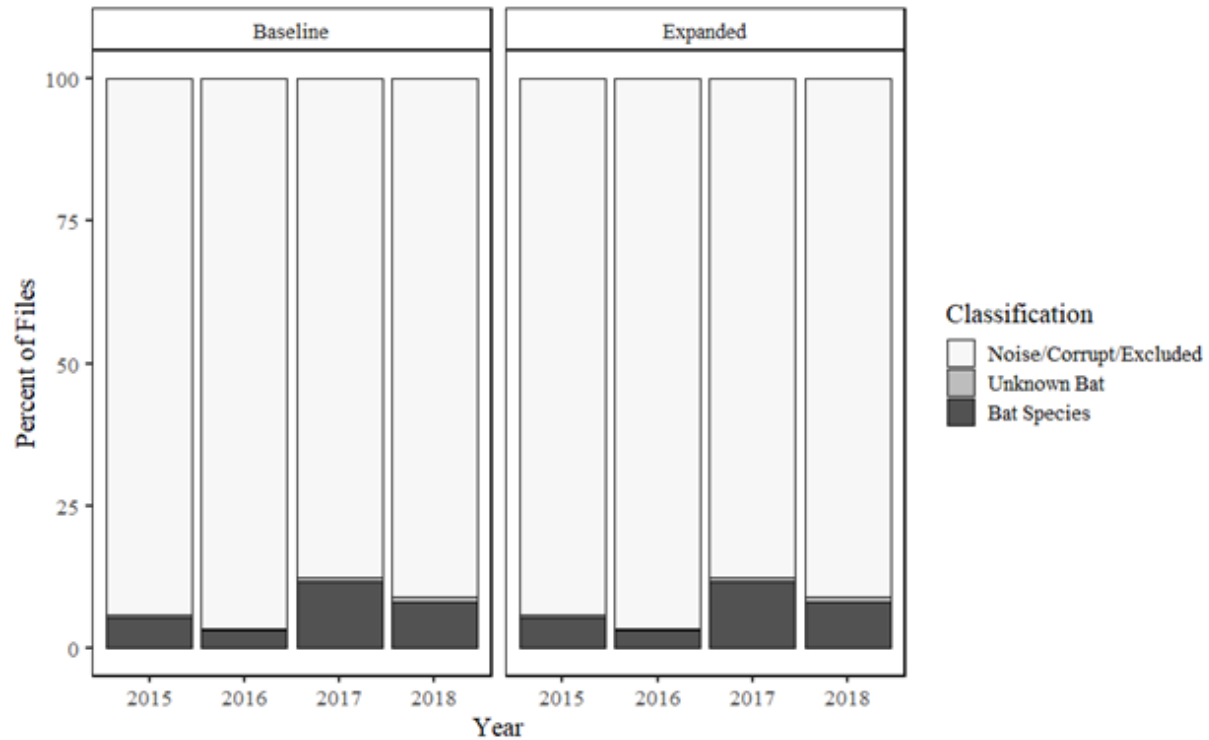


Figure 3. Percent of audio files classified by Kaleidoscope Pro as bat species vs. unknown bats vs. noise, corrupt, and excluded files, Pictured Rocks National Lakeshore, 2015–2018. Proportions are shown for the baseline (*left*) and expanded (*right*) analyses.

Kaleidoscope Pro’s automated classification resulted in a total of six species documented in the baseline analysis and seven species documented in the expanded analysis. For the subset of files that were successfully assigned a species-level classification, the percent classified to each species was similar between the baseline and expanded analyses but varied from year to year (Figure 4). In both the baseline and expanded analyses, the largest proportion of files was classified as silver-haired bat in 2015–2017, while in 2018, the largest proportion was classified as hoary bat.

After 2016, the proportion of files attributed to the three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) showed a strong decrease relative to the proportion attributed to the other species (Figure 5). The most notable changes for individual species were a continuing increase in the percentage of hoary bat files each year after 2015, and a sharp decrease in the percentage of little brown bat files after 2016. File counts and percentages are provided in Appendix E.

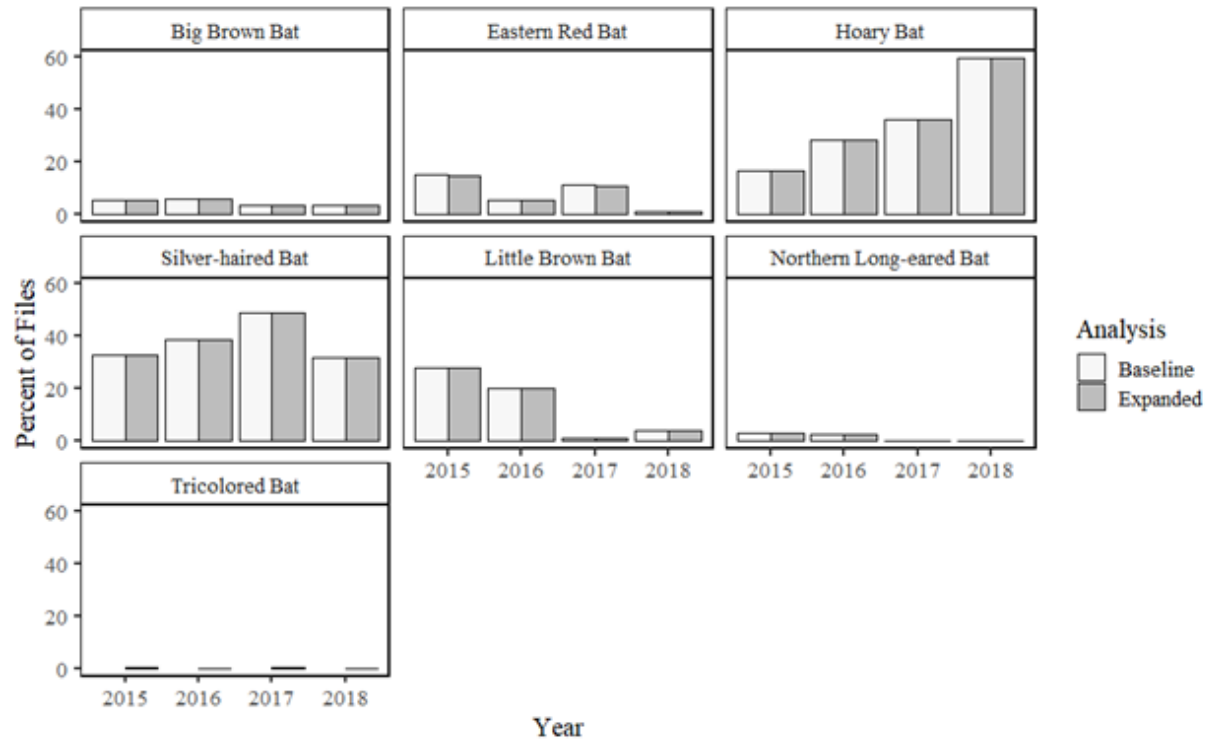


Figure 4. Proportion of files classified to each species each year in the baseline versus expanded analysis, Pictured Rocks National Lakeshore, 2015–2018. Tricolored bat was only allowed as a possible species in the expanded analysis. Includes only the subset of files successfully assigned a species-level classification by Kaleidoscope Pro.

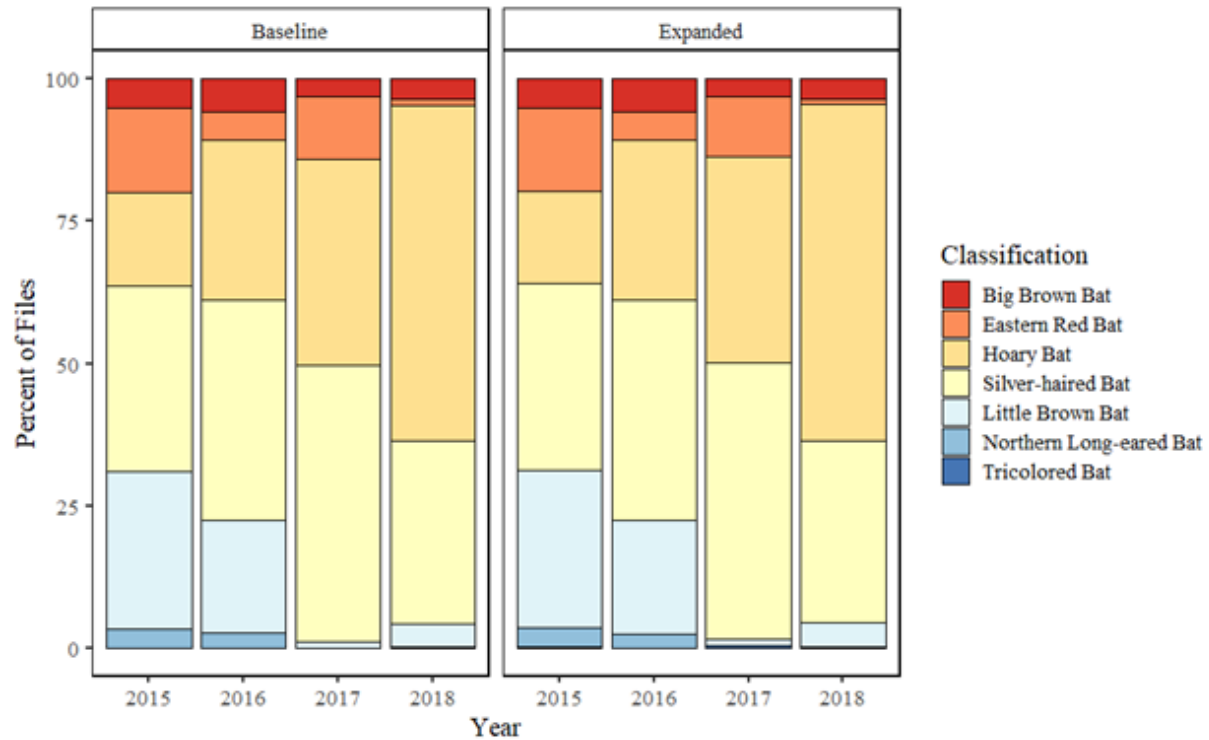


Figure 5. Proportion of files classified to each species each year relative to all other species, Pictured Rocks National Lakeshore, 2015–2018. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue, while less susceptible species are shown in red, orange, and yellow. Tricolored bat was only allowed as a possible species in the expanded analysis. Includes only the subset of files successfully assigned a species-level classification by Kaleidoscope Pro.

Call files per recording night were calculated on both the park level and individual site level using the results of the automated classification by Kaleidoscope. Parkwide, total call files per recording night were highest in 2017 and lowest in 2018 (Figure 6). As compared to the earlier years, in 2018 the parkwide call files per recording night were considerably lower for little brown, silver-haired, and eastern red bats (Figure 6).

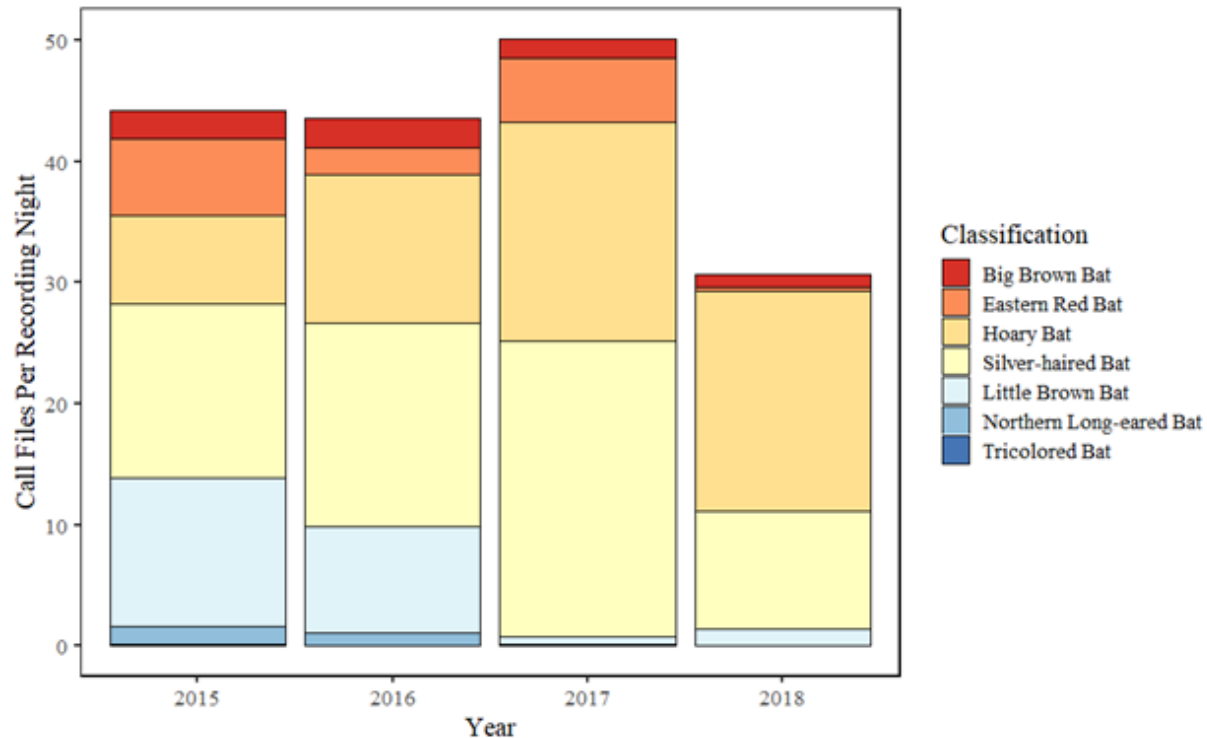


Figure 6. Parkwide call files per recording night by species and year for the expanded analysis, Pictured Rocks National Lakeshore, 2015–2018. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue while less susceptible species are shown in red, orange, and yellow. Results were similar for baseline and expanded analysis so only the expanded analysis is shown.

At the site level, when looking at all species combined, the median call files per recording night was lowest in 2018 and highest in 2016, and we observed a smaller range of values after the first year (Figure 7, lower right panel). Looking at individual species, the median call files per recording night was very low, generally less than one, across all years for most species: big brown bat, eastern red bat, hoary bat, little brown bat, and northern long-eared bat (Figure 7). Median silver-haired bat values were somewhat higher, but still less than five every year. Median tricolored bat values were close to zero every year. We observed a smaller range of values after 2015 for eastern red bat, little brown bat, and northern long-eared bat. Adding the tricolored bat as a possible species in the expanded analysis did not substantially change the call files per recording night values for other species, because only a small number of files were reassigned to tricolored bat.

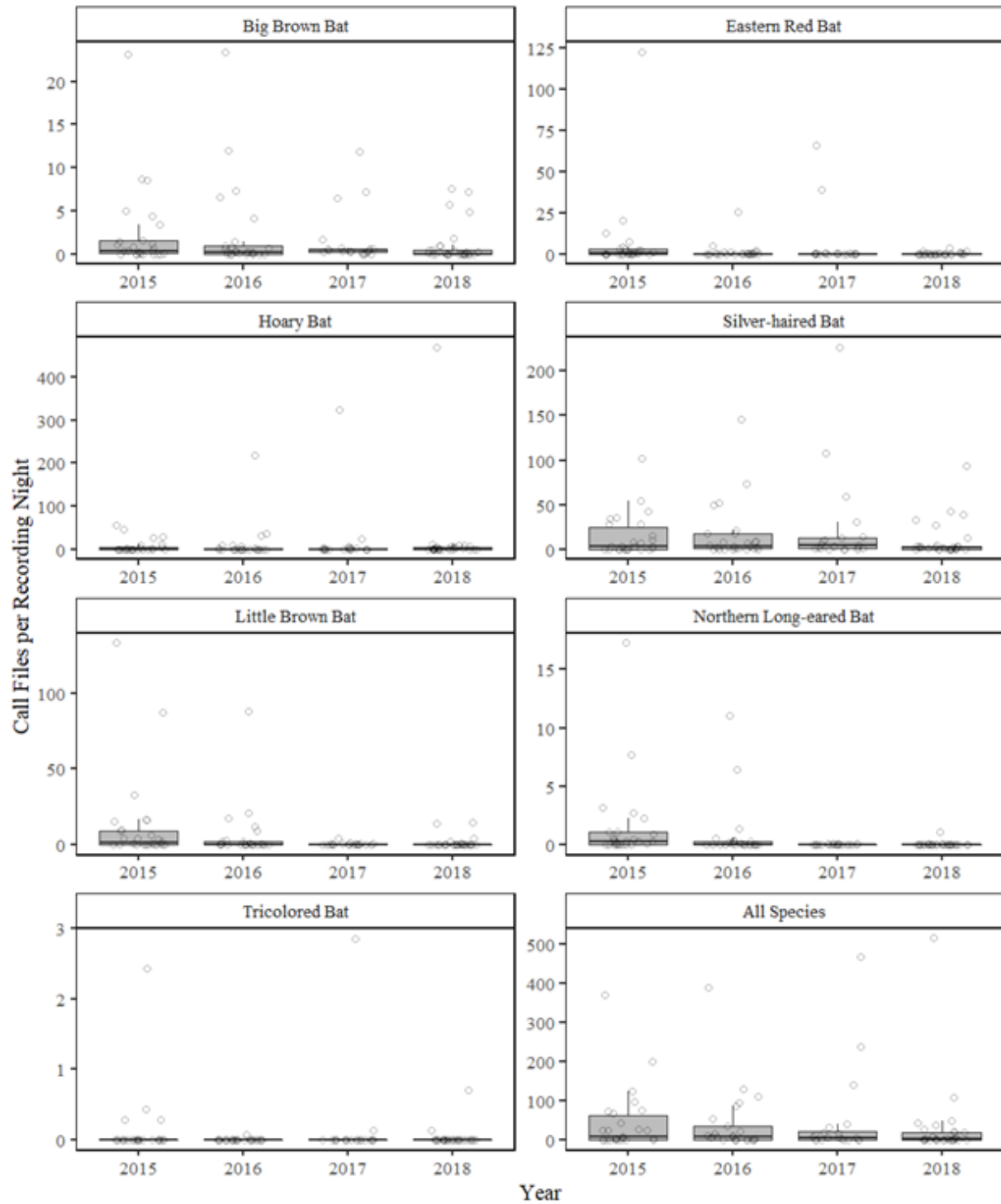


Figure 7. Call files per recording night for each species and for all species combined, by year, for the expanded analysis, Pictured Rocks National Lakeshore, 2015–2018. Each point represents call files per recording night at a particular survey site. The dark line across the boxplot represents the median. Note that the y-axis scale is different for each species. Results were similar for baseline and expanded analysis so only the expanded analysis is shown.

Spatial and Temporal Distribution

Spatial and temporal species distributions were assessed using the results of the automated classification. A species was considered to be detected at a site if at least one audio file was classified as that species by Kaleidoscope Pro. The two species most widely distributed across the park were hoary and silver-haired bats, with detections at more than 70% of monitoring sites in all four years (Figure 8, Appendix E). Big brown bats were also detected at more than 70% of sites for the first three years. When included in the expanded analysis, the tricolored bat was detected at 15% or less of sites, a lower percentage on average than all other species. Hoary and silver-haired bats were detected on a greater proportion of recording nights than the other species, about 40%–60% of nights in all four years (Figure 9, Appendix E). With the exception of the little brown bat in 2015, none of the other species was detected on more than 40% of nights in any year. When included in the expanded analysis, the tricolored bat was detected on a small proportion of recording nights, no more than 5%, less than all other species except northern long-eared bat in 2017–2018.

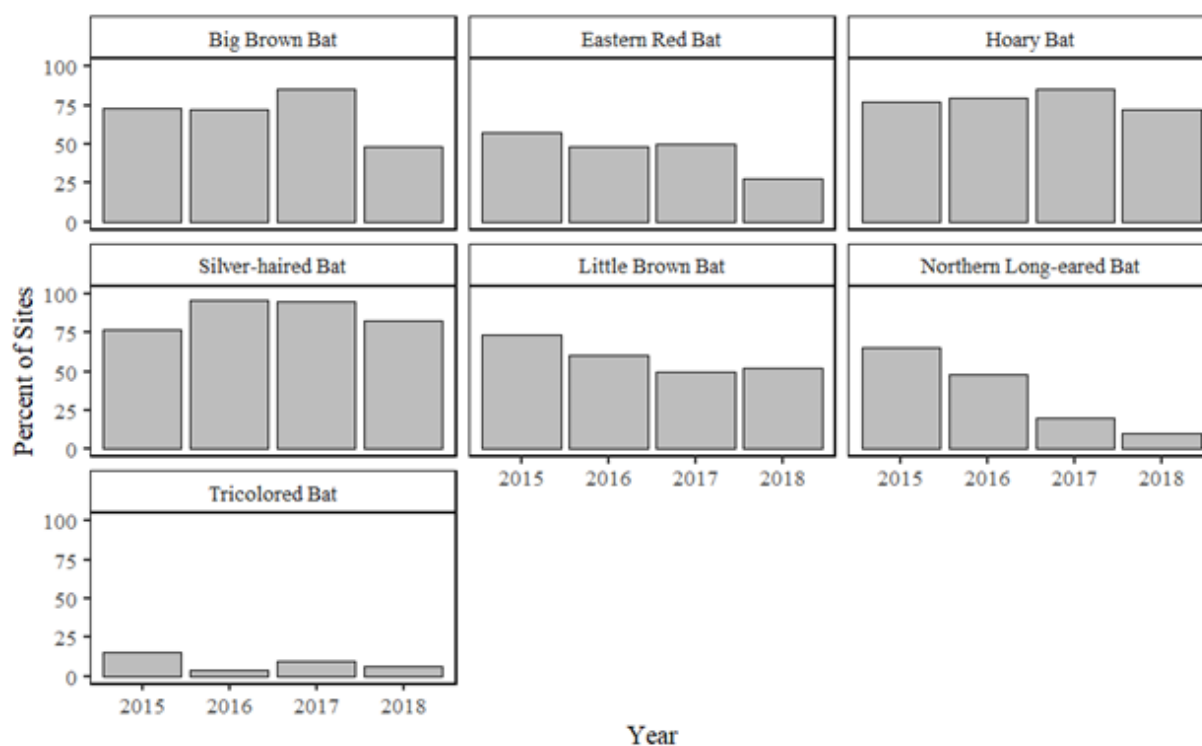


Figure 8. Proportion of monitoring sites where each species was detected each year, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected at a site if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and expanded analysis so only the expanded analysis is shown.

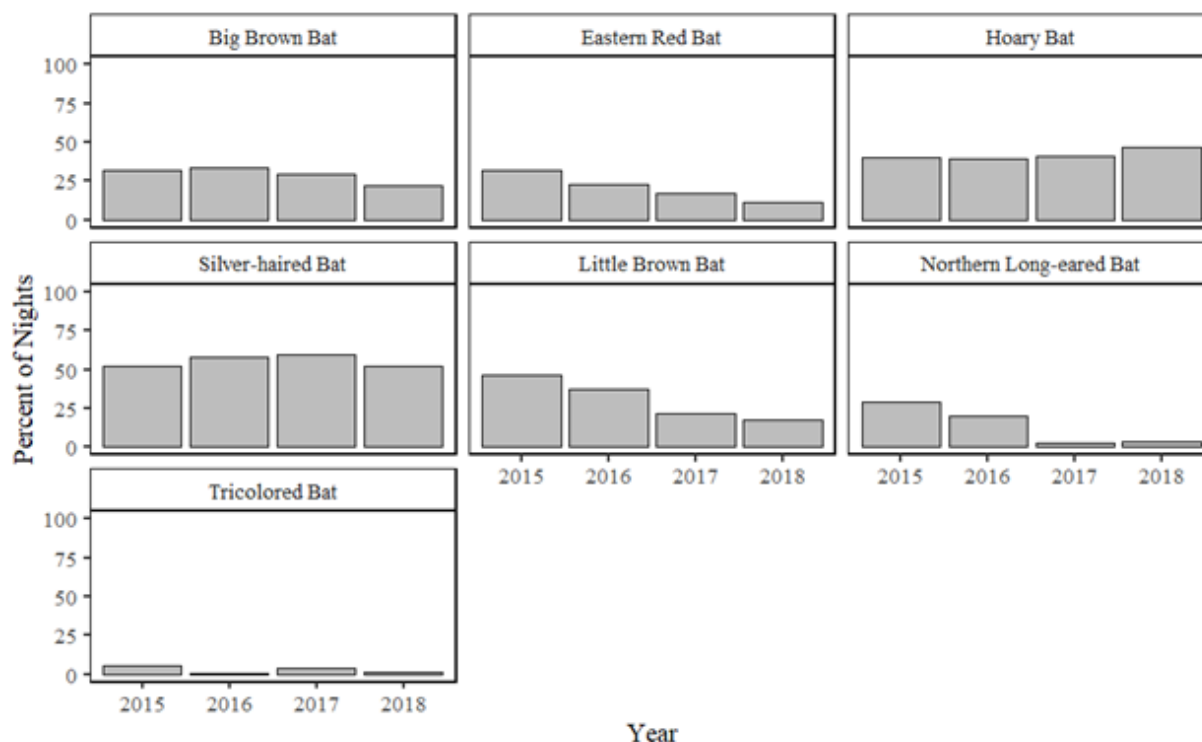


Figure 9. Proportion of recording nights on which each species was detected each year, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected on a night if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and expanded analysis so only the expanded analysis is shown.

Manual Vetting

A small subset of audio files—approximately 1% of files identified to each species—was manually vetted. Because the 1% sometimes equated to only a few files, we required a minimum of 10 files per species per park to be vetted unless there were fewer than 10 files available (see Methods). Manual vetting resulted in a total of six species being verified at PIRO between 2015 and 2018. The species that was not verified through manual vetting was the northern long-eared bat. Detailed manual vetting results for the park as a whole are provided in Appendix G and for each monitoring site in Appendix H.

The percentage of files that were verified by manual vetting varied widely by species. The mean percentage verified (calculated parkwide, across all survey years) ranged from 0% for the northern long-eared bat to 74% for the hoary bat (Appendix G). The variation in percentage verified is related to how difficult the calls are to identify. Ease of identification can depend on both call structure and recording environment. For example, the hoary bat consistently vocalizes at a much lower frequency than any other bat in the region, making its call signature unique and relatively easy to distinguish. On the other hand, the two *Myotis* species at PIRO (little brown bat and northern long-eared bat) produce very similar calls with highly overlapping call characteristics. Northern long-eared and little brown bat calls tend to be more distinctive from each other in cluttered environments, such as under

a closed forest canopy, than in open environments (Broders et al. 2004) and can therefore sometimes be identified.

Species Summaries

Results for each species are summarized below and in the next section. For comparison purposes, species composition over time across all GLKN parks is provided in Appendix I.

Big Brown Bat

- Documented in every year of surveys via automated identification and verified manually in every year except 2015.
- Widely distributed: Present at over 70% of survey sites in 2015–2017 but declined to 48% of survey sites in 2018.
- Percent of total files ranged from 3%–6%, with relatively little change from year to year.
- Recorded on 22%–34% of nights, with a slight decrease in the last year.
- Median call files per recording night was consistently low each year (<1).

Eastern Red Bat

- Documented in every year of surveys via automated identification and verified manually in every year except 2016.
- Moderately widely distributed: Present at 48%–58% of survey sites in 2015–2018 but declined to 28% of survey sites in 2018.
- Percent of total files ranged from 1%–15%, with highest percentages observed in 2015 and 2017.
- Recorded on 32% of nights in 2015, then decreased each subsequent year.
- Median call files per recording night was consistently low each year (<1).

Hoary Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 70% of survey sites each year.
- Percent of total files ranged from 16%–59%. First or second most commonly recorded species in three out of four years.
- Recorded on 39%–47% of nights, with relatively little change from year to year.
- Median call files per recording night was consistently low each year (<1). One site, PIRO025 (Grand Sable Dunes) had the highest call files per recording night of all sites in all four years. This site is located at the boundary of coniferous forest and open sand dunes. Hoary bats can roost in coniferous trees and often forage over open areas.

Silver-haired Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 75% of survey sites each year.

- Percent of total files ranged from 32%–49%. Most commonly recorded species in three out of four years.
- Recorded on 52%–59% of nights, with relatively little change from year to year.
- Median call files per recording night higher than other species (5 or less each year). Median was slightly higher in 2015–2017 than in 2018. One site, PIRO010 (Mosquito River and Beaver Dam Pond) was within the top three highest call files per recording night of all sites every year. Silver-haired bats often forage over water, and this site is located at an emergent wetland with standing water.

Little Brown Bat

- Documented in every year of surveys via automated identification and verified manually in every year except 2017.
- Moderately widely distributed: Present at 50%–73% of survey sites each year, with a decreasing trend.
- Second or third most commonly recorded species in 2015–2016, with 20%–28% of total files. Decreased sharply in 2017–2018, to less than 5% of files.
- Recorded on 46% of nights in 2015, then decreased each subsequent year.
- Median call files per recording night were low each year. The highest median was observed in 2015 (approximately 1.5), decreasing to less than 0.5 for 2016–2018.

Northern Long-eared Bat

- Documented in every year of surveys via automated identification but not verified manually.
- Moderately widely distributed in first two years but then declined. Present at 65% of survey sites in 2015, but only 10% of sites by 2018.
- Percent of total files was about 3% in the first two years and less than 1% in last two years.
- Recorded on 20%–29% of nights in 2015–2016. Decreased sharply to about 3% of nights in 2017–2018.
- Median call files per recording night was low each year (<1) and approached zero in 2016–2018.

Tricolored Bat

- Documented in every year of surveys via automated identification (expanded analysis only) and verified manually in 2017.
- Less widely distributed than other species: Present at 4%–15% of sites each year.
- Recorded rarely compared to other species: less than 1% of total files each year.
- Recorded less often than other species. Recorded on no more than about 5% of nights each year.
- Median call files per recording night very low compared to all other species, near zero every year.

Summary and Conclusions

Five of the six bat species previously documented at PIRO (see Table 1) were reconfirmed through this monitoring effort: big brown bat, eastern red bat, hoary bat, silver-haired bat, and little brown bat. Based on automated Kaleidoscope Pro classifications, we recorded call files from these five species in every year of surveys and manually verified recordings in at least three out of four years (Table 2).

The Kaleidoscope software also classified hundreds of call files as northern long-eared bats; however, we were unable to verify any of these recordings during manual vetting. Despite the lack of manually verified northern long-eared bat recordings, we do know this species is present in the park based on the capture of two individuals in the summer of 2016 (Kurta and Slider 2017).

Table 2. Summary of bat species documented at Pictured Rocks National Lakeshore through automated classification and manual vetting of acoustic files.

Species	Year	Detected	
		Automated	Manual
Big Brown Bat	2015	Yes	No
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
Eastern Red Bat	2015	Yes	Yes
	2016	Yes	No
	2017	Yes	Yes
	2018	Yes	Yes
Hoary Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
Silver-haired Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes

Table 2 (continued). Summary of bat species documented at Pictured Rocks National Lakeshore through automated classification and manual vetting of acoustic files.

Species	Year	Detected	
		Automated	Manual
Little Brown Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	No
	2018	Yes	Yes
Northern Long-eared Bat	2015	Yes	No
	2016	Yes	No
	2017	Yes	No
	2018	Yes	No
Tricolored Bat	2015	Yes	No
	2016	Yes	No
	2017	Yes	Yes
	2018	Yes	No

Our acoustic surveys also suggest that a seventh species, the tricolored bat, may possibly be present in the park. PIRO is located near the edge of the tricolored bat's known range. Although there are records from elsewhere in northern Michigan, tricolored bats have not been confirmed at PIRO through physical captures, which would allow positive in-hand identification. We obtained four manually verified tricolored bat recordings in 2017 from site PIRO025 (Grand Sable Dunes). This site is located at the boundary of coniferous forest and open sand dunes; tricolored bats often travel and forage along forest edges. The status of tricolored bat at PIRO remains uncertain due to the minimal number of verified recordings.

It is important to note that less than half of the call files identified by the Kaleidoscope software as northern long-eared bats and tricolored bats have so far been manually reviewed (29 files and 25 files, respectively). Conducting additional manual review on the remaining files could potentially increase the number of locations or years with verified records of these species.

Our results indicate that activity levels for two of the seven species (hoary bat and silver-haired bat) were stable over the four years of surveys. Another four species had decreasing trends in activity levels: big brown bat, eastern red bat, little brown bat, and northern long-eared bat. For the seventh species, tricolored bat, we have very limited data (less than 0.5% of all files were identified to this species), therefore we cannot draw any clear conclusions about their trends in activity.

We observed a high prevalence of noise recordings in the PIRO dataset for all four years of data (Appendix E, Table E1). This result was likely due to the settings used on the bat detectors, in particular the high pass filter setting. When the high pass filter is turned on, the detector attenuates lower frequency sounds, thereby limiting recordings of sounds below 20 kHz. When the high pass filter is turned off, this attenuation is not applied, so sounds below 20 kHz can be recorded. The high pass filter was turned off for PIRO deployments from 2015–2018, allowing lower frequency, non-bat sounds to be recorded often. The bat species found at PIRO typically echolocate at 20 kHz or above, therefore the high pass filter can be turned on to reduce noise recordings without detrimental effect on recording bats. For PIRO surveys taking place after 2018, the detector settings will be changed to turn on the high pass filter.

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Appendix A. Bat Species of the Great Lakes Region.

Table A1. Nine bat species are found in the Great Lakes region. Species affected by white-nose syndrome (WNS) are listed as “Confirmed” if they have been identified with diagnostic symptoms of the disease, or “Pd Positive” if the causative fungus *Pseudogymnoascus destructans* has been detected but without diagnostic symptoms of the disease. Federal/state status is indicated as E (Endangered), PE (Proposed Endangered), T (Threatened), or SC (Special Concern).

Species Name	Roosting/Wintering Behavior	WNS Affected? ^a	Federal Status ^b	State Status ^c
Big Brown Bat <i>Eptesicus fuscus</i>	Cavity-roosting/ Hibernating	Confirmed WNS	–	T (WI) SC (MN)
Eastern Red Bat <i>Lasiurus borealis</i>	Tree-roosting/ Migratory	Pd Positive	–	SC (IN)
Hoary Bat <i>Lasiurus cinereus</i>	Tree-roosting/ Migratory	–	–	SC (IN)
Silver-haired Bat <i>Lasionycteris noctivagans</i>	Tree-roosting/ Migratory	Pd Positive	–	SC (IN, WI)
Little Brown Bat <i>Myotis lucifugus</i>	Cavity-roosting/ Hibernating	Confirmed WNS	–	E (IN) T (WI) SC (MI, MN)
Northern Long-eared Bat <i>Myotis septentrionalis</i>	Cavity-roosting/ Hibernating	Confirmed WNS	E	E (IN) T (WI) SC (MI, MN)
Indiana Bat <i>Myotis sodalis</i>	Cavity-roosting/ Hibernating	Confirmed WNS	E	E (IN, MI)
Evening Bat <i>Nycticeius humeralis</i>	Tree-roosting/ Migratory	–	–	E (IN) T (MI)
Tricolored Bat <i>Perimyotis subflavus</i>	Cavity-roosting/ Hibernating	Confirmed WNS	PE	E (IN) T (WI) SC (MI, MN)

^a White-nose Syndrome Response Team, www.whitenosesyndrome.org

^b U. S. Fish and Wildlife Service (1967, 2022a, 2022b)

^c Indiana Department of Natural Resources (2021), Michigan Natural Features Inventory (2009), Minnesota Department of Natural Resources (2013), Wisconsin Department of Natural Resources (2021).

Appendix B. Baseline and Expanded Species Lists.

Table B1. Bat species included as possible candidates during Kaleidoscope Pro species classification. The first column shows the “baseline” species group (known ranges within the boundaries of the park). The second column shows the “expanded” species group (documented near the park, possibly present).

Species Name	Baseline Analysis	Expanded Analysis
Big Brown Bat <i>Eptesicus fuscus</i>	X	X
Eastern Red Bat <i>Lasiurus borealis</i>	X	X
Hoary Bat <i>Lasiurus cinereus</i>	X	X
Silver-haired Bat <i>Lasionycteris noctivagans</i>	X	X
Little Brown Bat <i>Myotis lucifugus</i>	X	X
Northern Long-eared Bat <i>Myotis septentrionalis</i>	X	X
Tricolored Bat <i>Perimyotis subflavus</i>	–	X

Appendix C. Analysis Settings for Kaleidoscope Pro.

The following software settings were used during Kaleidoscope Pro analysis for species classification.

Software Version: Kaleidoscope Pro 4.0.0

Classifier: Bats of North America 3.1.0

Classifier Sensitivity: -1 More Sensitive/Liberal

Signal Parameters:

Frequency: 8–120 kHz

Duration: 2–500 ms

Maximum inter-syllable gap: 500 ms

Minimum Number of Pulses: 2

Full spectrum WAV files were converted to zero crossing format before analysis.

Zero crossing conversion/analysis was enhanced with advanced signal processing option.

Appendix D. Yearly Deployment Data.

Table D1. Earliest and latest dates equipment was deployed, number of deployments in each category, and total number of files recorded for each survey year, Pictured Rocks National Lakeshore, 2015–2018.

Year	Earliest	Latest	Deployment Category ¹							Total Files
			Early	Failed	Failed (short)	Late	Non-protocol	Valid	Valid (dupl.)	
2015	27 May	19 August	0	0	0	0	0	26	0	165,189
2016	14 April	31 October	7	0	0	0	57	25	1	857,598
2017	7 April	25 August	0	2	1	2	20	20	0	119,630
2018	23 April	15 August	0	2	3	0	22	29	0	156,048

¹ “**Early**” = deployment occurred before 1 June, outside the protocol sampling period; “**Failed**” = deployment was unsuccessful due to equipment malfunction, improper programming, and/or vandalism; “**Failed (short)**” = deployment was unsuccessful because the minimum required four nights of recording were not completed; “**Late**” = deployment occurred after 15 August, outside the protocol sampling period; “**Non-protocol**” = deployment was completed for park-specific monitoring goals at a location selected intentionally, rather than following the GRTS sample design; “**Valid**” = deployment with at least four nights of successful recording during the protocol sampling period (1 June–15 August); “**Valid (dupl.)**” = valid deployment at a particular site in addition to the first valid deployment.

Table D2. Total number of sites, recording nights, files recorded, and mean recording nights per site, mean files per site, and mean files per recording night for each survey year’s valid deployments only, Pictured Rocks National Lakeshore, 2015–2018. This table corresponds to Figure 2 in the main text.

Year	Total Sites	Total Nights	Mean Nights Per Site	Total Files	Mean Files Per Site	Mean Files Per Night
2015	26	204	7.8	165,189	6,353	810
2016	25	215	8.6	301,671	12,067	1,403
2017	20	142	7.1	60,880	3,044	429
2018	29	208	7.2	78,714	2,714	378

Appendix E. Automated Classification Results.

Table E1. Total number of audio files recorded, and number and percent classified by Kaleidoscope Pro as bat species vs. unknown bats vs. noise for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. Noise category includes files classified as noise and files that were corrupt, unreadable, or excluded because the recording night was less than six hours long. Only data from valid deployments are shown. This table corresponds to Figure 3 in the main text.

Year	Analysis	Total Files	# Bat Species	# Bat Unknown	# Noise	% Bat Species	% Bat Unknown	% Noise
2015	baseline	165,189	9,015	379	155,795	5.46	0.23	94.31
2015	expanded	165,189	9,005	389	155,795	5.45	0.24	94.31
2016	baseline	301,671	9,375	620	291,676	3.11	0.21	96.69
2016	expanded	301,671	9,371	624	291,676	3.11	0.21	96.69
2017	baseline	60,880	7,126	415	53,339	11.70	0.68	87.61
2017	expanded	60,880	7,118	423	53,339	11.69	0.69	87.61
2018	baseline	78,714	6,374	711	71,629	8.10	0.90	91.00
2018	expanded	78,714	6,373	712	71,629	8.10	0.90	91.00

Table E2. Total number of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. Tricolored bat was allowed as a possible species only in the expanded analysis. Only data from valid deployments are shown.

Year	Analysis	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	468	1,339	1,466	2,948	2,498	296	n/a
2015	expanded	466	1,303	1,468	2,949	2,497	298	24
2016	baseline	537	476	2,627	3,622	1,874	239	n/a
2016	expanded	537	476	2,627	3,622	1,872	236	1
2017	baseline	223	786	2,572	3,464	77	4	n/a
2017	expanded	223	752	2,575	3,466	77	4	21
2018	baseline	218	72	3,771	2,037	266	10	n/a
2018	expanded	217	64	3,772	2,037	267	10	6

Table E3. Percent of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. Tricolored bat was allowed as a possible species only in the expanded analysis. Only data from valid deployments are shown. This table corresponds to Figures 4 and 5 in the main text.

Year	Analysis	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	5.19	14.85	16.26	32.70	27.71	3.28	n/a
2015	expanded	5.17	14.47	16.30	32.75	27.73	3.31	0.27
2016	baseline	5.73	5.08	28.02	38.63	19.99	2.55	n/a
2016	expanded	5.73	5.08	28.03	38.65	19.98	2.52	0.01
2017	baseline	3.13	11.03	36.09	48.61	1.08	0.06	n/a
2017	expanded	3.13	10.56	36.18	48.69	1.08	0.06	0.30
2018	baseline	3.42	1.13	59.16	31.96	4.17	0.16	n/a
2018	expanded	3.40	1.00	59.19	31.96	4.19	0.16	0.09

Table E4. Total number of monitoring sites, and count of sites where each species was detected for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected at a site if at least one audio file was classified by Kaleidoscope Pro to that species. Tricolored bat was allowed as a possible species only during the expanded analysis.

Year	Analysis	Total Sites	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	26	19	15	20	20	19	17	n/a
2015	expanded	26	19	15	20	20	19	17	4
2016	baseline	25	18	12	20	24	15	12	n/a
2016	expanded	25	18	12	20	24	15	12	1
2017	baseline	20	17	10	17	19	10	4	n/a
2017	expanded	20	17	10	17	19	10	4	2
2018	baseline	29	14	8	21	24	15	3	n/a
2018	expanded	29	14	8	21	24	15	3	2

Table E5. Total number of monitoring sites, and percent of sites where each species was detected for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected at a site if at least one audio file was classified by Kaleidoscope Pro to that species. Tricolored bat was allowed as a possible species only during the expanded analysis. This table corresponds to Figure 8 in the main text.

Year	Analysis	Total Sites	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	26	73.08	57.69	76.92	76.92	73.08	65.38	n/a
2015	expanded	26	73.08	57.69	76.92	76.92	73.08	65.38	15.38
2016	baseline	25	72.00	48.00	80.00	96.00	60.00	48.00	n/a
2016	expanded	25	72.00	48.00	80.00	96.00	60.00	48.00	4.00
2017	baseline	20	85.00	50.00	85.00	95.00	50.00	20.00	n/a
2017	expanded	20	85.00	50.00	85.00	95.00	50.00	20.00	10.00
2018	baseline	29	48.28	27.59	72.41	82.76	51.72	10.34	n/a
2018	expanded	29	48.28	27.59	72.41	82.76	51.72	10.34	6.90

Table E6. Total number of recording nights, and count of recording nights on which each species was detected for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected on a night if at least one audio file was classified by Kaleidoscope Pro to that species. Tricolored bat was allowed as a possible species only during the expanded analysis.

Year	Analysis	Total Nights	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	204	66	65	82	107	95	60	n/a
2015	expanded	204	66	66	82	107	94	60	11
2016	baseline	215	73	52	84	125	81	44	n/a
2016	expanded	215	73	50	84	125	81	43	1
2017	baseline	142	42	24	58	84	31	4	n/a
2017	expanded	142	42	24	58	84	31	4	6
2018	baseline	208	46	25	97	108	37	7	n/a
2018	expanded	208	46	23	97	108	37	7	3

Table E7. Total number of recording nights, and percent of recording nights on which each species was detected for each year and analysis type, Pictured Rocks National Lakeshore, 2015–2018. A species was considered to be detected on a night if at least one audio file was classified by Kaleidoscope Pro to that species. Tricolored bat was allowed as a possible species only during the expanded analysis. This table corresponds to Figure 9 in the main text.

Year	Analysis	Total Nights	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver- haired Bat	Little Brown Bat	Northern Long-eared Bat	Tricolored Bat
2015	baseline	204	32.35	31.86	40.20	52.45	46.57	29.41	n/a
2015	expanded	204	32.35	32.35	40.20	52.45	46.08	29.41	5.39
2016	baseline	215	33.95	24.19	39.07	58.14	37.67	20.47	n/a
2016	expanded	215	33.95	23.26	39.07	58.14	37.67	20.00	0.47
2017	baseline	142	29.58	16.90	40.85	59.15	21.83	2.82	n/a
2017	expanded	142	29.58	16.90	40.85	59.15	21.83	2.82	4.23
2018	baseline	208	22.12	12.02	46.63	51.92	17.79	3.37	n/a
2018	expanded	208	22.12	11.06	46.63	51.92	17.79	3.37	1.44

Appendix F. Noise Assessment.

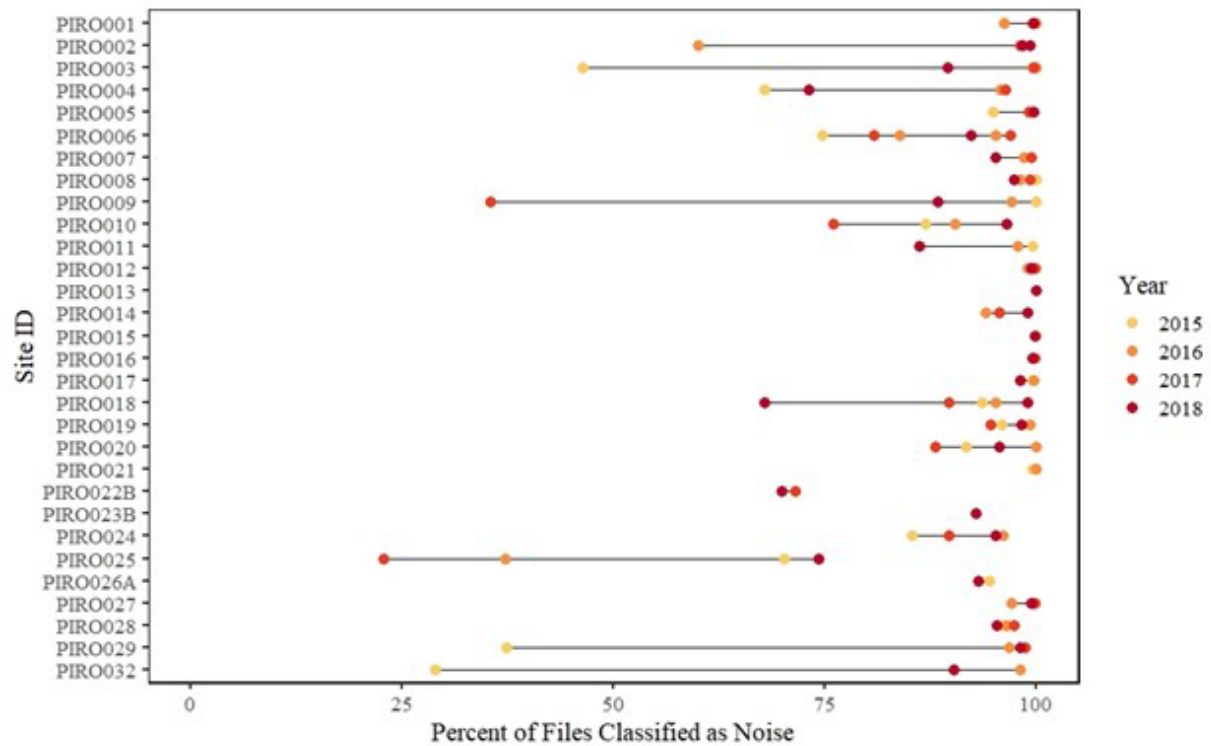


Figure F1. Percent of audio files classified as noise for each sampling site at Pictured Rocks National Lakeshore, 2015–2018. Each point represents the percent noise for one year's deployment at that sampling site. Excludes failed deployments and non-protocol deployments.

Table F1. Mean percent of audio files classified as noise for each sampling site at Pictured Rocks National Lakeshore, 2015–2018. Excludes failed deployments and non-protocol deployments. Standard deviation, minimum percent noise, and maximum percent noise are given for each site. The last column indicates whether the site’s mean percent noise exceeded the parkwide mean percent noise, with asterisks indicating the top five sites with the highest mean percent noise.

Site ID	Mean % Noise	St. Dev.	Min. % Noise	Max. % Noise	Exceeds Parkwide Mean
PIRO001	99.0	1.6	96.2	99.9	Yes
PIRO002	90.8	17.2	60.0	99.3	Yes
PIRO003	87.0	23.2	46.3	99.9	–
PIRO004	83.2	14.9	67.8	96.3	–
PIRO005	98.2	2.2	94.9	99.7	Yes
PIRO006	87.2	8.9	74.6	96.9	–
PIRO007	98.1	2.0	95.1	99.4	Yes
PIRO008	98.7	1.2	97.3	100.0	Yes
PIRO009	80.2	30.3	35.4	99.9	–
PIRO010	87.4	8.6	75.9	96.4	–
PIRO011	94.5	7.3	86.1	99.5	Yes
PIRO012	99.5	0.4	99.0	99.9	Yes *
PIRO013	100.0	0.1	99.9	100.0	Yes *
PIRO014	96.2	2.5	94.0	98.9	Yes
PIRO015	99.8	0.1	99.8	99.9	Yes *
PIRO016	99.7	0.1	99.5	99.8	Yes *
PIRO017	99.1	0.8	98.1	99.6	Yes
PIRO018	89.0	12.3	67.8	99.0	–
PIRO019	97.0	2.1	94.6	99.3	Yes
PIRO020	93.8	5.1	88.1	100.0	Yes
PIRO021	99.8	0.4	99.5	100.0	Yes *
PIRO022B	70.7	1.2	69.8	71.5	–
PIRO023B	92.9	NA	92.9	92.9	Yes
PIRO024	91.6	5.0	85.3	96.1	Yes
PIRO025	51.1	25.1	22.8	74.2	–
PIRO026A	93.8	0.9	93.1	94.4	Yes
PIRO027	98.7	1.5	97.0	99.8	Yes

Table F1 (continued). Mean percent of audio files classified as noise for each sampling site at Pictured Rocks National Lakeshore, 2015–2018. Excludes failed deployments and non-protocol deployments. Standard deviation, minimum percent noise, and maximum percent noise are given for each site. The last column indicates whether the site’s mean percent noise exceeded the parkwide mean percent noise, with asterisks indicating the top five sites with the highest mean percent noise.

Site ID	Mean % Noise	St. Dev.	Min. % Noise	Max. % Noise	Exceeds Parkwide Mean
PIRO028	96.3	0.9	95.3	97.4	Yes
PIRO029	82.7	30.3	37.3	98.7	–
PIRO032	72.4	37.9	28.8	98.1	–

Appendix G. Manual Vetting Results for Entire Park.

Manual vetting was performed on approximately 1% of call files classified to each species by Kaleidoscope Pro (or minimum of 10 files).

Table G1. Total number of files manually vetted, and the results of manual vetting for each year, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2015	baseline	Big Brown Bat	10	0	0.00
2015	baseline	Eastern Red Bat	13	8	61.54
2015	baseline	Hoary Bat	15	9	60.00
2015	baseline	Silver-haired Bat	29	17	58.62
2015	baseline	Little Brown Bat	25	14	56.00
2015	baseline	Northern Long-eared Bat	10	0	0.00
2015	expanded	Tricolored Bat	10	0	0.00
2016	baseline	Big Brown Bat	9	1	11.11
2016	baseline	Eastern Red Bat	9	0	0.00
2016	baseline	Hoary Bat	27	22	81.48
2016	baseline	Silver-haired Bat	35	13	37.14
2016	baseline	Little Brown Bat	18	16	88.89
2016	baseline	Northern Long-eared Bat	9	0	0.00
2016	expanded	Tricolored Bat	1	0	0.00
2017	baseline	Big Brown Bat	6	1	16.67
2017	baseline	Eastern Red Bat	4	4	100.00
2017	baseline	Hoary Bat	24	17	70.83
2017	baseline	Silver-haired Bat	28	15	53.57
2017	baseline	Little Brown Bat	1	0	0.00
2017	expanded	Tricolored Bat	8	4	50.00
2018	baseline	Big Brown Bat	10	4	40.00
2018	baseline	Eastern Red Bat	10	4	40.00
2018	baseline	Hoary Bat	38	32	84.21
2018	baseline	Silver-haired Bat	20	16	80.00

Table G1 (continued). Total number of files manually vetted, and the results of manual vetting for each year, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2018	baseline	Little Brown Bat	10	10	100.00
2018	baseline	Northern Long-eared Bat	10	0	0.00
2018	expanded	Tricolored Bat	6	0	0.00

Appendix H. Manual Vetting Results by Site.

Manual vetting was performed on approximately 1% of call files classified to each species by Kaleidoscope Pro (or minimum of 10 files). This was 1% parkwide, so not every combination of monitoring site/species had files vetted.

Table H1. Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2015	PIRO002_2015	baseline	Hoary Bat	3	0	0.00
2015	PIRO002_2015	baseline	Northern Long-eared Bat	1	0	0.00
2015	PIRO003_2015	baseline	Little Brown Bat	2	1	50.00
2015	PIRO003_2015	expanded	Tricolored Bat	2	0	0.00
2015	PIRO004_2015	baseline	Big Brown Bat	1	0	0.00
2015	PIRO004_2015	baseline	Silver-haired Bat	4	3	75.00
2015	PIRO004_2015	baseline	Little Brown Bat	1	0	0.00
2015	PIRO005_2015	baseline	Silver-haired Bat	3	3	100.00
2015	PIRO006_2015	baseline	Eastern Red Bat	1	0	0.00
2015	PIRO006_2015	baseline	Silver-haired Bat	2	1	50.00
2015	PIRO006_2015	baseline	Little Brown Bat	6	3	50.00
2015	PIRO006_2015	baseline	Northern Long-eared Bat	6	0	0.00
2015	PIRO006_2015	expanded	Tricolored Bat	1	0	0.00
2015	PIRO007_2015	baseline	Northern Long-eared Bat	1	0	0.00
2015	PIRO009_2015	baseline	Little Brown Bat	2	1	50.00
2015	PIRO010_2015	baseline	Silver-haired Bat	7	4	57.14
2015	PIRO010_2015	baseline	Little Brown Bat	3	2	66.67
2015	PIRO016_2015	baseline	Silver-haired Bat	1	1	100.00
2015	PIRO018_2015	baseline	Big Brown Bat	1	0	0.00
2015	PIRO018_2015	baseline	Eastern Red Bat	1	1	100.00
2015	PIRO018_2015	baseline	Hoary Bat	1	1	100.00
2015	PIRO018_2015	baseline	Silver-haired Bat	2	1	50.00

Table H1 (continued). Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2015	PIRO019_2015	baseline	Big Brown Bat	1	0	0.00
2015	PIRO019_2015	baseline	Little Brown Bat	2	1	50.00
2015	PIRO024_2015	baseline	Hoary Bat	2	1	50.00
2015	PIRO025_2015	baseline	Eastern Red Bat	1	1	100.00
2015	PIRO025_2015	baseline	Hoary Bat	4	3	75.00
2015	PIRO025_2015	baseline	Silver-haired Bat	1	0	0.00
2015	PIRO025_2015	expanded	Tricolored Bat	1	0	0.00
2015	PIRO028_2015	baseline	Silver-haired Bat	1	1	100.00
2015	PIRO028_2015	baseline	Little Brown Bat	2	2	100.00
2015	PIRO029_2015	baseline	Big Brown Bat	5	0	0.00
2015	PIRO029_2015	baseline	Eastern Red Bat	8	5	62.50
2015	PIRO029_2015	baseline	Hoary Bat	2	2	100.00
2015	PIRO029_2015	baseline	Silver-haired Bat	4	1	25.00
2015	PIRO029_2015	baseline	Little Brown Bat	7	4	57.14
2015	PIRO029_2015	baseline	Northern Long-eared Bat	2	0	0.00
2015	PIRO029_2015	expanded	Tricolored Bat	6	0	0.00
2015	PIRO032_2015	baseline	Big Brown Bat	2	0	0.00
2015	PIRO032_2015	baseline	Eastern Red Bat	2	1	50.00
2015	PIRO032_2015	baseline	Hoary Bat	3	2	66.67
2015	PIRO032_2015	baseline	Silver-haired Bat	4	2	50.00
2016	PIRO004_2016	baseline	Big Brown Bat	3	1	33.33
2016	PIRO004_2016	baseline	Eastern Red Bat	2	0	0.00
2016	PIRO004_2016	baseline	Hoary Bat	2	2	100.00
2016	PIRO004_2016	baseline	Silver-haired Bat	4	1	25.00
2016	PIRO004_2016	expanded	Tricolored Bat	1	0	0.00
2016	PIRO005_2016	baseline	Silver-haired Bat	1	0	0.00

Table H1 (continued). Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2016	PIRO006_2016	baseline	Hoary Bat	3	0	0.00
2016	PIRO006_2016	baseline	Silver-haired Bat	7	2	28.57
2016	PIRO006_2016	baseline	Northern Long-eared Bat	2	0	0.00
2016	PIRO007_2016	baseline	Silver-haired Bat	1	0	0.00
2016	PIRO010_2016	baseline	Big Brown Bat	1	0	0.00
2016	PIRO010_2016	baseline	Silver-haired Bat	7	4	57.14
2016	PIRO011_2016	baseline	Silver-haired Bat	1	0	0.00
2016	PIRO014_2016	baseline	Silver-haired Bat	1	1	100.00
2016	PIRO014_2016	baseline	Northern Long-eared Bat	1	0	0.00
2016	PIRO018_2016	baseline	Hoary Bat	3	1	33.33
2016	PIRO018_2016	baseline	Silver-haired Bat	3	1	33.33
2016	PIRO021_2016	baseline	Little Brown Bat	1	0	0.00
2016	PIRO022A_2016	baseline	Big Brown Bat	1	0	0.00
2016	PIRO024_2016	baseline	Big Brown Bat	1	0	0.00
2016	PIRO025_2016	baseline	Big Brown Bat	3	0	0.00
2016	PIRO025_2016	baseline	Hoary Bat	18	18	100.00
2016	PIRO025_2016	baseline	Silver-haired Bat	7	2	28.57
2016	PIRO026_2016	baseline	Hoary Bat	1	1	100.00
2016	PIRO026_2016	baseline	Silver-haired Bat	2	1	50.00
2016	PIRO027_2016	baseline	Little Brown Bat	5	5	100.00
2016	PIRO028_2016	baseline	Eastern Red Bat	7	0	0.00
2016	PIRO028_2016	baseline	Little Brown Bat	12	11	91.67
2016	PIRO028_2016	baseline	Northern Long-eared Bat	6	0	0.00
2016	PIRO032_2016	baseline	Silver-haired Bat	1	1	100.00
2017	PIRO002_2017	baseline	Silver-haired Bat	1	0	0.00
2017	PIRO009_2017	baseline	Eastern Red Bat	3	3	100.00

Table H1 (continued). Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2017	PIRO010_2017	baseline	Big Brown Bat	5	0	0.00
2017	PIRO010_2017	baseline	Silver-haired Bat	5	1	20.00
2017	PIRO018_2017	baseline	Eastern Red Bat	1	1	100.00
2017	PIRO018_2017	baseline	Silver-haired Bat	2	1	50.00
2017	PIRO019_2017	baseline	Silver-haired Bat	1	1	100.00
2017	PIRO020_2017	baseline	Silver-haired Bat	3	1	33.33
2017	PIRO022B_2017	baseline	Hoary Bat	1	0	0.00
2017	PIRO022B_2017	baseline	Silver-haired Bat	7	4	57.14
2017	PIRO025_2017	baseline	Big Brown Bat	1	1	100.00
2017	PIRO025_2017	baseline	Hoary Bat	23	17	73.91
2017	PIRO025_2017	baseline	Silver-haired Bat	8	6	75.00
2017	PIRO025_2017	expanded	Tricolored Bat	8	4	50.00
2017	PIRO028_2017	baseline	Silver-haired Bat	1	1	100.00
2017	PIRO028_2017	baseline	Little Brown Bat	1	0	0.00
2018	PIRO003_2018	baseline	Hoary Bat	1	0	0.00
2018	PIRO004_2018	baseline	Big Brown Bat	2	2	100.00
2018	PIRO004_2018	baseline	Silver-haired Bat	2	2	100.00
2018	PIRO006_2018	baseline	Big Brown Bat	2	0	0.00
2018	PIRO006_2018	baseline	Silver-haired Bat	6	5	83.33
2018	PIRO010_2018	baseline	Big Brown Bat	1	1	100.00
2018	PIRO010_2018	baseline	Hoary Bat	2	2	100.00
2018	PIRO010_2018	baseline	Silver-haired Bat	5	4	80.00
2018	PIRO017_2018	baseline	Hoary Bat	1	0	0.00
2018	PIRO017_2018	baseline	Silver-haired Bat	1	0	0.00
2018	PIRO018_2018	baseline	Hoary Bat	3	2	66.67
2018	PIRO018_2018	baseline	Silver-haired Bat	1	1	100.00
2018	PIRO020_2018	baseline	Silver-haired Bat	1	1	100.00

Table H1 (continued). Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Pictured Rocks National Lakeshore, 2015–2018. “Verified” indicates that the manual identification matched, and thus verified, the automated identification.

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2018	PIRO022B_2018	baseline	Big Brown Bat	1	0	0.00
2018	PIRO022B_2018	baseline	Eastern Red Bat	1	0	0.00
2018	PIRO022B_2018	baseline	Little Brown Bat	3	3	100.00
2018	PIRO022B_2018	expanded	Tricolored Bat	1	0	0.00
2018	PIRO024_2018	baseline	Silver-haired Bat	1	0	0.00
2018	PIRO024_2018	baseline	Northern Long-eared Bat	1	0	0.00
2018	PIRO025_2018	baseline	Big Brown Bat	1	0	0.00
2018	PIRO025_2018	baseline	Eastern Red Bat	4	2	50.00
2018	PIRO025_2018	baseline	Hoary Bat	28	26	92.86
2018	PIRO025_2018	baseline	Silver-haired Bat	2	2	100.00
2018	PIRO025_2018	baseline	Little Brown Bat	1	1	100.00
2018	PIRO026A_2018	baseline	Hoary Bat	3	2	66.67
2018	PIRO026A_2018	baseline	Silver-haired Bat	1	1	100.00
2018	PIRO028_2018	baseline	Eastern Red Bat	2	0	0.00
2018	PIRO028_2018	baseline	Little Brown Bat	5	5	100.00
2018	PIRO028_2018	baseline	Northern Long-eared Bat	8	0	0.00
2018	PIRO032_2018	baseline	Big Brown Bat	3	1	33.33
2018	PIRO032_2018	baseline	Eastern Red Bat	3	2	66.67
2018	PIRO032_2018	baseline	Little Brown Bat	1	1	100.00
2018	PIRO032_2018	baseline	Northern Long-eared Bat	1	0	0.00
2018	PIRO032_2018	expanded	Tricolored Bat	5	0	0.00

Appendix I. Species Composition Across Parks.

Figure I1 is for the baseline analysis only and includes all Great Lakes Network parks in which bat monitoring occurred.

APIS: Apostle Islands National Lakeshore (Wisconsin)

GRPO: Grand Portage National Monument (Minnesota)

INDU: Indiana Dunes National Park (Indiana)

ISRO: Isle Royale National Park (Michigan)

MISS: Mississippi National River and Recreation Area (Minnesota)

PIRO: Pictured Rocks National Lakeshore (Michigan)

SACN: St. Croix National Scenic Riverway (Wisconsin/Minnesota)

SLBE: Sleeping Bear Dunes National Lakeshore (Michigan)

VOYA: Voyageurs National Park (Minnesota)

The baseline analysis had Indiana bat and evening bat allowed as possible species only for INDU, and tricolored bat allowed as a possible species only for INDU, MISS, and SACN.

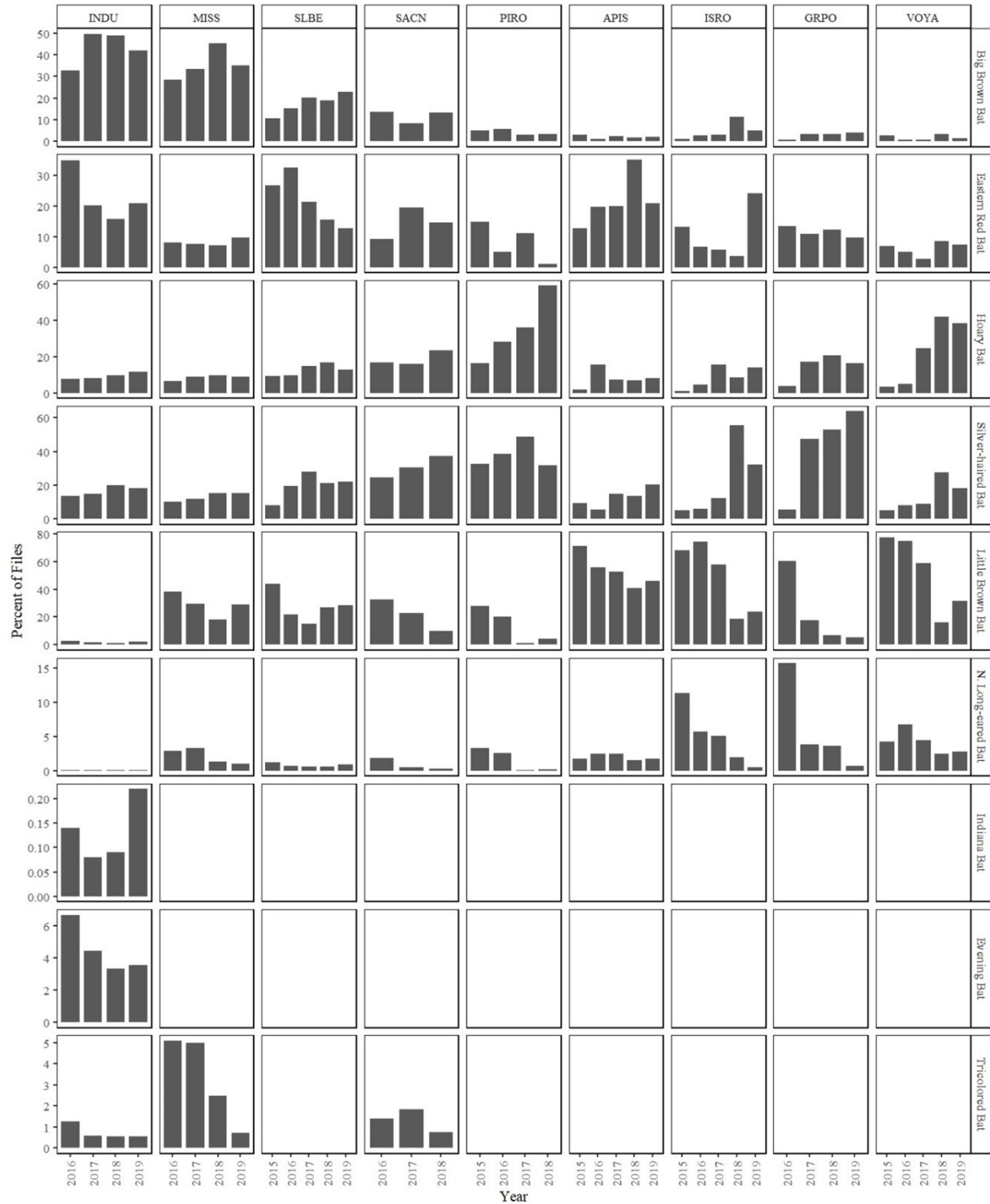


Figure 11. Percent of audio files classified as each bat species by Kaleidoscope Pro in the baseline analysis for each park and year. Note that the y-axis scale is different for each species and not all parks conducted surveys in all years. Only data from valid deployments are shown. Parks are ordered approximately by latitude, from INDU (southernmost) to VOYA (northernmost).

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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