



Acoustic Monitoring for Bats at Apostle Islands National Lakeshore

Data Summary Report, 2015–2019

Natural Resource Data Series NPS/GLKN/NRDS—2021/1320



ON THE COVER

Bat acoustic monitoring equipment at Apostle Islands National Lakeshore.

NPS Photo

Acoustic Monitoring for Bats at Apostle Islands National Lakeshore

Data Summary Report, 2015–2019

Natural Resource Data Series NPS/GLKN/NRDS—2021/1320

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Abstract

The Great Lakes Inventory and Monitoring Network initiated an acoustic monitoring program for bats in 2015. This report presents results for 2015–2019 surveys at Apostle Islands National Lakeshore. 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. These include 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. A seventh species, the tricolored bat, was also documented. The tricolored bat has not been physically captured in the park; however our acoustic data suggests it is present based on manually verified recordings from two different sites. Activity levels for big brown bat, eastern red bat, hoary bat, and silver-haired bat appear to be stable or increasing slightly. Activity levels for little brown bat, northern long-eared bat, and tricolored 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 J. Van Stappen, P. Burkman, K. Pemble, D. Cooper, K. Cullen Bartnick, E. Smith, L. Schultz, K. Faber, M. Gutt, J. Burman, T. Pichler, S. Herring, and E. Newton. 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. J. Van Stappen, P. Burkman, 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 begun implementing or expanding 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 the network parks established a bat acoustic monitoring program with a particular focus on documenting the impacts of WNS. When the project was 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). GLKN's monitoring program is helping parks to document baseline data on their bat populations and assess changes over time. Apostle Islands National Lakeshore (APIS) has participated in this monitoring program since 2015.

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*) as federally endangered and the northern long-eared bat (*Myotis septentrionalis*) as federally threatened under the Endangered Species Act (U.S. Fish and Wildlife Service 1967, 2016). 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 2016, Indiana Division of Fish and Wildlife 2020) (Appendix A).

Prior to the initiation of the GLKN bat acoustic monitoring program, a total of six species had been documented at APIS (Table 1). Historic observations of two species, hoary bat (*Lasiurus cinereus*) and an unknown *Myotis*, were noted in a report on mammal surveys completed in 1919 (Jackson 1920). More recently, surveys specifically targeting bats were completed at APIS in 2002–2003, consisting of acoustic recording, mist-netting, and roost surveys (Kruger and Peterson 2008, Miller 2010). Four species were captured and two others were detected only through acoustics. Although the tricolored bat (*Perimyotis subflavus*) has not been captured at APIS or otherwise identified in-hand, the park lies near the edge of its range and this species may potentially be present. It is included in the park's NPSpecies list as "Probably Present" (<https://irma.nps.gov/NPSpecies/Search/SpeciesList/APIS>).

The ranges of the Indiana bat (*Myotis sodalis*) and evening bat (*Nycticeius humeralis*) lie further south, so these species are not expected to be present at APIS.

Table 1. Bat species occurrences recorded at Apostle Islands National Lakeshore prior to the initiation of the GLKN acoustic monitoring program in 2015 and method(s) by which the species were documented. Data sources include Jackson (1920), Kruger and Peterson (2008), and Miller (2010). Range information derived from Kurta (2017).

Species Name	Prior Records	Methods Used
Big Brown Bat <i>Eptesicus fuscus</i>	Yes	Acoustic
Eastern Red Bat <i>Lasiurus borealis</i>	Yes	Acoustic, Capture, Genetic Voucher
Hoary Bat <i>Lasiurus cinereus</i>	Yes	Acoustic, Direct Observation
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

Methods

Bat acoustic monitoring at APIS was conducted according to the protocol and standard operating procedures developed by GLKN (Goodwin 2020). Initial protocol development was done in coordination with an outside consultant, Western EcoSystems Technology, Inc. (Gruver et al. 2016). Although methods were revised by GLKN after the 2015 season of monitoring, the majority of the sampling procedures were consistent across all years.

Site Selection

GLKN utilizes a probabilistic sample design based on the creation of a master sample, as described by Larsen et al. (2008). The sampling frame for each park consists of a finite grid of 1-km² cells. For some parks certain areas were excluded from the sampling frame *a priori* based on inaccessibility from roads, trails, or shorelines. Using the Generalized Random Tessellation Stratified (GRTS) algorithm, cells within the sampling frame were arranged into an ordered list, referred to as the “master sample”; this list is both randomized and spatially balanced (Stevens and Olsen 2004). Cells to be sampled were identified by working through the master sample list in numerical order, starting with Cell #001. Each cell was evaluated for accessibility and safety to determine if it should be included. Omitted cells were documented to justify the reason for exclusion.

At APIS, the GRTS design was used beginning in 2016. A total of 28 cells were selected for sampling, equivalent to approximately 8% of the park’s sampling frame. The selected cells have been used from 2016 onward, except for two cells that were omitted after 2016 due to issues with safety and inaccessibility (APIS004 and APIS028). For the most part, the 2015 monitoring sites were completely different; however there were two sites (APIS017 and APIS018) that were monitored both in 2015 and in all following years.

The *cell* is defined as the 1-km² area that is selected for sampling. The *site* is defined as the exact location within the cell where the acoustic recording equipment is placed. Sites were chosen by identifying locations that were reasonably accessible and had suitable bat habitat such as travel corridors (e.g., cut line, road, trail, or forest edge) or foraging areas (e.g., wetland). As much as possible, sites were located away from dense vegetative clutter, buildings, or open water to optimize recording quality. Each site was assigned a Site ID based on the cell’s GRTS order number, in the format APIS001A. A map of APIS sample sites is provided in Figure 1.

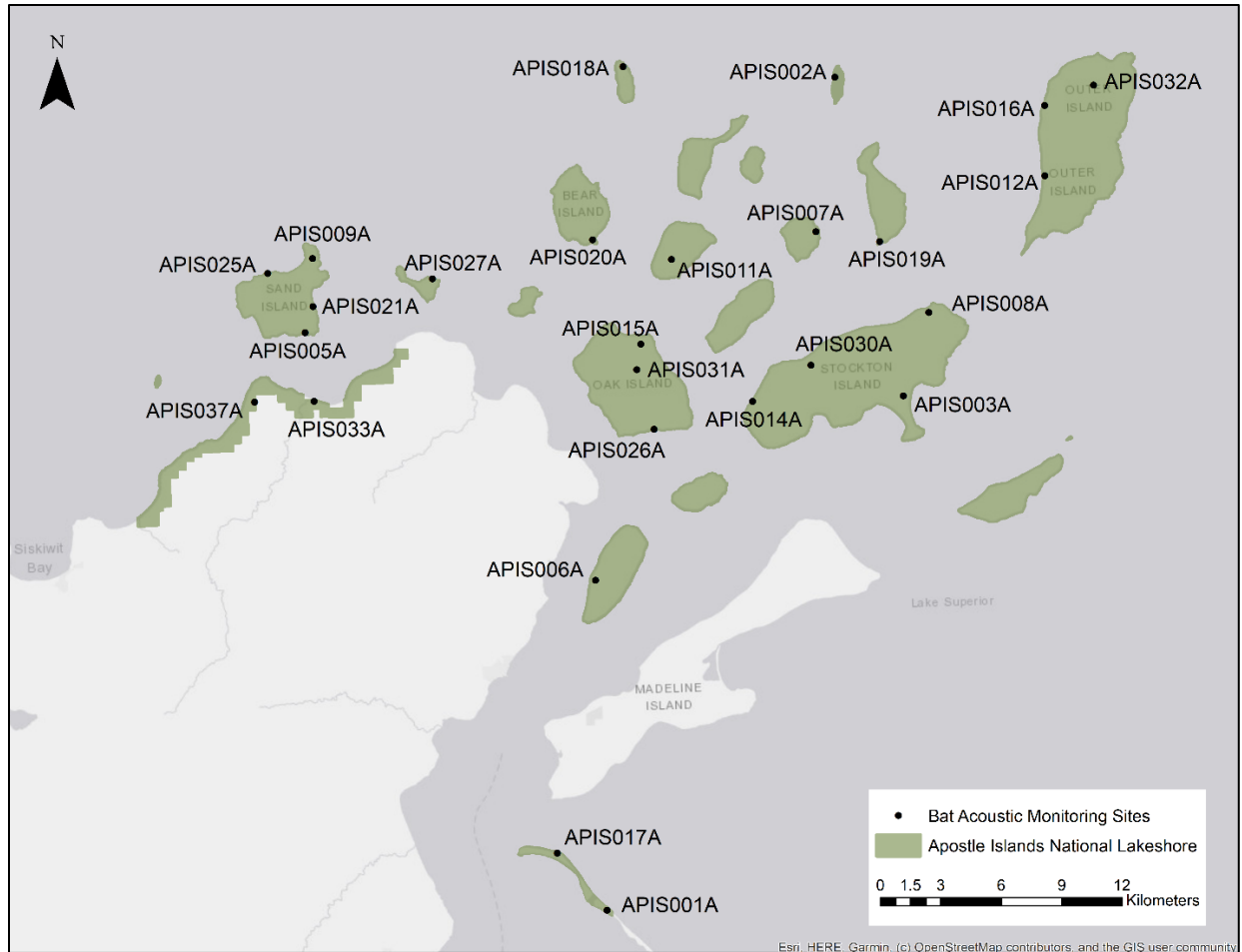


Figure 1. Bat monitoring sites at Apostle Islands National Lakeshore. Sites shown were established in 2016 and used each year since. Sites used in 2015 were different and are not shown.

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 7–14 consecutive nights. Detectors are programmed to record every night from 6:00 p.m. to 8:00 a.m.

One acoustic detector with an external ultrasonic microphone is deployed at each survey site to passively record bat echolocation calls. Equipment used at APIS includes Wildlife Acoustics Song Meter SM3BAT and Song Meter SM4BAT-FS detectors and Wildlife Acoustics SMM-U1 microphones. Recordings are collected in full-spectrum format and stored as WAV files on SD cards mounted in the detector. Field technicians complete a datasheet for each deployment and collect site photographs and GPS coordinates. After retrieving equipment, the WAV files and detector program/status files are downloaded.

Data Management and Analysis

Field technicians are responsible for data organization and securely storing data at the APIS 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 2015–2019 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, and thus were outside the protocol sampling period. Finally, “nonprotocol” indicates deployments that were completed for park-specific monitoring goals at locations that 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 (2015–2018) or Version 5.0.3 (2019), 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 to 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 APIS 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 APIS 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, with a required minimum of 10 files per species 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. Potentially identifying information 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. 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 the above-described methods does not allow estimation of population size or number of individual bats detected. Instead, data 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), using the results of the Kaleidoscope Pro analysis. 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 APIS during the years 2015 to 2019. There were 14 to 28 valid deployments per year. This report provides results only for the sites that had valid deployments.

Monitoring occurred over a total of 181 to 302 nights of recording. The number of audio files collected per year ranged from 21,818 to 84,824. Yearly survey effort and deployment information are summarized in Figure 2 and Appendix D.

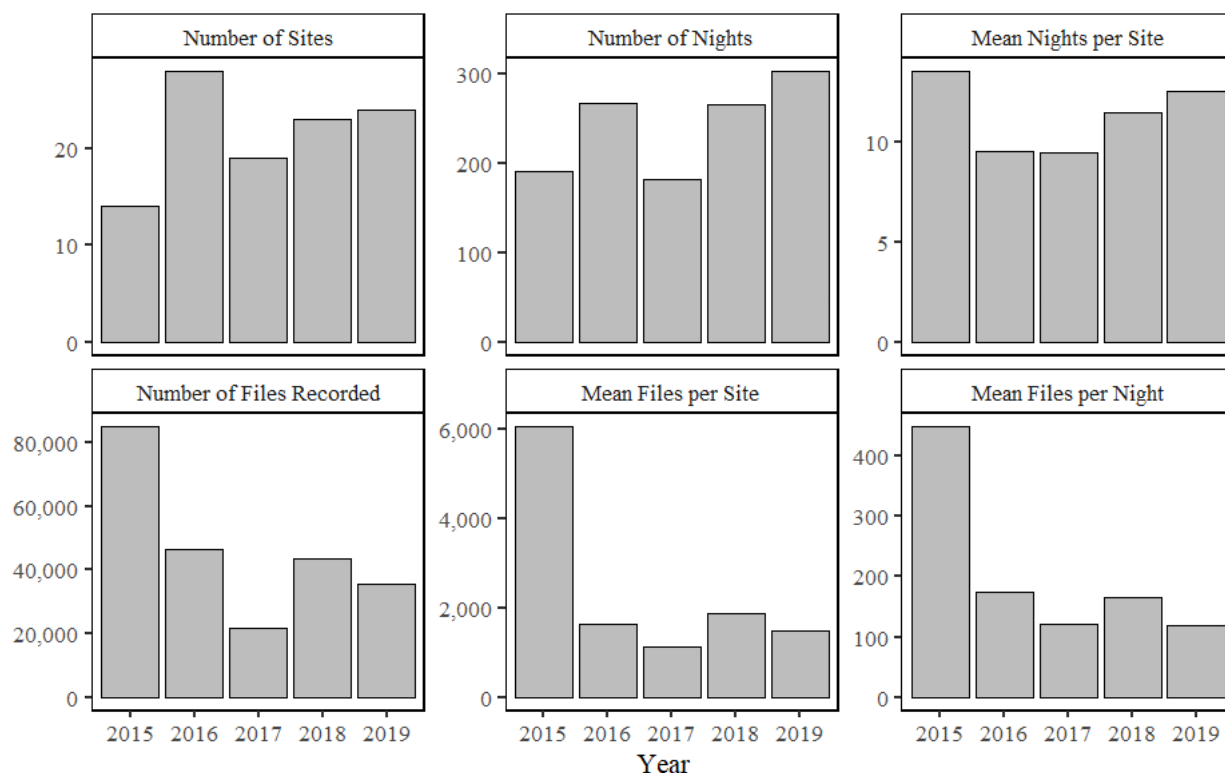


Figure 2. Yearly survey effort at Apostle Islands National Lakeshore, 2015–2019. *Top, left to right:* Number of sites, number of nights, and mean nights per site; *bottom, left to right:* total number of audio files recorded, mean files per site, and mean files per night. Number of files is prior to classification (i.e., includes noise).

Automated Classification

The proportion of files identified to the species level each year ranged from 80% to 93% (Figure 3, Appendix E). The proportion of files assigned to a species versus unknown bat was similar for the baseline and expanded analyses. The two detector models (SM3BAT and SM4BAT-FS) had similar proportions of files classified as noise (data from all parks combined; Appendix F). Noise was highly variable across the different APIS sampling sites (Appendix F).

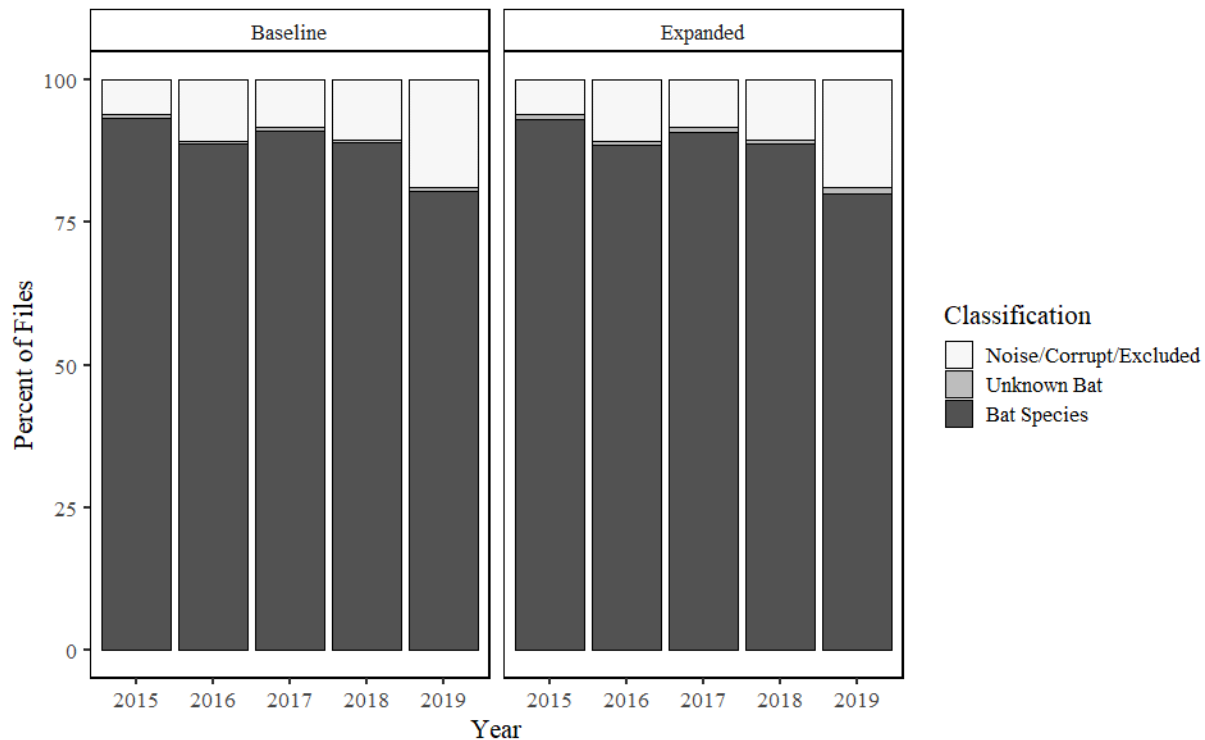


Figure 3. Percent of audio files classified by Kaleidoscope Pro as bat species vs. unknown bats vs. noise, corrupt, and excluded files, Apostle Islands National Lakeshore, 2015–2019. Proportions are shown for the baseline (*left*) and expanded (*right*) analyses.

Kaleidoscope Pro 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 (Figure 4). In both the baseline and expanded analyses, the largest proportion of files was classified as little brown bats in every year (2015 through 2019). The proportion of files attributed to the three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) showed a decreasing trend from 2015 to 2019 relative to the proportion attributed to the other species (Figure 5). The most notable changes for individual species were an increase in the percentage of eastern red bat files and a decrease in the percentage of little brown bat files. File counts and percentages are provided in Appendix E.

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 much higher in 2015 than in any of the later years, with little brown bat showing the largest difference (Figure 6).

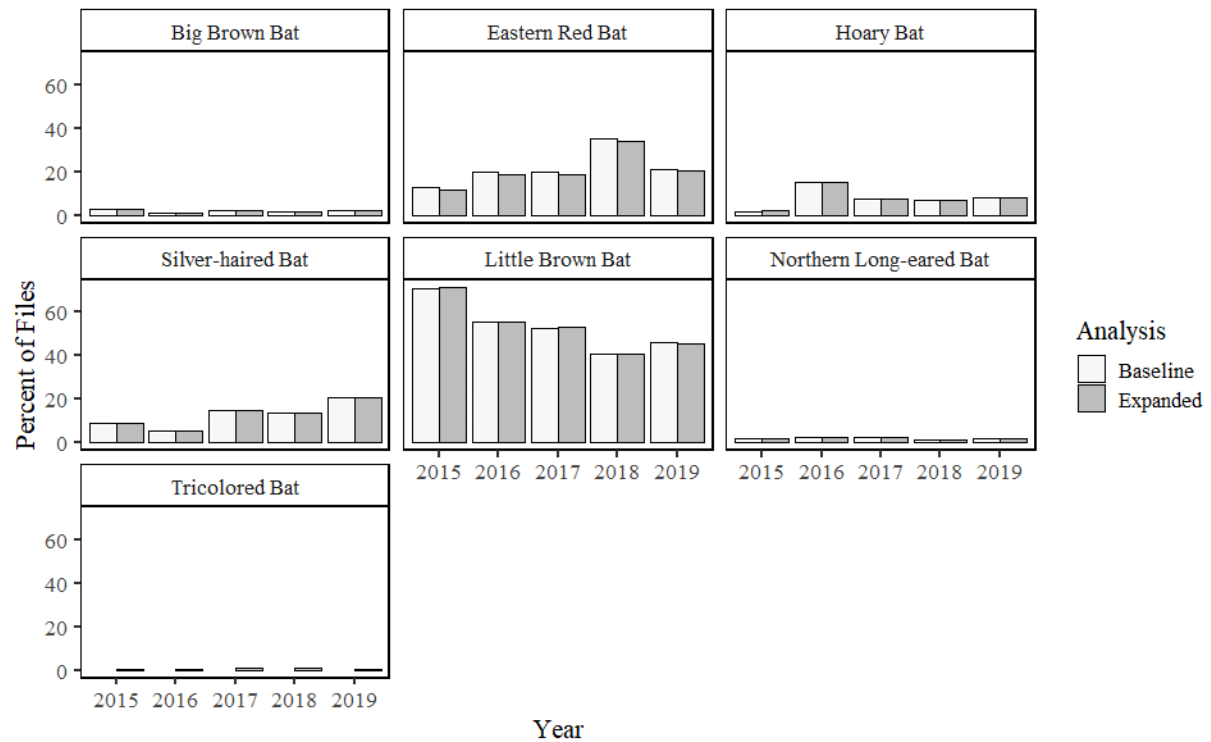


Figure 4. Proportion of files classified to each species each year in the baseline versus expanded analysis, Apostle Islands National Lakeshore, 2015–2019. Tricolored bat was only allowed as a possible species in the expanded analysis. Includes only the subset of files successfully assigned a species-level classification by Kaleidoscope Pro.

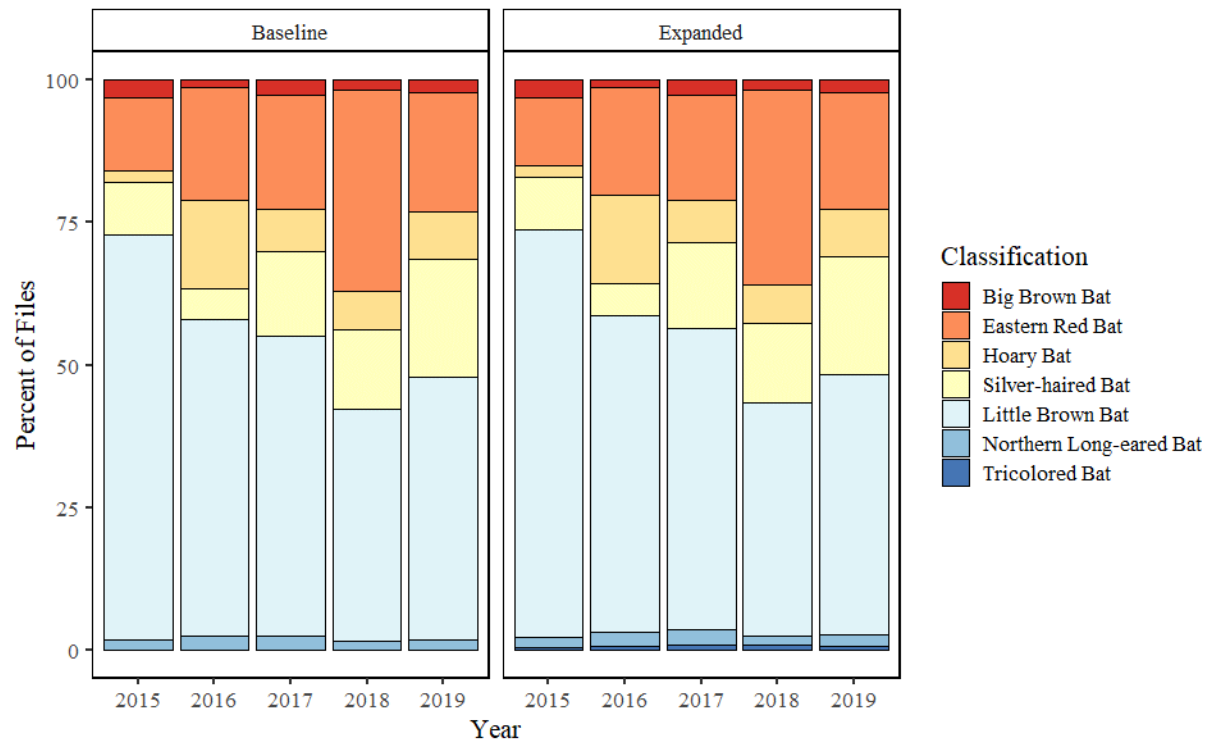


Figure 5. Proportion of files classified to each species each year relative to all other species, Apostle Islands National Lakeshore, 2015–2019. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue while less susceptible species are 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.

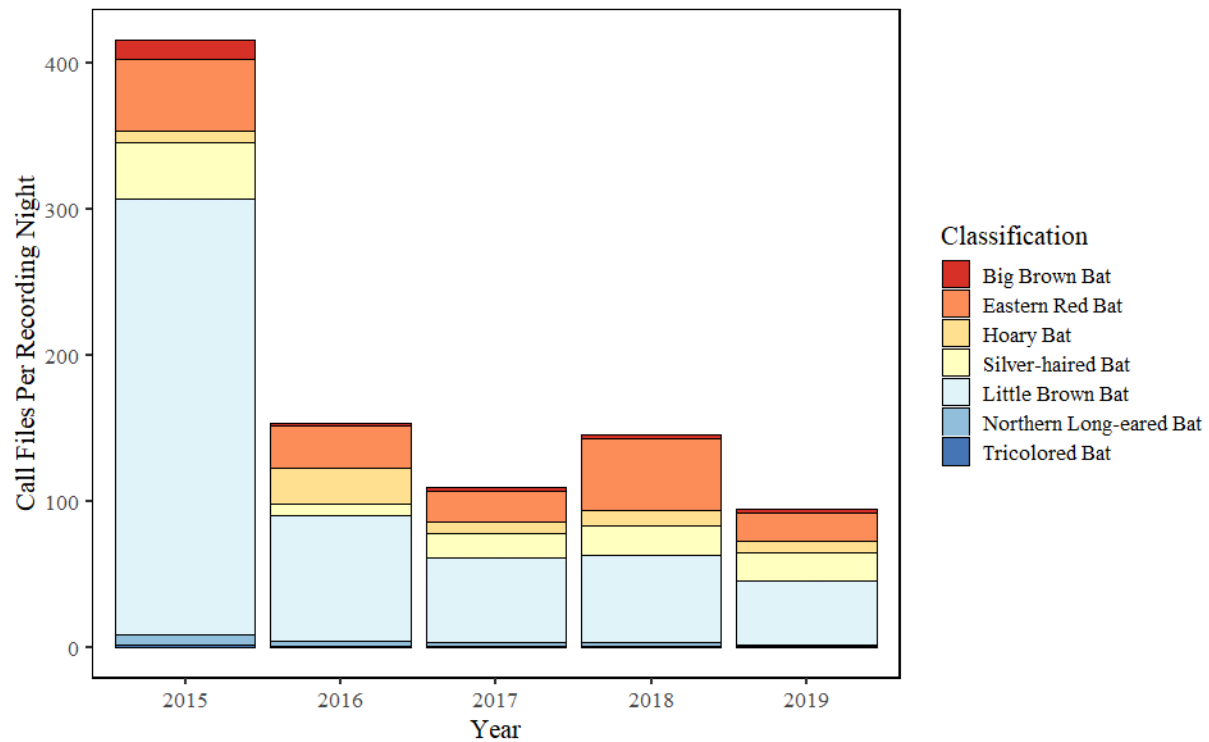


Figure 6. Parkwide call files per recording night by species and year for the expanded analysis, Apostle Islands National Lakeshore, 2015–2019. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue while less susceptible species are 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 higher in 2015 than in the other years, and results from 2016–2019 were all similar (Figure 7, lower right panel). Looking at individual species, we observed a much smaller range of values after 2015 for big brown bat, little brown bat, and northern long-eared bat (Figure 7). The median call files per recording night was also noticeably lower after 2015 for big brown bat, eastern red bat, and little brown 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.

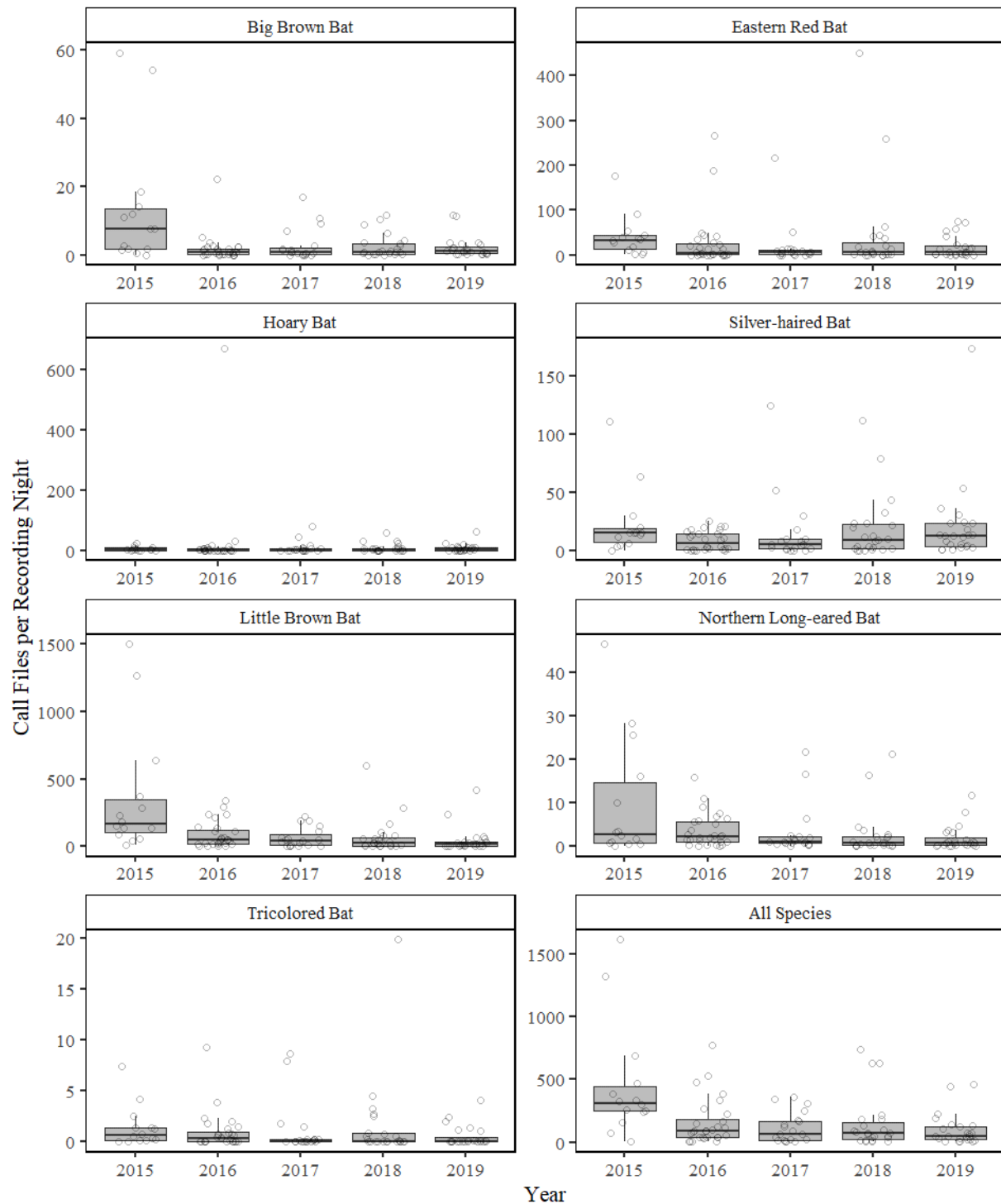


Figure 7. Call files per recording night for each species and for all species combined, by year, for the expanded analysis, Apostle Islands National Lakeshore, 2015–2019. Each point represents call files per recording night at a particular survey site. The dark line across the boxplot represents the 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. Most species were widely distributed across the park, with detections at greater than 75% of monitoring sites in every year (Figure 8, Appendix E). Four species were detected on at least 50% of recording nights each year, while the others were detected less frequently (Figure 9, Appendix E). On average, the little brown bat was detected at the highest percentage of sites and on the highest percentage of nights. When included in the expanded analysis, the tricolored bat was detected at 52%–86% of sites and on 22%–50% of nights.

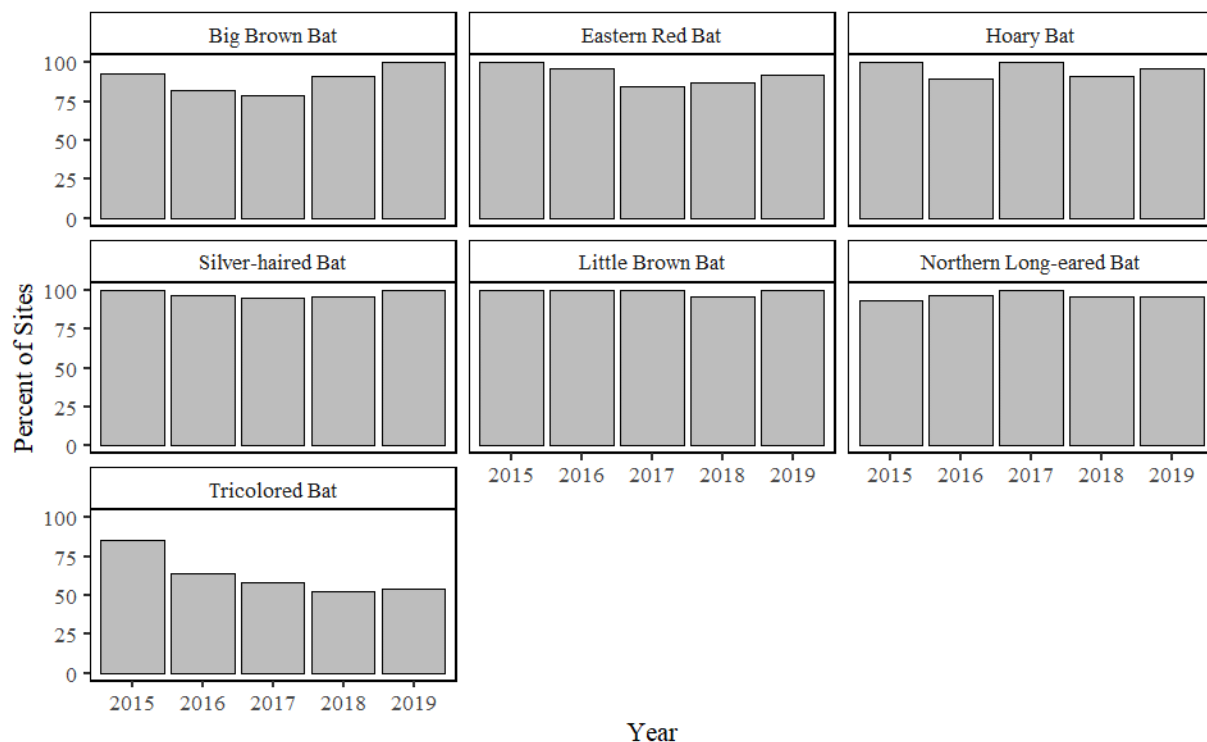


Figure 8. Proportion of monitoring sites where each species was detected each year, Apostle Islands National Lakeshore, 2015–2019. A species was considered to be detected at a site if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and expanded analysis so only the expanded analysis is shown.

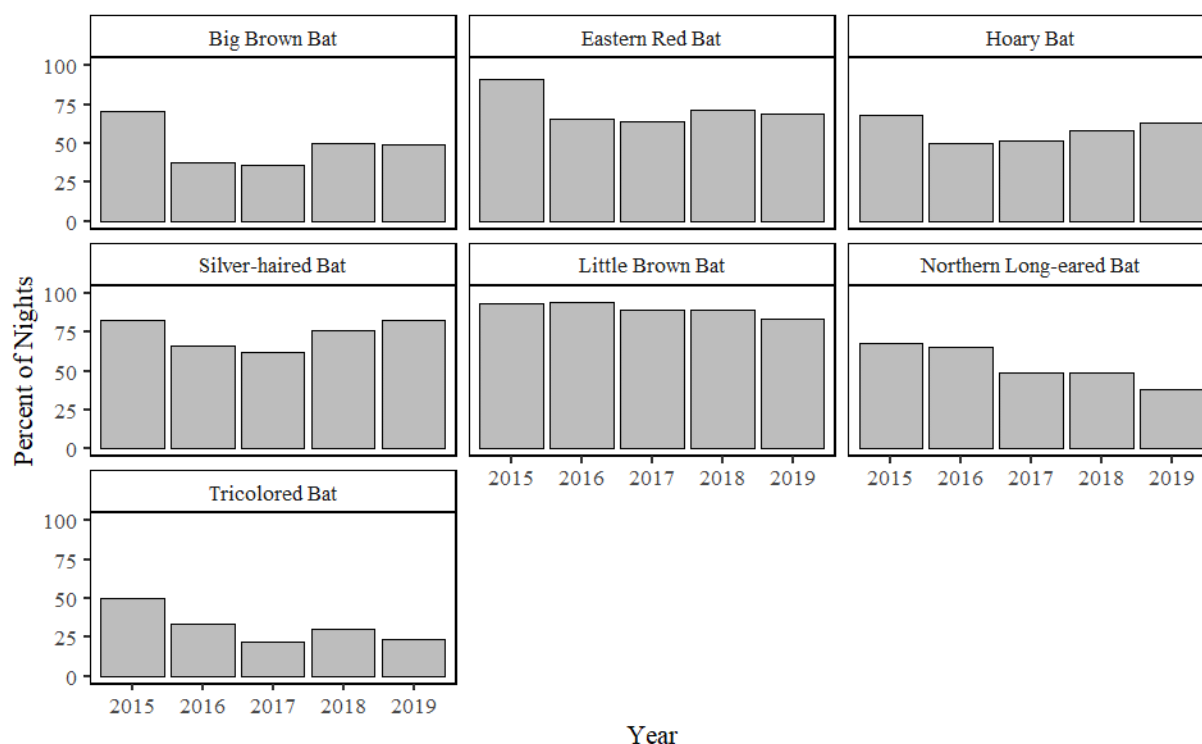


Figure 9. Proportion of recording nights on which each species was detected each year, Apostle Islands National Lakeshore, 2015–2019. A species was considered to be detected on a night if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and 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 to be vetted unless there were fewer than 10 files available (see Methods). Manual vetting resulted in a total of six species being verified between 2015 and 2019. The only 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 79% for the little brown 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 three *Myotis* species (little brown bat, northern long-eared bat, and Indiana bat) all 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.

Summary and Conclusions

The six bat species previously documented at APIS (see Table 1) were reconfirmed through this monitoring effort: 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. A seventh species, the tricolored bat, was also documented. Tricolored bats have not been confirmed at APIS through physical captures, but our acoustic surveys suggest this species is present, as evidenced by manually verified recordings of their calls in both 2016 and 2017. The manually verified recordings came from sites APIS026A (south side of Oak Island; one file in 2016 and three files in 2017) and APIS008A (north side of Stockton Island; one file in 2017). It is important to note that only a small number of the call files identified by the software as northern long-eared bats or tricolored bats have so far been manually reviewed (approximately 40–50 files per species). Conducting additional manual review on the remaining files could increase the number of locations or years with verified records of these species.

Taking into account the switchover of monitoring locations after 2015, activity levels for four of the seven species (big brown bat, eastern red bat, hoary bat, and silver-haired bat) appear to be stable or increasing slightly. The remaining three species (little brown bat, northern long-eared bat, and tricolored bat) appear to have decreasing trends in activity levels. These three species are all highly susceptible to WNS and the disease is mostly likely causing the observed declines.

Results for each species are summarized below and in Table 2. 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 (both automated and manual identification).
- Widely distributed: Present at over 75% of survey sites each year.
- Recorded relatively rarely compared to other species: Less than 4% of total files each year and little change from year to year.
- Recorded on a higher percentage of nights in 2015 (71%) than in later years (36%–50%).
- Median call files per recording night much higher in 2015 than in other years, but consistent from 2016–2019. Two 2015 sites, RO-01 (Rocky Island septic field behind ranger station) and ST-01 (Stockton Island septic field behind ranger residence), both had a very high number of call files per recording night compared to all other sites in all years. It is possible that big brown bats were roosting in the buildings adjacent to each of these sample sites. These two sites were not resampled after 2015.

Eastern Red Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 80% of survey sites each year.
- Second most commonly recorded species with 12%–35% of total files.
- Recorded on a higher percentage of nights in 2015 (91%) than in later years (64%–72%).

- Median call files per recording night higher in 2015 than in other years, but consistent from 2016–2019.

Hoary Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 85% of survey sites each year.
- Percent of total files ranged from 2%–16%.
- Recorded on 50%–68% of nights each year.
- Median call files per recording night similar across all years. One site (APIS012A, Outer Island) had extremely high hoary bat activity in 2016, with over 600 call files per recording night. This site also had the highest hoary bat activity of all APIS sites in 2018 and 2019. It is located in an open wetland area along a stream corridor, providing excellent foraging habitat for this species.

Silver-haired Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at 95% or more of survey sites each year.
- Percent of total files ranged from 5%–21%, with the lowest percentage in 2016 and highest in 2019.
- Recorded on 62%–82% of nights each year.
- Median call files per recording night highest in 2015 and 2019 and lower in 2016–2018.

Little Brown Bat

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 95% of survey sites each year.
- Most commonly recorded species by far every year with 41%–71% of total files. The highest percentage occurred in 2015 and the lowest in 2018. A greater percentage of files were attributed to little brown bats than to all other species combined in 2015, 2016, and 2017 but not in 2018 or 2019.
- Recorded on a high percentage of nights each year (83%–94%), higher than any other species.
- Median call files per recording night much higher in 2015 than in 2016–2019. There was also a decreasing trend from 2016 to 2019.

Northern Long-eared Bat

- Documented in every year of surveys via automated identification, but not manually verified.
- Widely distributed: Present at over 90% of survey sites each year.
- Recorded relatively rarely compared to other species: Less than 3% of total files each year and little change from year to year.
- Recorded on 38%–68% of nights each year, with a decreasing trend since 2015.

- Median call files per recording night decreasing after 2015.

Tricolored Bat

- Documented in every year of surveys via automated identification (expanded analysis only) and verified manually in 2016 and 2017.
- Less widely distributed than other species: Present at only 52%–86% of survey sites each year, with a decreasing trend since 2015.
- Rarely recorded compared to other species: Less than 1% of total files each year and little change from year to year.
- Recorded on 22%–50% of nights each year.
- Median call files per recording night decreasing after 2015.

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

Species	Year	Detected	
		<i>Automated</i>	<i>Manual</i>
Big Brown Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
	2019	Yes	Yes
Eastern Red Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
	2019	Yes	Yes
Hoary Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
	2019	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 Apostle Islands National Lakeshore through automated classification and manual vetting of acoustic files.

Species	Year	Detected	
		Automated	Manual
Silver-haired Bat (continued)	2019	Yes	Yes
Little Brown Bat	2015	Yes	Yes
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	Yes
	2019	Yes	Yes
Northern Long-eared Bat	2015	Yes	No
	2016	Yes	No
	2017	Yes	No
	2018	Yes	No
	2019	Yes	No
Tricolored Bat	2015	Yes	No
	2016	Yes	Yes
	2017	Yes	Yes
	2018	Yes	No
	2019	Yes	No

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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), 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	T	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	–	E (IN) T (WI) SC (MI, MN)

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

^b U.S. Fish and Wildlife Service (1967, 2016).

^c Indiana Division of Fish and Wildlife (2020), Michigan Natural Features Inventory (2009), Minnesota Department of Natural Resources (2013), Wisconsin Department of Natural Resources (2016).

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. Although two different software versions were used, the classifier did not change, so results are still comparable.

Software Version: Kaleidoscope Pro 4.0.0 (2015–2018 data) and Kaleidoscope Pro 5.0.3 (2019 data)

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 at Apostle Islands National Lakeshore, 2015–2019.

Year	Earliest	Latest	Deployment Category ¹							Total Files
			Early	Failed	Failed (short)	Late	Non-protocol	Valid	Valid (dupl.)	
2015	4 June	17 October	0	3	1	13	0	14	3	118,432
2016	22 April	31 August	0	0	0	0	5	28	0	57,251
2017	30 May	1 September	0	5	1	0	0	19	0	22,317
2018	31 May	17 August	0	3	2	0	0	23	0	43,645
2019	4 June	26 August	0	0	1	0	0	24	0	35,953

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, Apostle Islands National Lakeshore, 2015–2019. 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	14	190	13.57	84,824	6,059	446
2016	28	267	9.54	46,305	1,654	173
2017	19	181	9.53	21,818	1,148	121
2018	23	265	11.52	43,549	1,893	164
2019	24	302	12.58	35,642	1,485	118

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, Apostle Islands National Lakeshore, 2015–2019. 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	84,824	79,146	517	5,161	93.31	0.61	6.08
2015	expanded	84,824	78,999	664	5,161	93.13	0.78	6.08
2016	baseline	46,305	41,125	213	4,967	88.81	0.46	10.73
2016	expanded	46,305	41,032	306	4,967	88.61	0.66	10.73
2017	baseline	21,818	19,886	123	1,809	91.14	0.56	8.29
2017	expanded	21,818	19,844	165	1,809	90.95	0.76	8.29
2018	baseline	43,549	38,797	215	4,537	89.09	0.49	10.42
2018	expanded	43,549	38,674	338	4,537	88.81	0.78	10.42
2019	baseline	35,642	28,664	254	6,724	80.42	0.71	18.87
2019	expanded	35,642	28,569	349	6,724	80.16	0.98	18.87

Table E2. Total number of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	2,502	10,110	1,585	7,315	56,234	1,400	n/a
2015	expanded	2,508	9,264	1,589	7,328	56,525	1,433	352
2016	baseline	494	8,182	6,364	2,242	22,821	1,022	n/a
2016	expanded	495	7,806	6,368	2,243	22,822	1,020	278
2017	baseline	509	3,979	1,475	2,953	10,472	498	n/a
2017	expanded	508	3,689	1,476	2,953	10,523	506	189
2018	baseline	696	13,675	2,648	5,354	15,817	607	n/a
2018	expanded	699	13,157	2,654	5,360	15,835	616	353
2019	baseline	627	6,005	2,393	5,887	13,249	503	n/a
2019	expanded	627	5,851	2,394	5,890	13,081	517	209

Table E3. Percent of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	3.16	12.77	2.00	9.24	71.05	1.77	n/a
2015	expanded	3.17	11.73	2.01	9.28	71.55	1.81	0.45
2016	baseline	1.20	19.90	15.47	5.45	55.49	2.49	n/a
2016	expanded	1.21	19.02	15.52	5.47	55.62	2.49	0.68
2017	baseline	2.56	20.01	7.42	14.85	52.66	2.50	n/a
2017	expanded	2.56	18.59	7.44	14.88	53.03	2.55	0.95
2018	baseline	1.79	35.25	6.83	13.80	40.77	1.56	n/a
2018	expanded	1.81	34.02	6.86	13.86	40.94	1.59	0.91
2019	baseline	2.19	20.95	8.35	20.54	46.22	1.75	n/a
2019	expanded	2.19	20.48	8.38	20.62	45.79	1.81	0.73

Table E4. Total number of monitoring sites, and count of sites where each species was detected for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	14	13	14	14	14	14	13	n/a
2015	expanded	14	13	14	14	14	14	13	12
2016	baseline	28	23	27	25	27	28	27	n/a
2016	expanded	28	23	27	25	27	28	27	18
2017	baseline	19	15	16	19	18	19	19	n/a
2017	expanded	19	15	16	19	18	19	19	11
2018	baseline	23	21	20	21	22	22	21	n/a
2018	expanded	23	21	20	21	22	22	22	12
2019	baseline	24	24	22	23	24	24	23	n/a
2019	expanded	24	24	22	23	24	24	23	13

Table E5. Total number of monitoring sites, and percent of sites where each species was detected for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	14	92.86	100.00	100.00	100.00	100.00	92.86	n/a
2015	expanded	14	92.86	100.00	100.00	100.00	100.00	92.86	85.71
2016	baseline	28	82.14	96.43	89.29	96.43	100.00	96.43	n/a
2016	expanded	28	82.14	96.43	89.29	96.43	100.00	96.43	64.29
2017	baseline	19	78.95	84.21	100.00	94.74	100.00	100.00	n/a
2017	expanded	19	78.95	84.21	100.00	94.74	100.00	100.00	57.89
2018	baseline	23	91.30	86.96	91.30	95.65	95.65	91.30	n/a
2018	expanded	23	91.30	86.96	91.30	95.65	95.65	95.65	52.17
2019	baseline	24	100.00	91.67	95.83	100.00	100.00	95.83	n/a
2019	expanded	24	100.00	91.67	95.83	100.00	100.00	95.83	54.17

Table E6. Total number of recording nights, and count of recording nights on which each species was detected for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	190	134	173	130	156	177	126	n/a
2015	expanded	190	134	173	130	156	177	129	95
2016	baseline	267	100	182	133	177	251	176	n/a
2016	expanded	267	100	175	133	177	251	174	89
2017	baseline	181	65	117	93	112	161	88	n/a
2017	expanded	181	65	116	93	112	161	88	40
2018	baseline	265	132	191	154	202	237	129	n/a
2018	expanded	265	132	190	154	202	236	130	81
2019	baseline	302	149	210	190	249	254	114	n/a
2019	expanded	302	149	208	190	249	252	116	71

Table E7. Total number of recording nights, and percent of recording nights on which each species was detected for each year and analysis type, Apostle Islands National Lakeshore, 2015–2019. 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	190	70.53	91.05	68.42	82.11	93.16	66.32	n/a
2015	expanded	190	70.53	91.05	68.42	82.11	93.16	67.89	50.00
2016	baseline	267	37.45	68.16	49.81	66.29	94.01	65.92	n/a
2016	expanded	267	37.45	65.54	49.81	66.29	94.01	65.17	33.33
2017	baseline	181	35.91	64.64	51.38	61.88	88.95	48.62	n/a
2017	expanded	181	35.91	64.09	51.38	61.88	88.95	48.62	22.10
2018	baseline	265	49.81	72.08	58.11	76.23	89.43	48.68	n/a
2018	expanded	265	49.81	71.70	58.11	76.23	89.06	49.06	30.57
2019	baseline	302	49.34	69.54	62.91	82.45	84.11	37.75	n/a
2019	expanded	302	49.34	68.87	62.91	82.45	83.44	38.41	23.51

Appendix F. Noise Assessment.

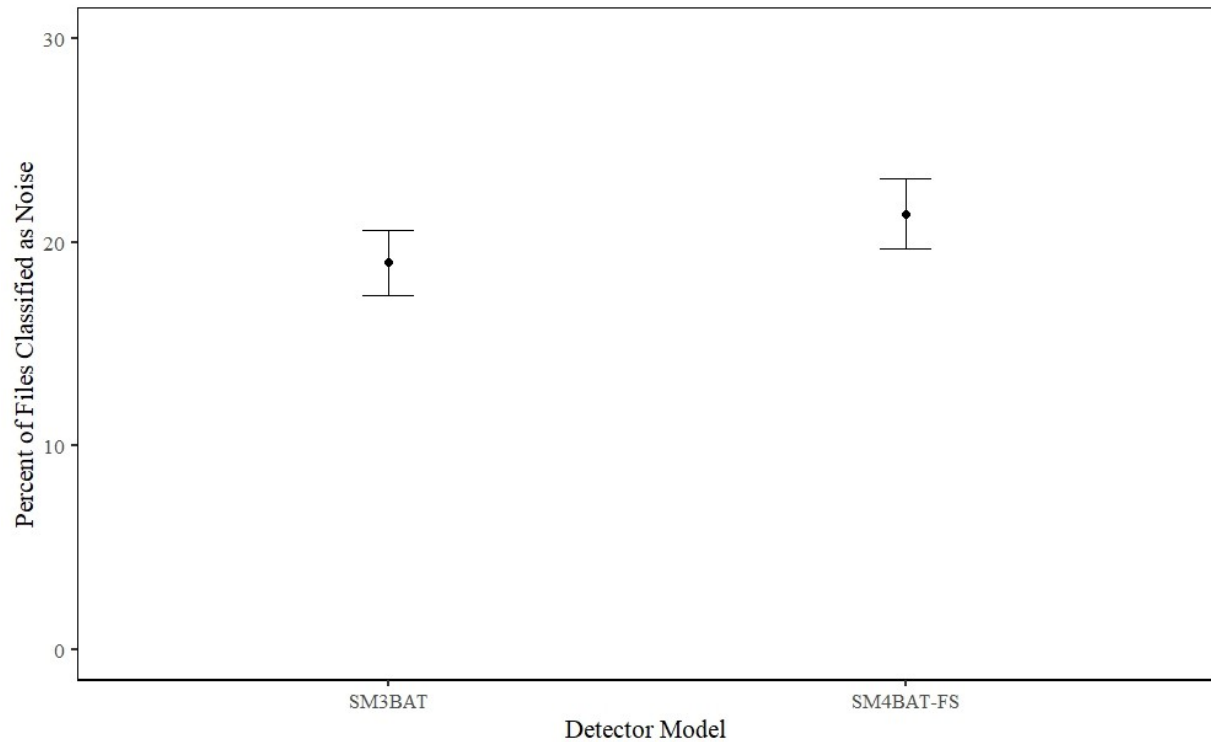


Figure F1. Percent of audio files classified as noise for each detector model (mean \pm 95% confidence interval). Includes all Great Lakes Network parks in which bat monitoring occurred. Includes all deployments from 2015–2019 except failed deployments. Sample size: $n = 442$ for SM3BAT; $n = 452$ for SM4BAT-FS.

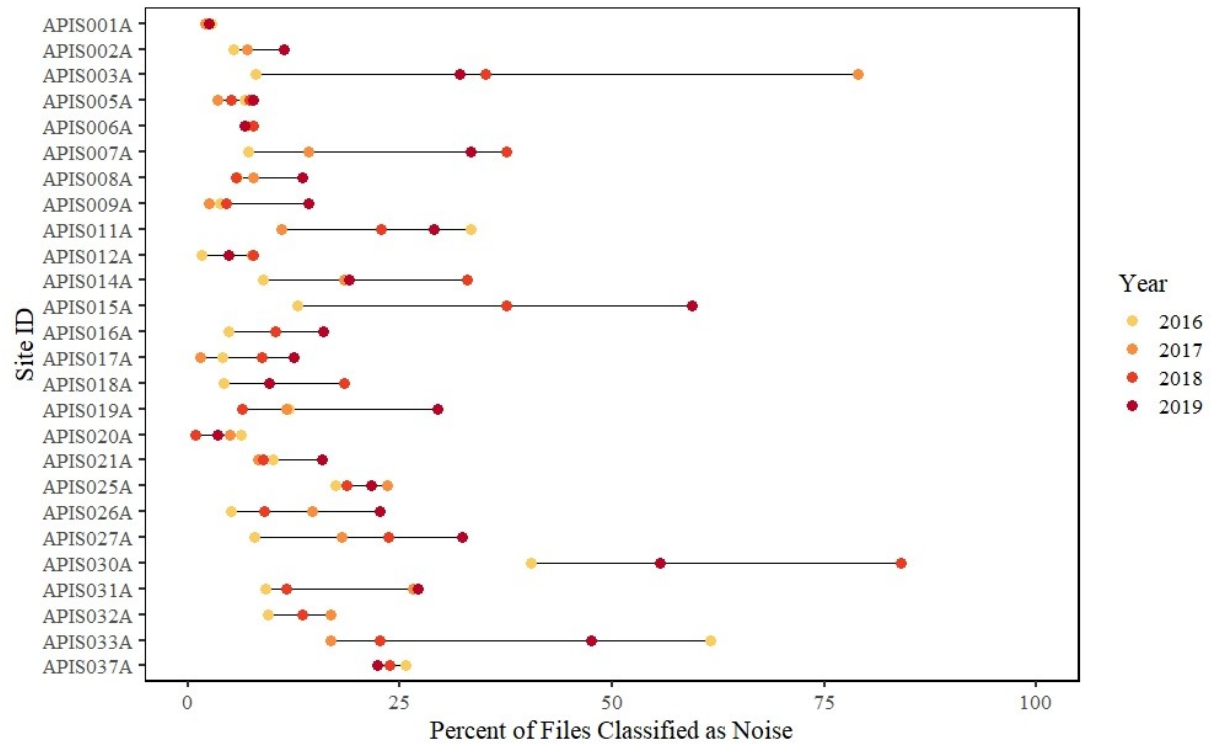


Figure F2. Percent of audio files classified as noise for each sampling site at Apostle Islands National Lakeshore, 2016–2019. Each point represents the percent noise for one year's deployment at that sampling site. Excludes failed deployments and all sites that were sampled only in 2015 or only in 2016.

Table F1. Mean percent of audio files classified as noise for each sampling site at Apostle Islands National Lakeshore, 2016–2019. Excludes failed deployments and all sites that were sampled only in 2015 or only in 2016. 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
APIS001A	2.5	0.4	2.1	2.8	–
APIS002A	7.9	3.1	5.4	11.3	–
APIS003A	38.5	29.6	8.0	79.0	Yes*
APIS005A	6.1	1.7	3.6	7.8	–
APIS006A	7.1	0.5	6.7	7.7	–
APIS007A	23.1	14.7	7.1	37.5	Yes
APIS008A	8.2	3.7	5.7	13.6	–
APIS009A	6.3	5.3	2.6	14.2	–
APIS011A	24.1	9.6	11.1	33.3	Yes*
APIS012A	5.5	2.9	1.7	7.8	–
APIS014A	19.9	9.9	8.9	33.0	Yes
APIS015A	36.6	23.3	12.9	59.4	Yes*
APIS016A	10.4	5.6	4.9	16.0	–
APIS017A	6.7	4.9	1.5	12.5	–
APIS018A	10.8	7.1	4.3	18.4	–
APIS019A	14.9	10.1	6.4	29.5	–
APIS020A	4.0	2.3	0.9	6.3	–
APIS021A	10.8	3.4	8.3	15.8	–
APIS025A	20.3	2.7	17.5	23.5	Yes
APIS026A	12.9	7.6	5.2	22.6	–
APIS027A	20.5	10.2	7.9	32.3	Yes
APIS030A	60.0	22.1	40.5	84.0	Yes*
APIS031A	18.6	9.6	9.2	27.2	Yes
APIS032A	13.3	3.7	9.5	16.8	–
APIS033A	37.2	21.1	16.8	61.6	Yes*
APIS037A	24.0	1.7	22.4	25.7	Yes

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, Apostle Islands National Lakeshore, 2015–2019. “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	18	6	33.33
2015	baseline	Eastern Red Bat	70	24	34.29
2015	baseline	Hoary Bat	8	4	50.00
2015	baseline	Silver-haired Bat	41	15	36.59
2015	baseline	Little Brown Bat	561	363	64.71
2015	baseline	Northern Long-eared Bat	11	0	0.00
2015	expanded	Tricolored Bat	3	0	0.00
2016	baseline	Big Brown Bat	10	2	20.00
2016	baseline	Eastern Red Bat	82	62	75.61
2016	baseline	Hoary Bat	64	57	89.06
2016	baseline	Silver-haired Bat	22	13	59.09
2016	baseline	Little Brown Bat	228	183	80.26
2016	baseline	Northern Long-eared Bat	10	0	0.00
2016	expanded	Tricolored Bat	10	1	10.00
2017	baseline	Big Brown Bat	10	3	30.00
2017	baseline	Eastern Red Bat	40	37	92.50
2017	baseline	Hoary Bat	15	13	86.67
2017	baseline	Silver-haired Bat	30	22	73.33
2017	baseline	Little Brown Bat	105	91	86.67
2017	baseline	Northern Long-eared Bat	10	0	0.00
2017	expanded	Tricolored Bat	10	4	40.00
2018	baseline	Big Brown Bat	10	1	10.00
2018	baseline	Eastern Red Bat	102	86	84.31
2018	baseline	Hoary Bat	26	20	76.92

Year	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2018	baseline	Silver-haired Bat	49	31	63.27
2018	baseline	Little Brown Bat	152	135	88.82
2018	baseline	Northern Long-eared Bat	10	0	0.00
2018	expanded	Tricolored Bat	10	0	0.00
2019	baseline	Big Brown Bat	10	2	20.00
2019	baseline	Eastern Red Bat	46	32	69.57
2019	baseline	Hoary Bat	23	20	86.96
2019	baseline	Silver-haired Bat	57	24	42.11
2019	baseline	Little Brown Bat	126	95	75.40
2019	baseline	Northern Long-eared Bat	10	0	0.00
2019	expanded	Tricolored Bat	10	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, Apostle Islands National Lakeshore, 2015–2019. “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	BE-01_2015	baseline	Big Brown Bat	1	0	0.00
2015	BE-01_2015	baseline	Eastern Red Bat	3	0	0.00
2015	BE-01_2015	baseline	Little Brown Bat	112	79	70.54
2015	BE-01_2015	baseline	Northern Long-eared Bat	5	0	0.00
2015	CA-01_2015	baseline	Eastern Red Bat	1	1	100.00
2015	CA-01_2015	baseline	Little Brown Bat	2	1	50.00
2015	IR-01_2015	baseline	Eastern Red Bat	2	2	100.00
2015	IR-01_2015	baseline	Silver-haired Bat	2	1	50.00
2015	IR-01_2015	baseline	Little Brown Bat	4	0	0.00
2015	MA-01_2015	baseline	Hoary Bat	1	0	0.00
2015	MA-01_2015	baseline	Little Brown Bat	20	17	85.00
2015	MD-01_2015	baseline	Eastern Red Bat	8	1	12.50
2015	MD-01_2015	baseline	Hoary Bat	1	1	100.00
2015	MD-01_2015	baseline	Silver-haired Bat	5	3	60.00
2015	MD-01_2015	baseline	Little Brown Bat	24	19	79.17
2015	MD-02_2015	baseline	Eastern Red Bat	10	6	60.00
2015	MD-02_2015	baseline	Silver-haired Bat	21	8	38.10
2015	MD-02_2015	baseline	Little Brown Bat	6	4	66.67
2015	MI-01_2015	baseline	Hoary Bat	2	2	100.00
2015	MI-01_2015	baseline	Silver-haired Bat	1	1	100.00
2015	MI-01_2015	baseline	Little Brown Bat	190	120	63.16
2015	MI-01_2015	baseline	Northern Long-eared Bat	1	0	0.00
2015	OA-01_2015	baseline	Big Brown Bat	1	0	0.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2015	OA-01_2015	baseline	Eastern Red Bat	4	2	50.00
2015	OA-01_2015	baseline	Little Brown Bat	27	12	44.44
2015	OA-01_2015	baseline	Northern Long-eared Bat	1	0	0.00
2015	OA-01_2015	expanded	Tricolored Bat	2	0	0.00
2015	OT-01_2015	baseline	Little Brown Bat	3	0	0.00
2015	OU-02_2015	baseline	Eastern Red Bat	33	11	33.33
2015	OU-02_2015	baseline	Silver-haired Bat	1	0	0.00
2015	OU-02_2015	baseline	Little Brown Bat	24	12	50.00
2015	OU-02_2015	expanded	Tricolored Bat	1	0	0.00
2015	RA-01_2015	baseline	Eastern Red Bat	6	0	0.00
2015	RA-01_2015	baseline	Hoary Bat	4	1	25.00
2015	RA-01_2015	baseline	Silver-haired Bat	4	0	0.00
2015	RA-01_2015	baseline	Little Brown Bat	35	13	37.14
2015	RO-01_2015	baseline	Big Brown Bat	11	3	27.27
2015	RO-01_2015	baseline	Eastern Red Bat	1	0	0.00
2015	RO-01_2015	baseline	Silver-haired Bat	4	1	25.00
2015	RO-01_2015	baseline	Little Brown Bat	24	15	62.50
2015	RO-01_2015	baseline	Northern Long-eared Bat	1	0	0.00
2015	SO-01_2015	baseline	Big Brown Bat	1	1	100.00
2015	SO-01_2015	baseline	Eastern Red Bat	2	1	50.00
2015	SO-01_2015	baseline	Little Brown Bat	70	53	75.71
2015	ST-01_2015	baseline	Big Brown Bat	4	2	50.00
2015	ST-01_2015	baseline	Silver-haired Bat	3	1	33.33
2015	ST-01_2015	baseline	Little Brown Bat	20	18	90.00
2015	ST-01_2015	baseline	Northern Long-eared Bat	3	0	0.00
2016	APIS001A_2016	baseline	Eastern Red Bat	3	0	0.00
2016	APIS001A_2016	baseline	Silver-haired Bat	2	2	100.00
2016	APIS001A_2016	baseline	Little Brown Bat	31	28	90.32
2016	APIS001A_2016	expanded	Tricolored Bat	1	0	0.00
2016	APIS002A_2016	baseline	Little Brown Bat	1	1	100.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2016	APIS003A_2016	baseline	Little Brown Bat	2	2	100.00
2016	APIS004A_2016	baseline	Little Brown Bat	1	0	0.00
2016	APIS005A_2016	baseline	Hoary Bat	2	2	100.00
2016	APIS006A_2016	baseline	Little Brown Bat	7	7	100.00
2016	APIS006A_2016	baseline	Northern Long-eared Bat	1	0	0.00
2016	APIS007A_2016	baseline	Little Brown Bat	7	5	71.43
2016	APIS008A_2016	baseline	Eastern Red Bat	3	2	66.67
2016	APIS008A_2016	baseline	Silver-haired Bat	5	4	80.00
2016	APIS008A_2016	baseline	Little Brown Bat	6	4	66.67
2016	APIS009A_2016	baseline	Little Brown Bat	8	8	100.00
2016	APIS012A_2016	baseline	Big Brown Bat	1	0	0.00
2016	APIS012A_2016	baseline	Eastern Red Bat	4	3	75.00
2016	APIS012A_2016	baseline	Hoary Bat	54	50	92.59
2016	APIS012A_2016	baseline	Silver-haired Bat	1	0	0.00
2016	APIS012A_2016	baseline	Little Brown Bat	1	1	100.00
2016	APIS014A_2016	baseline	Silver-haired Bat	1	1	100.00
2016	APIS014A_2016	baseline	Little Brown Bat	4	3	75.00
2016	APIS016A_2016	baseline	Silver-haired Bat	1	0	0.00
2016	APIS016A_2016	baseline	Little Brown Bat	4	2	50.00
2016	APIS017A_2016	baseline	Eastern Red Bat	2	0	0.00
2016	APIS017A_2016	baseline	Hoary Bat	1	0	0.00
2016	APIS017A_2016	baseline	Little Brown Bat	20	17	85.00
2016	APIS018A_2016	baseline	Big Brown Bat	4	2	50.00
2016	APIS018A_2016	baseline	Eastern Red Bat	18	16	88.89
2016	APIS018A_2016	baseline	Hoary Bat	5	5	100.00
2016	APIS018A_2016	baseline	Silver-haired Bat	2	1	50.00
2016	APIS018A_2016	baseline	Little Brown Bat	22	16	72.73
2016	APIS018A_2016	expanded	Tricolored Bat	1	0	0.00
2016	APIS019A_2016	baseline	Eastern Red Bat	2	0	0.00
2016	APIS019A_2016	baseline	Silver-haired Bat	3	2	66.67

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2016	APIS019A_2016	baseline	Little Brown Bat	3	1	33.33
2016	APIS019A_2016	expanded	Tricolored Bat	1	0	0.00
2016	APIS020A_2016	baseline	Little Brown Bat	33	29	87.88
2016	APIS020A_2016	baseline	Northern Long-eared Bat	4	0	0.00
2016	APIS021A_2016	baseline	Big Brown Bat	1	0	0.00
2016	APIS021A_2016	baseline	Eastern Red Bat	1	0	0.00
2016	APIS021A_2016	baseline	Hoary Bat	2	0	0.00
2016	APIS021A_2016	baseline	Silver-haired Bat	2	1	50.00
2016	APIS021A_2016	baseline	Little Brown Bat	11	8	72.73
2016	APIS025A_2016	baseline	Eastern Red Bat	2	2	100.00
2016	APIS025A_2016	baseline	Little Brown Bat	7	5	71.43
2016	APIS026A_2016	baseline	Eastern Red Bat	2	1	50.00
2016	APIS026A_2016	baseline	Little Brown Bat	15	12	80.00
2016	APIS026A_2016	expanded	Tricolored Bat	1	1	100.00
2016	APIS027A_2016	baseline	Eastern Red Bat	1	0	0.00
2016	APIS027A_2016	baseline	Little Brown Bat	10	7	70.00
2016	APIS027A_2016	baseline	Northern Long-eared Bat	4	0	0.00
2016	APIS028A_2016	baseline	Eastern Red Bat	31	27	87.10
2016	APIS028A_2016	baseline	Silver-haired Bat	2	1	50.00
2016	APIS028A_2016	baseline	Little Brown Bat	24	18	75.00
2016	APIS028A_2016	baseline	Northern Long-eared Bat	1	0	0.00
2016	APIS028A_2016	expanded	Tricolored Bat	6	0	0.00
2016	APIS031A_2016	baseline	Big Brown Bat	1	0	0.00
2016	APIS031A_2016	baseline	Eastern Red Bat	1	0	0.00
2016	APIS033A_2016	baseline	Big Brown Bat	2	0	0.00
2016	APIS033A_2016	baseline	Eastern Red Bat	2	2	100.00
2016	APIS033A_2016	baseline	Silver-haired Bat	1	0	0.00
2016	APIS033A_2016	baseline	Little Brown Bat	9	8	88.89
2016	APIS037A_2016	baseline	Big Brown Bat	1	0	0.00
2016	APIS037A_2016	baseline	Eastern Red Bat	10	9	90.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2016	APIS037A_2016	baseline	Silver-haired Bat	2	1	50.00
2016	APIS037A_2016	baseline	Little Brown Bat	2	1	50.00
2017	APIS001A_2017	baseline	Big Brown Bat	6	1	16.67
2017	APIS001A_2017	baseline	Hoary Bat	1	1	100.00
2017	APIS001A_2017	baseline	Silver-haired Bat	15	12	80.00
2017	APIS001A_2017	baseline	Little Brown Bat	31	29	93.55
2017	APIS002A_2017	baseline	Little Brown Bat	2	2	100.00
2017	APIS002A_2017	baseline	Northern Long-eared Bat	1	0	0.00
2017	APIS005A_2017	baseline	Eastern Red Bat	1	1	100.00
2017	APIS005A_2017	baseline	Hoary Bat	7	7	100.00
2017	APIS005A_2017	baseline	Silver-haired Bat	4	4	100.00
2017	APIS005A_2017	baseline	Little Brown Bat	3	2	66.67
2017	APIS008A_2017	baseline	Eastern Red Bat	1	0	0.00
2017	APIS008A_2017	baseline	Little Brown Bat	4	4	100.00
2017	APIS008A_2017	expanded	Tricolored Bat	1	1	100.00
2017	APIS009A_2017	baseline	Eastern Red Bat	1	1	100.00
2017	APIS009A_2017	baseline	Little Brown Bat	15	14	93.33
2017	APIS009A_2017	baseline	Northern Long-eared Bat	3	0	0.00
2017	APIS012A_2017	baseline	Big Brown Bat	1	0	0.00
2017	APIS012A_2017	baseline	Eastern Red Bat	26	26	100.00
2017	APIS012A_2017	baseline	Silver-haired Bat	7	3	42.86
2017	APIS012A_2017	baseline	Little Brown Bat	5	1	20.00
2017	APIS012A_2017	expanded	Tricolored Bat	3	0	0.00
2017	APIS014A_2017	baseline	Big Brown Bat	1	0	0.00
2017	APIS014A_2017	baseline	Silver-haired Bat	2	2	100.00
2017	APIS014A_2017	baseline	Little Brown Bat	1	1	100.00
2017	APIS017A_2017	baseline	Eastern Red Bat	2	1	50.00
2017	APIS017A_2017	baseline	Little Brown Bat	6	6	100.00
2017	APIS019A_2017	baseline	Big Brown Bat	2	2	100.00
2017	APIS019A_2017	baseline	Eastern Red Bat	6	6	100.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2017	APIS019A_2017	baseline	Hoary Bat	1	1	100.00
2017	APIS019A_2017	baseline	Silver-haired Bat	1	1	100.00
2017	APIS019A_2017	baseline	Little Brown Bat	4	3	75.00
2017	APIS019A_2017	expanded	Tricolored Bat	2	0	0.00
2017	APIS020A_2017	baseline	Eastern Red Bat	1	1	100.00
2017	APIS020A_2017	baseline	Little Brown Bat	13	11	84.62
2017	APIS021A_2017	baseline	Hoary Bat	1	1	100.00
2017	APIS021A_2017	baseline	Little Brown Bat	5	5	100.00
2017	APIS021A_2017	baseline	Northern Long-eared Bat	1	0	0.00
2017	APIS025A_2017	baseline	Eastern Red Bat	1	1	100.00
2017	APIS025A_2017	baseline	Hoary Bat	1	1	100.00
2017	APIS025A_2017	baseline	Silver-haired Bat	1	0	0.00
2017	APIS025A_2017	baseline	Little Brown Bat	4	3	75.00
2017	APIS026A_2017	baseline	Hoary Bat	3	1	33.33
2017	APIS026A_2017	baseline	Little Brown Bat	10	8	80.00
2017	APIS026A_2017	baseline	Northern Long-eared Bat	4	0	0.00
2017	APIS026A_2017	expanded	Tricolored Bat	4	3	75.00
2017	APIS027A_2017	baseline	Eastern Red Bat	1	0	0.00
2017	APIS027A_2017	baseline	Hoary Bat	1	1	100.00
2017	APIS027A_2017	baseline	Little Brown Bat	2	2	100.00
2017	APIS032A_2017	baseline	Northern Long-eared Bat	1	0	0.00
2018	APIS005A_2018	baseline	Eastern Red Bat	1	0	0.00
2018	APIS005A_2018	baseline	Hoary Bat	1	1	100.00
2018	APIS005A_2018	baseline	Silver-haired Bat	1	1	100.00
2018	APIS005A_2018	baseline	Little Brown Bat	7	7	100.00
2018	APIS006A_2018	baseline	Northern Long-eared Bat	2	0	0.00
2018	APIS008A_2018	baseline	Eastern Red Bat	4	4	100.00
2018	APIS008A_2018	baseline	Hoary Bat	1	0	0.00
2018	APIS008A_2018	baseline	Silver-haired Bat	4	3	75.00
2018	APIS008A_2018	baseline	Little Brown Bat	19	19	100.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2018	APIS008A_2018	expanded	Tricolored Bat	1	0	0.00
2018	APIS009A_2018	baseline	Eastern Red Bat	1	0	0.00
2018	APIS009A_2018	baseline	Little Brown Bat	8	8	100.00
2018	APIS009A_2018	baseline	Northern Long-eared Bat	3	0	0.00
2018	APIS011A_2018	baseline	Silver-haired Bat	1	0	0.00
2018	APIS012A_2018	baseline	Big Brown Bat	5	1	20.00
2018	APIS012A_2018	baseline	Eastern Red Bat	53	46	86.79
2018	APIS012A_2018	baseline	Hoary Bat	5	4	80.00
2018	APIS012A_2018	baseline	Silver-haired Bat	16	10	62.50
2018	APIS012A_2018	baseline	Little Brown Bat	21	13	61.90
2018	APIS012A_2018	expanded	Tricolored Bat	2	0	0.00
2018	APIS014A_2018	baseline	Eastern Red Bat	1	1	100.00
2018	APIS014A_2018	baseline	Hoary Bat	3	0	0.00
2018	APIS015A_2018	baseline	Big Brown Bat	1	0	0.00
2018	APIS015A_2018	baseline	Silver-haired Bat	1	0	0.00
2018	APIS016A_2018	baseline	Little Brown Bat	2	2	100.00
2018	APIS016A_2018	baseline	Northern Long-eared Bat	1	0	0.00
2018	APIS017A_2018	baseline	Big Brown Bat	1	0	0.00
2018	APIS017A_2018	baseline	Eastern Red Bat	1	1	100.00
2018	APIS017A_2018	baseline	Hoary Bat	1	1	100.00
2018	APIS017A_2018	baseline	Silver-haired Bat	4	4	100.00
2018	APIS017A_2018	baseline	Little Brown Bat	3	2	66.67
2018	APIS017A_2018	expanded	Tricolored Bat	1	0	0.00
2018	APIS018A_2018	baseline	Big Brown Bat	1	0	0.00
2018	APIS018A_2018	baseline	Eastern Red Bat	8	6	75.00
2018	APIS018A_2018	baseline	Hoary Bat	7	7	100.00
2018	APIS018A_2018	baseline	Silver-haired Bat	2	1	50.00
2018	APIS018A_2018	baseline	Little Brown Bat	5	4	80.00
2018	APIS018A_2018	expanded	Tricolored Bat	1	0	0.00
2018	APIS019A_2018	baseline	Eastern Red Bat	21	18	85.71

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2018	APIS019A_2018	baseline	Hoary Bat	2	2	100.00
2018	APIS019A_2018	baseline	Silver-haired Bat	3	2	66.67
2018	APIS019A_2018	baseline	Little Brown Bat	31	28	90.32
2018	APIS019A_2018	baseline	Northern Long-eared Bat	1	0	0.00
2018	APIS019A_2018	expanded	Tricolored Bat	4	0	0.00
2018	APIS020A_2018	baseline	Big Brown Bat	2	0	0.00
2018	APIS020A_2018	baseline	Little Brown Bat	27	27	100.00
2018	APIS020A_2018	baseline	Northern Long-eared Bat	3	0	0.00
2018	APIS021A_2018	baseline	Eastern Red Bat	4	2	50.00
2018	APIS021A_2018	baseline	Little Brown Bat	8	6	75.00
2018	APIS025A_2018	baseline	Hoary Bat	1	1	100.00
2018	APIS025A_2018	baseline	Silver-haired Bat	5	2	40.00
2018	APIS026A_2018	baseline	Little Brown Bat	9	9	100.00
2018	APIS027A_2018	baseline	Eastern Red Bat	1	1	100.00
2018	APIS027A_2018	baseline	Silver-haired Bat	1	1	100.00
2018	APIS027A_2018	baseline	Little Brown Bat	8	6	75.00
2018	APIS031A_2018	baseline	Silver-haired Bat	1	0	0.00
2018	APIS033A_2018	baseline	Eastern Red Bat	7	7	100.00
2018	APIS033A_2018	baseline	Hoary Bat	5	4	80.00
2018	APIS033A_2018	baseline	Silver-haired Bat	8	5	62.50
2018	APIS033A_2018	baseline	Little Brown Bat	4	4	100.00
2018	APIS033A_2018	expanded	Tricolored Bat	1	0	0.00
2018	APIS037A_2018	baseline	Silver-haired Bat	2	2	100.00
2019	APIS001A_2019	baseline	Big Brown Bat	2	1	50.00
2019	APIS001A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS001A_2019	baseline	Silver-haired Bat	21	12	57.14
2019	APIS001A_2019	baseline	Little Brown Bat	25	22	88.00
2019	APIS002A_2019	baseline	Silver-haired Bat	3	0	0.00
2019	APIS002A_2019	baseline	Little Brown Bat	2	1	50.00
2019	APIS002A_2019	baseline	Northern Long-eared Bat	3	0	0.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2019	APIS003A_2019	baseline	Big Brown Bat	1	0	0.00
2019	APIS003A_2019	baseline	Eastern Red Bat	2	1	50.00
2019	APIS003A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS003A_2019	baseline	Silver-haired Bat	2	1	50.00
2019	APIS005A_2019	baseline	Big Brown Bat	3	1	33.33
2019	APIS005A_2019	baseline	Eastern Red Bat	1	0	0.00
2019	APIS005A_2019	baseline	Hoary Bat	3	1	33.33
2019	APIS005A_2019	baseline	Silver-haired Bat	3	1	33.33
2019	APIS005A_2019	baseline	Little Brown Bat	3	3	100.00
2019	APIS008A_2019	baseline	Eastern Red Bat	2	0	0.00
2019	APIS008A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS008A_2019	baseline	Silver-haired Bat	2	0	0.00
2019	APIS008A_2019	baseline	Little Brown Bat	3	2	66.67
2019	APIS008A_2019	baseline	Northern Long-eared Bat	2	0	0.00
2019	APIS009A_2019	baseline	Little Brown Bat	4	3	75.00
2019	APIS009A_2019	baseline	Northern Long-eared Bat	2	0	0.00
2019	APIS011A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS011A_2019	baseline	Little Brown Bat	1	0	0.00
2019	APIS011A_2019	baseline	Northern Long-eared Bat	1	0	0.00
2019	APIS012A_2019	baseline	Eastern Red Bat	4	4	100.00
2019	APIS012A_2019	baseline	Hoary Bat	5	4	80.00
2019	APIS012A_2019	baseline	Silver-haired Bat	4	3	75.00
2019	APIS012A_2019	baseline	Little Brown Bat	4	1	25.00
2019	APIS014A_2019	baseline	Eastern Red Bat	1	1	100.00
2019	APIS014A_2019	baseline	Silver-haired Bat	1	0	0.00
2019	APIS015A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS017A_2019	baseline	Eastern Red Bat	1	0	0.00
2019	APIS017A_2019	baseline	Silver-haired Bat	5	2	40.00
2019	APIS017A_2019	baseline	Little Brown Bat	1	1	100.00
2019	APIS019A_2019	baseline	Big Brown Bat	1	0	0.00

Year	Site ID	Analysis	Kaleidoscope Classification	Total Files Vetted	Number Files Verified	Percent Files Verified
2019	APIS019A_2019	baseline	Eastern Red Bat	8	5	62.50
2019	APIS019A_2019	baseline	Hoary Bat	2	2	100.00
2019	APIS019A_2019	baseline	Silver-haired Bat	6	2	33.33
2019	APIS019A_2019	baseline	Little Brown Bat	7	4	57.14
2019	APIS020A_2019	baseline	Big Brown Bat	1	0	0.00
2019	APIS020A_2019	baseline	Eastern Red Bat	3	3	100.00
2019	APIS020A_2019	baseline	Little Brown Bat	43	41	95.35
2019	APIS020A_2019	baseline	Northern Long-eared Bat	2	0	0.00
2019	APIS021A_2019	baseline	Eastern Red Bat	8	8	100.00
2019	APIS021A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS021A_2019	baseline	Little Brown Bat	8	2	25.00
2019	APIS021A_2019	expanded	Tricolored Bat	2	0	0.00
2019	APIS025A_2019	baseline	Eastern Red Bat	1	0	0.00
2019	APIS025A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS025A_2019	baseline	Silver-haired Bat	2	1	50.00
2019	APIS026A_2019	baseline	Eastern Red Bat	5	4	80.00
2019	APIS026A_2019	baseline	Hoary Bat	1	1	100.00
2019	APIS026A_2019	baseline	Silver-haired Bat	2	0	0.00
2019	APIS026A_2019	baseline	Little Brown Bat	15	8	53.33
2019	APIS026A_2019	expanded	Tricolored Bat	1	0	0.00
2019	APIS027A_2019	baseline	Big Brown Bat	1	0	0.00
2019	APIS027A_2019	baseline	Eastern Red Bat	1	0	0.00
2019	APIS027A_2019	baseline	Little Brown Bat	7	5	71.43
2019	APIS031A_2019	baseline	Eastern Red Bat	1	0	0.00
2019	APIS033A_2019	baseline	Big Brown Bat	1	0	0.00
2019	APIS033A_2019	baseline	Eastern Red Bat	8	6	75.00
2019	APIS033A_2019	baseline	Hoary Bat	5	5	100.00
2019	APIS033A_2019	baseline	Silver-haired Bat	6	2	33.33
2019	APIS033A_2019	baseline	Little Brown Bat	3	2	66.67
2019	APIS033A_2019	expanded	Tricolored Bat	7	0	0.00

Appendix I. Species Composition Across Parks.

Figure I1 is for the baseline analysis only, and it 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.

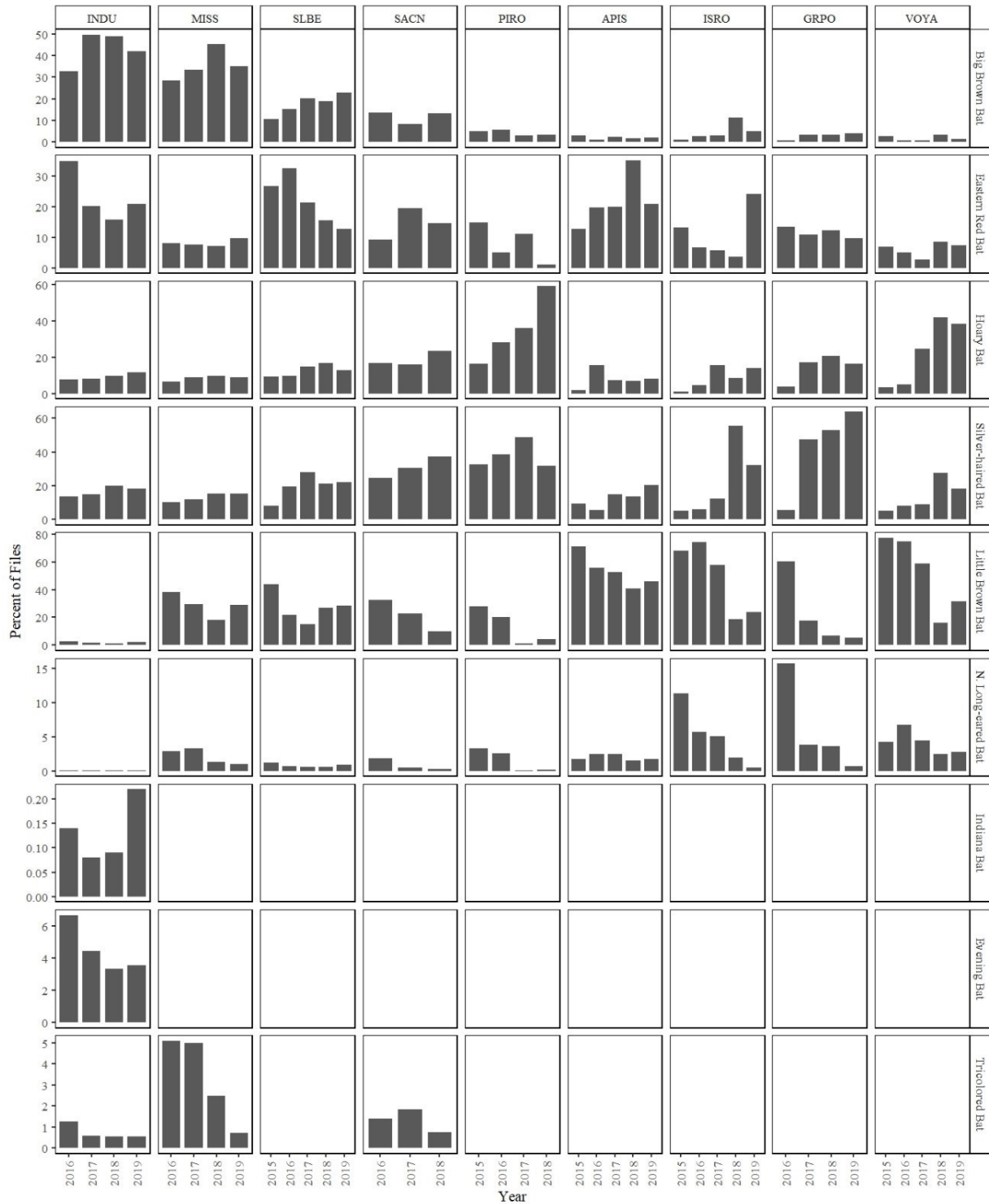


Figure 11. Percent of audio files classified as each bat species by Kaleidoscope Pro in the baseline analysis for each park and year. Note that the y-axis scale is different for each species and not all parks conducted surveys in all years. Only data from valid deployments are shown. Parks are ordered 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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National Park Service
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