



# Acoustic Monitoring for Bats at Isle Royale National Park

## *Data Summary Report, 2015–2019*

Natural Resource Data Series NPS/GLKN/NRDS—2021/1321



**ON THE COVER**

A technician sets up bat acoustic monitoring equipment at Isle Royale National Park.

NPS Photo

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# **Acoustic Monitoring for Bats at Isle Royale National Park**

## *Data Summary Report, 2015–2019*

Natural Resource Data Series NPS/GLKN/NRDS—2021/1321

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April 2021

U.S. Department of the Interior  
National Park Service  
Natural Resource Stewardship and Science  
Fort Collins, Colorado

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Please cite this publication as:

Goodwin, K. R., and A. A. Kirschbaum. 2021. Acoustic monitoring for bats at Isle Royale National Park: Data summary report, 2015–2019. Natural Resource Data Series NPS/GLKN/NRDS—2021/1321. National Park Service, Fort Collins, Colorado.

# Contents

|                                        | Page |
|----------------------------------------|------|
| Figures.....                           | v    |
| Tables.....                            | vii  |
| Appendices.....                        | ix   |
| Abstract.....                          | xi   |
| Acknowledgments.....                   | xi   |
| Introduction.....                      | 1    |
| Methods.....                           | 5    |
| Site Selection.....                    | 5    |
| Data Collection.....                   | 7    |
| Data Management and Analysis.....      | 7    |
| Results.....                           | 11   |
| Survey Effort.....                     | 11   |
| Automated Classification.....          | 11   |
| Spatial and Temporal Distribution..... | 17   |
| Manual Vetting.....                    | 18   |
| Summary and Conclusions.....           | 19   |
| Big Brown Bat.....                     | 20   |
| Eastern Red Bat.....                   | 20   |
| Hoary Bat.....                         | 20   |
| Silver-haired Bat.....                 | 20   |
| Little Brown Bat.....                  | 21   |
| Northern Long-eared Bat.....           | 21   |
| Tricolored Bat.....                    | 21   |
| Literature Cited.....                  | 25   |



# Figures

|                                                                                                                                                                                          | Page |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Figure 1.</b> Bat monitoring sites at Isle Royale National Park.....                                                                                                                  | 6    |
| <b>Figure 2.</b> Yearly survey effort for bat monitoring at Isle Royale National Park, 2015–2019.....                                                                                    | 11   |
| <b>Figure 3.</b> Percent of audio files classified by Kaleidoscope Pro as bat species vs. unknown bats vs. noise, corrupt, and excluded files, Isle Royale National Park, 2015–2019..... | 12   |
| <b>Figure 4.</b> Proportion of files classified to each species each year in the baseline versus expanded analysis, Isle Royale National Park, 2015–2019. ....                           | 13   |
| <b>Figure 5.</b> Proportion of files classified to each species each year relative to all other species, Isle Royale National Park, 2015–2019.....                                       | 14   |
| <b>Figure 6.</b> Parkwide call files per recording night by species and year for the expanded analysis, Isle Royale National Park, 2015–2019.....                                        | 15   |
| <b>Figure 7.</b> Call files per recording night for each species and for all species combined, by year, for the expanded analysis, Isle Royale National Park, 2015–2019.....             | 16   |
| <b>Figure 8.</b> Proportion of monitoring sites where each species was detected each year, Isle Royale National Park, 2015–2019. ....                                                    | 17   |
| <b>Figure 9.</b> Proportion of recording nights on which each species was detected each year, Isle Royale National Park, 2015–2019. ....                                                 | 18   |
| <b>Figure F1.</b> Percent of audio files classified as noise for each detector model (mean ± 95% confidence interval). ....                                                              | 45   |
| <b>Figure F2.</b> Percent of audio files classified as noise for each sampling site at Isle Royale National Park, 2016–2019. ....                                                        | 46   |
| <b>Figure I1.</b> Percent of audio files classified as each bat species by Kaleidoscope Pro in the baseline analysis for each park and year. ....                                        | 60   |



# Tables

|                                                                                                                                                                                                                                                                 | Page |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Table 1.</b> Bat species occurrences recorded at Isle Royale National Park prior to the initiation of the GLKN acoustic monitoring program in 2015 and method(s) by which the species were documented.....                                                   | 2    |
| <b>Table 2.</b> Summary of bat species documented at Isle Royale National Park, 2015–2019, through automated classification and manual vetting of acoustic files. ....                                                                                          | 22   |
| <b>Table A1.</b> Nine bat species are found in the Great Lakes region. ....                                                                                                                                                                                     | 29   |
| <b>Table B1.</b> Bat species included as possible candidates during Kaleidoscope Pro species classification. ....                                                                                                                                               | 31   |
| <b>Table D1.</b> Earliest and latest dates equipment was deployed, number of deployments in each category, and total number of files recorded for each survey year, Isle Royale National Park, 2015–2019. ....                                                  | 35   |
| <b>Table D2.</b> 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, Isle Royale National Park, 2015–2019. .... | 35   |
| <b>Table E1.</b> 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, Isle Royale National Park, 2015–2019.....                               | 37   |
| <b>Table E2.</b> Total number of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Isle Royale National Park, 2015–2019. ....                                                                                     | 38   |
| <b>Table E3.</b> Percent of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Isle Royale National Park, 2015–2019.....                                                                                           | 39   |
| <b>Table E4.</b> Total number of monitoring sites, and count of sites where each species was detected for each year and analysis type, Isle Royale National Park, 2015–2019.....                                                                                | 40   |
| <b>Table E5.</b> Total number of monitoring sites, and percent of sites where each species was detected for each year and analysis type, Isle Royale National Park, 2015–2019.....                                                                              | 41   |
| <b>Table E6.</b> Total number of recording nights, and count of recording nights on which each species was detected for each year and analysis type, Isle Royale National Park, 2015–2019.....                                                                  | 42   |
| <b>Table E7.</b> Total number of recording nights, and percent of recording nights on which each species was detected for each year and analysis type, Isle Royale National Park, 2015–2019.....                                                                | 43   |

## Tables (continued)

|                                                                                                                                                                                                                       | Page |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Table F1.</b> Mean percent of audio files classified as noise for each sampling site at Isle Royale National Park, 2016–2019, including standard deviation, minimum percent noise, and maximum percent noise. .... | 47   |
| <b>Table G1.</b> Total number of files manually vetted, and the results of manual vetting for each year, analysis type, and species, Isle Royale National Park, 2015–2019. ....                                       | 49   |
| <b>Table H1.</b> Total number of files manually vetted, and the results of manual vetting for each year, site, analysis type, and species, Isle Royale National Park, 2015–2019.....                                  | 51   |

# Appendices

|                                                          | Page |
|----------------------------------------------------------|------|
| Appendix A. Bat Species of the Great Lakes Region. ....  | 29   |
| Appendix B. Baseline and Expanded Species Lists. ....    | 31   |
| Appendix C. Analysis Settings for Kaleidoscope Pro. .... | 33   |
| Appendix D. Yearly Deployment Data. ....                 | 35   |
| Appendix E. Automated Classification Results. ....       | 37   |
| Appendix F. Noise Assessment. ....                       | 45   |
| Appendix G. Manual Vetting Results for Entire Park. .... | 49   |
| Appendix H. Manual Vetting Results by Site. ....         | 51   |
| Appendix I. Species Composition Across Parks. ....       | 59   |



## **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 Isle Royale National Park. Acoustic recordings were analyzed using the software program Kaleidoscope Pro and a subset of files were manually reviewed to confirm species identifications. The seven bat species previously documented at the park were reconfirmed through both automated and manual identification of calls. The status of tricolored bat remains uncertain due to limited data (only one confirmed call file). Activity levels for big brown bat, hoary bat, and silver-haired bat appear to be stable or increasing slightly. Activity levels for eastern red bat, 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 M. Romanski, L. Potvin, D. P. Brown, G. Gagnon, T. Hebert, E. Audia, M. Walimaa, L. Korsmeyer, J. Lee, N. Mallett, C. Lubinski, J. Gendelman, F. Hoeft, M. Pierle, M. Hartman, M. Barric, M. DeLandreau, A. Johnson, S. Trevethan, C. Roe, E. Bieri, K. Smith, E. Dlutkowski, D. Whipkey, J. Vigilant, and C. Divine. 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. M. Romanski, L. Potvin, 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. Isle Royale National Park (ISRO) 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 seven species had been documented at ISRO (Table 1). The oldest report states that little brown bats (*Myotis lucifugus*) “were the only bats seen on the island” (Adams 1906). Four bat species were included in 1970 and 1982 lists of Isle Royale's mammalian fauna, though no details were provided on the specifics of those records (Johnson 1970, Johnsson et al. 1982). The species were little brown bat, northern long-eared bat, big brown bat, and eastern red bat (*Lasiurus borealis*). There was also an observation of red bats mating near the Rock Harbor Lodge in late summer 1970 (Nichols and Stones 1971).

**Table 1.** Bat species occurrences recorded at Isle Royale National Park prior to the initiation of the GLKN acoustic monitoring program in 2015 and method(s) by which the species were documented. Data sources include Adams (1906), Nichols and Stones (1971), Parker (2002), Goodwin (2012), Lehnert (2013), and Stantec Consulting (2012a, 2012b, 2013). Ranges are as shown in Kurta (2017).

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

The first targeted bat survey at ISRO was completed in 2002, documenting six species using a combination of mist-netting and acoustic recording. Big brown, little brown, and northern long-eared bats were captured; eastern red, silver-haired (*Lasionycteris noctivagans*), hoary (*Lasiurus cinereus*), little brown, and northern long-eared bats were recorded acoustically (Parker 2002). Further acoustic surveys were done by park staff in 2011, 2012, and 2014. Analysis of the acoustic data from 2011 yielded additional records of the same six species found in 2002 (Goodwin 2012). Data from 2012 and 2014 have not been analyzed yet (Goodwin 2012, Lehnert 2014). Another trapping effort in 2013 resulted in captures of just two species (little brown and northern long-eared) (Lehnert 2013). As part of a Department of Energy project, acoustic monitors were placed at the Ojibway fire tower in 2012–2013 and at Rock of Ages lighthouse in 2012 (Stantec Consulting 2012a, 2012b, 2013). The resulting call sequences that could be identified to the species level documented silver-haired, hoary, eastern red, and big brown bats.

ISRO lies near the edge of the tricolored bat's range. There are prior records of this species hibernating in Keweenaw County, Michigan (Barron 1981) and at Palisade Head near Silver Bay, Minnesota (Knowles 1992). Three tricolored bat specimens have been collected at ISRO: one in the

1970s and two in 2012 (Goodwin 2012). However, it is still uncertain if this species is a regular summer resident.

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



## Methods

Bat acoustic monitoring at ISRO 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-km<sup>2</sup> 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 ISRO, the GRTS design was used beginning in 2016. That year, 27 cells were selected for sampling, plus one cell was added in 2017. The total of 28 selected cells is equivalent to approximately 10% of the park’s sampling frame. The ten monitoring sites used in 2015 were entirely different and were not resurveyed in 2016–2019.

The *cell* is defined as the 1-km<sup>2</sup> 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 ISRO001A. A map of ISRO sample sites is provided in Figure 1.

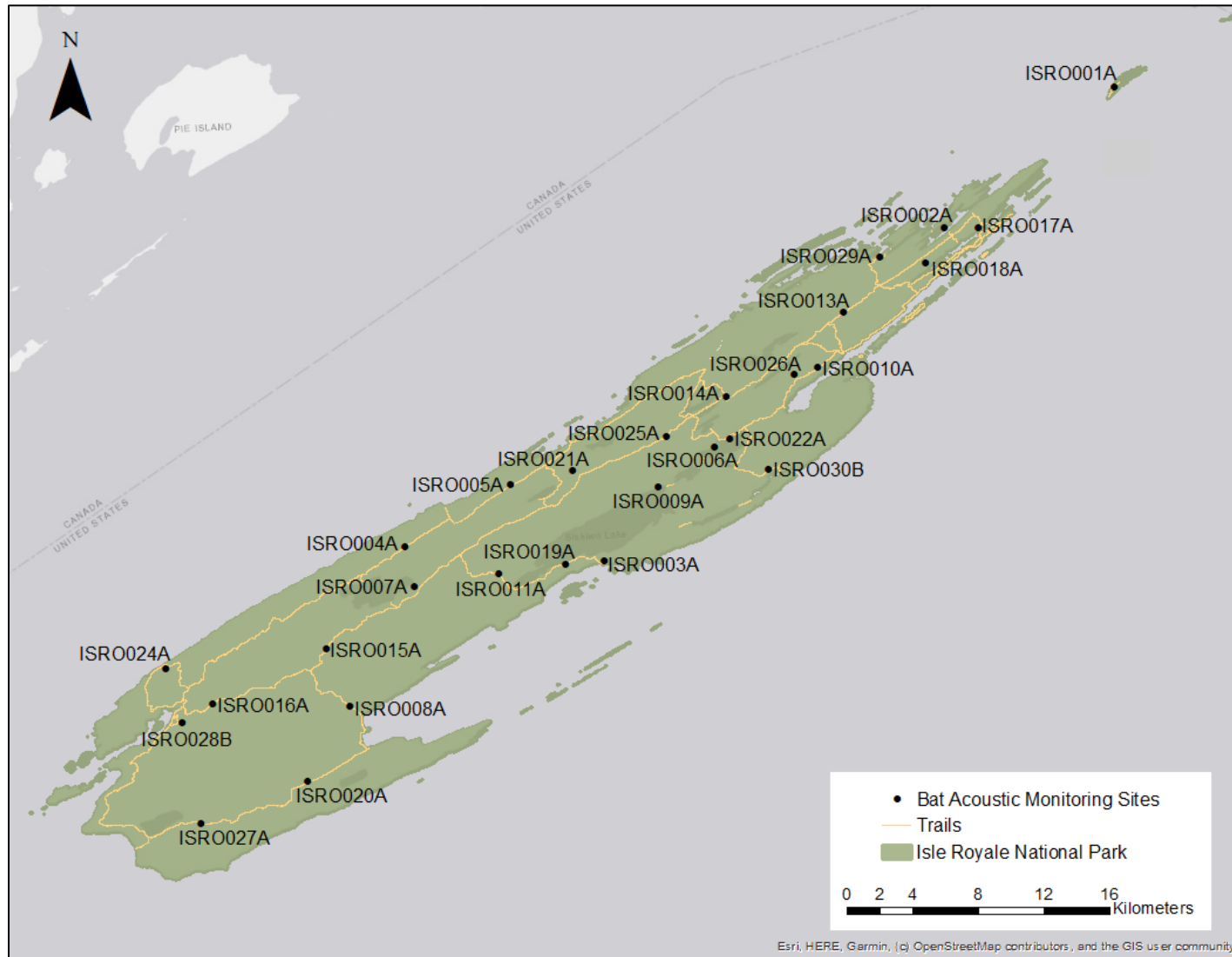


**Figure 1.** Bat monitoring sites at Isle Royale National Park. Sites shown were established in 2016 ( $n=27$ ) and 2017 ( $n=1$ ) and used each year since, with the exception of ISRO028, which was relocated from the “A” site to the “B” site in 2017, and ISRO030, which was relocated from the “A” site to the “B” site in 2018. 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 ISRO includes Wildlife Acoustics Song Meter SM2BAT+, Song Meter SM3BAT, and Song Meter SM4BAT-FS detectors and Wildlife Acoustics SM3-U1 and SMM-U1 microphones. The SM2BAT+ detector model and the SM3-U1 microphone were only used for two deployments in 2015, and not at all in subsequent years. Recordings are collected in full-spectrum format and stored on SD cards mounted in the detector. In general, files are recorded in WAV file format. However, recordings made in 2015 using the SM2BAT+ detectors were recorded as WAC files and later converted to WAV files. Field technicians complete a datasheet for each deployment and collect site photographs and GPS coordinates. After retrieving equipment, the audio 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 ISRO 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 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 ISRO 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 ISRO 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 ISRO during the years 2015 to 2019. There were 7 to 27 valid deployments per year. This report provides results only for the sites that had valid deployments.

Monitoring occurred over a total of 83 to 260 nights of recording. The number of audio files collected per year ranged from 3,944 to 28,518. Yearly survey effort and deployment information are summarized in Figure 2 and Appendix D.

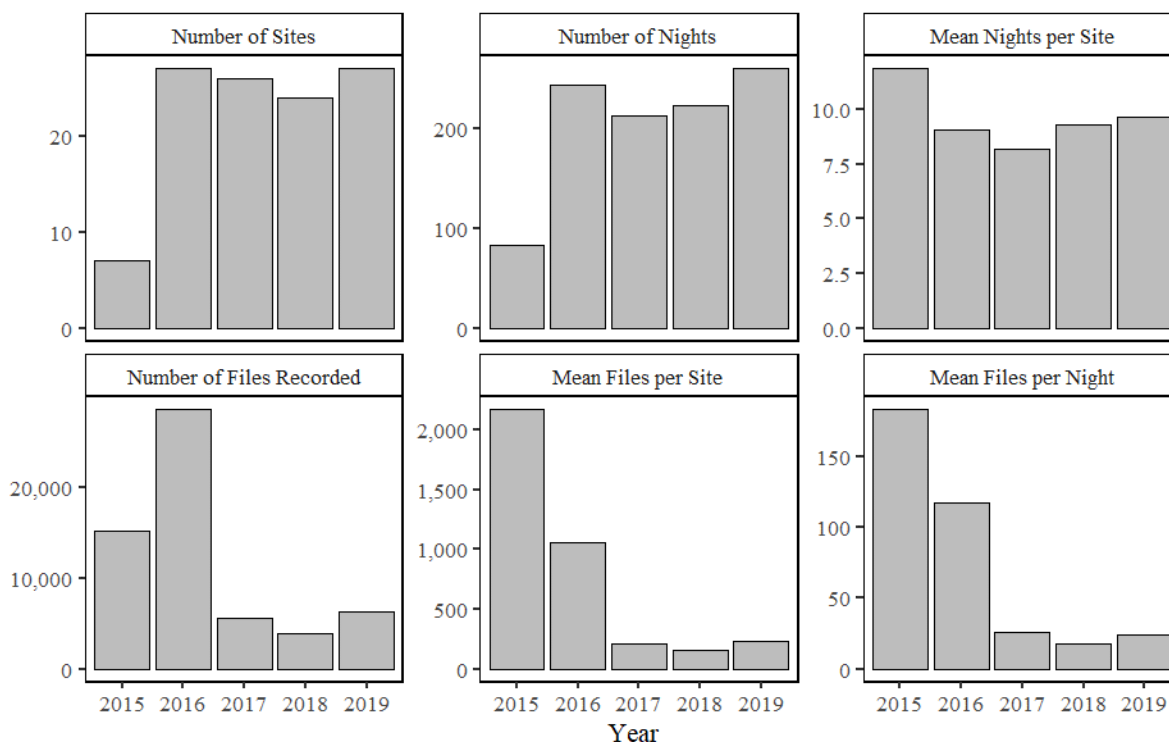


**Figure 2.** Yearly survey effort for bat monitoring at Isle Royale National Park, 2015–2019. *Top, left to right:* Number of sites, number of nights, and mean nights per site. *Bottom, left to right:* total number of audio files recorded, mean files per site, and mean files per night. Number of files is prior to classification (i.e., includes noise).

### Automated Classification

The proportion of files identified to the species level each year ranged from 26% to 84% (Figure 3, Appendix E). The proportion of files assigned to a species versus unknown bat was similar for the baseline and expanded analyses (Figure 3). The older detector model (SM2BAT+) had a much higher proportion of files classified as noise than the other two models (SM3BAT and SM4BAT-FS) (data from all parks combined; Appendix F). Noise was highly variable across the different ISRO sampling sites (Appendix F).

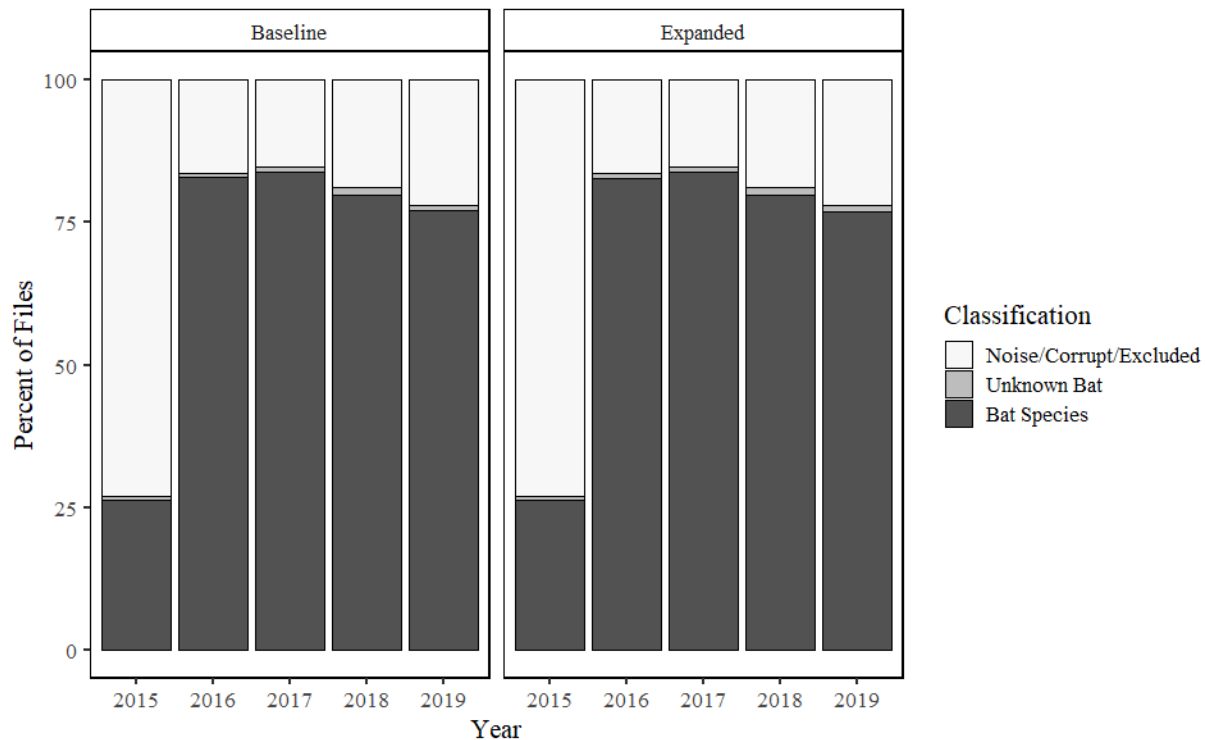


**Figure 3.** Percent of audio files classified by Kaleidoscope Pro as bat species vs. unknown bats vs. noise, corrupt, and excluded files, Isle Royale National Park, 2015–2019. Proportions are shown for the baseline (*left*) and expanded (*right*) analyses.

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 bat in 2015–2017 and silver-haired bat in 2018–2019. The proportion of files attributed to the three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) decreased substantially after 2016 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 silver-haired 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 Pro. Parkwide, total call files per recording night were about two to four times higher in 2015–2016 than in the three later years, with little brown bat showing the largest decline (Figure 6).

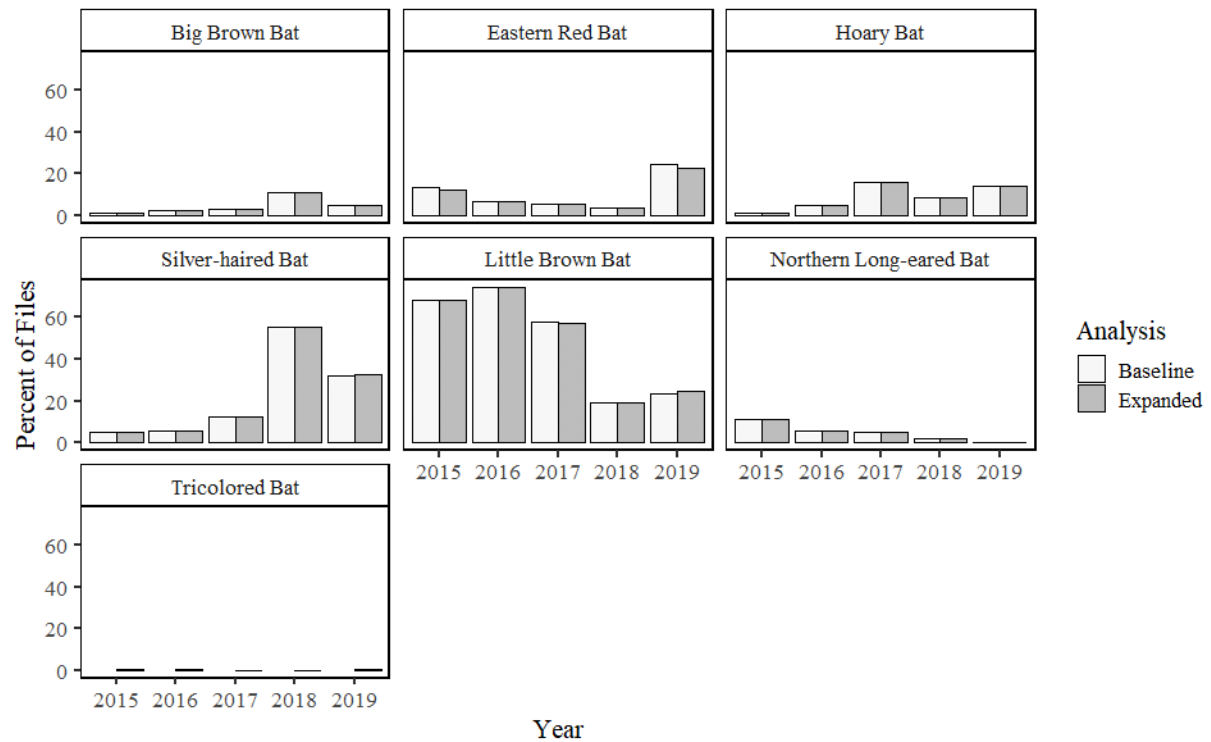


**Figure 4.** Proportion of files classified to each species each year in the baseline versus expanded analysis, Isle Royale National Park, 2015–2019. Tricolored bat was only allowed as a possible species in the expanded analysis. Includes only the subset of files successfully assigned a species-level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

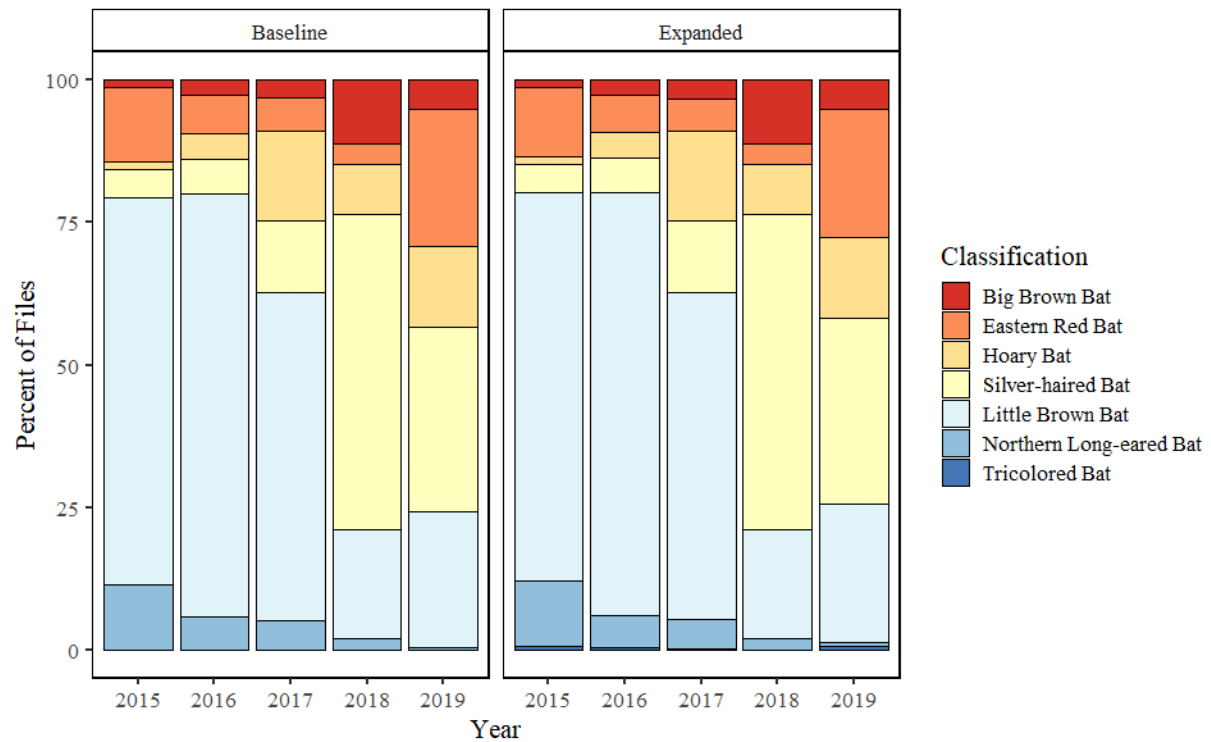


**Figure 5.** Proportion of files classified to each species each year relative to all other species, Isle Royale National Park, 2015–2019. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue while less susceptible species are shown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

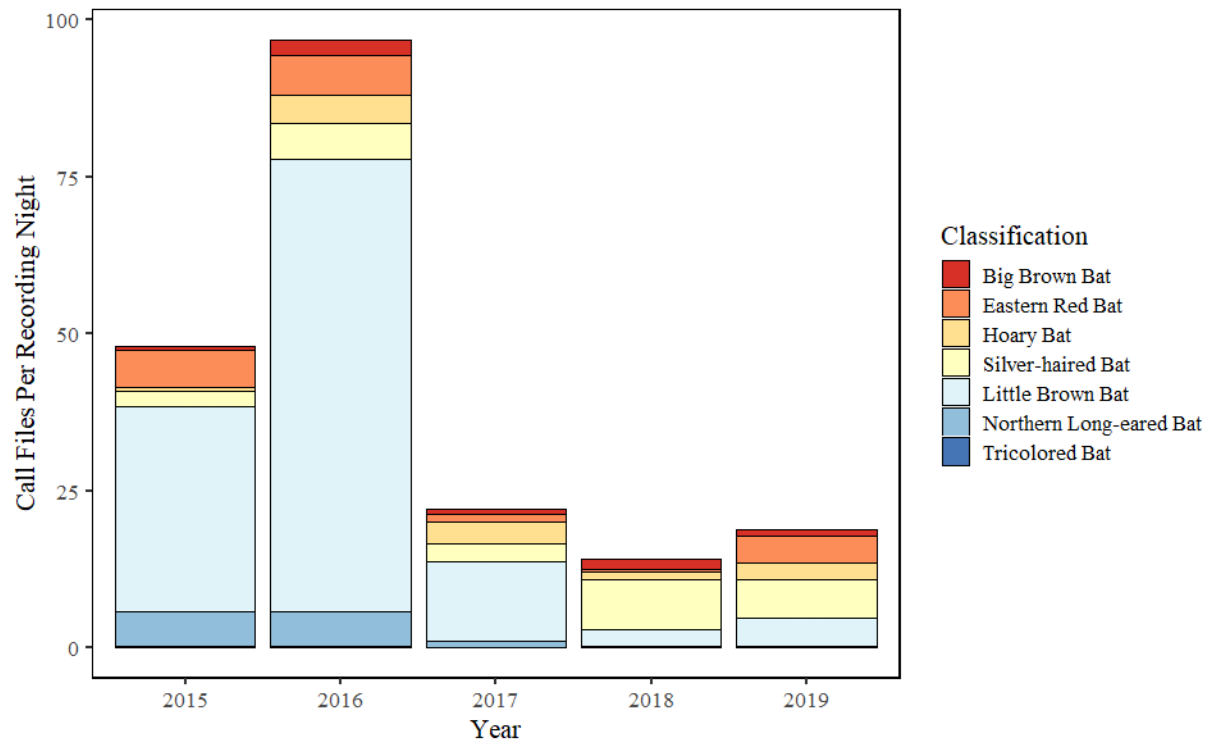


**Figure 6.** Parkwide call files per recording night by species and year for the expanded analysis, Isle Royale National Park, 2015–2019. The three most WNS-susceptible species (little brown, northern long-eared, and tricolored bats) are shown in shades of blue while less susceptible species are shown 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 highest in 2015 (about 70), followed by 2016 (about 40), and much lower in 2017–2019 (about 10) (Figure 7, lower right panel). Looking at individual species, we observed declines in the median call files per recording night after 2015 for eastern red, little brown, northern long-eared, and tricolored bats (Figure 7). The other three species did not show obvious trends. 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.

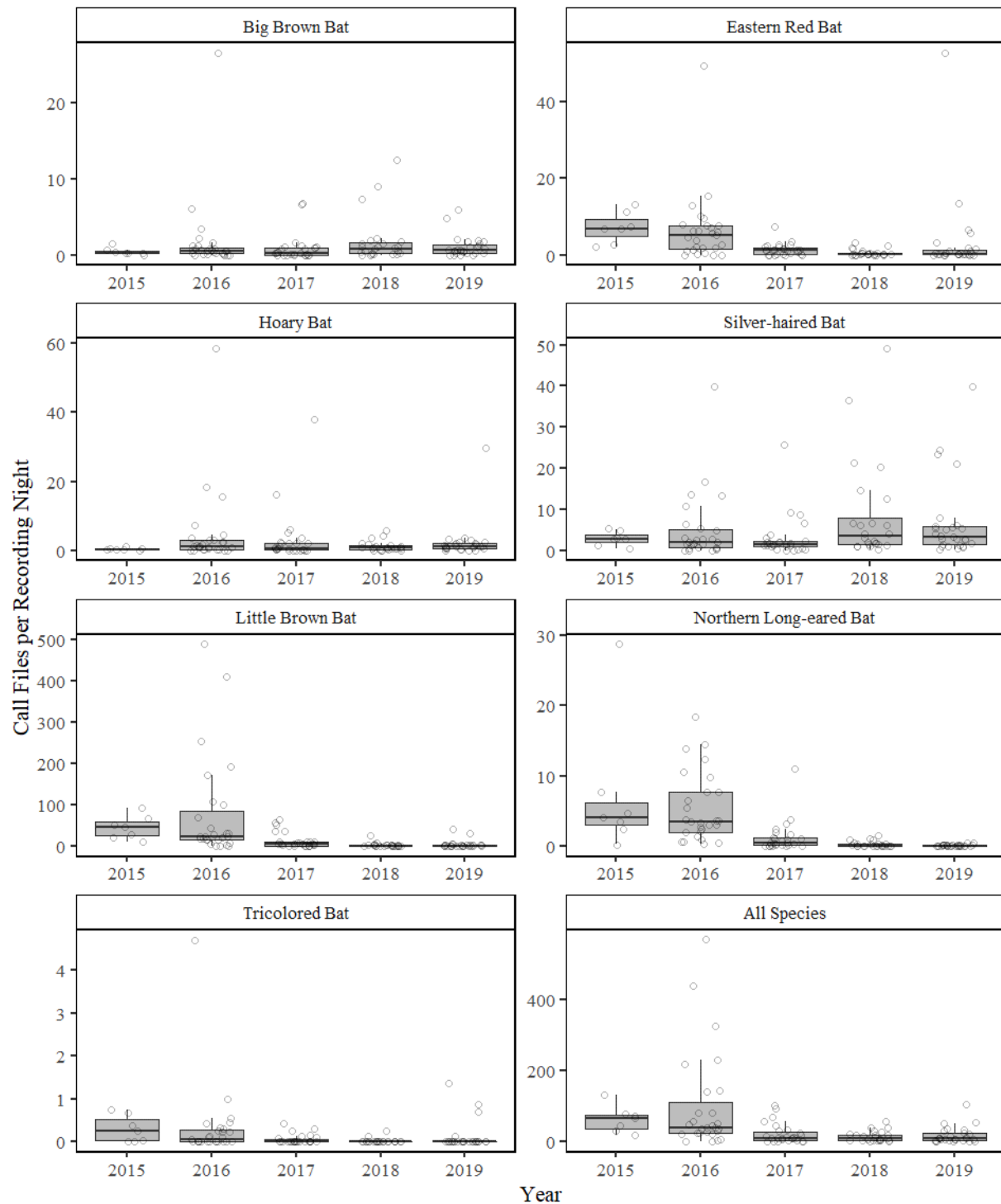


**Figure 7.** Call files per recording night for each species and for all species combined, by year, for the expanded analysis, Isle Royale National Park, 2015–2019. Each point represents call files per recording night at a particular survey site. The dark line across the boxplot represents the median. 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. Five species were widely distributed across the park, with detections at 70%–100% of monitoring sites in every year (Figure 8, Appendix E). Northern long-eared and tricolored bats were detected at a high proportion of sites in the earlier years but declined thereafter. Silver-haired bat and little brown bat were detected on more than half of recording nights every year; other species were detected less frequently (Figure 9, Appendix E). On average, the silver-haired bat was detected at the highest percentage of sites and the little brown bat was detected on the highest percentage of nights. When included in the expanded analysis, the tricolored bat was detected at 8%–71% of sites and on 1%–24% of nights.

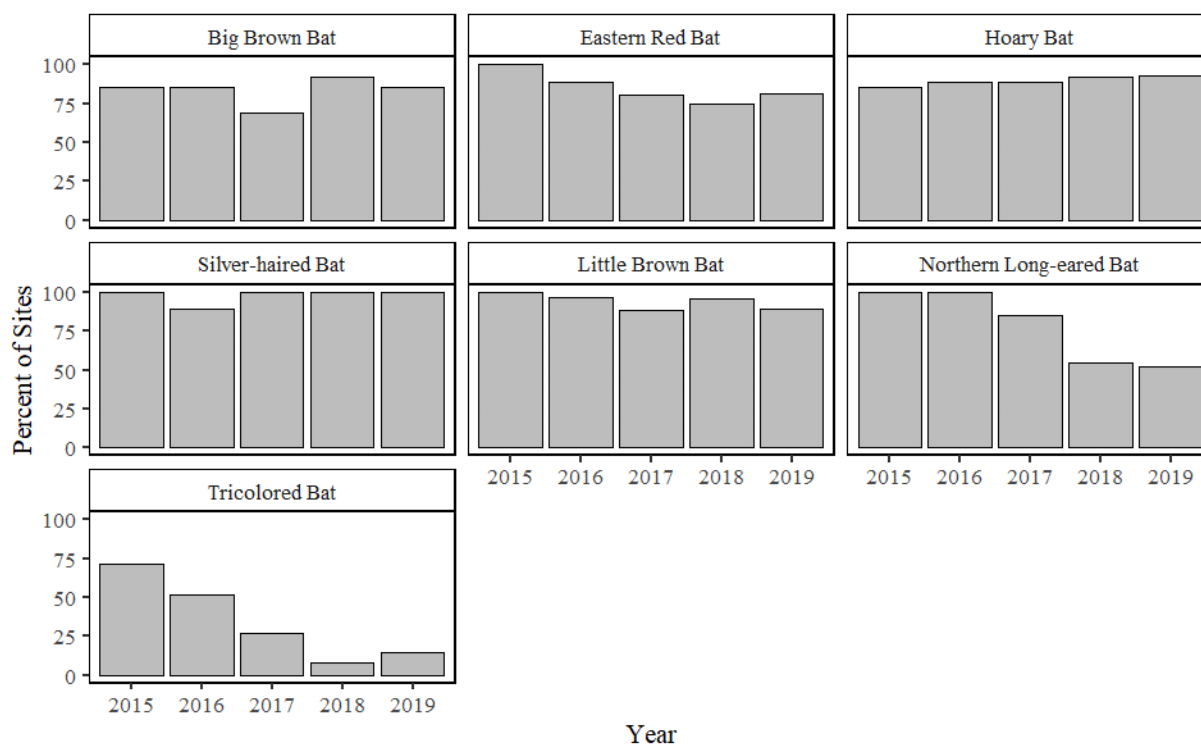


**Figure 8.** Proportion of monitoring sites where each species was detected each year, Isle Royale National Park, 2015–2019. A species was considered to be detected at a site if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and expanded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

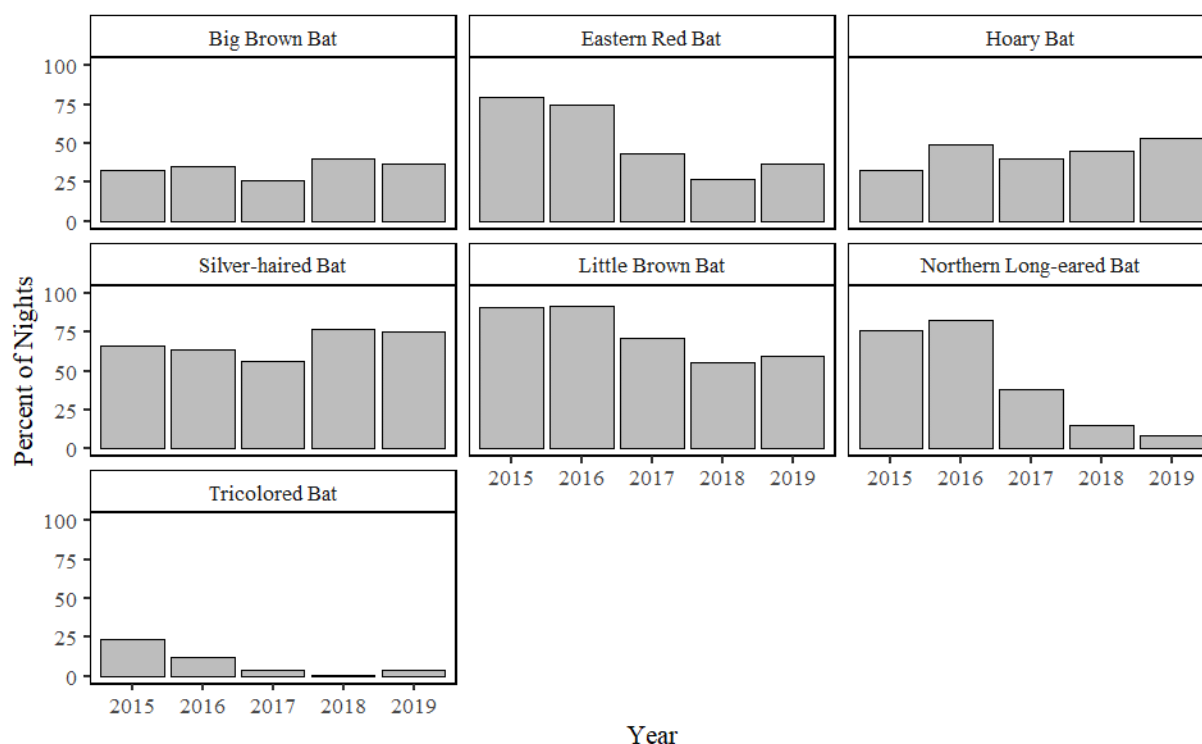


**Figure 9.** Proportion of recording nights on which each species was detected each year, Isle Royale National Park, 2015–2019. A species was considered to be detected on a night if at least one audio file was classified as that species by Kaleidoscope Pro. Results were similar for baseline and expanded 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 seven species being verified between 2015 and 2019. 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 2% for the tricolored bat to 75% 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 seven bat species previously recorded at ISRO (see Table 1) were reconfirmed through this monitoring effort. Tricolored bat had only been documented by a few specimens collected at the park and had never been captured during mist-netting efforts. Data on this species is still limited and inconclusive. Our acoustic surveys suggest this species may be present in the park, as evidenced by one tricolored bat recording that was manually verified. The manually verified recording came from site ISRO022A (Birch Isle, Lake Richie) and was collected in 2017. Only about one-third of the call files identified by the software as tricolored bats have so far been manually reviewed (42 files). Conducting additional manual review on the remaining files could increase the number of locations or years with positive records of this species.

Our results showed a much higher percentage of files classified as noise in 2015 compared to all other years (see Figure 3). This is most likely related to the change in equipment and recording settings after the first year. It is possible that the 2015 locations were inherently noisier, but since none of the 2015 sites were resampled in later years, we cannot verify this. The older detector model, SM2BAT+, was used for two sites in 2015 but was not used at all in subsequent years. Two recording differences were associated with use of the SM2BAT+ as compared to the newer detectors: a different microphone type (SM3-U1) and a different file format (WAC). WAV file format, used with the SM3BAT and SM4BAT-FS detectors, allows for automatic noise scrubbing at the time of recording, resulting in fewer noise files being saved to the SD card. WAC file format does not allow this noise scrubbing feature. In 2015, SM2BAT+ deployments had an average of 88% of files classified as noise, while SM3BAT deployments had an average of 47% of files classified as noise. In 2016–2019, the average percent of files classified as noise was 27% for SM3BAT deployments and 30% for SM4BAT-FS deployments. The lower noise rates in 2016–2019 may be due to the fact that recording settings (e.g., gain, frequency filter, sample rate) used in 2015 on both the SM2BAT+ and SM3BAT models were different from the settings used in subsequent years.

Taking into account these changes after 2015, activity levels for three of the seven species (big brown bat, hoary bat, and silver-haired bat) appeared to be stable or slightly increasing. The remaining four species appeared to have decreasing trends in activity levels. Three of these (little brown bat, northern long-eared bat, and tricolored bat) are highly susceptible to WNS and the disease is mostly likely causing the observed declines. The fourth species (eastern red bat) is not susceptible to WNS but is one of the most frequently killed at wind energy facilities (Arnett et al. 2015). Although there are no wind energy facilities in close proximity to ISRO, there are many located in the upper Midwest. Migration routes of migratory bats are not well understood, but red bats are thought to move south and east, concentrating on the Atlantic and Gulf coasts for the winter (Cryan 2003). Hoary and silver-haired bats also have high fatality rates at wind facilities, but do not seem to be declining at ISRO. The decrease in red bat activity may therefore be due to other unknown factors.

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 via automated identification and verified manually in 2017–2019.
- Widely distributed: Present at 69% or more of survey sites each year.
- Percent of total files ranged from 1%–11%.
- Recorded on 26%–40% of nights each year.
- Median call files per recording night low ( $\leq 1$ ) in all five years. One site (ISRO025A, Greenstone Ridge Trail, west of Chickenbone Lake) had the highest number of big brown bat calls per recording night of all sites in 2016–2019. Its location in a forest opening may provide good foraging opportunities.

### **Eastern Red Bat**

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at 75% or more of survey sites each year.
- Percent of total files ranged from 4%–24%.
- Recorded on over 75% of nights in 2015–2016, but less than 50% of nights in 2017–2019.
- Median call files per recording night highest in 2015, lower in 2016, and even further reduced in 2017–2019.

### **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 1%–16%.
- Recorded on 33%–53% of nights each year.
- Median call files per recording night low ( $\leq 1.5$ ) in all five years. Median was lowest in 2015, then higher and generally similar across the last four years. One site (ISRO026A, wetland north of Moskey Basin) had a much higher number of hoary bat calls per recording night than all other sites in both 2016 and 2017. Its location at the forest edge adjacent to a wetland may provide good foraging opportunities.

### **Silver-haired 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 5%–55%. Made up a much larger proportion of files in the last two years than in 2015–2017.
- Recorded on more than half of nights each year (56%–78%), highest in the last two years.
- Median call files per recording night similar across all five years.

### **Little Brown Bat**

- Documented in every year of surveys (both automated and manual identification).
- Widely distributed: Present at over 85% of survey sites each year.
- Most commonly recorded species by far in 2015–2017, with 58%–74% of the total files, but only about 20% of total files in the last two years.
- Recorded on more than half of nights each year (56%–92%), with a decreasing trend after 2016.
- Median call files per recording night highest in 2015, lower in 2016, and even further reduced in 2017–2019. Seven sites had >100 little brown bat calls per night in 2016, but no site reached this level of activity in any other year.

### **Northern Long-eared Bat**

- Documented in every year of surveys via automated identification and verified manually in 2016–2018.
- Present at 85% or more of survey sites in 2015–2017, but only about 50% of sites in 2018–2019.
- Third-most commonly recorded species in 2015, with 11% of the total files. Decreased to only about 5% of total files in 2016–2017 and less than 2% of files in 2018–2019.
- Recorded on over 75% of nights in 2015–2016, but less than 40% of nights in 2017–2019.
- Median call files per recording night highest in 2015–2016, and substantially reduced in 2017–2019.

### **Tricolored Bat**

- Documented in every year of surveys via automated identification (expanded analysis only) and verified manually in 2017.
- Present at over 50% of survey sites in 2015–2016, but only 8%–27% of sites in 2017–2019.
- Rarely recorded compared to other species: Less than 1% of total files each year.
- Recorded infrequently, on less than 25% of nights each year and less than 5% of nights in the last three years.
- Median call files per recording night low (<1) in all five years. One site (ISRO029A, Lane Cove) had much higher activity in 2016 than any other sites in any other years (>4 calls per night).

**Table 2.** Summary of bat species documented at Isle Royale National Park, 2015–2019, through automated classification and manual vetting of acoustic files.

| Species                 | Year | Detected  |        |
|-------------------------|------|-----------|--------|
|                         |      | Automated | Manual |
| Big Brown Bat           | 2015 | Yes       | No     |
|                         | 2016 | Yes       | No     |
|                         | 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    |
|                         | 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       | Yes    |
|                         | 2017 | Yes       | Yes    |
|                         | 2018 | Yes       | Yes    |

**Table 2 (continued).** Summary of bat species documented at Isle Royale National Park, 2015–2019, through automated classification and manual vetting of acoustic files.

| <b>Species</b>                         | <b>Year</b> | <b>Detected</b>         |                      |
|----------------------------------------|-------------|-------------------------|----------------------|
|                                        |             | <b><i>Automated</i></b> | <b><i>Manual</i></b> |
| Northern Long-eared Bat<br>(continued) | 2019        | Yes                     | No                   |
| Tricolored Bat                         | 2015        | Yes                     | No                   |
|                                        | 2016        | Yes                     | No                   |
|                                        | 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? <sup>a</sup> | Federal Status <sup>b</sup> | State Status <sup>c</sup>       |
|----------------------------------------------------------|---------------------------------|----------------------------|-----------------------------|---------------------------------|
| Big Brown Bat<br><i>Eptesicus fuscus</i>                 | Cavity-roosting/<br>Hibernating | Confirmed WNS              | –                           | T (WI)<br>SC (MN)               |
| Eastern Red Bat<br><i>Lasiurus borealis</i>              | Tree-roosting/<br>Migratory     | Pd Positive                | –                           | SC (IN)                         |
| Hoary Bat<br><i>Lasiurus cinereus</i>                    | Tree-roosting/<br>Migratory     | –                          | –                           | SC (IN)                         |
| Silver-haired Bat<br><i>Lasionycteris noctivagans</i>    | Tree-roosting/<br>Migratory     | Pd Positive                | –                           | SC (IN, WI)                     |
| Little Brown Bat<br><i>Myotis lucifugus</i>              | Cavity-roosting/<br>Hibernating | Confirmed WNS              | –                           | E (IN)<br>T (WI)<br>SC (MI, MN) |
| Northern Long-eared Bat<br><i>Myotis septentrionalis</i> | Cavity-roosting/<br>Hibernating | Confirmed WNS              | T                           | E (IN)<br>T (WI)<br>SC (MI, MN) |
| Indiana Bat<br><i>Myotis sodalis</i>                     | Cavity-roosting/<br>Hibernating | Confirmed WNS              | E                           | E (IN, MI)                      |
| Evening Bat<br><i>Nycticeius humeralis</i>               | Tree-roosting/<br>Migratory     | –                          | –                           | E (IN)<br>T (MI)                |
| Tricolored Bat<br><i>Perimyotis subflavus</i>            | Cavity-roosting/<br>Hibernating | Confirmed WNS              | –                           | E (IN)<br>T (WI)<br>SC (MI, MN) |

<sup>a</sup> White-nose Syndrome Response Team, [www.whitenosesyndrome.org](http://www.whitenosesyndrome.org).

<sup>b</sup> U. S. Fish and Wildlife Service (1967, 2016).

<sup>c</sup> 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<br><i>Eptesicus fuscus</i>                 | X                 | X                 |
| Eastern Red Bat<br><i>Lasiurus borealis</i>              | X                 | X                 |
| Hoary Bat<br><i>Lasiurus cinereus</i>                    | X                 | X                 |
| Silver-haired Bat<br><i>Lasionycteris noctivagans</i>    | X                 | X                 |
| Little Brown Bat<br><i>Myotis lucifugus</i>              | X                 | X                 |
| Northern Long-eared Bat<br><i>Myotis septentrionalis</i> | X                 | X                 |
| Tricolored Bat<br><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, Isle Royale National Park, 2015–2019.

| Year | Earliest | Latest    | Deployment Category <sup>1</sup> |        |                |      |              |       |               | Total Files |
|------|----------|-----------|----------------------------------|--------|----------------|------|--------------|-------|---------------|-------------|
|      |          |           | Early                            | Failed | Failed (short) | Late | Non-protocol | Valid | Valid (dupl.) |             |
| 2015 | 10 July  | 28 August | 0                                | 0      | 1              | 2    | 0            | 7     | 0             | 17,151      |
| 2016 | 6 June   | 25 August | 0                                | 0      | 0              | 0    | 0            | 27    | 0             | 28,518      |
| 2017 | 8 June   | 24 August | 0                                | 0      | 2              | 1    | 0            | 26    | 0             | 5,709       |
| 2018 | 7 June   | 17 August | 0                                | 3      | 4              | 0    | 0            | 24    | 0             | 4,458       |
| 2019 | 6 June   | 22 August | 0                                | 1      | 1              | 0    | 0            | 27    | 0             | 7,161       |

<sup>1</sup> “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, Isle Royale National Park, 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 | 7           | 83           | 11.86                | 15,166      | 2,167               | 183                  |
| 2016 | 27          | 244          | 9.04                 | 28,518      | 1,056               | 117                  |
| 2017 | 26          | 213          | 8.19                 | 5,583       | 215                 | 26                   |
| 2018 | 24          | 223          | 9.29                 | 3,944       | 164                 | 18                   |
| 2019 | 27          | 260          | 9.63                 | 6,362       | 236                 | 24                   |



## 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, Isle Royale National Park, 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 | 15,166      | 3,994         | 99            | 11,073  | 26.34         | 0.65          | 73.01   |
| 2015 | expanded | 15,166      | 3,977         | 116           | 11,073  | 26.22         | 0.76          | 73.01   |
| 2016 | baseline | 28,518      | 23,657        | 194           | 4,667   | 82.95         | 0.68          | 16.37   |
| 2016 | expanded | 28,518      | 23,619        | 232           | 4,667   | 82.82         | 0.81          | 16.37   |
| 2017 | baseline | 5,583       | 4,686         | 42            | 855     | 83.93         | 0.75          | 15.31   |
| 2017 | expanded | 5,583       | 4,684         | 44            | 855     | 83.90         | 0.79          | 15.31   |
| 2018 | baseline | 3,944       | 3,151         | 55            | 738     | 79.89         | 1.39          | 18.71   |
| 2018 | expanded | 3,944       | 3,151         | 55            | 738     | 79.89         | 1.39          | 18.71   |
| 2019 | baseline | 6,362       | 4,906         | 56            | 1,400   | 77.11         | 0.88          | 22.01   |
| 2019 | expanded | 6,362       | 4,894         | 68            | 1,400   | 76.93         | 1.07          | 22.01   |

**Table E2.** Total number of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Isle Royale National Park, 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 | 48            | 528             | 50        | 198               | 2,715            | 455                     | n/a            |
| 2015 | expanded | 48            | 490             | 50        | 198               | 2,707            | 457                     | 27             |
| 2016 | baseline | 624           | 1,581           | 1,075     | 1,412             | 17,619           | 1,346                   | n/a            |
| 2016 | expanded | 627           | 1,523           | 1,075     | 1,413             | 17,561           | 1,349                   | 71             |
| 2017 | baseline | 148           | 270             | 741       | 587               | 2,702            | 238                     | n/a            |
| 2017 | expanded | 149           | 267             | 740       | 587               | 2,692            | 239                     | 10             |
| 2018 | baseline | 349           | 118             | 275       | 1,745             | 602              | 62                      | n/a            |
| 2018 | expanded | 349           | 117             | 276       | 1,744             | 601              | 62                      | 2              |
| 2019 | baseline | 246           | 1,189           | 697       | 1,587             | 1,164            | 23                      | n/a            |
| 2019 | expanded | 246           | 1,106           | 697       | 1,587             | 1,199            | 24                      | 35             |

**Table E3.** Percent of audio files classified as each bat species by Kaleidoscope Pro for each year and analysis type, Isle Royale National Park, 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 | 1.20          | 13.22           | 1.25      | 4.96              | 67.98            | 11.39                   | n/a            |
| 2015 | expanded | 1.21          | 12.32           | 1.26      | 4.98              | 68.07            | 11.49                   | 0.68           |
| 2016 | baseline | 2.64          | 6.68            | 4.54      | 5.97              | 74.48            | 5.69                    | n/a            |
| 2016 | expanded | 2.65          | 6.45            | 4.55      | 5.98              | 74.35            | 5.71                    | 0.30           |
| 2017 | baseline | 3.16          | 5.76            | 15.81     | 12.53             | 57.66            | 5.08                    | n/a            |
| 2017 | expanded | 3.18          | 5.70            | 15.80     | 12.53             | 57.47            | 5.10                    | 0.21           |
| 2018 | baseline | 11.08         | 3.74            | 8.73      | 55.38             | 19.11            | 1.97                    | n/a            |
| 2018 | expanded | 11.08         | 3.71            | 8.76      | 55.35             | 19.07            | 1.97                    | 0.06           |
| 2019 | baseline | 5.01          | 24.24           | 14.21     | 32.35             | 23.73            | 0.47                    | n/a            |
| 2019 | expanded | 5.03          | 22.60           | 14.24     | 32.43             | 24.50            | 0.49                    | 0.72           |

**Table E4.** Total number of monitoring sites, and count of sites where each species was detected for each year and analysis type, Isle Royale National Park, 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.

| <b>Year</b> | <b>Analysis</b> | <b>Total Sites</b> | <b>Big Brown Bat</b> | <b>Eastern Red Bat</b> | <b>Hoary Bat</b> | <b>Silver-haired Bat</b> | <b>Little Brown Bat</b> | <b>Northern Long-eared Bat</b> | <b>Tricolored Bat</b> |
|-------------|-----------------|--------------------|----------------------|------------------------|------------------|--------------------------|-------------------------|--------------------------------|-----------------------|
| 2015        | baseline        | 7                  | 6                    | 7                      | 6                | 7                        | 7                       | 7                              | n/a                   |
| 2015        | expanded        | 7                  | 6                    | 7                      | 6                | 7                        | 7                       | 7                              | 5                     |
| 2016        | baseline        | 27                 | 23                   | 25                     | 24               | 24                       | 26                      | 27                             | n/a                   |
| 2016        | expanded        | 27                 | 23                   | 24                     | 24               | 24                       | 26                      | 27                             | 14                    |
| 2017        | baseline        | 26                 | 18                   | 21                     | 23               | 26                       | 23                      | 23                             | n/a                   |
| 2017        | expanded        | 26                 | 18                   | 21                     | 23               | 26                       | 23                      | 22                             | 7                     |
| 2018        | baseline        | 24                 | 22                   | 18                     | 22               | 24                       | 23                      | 13                             | n/a                   |
| 2018        | expanded        | 24                 | 22                   | 18                     | 22               | 24                       | 23                      | 13                             | 2                     |
| 2019        | baseline        | 27                 | 23                   | 22                     | 25               | 27                       | 24                      | 14                             | n/a                   |
| 2019        | expanded        | 27                 | 23                   | 22                     | 25               | 27                       | 24                      | 14                             | 4                     |

**Table E5.** Total number of monitoring sites, and percent of sites where each species was detected for each year and analysis type, Isle Royale National Park, 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 | 7           | 85.71         | 100.00          | 85.71     | 100.00            | 100.00           | 100.00                  | n/a            |
| 2015 | expanded | 7           | 85.71         | 100.00          | 85.71     | 100.00            | 100.00           | 100.00                  | 71.43          |
| 2016 | baseline | 27          | 85.19         | 92.59           | 88.89     | 88.89             | 96.30            | 100.00                  | n/a            |
| 2016 | expanded | 27          | 85.19         | 88.89           | 88.89     | 88.89             | 96.30            | 100.00                  | 51.85          |
| 2017 | baseline | 26          | 69.23         | 80.77           | 88.46     | 100.00            | 88.46            | 88.46                   | n/a            |
| 2017 | expanded | 26          | 69.23         | 80.77           | 88.46     | 100.00            | 88.46            | 84.62                   | 26.92          |
| 2018 | baseline | 24          | 91.67         | 75.00           | 91.67     | 100.00            | 95.83            | 54.17                   | n/a            |
| 2018 | expanded | 24          | 91.67         | 75.00           | 91.67     | 100.00            | 95.83            | 54.17                   | 8.33           |
| 2019 | baseline | 27          | 85.19         | 81.48           | 92.59     | 100.00            | 88.89            | 51.85                   | n/a            |
| 2019 | expanded | 27          | 85.19         | 81.48           | 92.59     | 100.00            | 88.89            | 51.85                   | 14.81          |

**Table E6.** Total number of recording nights, and count of recording nights on which each species was detected for each year and analysis type, Isle Royale National Park, 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<br>Nights | Big Brown<br>Bat | Eastern<br>Red Bat | Hoary<br>Bat | Silver-<br>haired<br>Bat | Little<br>Brown<br>Bat | Northern<br>Long-<br>eared Bat | Tricolored<br>Bat |
|------|----------|-----------------|------------------|--------------------|--------------|--------------------------|------------------------|--------------------------------|-------------------|
| 2015 | baseline | 83              | 27               | 67                 | 27           | 55                       | 75                     | 63                             | n/a               |
| 2015 | expanded | 83              | 27               | 66                 | 27           | 55                       | 75                     | 63                             | 20                |
| 2016 | baseline | 244             | 86               | 182                | 121          | 156                      | 224                    | 201                            | n/a               |
| 2016 | expanded | 244             | 87               | 182                | 121          | 156                      | 224                    | 202                            | 30                |
| 2017 | baseline | 213             | 55               | 97                 | 86           | 120                      | 154                    | 82                             | n/a               |
| 2017 | expanded | 213             | 55               | 92                 | 86           | 120                      | 152                    | 81                             | 9                 |
| 2018 | baseline | 223             | 89               | 60                 | 99           | 173                      | 124                    | 34                             | n/a               |
| 2018 | expanded | 223             | 89               | 60                 | 100          | 172                      | 124                    | 34                             | 2                 |
| 2019 | baseline | 260             | 96               | 95                 | 138          | 195                      | 148                    | 21                             | n/a               |
| 2019 | expanded | 260             | 96               | 95                 | 138          | 195                      | 155                    | 22                             | 11                |

**Table E7.** Total number of recording nights, and percent of recording nights on which each species was detected for each year and analysis type, Isle Royale National Park, 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 | 83           | 32.53         | 80.72           | 32.53     | 66.27             | 90.36            | 75.90                   | n/a            |
| 2015 | expanded | 83           | 32.53         | 79.52           | 32.53     | 66.27             | 90.36            | 75.90                   | 24.10          |
| 2016 | baseline | 244          | 35.25         | 74.59           | 49.59     | 63.93             | 91.80            | 82.38                   | n/a            |
| 2016 | expanded | 244          | 35.66         | 74.59           | 49.59     | 63.93             | 91.80            | 82.79                   | 12.30          |
| 2017 | baseline | 213          | 25.82         | 45.54           | 40.38     | 56.34             | 72.30            | 38.50                   | n/a            |
| 2017 | expanded | 213          | 25.82         | 43.19           | 40.38     | 56.34             | 71.36            | 38.03                   | 4.23           |
| 2018 | baseline | 223          | 39.91         | 26.91           | 44.39     | 77.58             | 55.61            | 15.25                   | n/a            |
| 2018 | expanded | 223          | 39.91         | 26.91           | 44.84     | 77.13             | 55.61            | 15.25                   | 0.90           |
| 2019 | baseline | 260          | 36.92         | 36.54           | 53.08     | 75.00             | 56.92            | 8.08                    | n/a            |
| 2019 | expanded | 260          | 36.92         | 36.54           | 53.08     | 75.00             | 59.62            | 8.46                    | 4.23           |



## Appendix F. Noise Assessment.

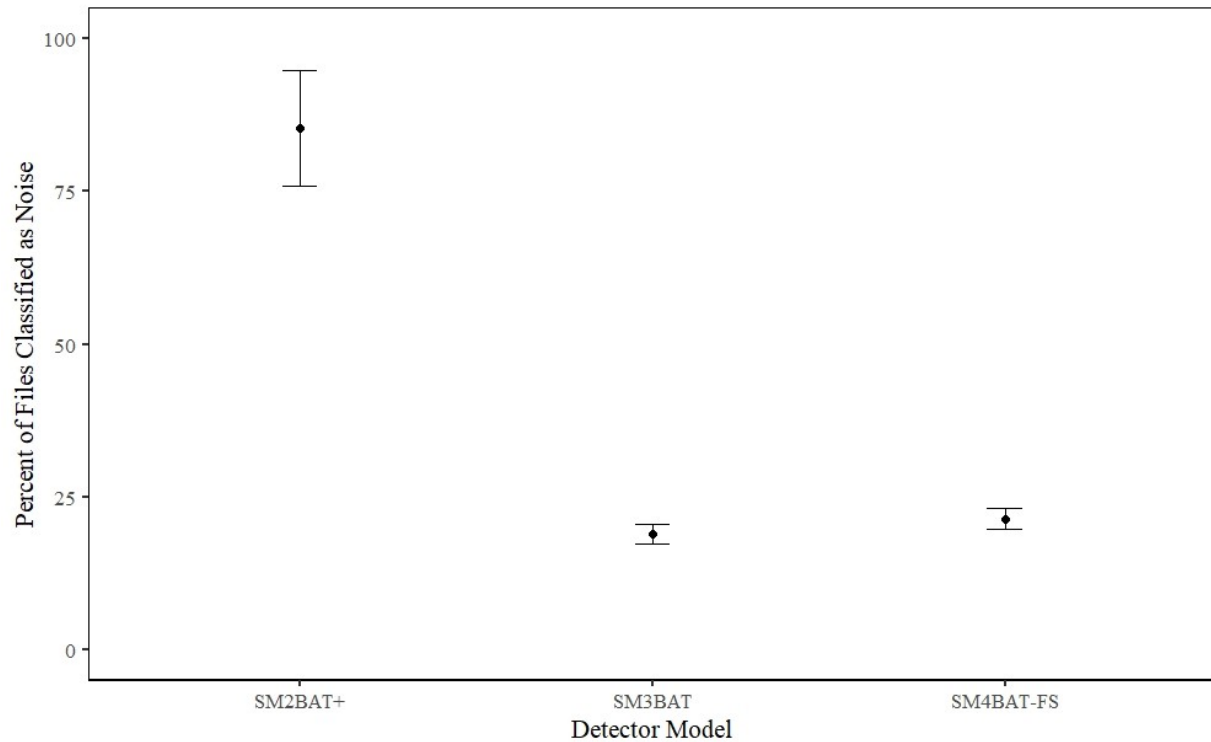


**Figure F1.** Percent of audio files classified as noise for each detector model (mean  $\pm$  95% confidence interval). Includes all Great Lakes Network parks in which bat monitoring occurred. Includes all deployments from 2015–2019 except failed deployments and deployments that used two microphones. Sample size:  $n = 8$  for SM2BAT+;  $n = 442$  for SM3BAT;  $n = 452$  for SM4BAT-FS.

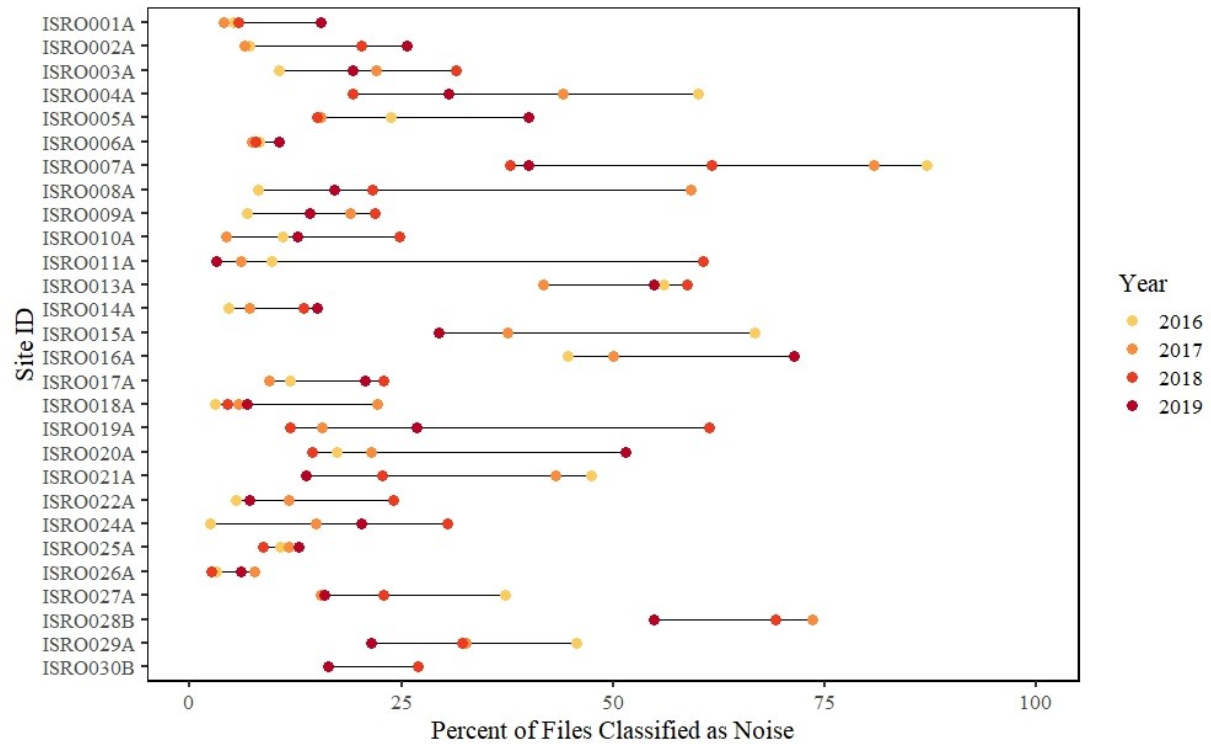


**Figure F2.** Percent of audio files classified as noise for each sampling site at Isle Royale National Park, 2016–2019. Each point represents the percent noise for one year's deployment at that sampling site. Excludes failed deployments, sites that were sampled only in 2015, and sites that were relocated (ISRO028A and ISRO030A).

**Table F1.** Mean percent of audio files classified as noise for each sampling site at Isle Royale National Park, 2016–2019, including standard deviation, minimum percent noise, and maximum percent noise. Excludes failed deployments, sites only sampled in 2015, and sites that were relocated (ISRO028A and ISRO030A). 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<br>Parkwide Mean |
|----------|--------------|----------|--------------|--------------|--------------------------|
| ISRO001A | 7.6          | 5.3      | 4.0          | 15.4         | –                        |
| ISRO002A | 14.8         | 9.7      | 6.4          | 25.7         | –                        |
| ISRO003A | 20.8         | 8.6      | 10.6         | 31.4         | –                        |
| ISRO004A | 38.5         | 17.6     | 19.2         | 60.0         | Yes                      |
| ISRO005A | 23.6         | 11.7     | 15.0         | 40.0         | –                        |
| ISRO006A | 8.4          | 1.4      | 7.3          | 10.5         | –                        |
| ISRO007A | 61.5         | 22.6     | 37.8         | 87.0         | Yes*                     |
| ISRO008A | 26.5         | 22.5     | 8.0          | 59.1         | Yes                      |
| ISRO009A | 15.4         | 6.6      | 6.8          | 21.8         | –                        |
| ISRO010A | 13.2         | 8.5      | 4.3          | 24.7         | –                        |
| ISRO011A | 19.9         | 27.3     | 3.1          | 60.6         | –                        |
| ISRO013A | 52.8         | 7.6      | 41.7         | 58.8         | Yes*                     |
| ISRO014A | 10.1         | 5.0      | 4.6          | 15.0         | –                        |
| ISRO015A | 44.5         | 19.6     | 29.4         | 66.7         | Yes*                     |
| ISRO016A | 55.3         | 14.2     | 44.6         | 71.4         | Yes*                     |
| ISRO017A | 16.2         | 6.6      | 9.4          | 22.9         | –                        |
| ISRO018A | 8.4          | 7.8      | 3.0          | 22.2         | –                        |
| ISRO019A | 25.5         | 21.0     | 11.8         | 61.4         | Yes                      |
| ISRO020A | 26.1         | 17.1     | 14.4         | 51.5         | Yes                      |
| ISRO021A | 31.8         | 16.1     | 13.7         | 47.4         | Yes                      |
| ISRO022A | 12.1         | 8.4      | 5.5          | 24.1         | –                        |
| ISRO024A | 17.0         | 11.7     | 2.4          | 30.4         | –                        |
| ISRO025A | 10.9         | 1.8      | 8.6          | 12.8         | –                        |
| ISRO026A | 4.9          | 2.4      | 2.6          | 7.7          | –                        |
| ISRO027A | 22.9         | 10.2     | 15.4         | 37.2         | –                        |
| ISRO028B | 65.9         | 9.8      | 54.8         | 73.6         | Yes*                     |
| ISRO029A | 33.0         | 9.9      | 21.4         | 45.7         | Yes                      |

| <b>Site ID</b> | <b>Mean % Noise</b> | <b>St. Dev.</b> | <b>Min. % Noise</b> | <b>Max. % Noise</b> | <b>Exceeds<br/>Parkwide Mean</b> |
|----------------|---------------------|-----------------|---------------------|---------------------|----------------------------------|
| ISRO030B       | 21.6                | 7.5             | 16.3                | 26.9                | –                                |

## 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, Isle Royale National Park, 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               | 10                 | 0                     | 0.00                   |
| 2015 | baseline | Eastern Red Bat             | 10                 | 5                     | 50.00                  |
| 2015 | baseline | Hoary Bat                   | 10                 | 8                     | 80.00                  |
| 2015 | baseline | Silver-haired Bat           | 10                 | 6                     | 60.00                  |
| 2015 | baseline | Little Brown Bat            | 22                 | 15                    | 68.18                  |
| 2015 | baseline | Northern Long-eared Bat     | 10                 | 0                     | 0.00                   |
| 2015 | expanded | Tricolored Bat              | 10                 | 0                     | 0.00                   |
| 2016 | baseline | Big Brown Bat               | 10                 | 0                     | 0.00                   |
| 2016 | baseline | Eastern Red Bat             | 18                 | 4                     | 22.22                  |
| 2016 | baseline | Hoary Bat                   | 18                 | 8                     | 44.44                  |
| 2016 | baseline | Silver-haired Bat           | 22                 | 12                    | 54.55                  |
| 2016 | baseline | Little Brown Bat            | 339                | 291                   | 85.84                  |
| 2016 | baseline | Northern Long-eared Bat     | 19                 | 8                     | 42.11                  |
| 2016 | expanded | Tricolored Bat              | 10                 | 0                     | 0.00                   |
| 2017 | baseline | Big Brown Bat               | 10                 | 4                     | 40.00                  |
| 2017 | baseline | Eastern Red Bat             | 10                 | 1                     | 10.00                  |
| 2017 | baseline | Hoary Bat                   | 10                 | 6                     | 60.00                  |
| 2017 | baseline | Silver-haired Bat           | 10                 | 5                     | 50.00                  |
| 2017 | baseline | Little Brown Bat            | 27                 | 23                    | 85.19                  |
| 2017 | baseline | Northern Long-eared Bat     | 10                 | 3                     | 30.00                  |
| 2017 | expanded | Tricolored Bat              | 10                 | 1                     | 10.00                  |
| 2018 | baseline | Big Brown Bat               | 10                 | 3                     | 30.00                  |
| 2018 | baseline | Eastern Red Bat             | 10                 | 5                     | 50.00                  |
| 2018 | baseline | Hoary Bat                   | 10                 | 9                     | 90.00                  |

| <b>Year</b> | <b>Analysis</b> | <b>Kaleidoscope Classification</b> | <b>Total Files Vetted</b> | <b>Number Files Verified</b> | <b>Percent Files Verified</b> |
|-------------|-----------------|------------------------------------|---------------------------|------------------------------|-------------------------------|
| 2018        | baseline        | Silver-haired Bat                  | 17                        | 2                            | 11.76                         |
| 2018        | baseline        | Little Brown Bat                   | 10                        | 7                            | 70.00                         |
| 2018        | baseline        | Northern Long-eared Bat            | 10                        | 6                            | 60.00                         |
| 2018        | expanded        | Tricolored Bat                     | 2                         | 0                            | 0.00                          |
| 2019        | baseline        | Big Brown Bat                      | 10                        | 4                            | 40.00                         |
| 2019        | baseline        | Eastern Red Bat                    | 11                        | 8                            | 72.73                         |
| 2019        | baseline        | Hoary Bat                          | 10                        | 9                            | 90.00                         |
| 2019        | baseline        | Silver-haired Bat                  | 15                        | 5                            | 33.33                         |
| 2019        | baseline        | Little Brown Bat                   | 11                        | 7                            | 63.64                         |
| 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, Isle Royale National Park, 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 | BAT605_2015 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2015 | BAT605_2015 | baseline | Hoary Bat                   | 2                  | 1                     | 50.00                  |
| 2015 | BAT85_2015  | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2015 | BAT85_2015  | baseline | Eastern Red Bat             | 2                  | 1                     | 50.00                  |
| 2015 | BAT85_2015  | baseline | Hoary Bat                   | 1                  | 0                     | 0.00                   |
| 2015 | BAT85_2015  | baseline | Little Brown Bat            | 6                  | 4                     | 66.67                  |
| 2015 | BAT85_2015  | baseline | Northern Long-eared Bat     | 2                  | 0                     | 0.00                   |
| 2015 | BAT85_2015  | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2015 | FS1_2015    | baseline | Big Brown Bat               | 7                  | 0                     | 0.00                   |
| 2015 | FS1_2015    | baseline | Eastern Red Bat             | 3                  | 2                     | 66.67                  |
| 2015 | FS1_2015    | baseline | Hoary Bat                   | 6                  | 6                     | 100.00                 |
| 2015 | FS1_2015    | baseline | Silver-haired Bat           | 2                  | 1                     | 50.00                  |
| 2015 | FS1_2015    | baseline | Little Brown Bat            | 5                  | 3                     | 60.00                  |
| 2015 | FS1_2015    | baseline | Northern Long-eared Bat     | 3                  | 0                     | 0.00                   |
| 2015 | FS1_2015    | expanded | Tricolored Bat              | 6                  | 0                     | 0.00                   |
| 2015 | FS2_2015    | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2015 | FS2_2015    | baseline | Eastern Red Bat             | 2                  | 1                     | 50.00                  |
| 2015 | FS2_2015    | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2015 | FS2_2015    | baseline | Silver-haired Bat           | 4                  | 2                     | 50.00                  |
| 2015 | FS2_2015    | baseline | Little Brown Bat            | 5                  | 4                     | 80.00                  |
| 2015 | FS2_2015    | baseline | Northern Long-eared Bat     | 2                  | 0                     | 0.00                   |
| 2015 | MPL1_2015   | baseline | Eastern Red Bat             | 2                  | 1                     | 50.00                  |
| 2015 | MPL1_2015   | baseline | Silver-haired Bat           | 4                  | 3                     | 75.00                  |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2015 | MPL1_2015     | baseline | Little Brown Bat            | 5                  | 4                     | 80.00                  |
| 2015 | MPL1_2015     | expanded | Tricolored Bat              | 3                  | 0                     | 0.00                   |
| 2015 | MSF1_2015     | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2015 | MSF1_2015     | baseline | Northern Long-eared Bat     | 3                  | 0                     | 0.00                   |
| 2015 | PIBH1_2015    | baseline | Little Brown Bat            | 1                  | 0                     | 0.00                   |
| 2016 | ISRO001A_2016 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2016 | ISRO001A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO001A_2016 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2016 | ISRO001A_2016 | baseline | Silver-haired Bat           | 2                  | 1                     | 50.00                  |
| 2016 | ISRO001A_2016 | baseline | Little Brown Bat            | 4                  | 4                     | 100.00                 |
| 2016 | ISRO001A_2016 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2016 | ISRO002A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO002A_2016 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2016 | ISRO002A_2016 | baseline | Little Brown Bat            | 9                  | 8                     | 88.89                  |
| 2016 | ISRO002A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO003A_2016 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2016 | ISRO003A_2016 | baseline | Silver-haired Bat           | 1                  | 1                     | 100.00                 |
| 2016 | ISRO003A_2016 | baseline | Little Brown Bat            | 4                  | 3                     | 75.00                  |
| 2016 | ISRO004A_2016 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2016 | ISRO004A_2016 | baseline | Northern Long-eared Bat     | 2                  | 0                     | 0.00                   |
| 2016 | ISRO005A_2016 | baseline | Little Brown Bat            | 6                  | 2                     | 33.33                  |
| 2016 | ISRO006A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO006A_2016 | baseline | Hoary Bat                   | 1                  | 0                     | 0.00                   |
| 2016 | ISRO006A_2016 | baseline | Little Brown Bat            | 21                 | 18                    | 85.71                  |
| 2016 | ISRO008A_2016 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2016 | ISRO008A_2016 | baseline | Little Brown Bat            | 6                  | 4                     | 66.67                  |
| 2016 | ISRO008A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO009A_2016 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2016 | ISRO009A_2016 | baseline | Little Brown Bat            | 5                  | 4                     | 80.00                  |
| 2016 | ISRO009A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2016 | ISRO010A_2016 | baseline | Little Brown Bat            | 2                  | 2                     | 100.00                 |
| 2016 | ISRO011A_2016 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2016 | ISRO011A_2016 | baseline | Silver-haired Bat           | 5                  | 4                     | 80.00                  |
| 2016 | ISRO011A_2016 | baseline | Little Brown Bat            | 24                 | 18                    | 75.00                  |
| 2016 | ISRO011A_2016 | baseline | Northern Long-eared Bat     | 3                  | 0                     | 0.00                   |
| 2016 | ISRO011A_2016 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2016 | ISRO013A_2016 | baseline | Silver-haired Bat           | 2                  | 0                     | 0.00                   |
| 2016 | ISRO013A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO014A_2016 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2016 | ISRO014A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO014A_2016 | baseline | Little Brown Bat            | 6                  | 6                     | 100.00                 |
| 2016 | ISRO017A_2016 | baseline | Silver-haired Bat           | 2                  | 2                     | 100.00                 |
| 2016 | ISRO017A_2016 | baseline | Little Brown Bat            | 2                  | 2                     | 100.00                 |
| 2016 | ISRO018A_2016 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2016 | ISRO018A_2016 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2016 | ISRO018A_2016 | baseline | Little Brown Bat            | 7                  | 6                     | 85.71                  |
| 2016 | ISRO019A_2016 | baseline | Eastern Red Bat             | 3                  | 2                     | 66.67                  |
| 2016 | ISRO019A_2016 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2016 | ISRO019A_2016 | baseline | Silver-haired Bat           | 1                  | 1                     | 100.00                 |
| 2016 | ISRO019A_2016 | baseline | Little Brown Bat            | 9                  | 7                     | 77.78                  |
| 2016 | ISRO020A_2016 | baseline | Big Brown Bat               | 2                  | 0                     | 0.00                   |
| 2016 | ISRO020A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO020A_2016 | baseline | Hoary Bat                   | 1                  | 0                     | 0.00                   |
| 2016 | ISRO020A_2016 | baseline | Silver-haired Bat           | 3                  | 2                     | 66.67                  |
| 2016 | ISRO020A_2016 | baseline | Little Brown Bat            | 46                 | 38                    | 82.61                  |
| 2016 | ISRO020A_2016 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2016 | ISRO021A_2016 | baseline | Little Brown Bat            | 7                  | 4                     | 57.14                  |
| 2016 | ISRO021A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO022A_2016 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2016 | ISRO022A_2016 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2016 | ISRO022A_2016 | baseline | Little Brown Bat            | 21                 | 17                    | 80.95                  |
| 2016 | ISRO022A_2016 | baseline | Northern Long-eared Bat     | 2                  | 0                     | 0.00                   |
| 2016 | ISRO024A_2016 | baseline | Hoary Bat                   | 1                  | 0                     | 0.00                   |
| 2016 | ISRO024A_2016 | baseline | Silver-haired Bat           | 4                  | 1                     | 25.00                  |
| 2016 | ISRO024A_2016 | baseline | Little Brown Bat            | 62                 | 62                    | 100.00                 |
| 2016 | ISRO024A_2016 | baseline | Northern Long-eared Bat     | 2                  | 1                     | 50.00                  |
| 2016 | ISRO025A_2016 | baseline | Big Brown Bat               | 5                  | 0                     | 0.00                   |
| 2016 | ISRO025A_2016 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2016 | ISRO026A_2016 | baseline | Hoary Bat                   | 8                  | 1                     | 12.50                  |
| 2016 | ISRO026A_2016 | baseline | Little Brown Bat            | 69                 | 65                    | 94.20                  |
| 2016 | ISRO026A_2016 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2016 | ISRO027A_2016 | baseline | Hoary Bat                   | 2                  | 2                     | 100.00                 |
| 2016 | ISRO028A_2016 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2016 | ISRO028A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO029A_2016 | baseline | Eastern Red Bat             | 3                  | 2                     | 66.67                  |
| 2016 | ISRO029A_2016 | baseline | Little Brown Bat            | 28                 | 20                    | 71.43                  |
| 2016 | ISRO029A_2016 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2016 | ISRO029A_2016 | expanded | Tricolored Bat              | 8                  | 0                     | 0.00                   |
| 2017 | ISRO001A_2017 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2017 | ISRO001A_2017 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2017 | ISRO001A_2017 | baseline | Hoary Bat                   | 2                  | 2                     | 100.00                 |
| 2017 | ISRO001A_2017 | baseline | Silver-haired Bat           | 6                  | 4                     | 66.67                  |
| 2017 | ISRO002A_2017 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2017 | ISRO005A_2017 | baseline | Northern Long-eared Bat     | 2                  | 1                     | 50.00                  |
| 2017 | ISRO005A_2017 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2017 | ISRO006A_2017 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2017 | ISRO006A_2017 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2017 | ISRO011A_2017 | baseline | Little Brown Bat            | 3                  | 3                     | 100.00                 |
| 2017 | ISRO011A_2017 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2017 | ISRO014A_2017 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2017 | ISRO018A_2017 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2017 | ISRO019A_2017 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2017 | ISRO020A_2017 | baseline | Little Brown Bat            | 6                  | 6                     | 100.00                 |
| 2017 | ISRO020A_2017 | baseline | Northern Long-eared Bat     | 4                  | 1                     | 25.00                  |
| 2017 | ISRO022A_2017 | baseline | Eastern Red Bat             | 4                  | 0                     | 0.00                   |
| 2017 | ISRO022A_2017 | baseline | Hoary Bat                   | 2                  | 1                     | 50.00                  |
| 2017 | ISRO022A_2017 | baseline | Little Brown Bat            | 7                  | 3                     | 42.86                  |
| 2017 | ISRO022A_2017 | expanded | Tricolored Bat              | 3                  | 1                     | 33.33                  |
| 2017 | ISRO024A_2017 | baseline | Big Brown Bat               | 1                  | 1                     | 100.00                 |
| 2017 | ISRO024A_2017 | baseline | Eastern Red Bat             | 1                  | 1                     | 100.00                 |
| 2017 | ISRO024A_2017 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2017 | ISRO024A_2017 | baseline | Little Brown Bat            | 5                  | 5                     | 100.00                 |
| 2017 | ISRO025A_2017 | baseline | Big Brown Bat               | 3                  | 1                     | 33.33                  |
| 2017 | ISRO025A_2017 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2017 | ISRO025A_2017 | baseline | Hoary Bat                   | 2                  | 2                     | 100.00                 |
| 2017 | ISRO025A_2017 | baseline | Silver-haired Bat           | 1                  | 1                     | 100.00                 |
| 2017 | ISRO025A_2017 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2017 | ISRO026A_2017 | baseline | Hoary Bat                   | 2                  | 0                     | 0.00                   |
| 2017 | ISRO026A_2017 | baseline | Little Brown Bat            | 4                  | 4                     | 100.00                 |
| 2017 | ISRO026A_2017 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2017 | ISRO028B_2017 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2017 | ISRO029A_2017 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2017 | ISRO029A_2017 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2017 | ISRO029A_2017 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2017 | ISRO030A_2017 | baseline | Big Brown Bat               | 4                  | 2                     | 50.00                  |
| 2017 | ISRO030A_2017 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2017 | ISRO030A_2017 | baseline | Hoary Bat                   | 2                  | 1                     | 50.00                  |
| 2017 | ISRO030A_2017 | expanded | Tricolored Bat              | 2                  | 0                     | 0.00                   |
| 2018 | ISRO001A_2018 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2018 | ISRO001A_2018 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2018 | ISRO002A_2018 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2018 | ISRO004A_2018 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2018 | ISRO005A_2018 | baseline | Eastern Red Bat             | 3                  | 3                     | 100.00                 |
| 2018 | ISRO005A_2018 | baseline | Silver-haired Bat           | 1                  | 1                     | 100.00                 |
| 2018 | ISRO005A_2018 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2018 | ISRO005A_2018 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2018 | ISRO006A_2018 | baseline | Big Brown Bat               | 4                  | 3                     | 75.00                  |
| 2018 | ISRO006A_2018 | baseline | Eastern Red Bat             | 2                  | 0                     | 0.00                   |
| 2018 | ISRO006A_2018 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2018 | ISRO006A_2018 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2018 | ISRO007A_2018 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2018 | ISRO008A_2018 | baseline | Big Brown Bat               | 2                  | 0                     | 0.00                   |
| 2018 | ISRO008A_2018 | baseline | Silver-haired Bat           | 8                  | 0                     | 0.00                   |
| 2018 | ISRO009A_2018 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2018 | ISRO010A_2018 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2018 | ISRO013A_2018 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2018 | ISRO013A_2018 | baseline | Northern Long-eared Bat     | 4                  | 3                     | 75.00                  |
| 2018 | ISRO014A_2018 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2018 | ISRO014A_2018 | baseline | Hoary Bat                   | 2                  | 2                     | 100.00                 |
| 2018 | ISRO017A_2018 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2018 | ISRO018A_2018 | baseline | Hoary Bat                   | 3                  | 2                     | 66.67                  |
| 2018 | ISRO018A_2018 | baseline | Silver-haired Bat           | 2                  | 1                     | 50.00                  |
| 2018 | ISRO018A_2018 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |
| 2018 | ISRO020A_2018 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2018 | ISRO020A_2018 | baseline | Silver-haired Bat           | 3                  | 0                     | 0.00                   |
| 2018 | ISRO020A_2018 | baseline | Little Brown Bat            | 1                  | 0                     | 0.00                   |
| 2018 | ISRO020A_2018 | baseline | Northern Long-eared Bat     | 2                  | 0                     | 0.00                   |
| 2018 | ISRO021A_2018 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2018 | ISRO021A_2018 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2018 | ISRO021A_2018 | baseline | Northern Long-eared Bat     | 1                  | 1                     | 100.00                 |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2018 | ISRO022A_2018 | baseline | Hoary Bat                   | 2                  | 2                     | 100.00                 |
| 2018 | ISRO022A_2018 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2018 | ISRO024A_2018 | baseline | Eastern Red Bat             | 1                  | 1                     | 100.00                 |
| 2018 | ISRO024A_2018 | baseline | Little Brown Bat            | 2                  | 0                     | 0.00                   |
| 2018 | ISRO024A_2018 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2018 | ISRO025A_2018 | baseline | Eastern Red Bat             | 1                  | 1                     | 100.00                 |
| 2018 | ISRO025A_2018 | expanded | Tricolored Bat              | 1                  | 0                     | 0.00                   |
| 2018 | ISRO026A_2018 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2018 | ISRO026A_2018 | baseline | Little Brown Bat            | 2                  | 2                     | 100.00                 |
| 2019 | ISRO003A_2019 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |
| 2019 | ISRO004A_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO005A_2019 | baseline | Hoary Bat                   | 1                  | 0                     | 0.00                   |
| 2019 | ISRO006A_2019 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2019 | ISRO006A_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO007A_2019 | baseline | Silver-haired Bat           | 2                  | 1                     | 50.00                  |
| 2019 | ISRO008A_2019 | baseline | Silver-haired Bat           | 2                  | 0                     | 0.00                   |
| 2019 | ISRO009A_2019 | baseline | Big Brown Bat               | 1                  | 1                     | 100.00                 |
| 2019 | ISRO010A_2019 | baseline | Big Brown Bat               | 2                  | 1                     | 50.00                  |
| 2019 | ISRO011A_2019 | baseline | Big Brown Bat               | 1                  | 1                     | 100.00                 |
| 2019 | ISRO011A_2019 | baseline | Silver-haired Bat           | 3                  | 2                     | 66.67                  |
| 2019 | ISRO011A_2019 | baseline | Little Brown Bat            | 1                  | 1                     | 100.00                 |
| 2019 | ISRO013A_2019 | baseline | Big Brown Bat               | 1                  | 1                     | 100.00                 |
| 2019 | ISRO014A_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO017A_2019 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2019 | ISRO017A_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO018A_2019 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2019 | ISRO018A_2019 | baseline | Silver-haired Bat           | 2                  | 0                     | 0.00                   |
| 2019 | ISRO019A_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO020A_2019 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2019 | ISRO020A_2019 | baseline | Silver-haired Bat           | 1                  | 0                     | 0.00                   |

| Year | Site ID       | Analysis | Kaleidoscope Classification | Total Files Vetted | Number Files Verified | Percent Files Verified |
|------|---------------|----------|-----------------------------|--------------------|-----------------------|------------------------|
| 2019 | ISRO021A_2019 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2019 | ISRO021A_2019 | baseline | Silver-haired Bat           | 3                  | 1                     | 33.33                  |
| 2019 | ISRO022A_2019 | baseline | Eastern Red Bat             | 1                  | 0                     | 0.00                   |
| 2019 | ISRO024A_2019 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2019 | ISRO024A_2019 | baseline | Eastern Red Bat             | 5                  | 4                     | 80.00                  |
| 2019 | ISRO024A_2019 | baseline | Silver-haired Bat           | 1                  | 1                     | 100.00                 |
| 2019 | ISRO024A_2019 | baseline | Little Brown Bat            | 4                  | 2                     | 50.00                  |
| 2019 | ISRO024A_2019 | baseline | Northern Long-eared Bat     | 3                  | 0                     | 0.00                   |
| 2019 | ISRO024A_2019 | expanded | Tricolored Bat              | 7                  | 0                     | 0.00                   |
| 2019 | ISRO026A_2019 | baseline | Big Brown Bat               | 1                  | 0                     | 0.00                   |
| 2019 | ISRO026A_2019 | baseline | Little Brown Bat            | 5                  | 3                     | 60.00                  |
| 2019 | ISRO027A_2019 | baseline | Eastern Red Bat             | 4                  | 3                     | 75.00                  |
| 2019 | ISRO027A_2019 | baseline | Hoary Bat                   | 7                  | 7                     | 100.00                 |
| 2019 | ISRO027A_2019 | expanded | Tricolored Bat              | 3                  | 0                     | 0.00                   |
| 2019 | ISRO028B_2019 | baseline | Eastern Red Bat             | 1                  | 1                     | 100.00                 |
| 2019 | ISRO028B_2019 | baseline | Northern Long-eared Bat     | 1                  | 0                     | 0.00                   |
| 2019 | ISRO030B_2019 | baseline | Hoary Bat                   | 1                  | 1                     | 100.00                 |
| 2019 | ISRO030B_2019 | baseline | Northern Long-eared Bat     | 1                  | 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.

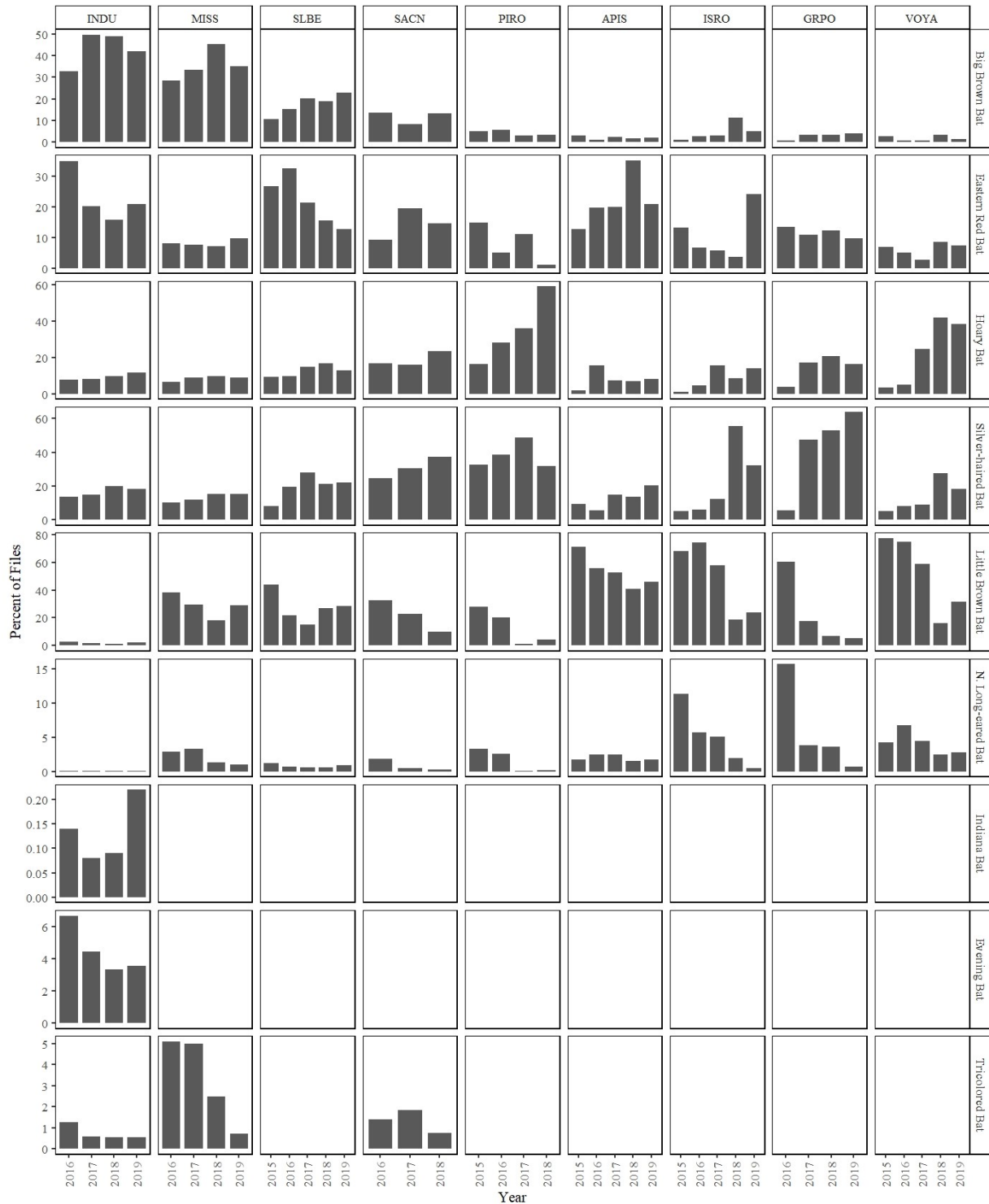


**Figure 11.** Percent of audio files classified as each bat species by Kaleidoscope Pro in the baseline analysis for each park and year. Note that the y-axis scale is different for each species and not all parks conducted surveys in all years. Only data from valid deployments are shown. Parks are ordered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

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NPS 139/175195, April 2021

National Park Service  
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