

Summary Results of 2015 Acoustic Monitoring

Great Lakes Inventory and Monitoring Network

Prepared for

National Park Service
Great Lakes Inventory and Monitoring Network
2800 Lake Shore Drive East
Ashland, WI 54806



Prepared by

Normandeau Associates, Inc.
4581 NW 6th Street, Suite G
Gainesville, FL 32609
(352) 372-4747



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1 Introduction

Normandeau Associates Inc. (Normandeau) was tasked with creating a streamlined automated Microsoft Access-based data management system for importing and summarizing the results of automatic identification of bat species and audio files for nine parks within the Great Lakes Inventory and Monitoring Network (GLKN). The management system involved quality checking (QC) the audio files, organizing them by park, sampling site and date, performing automatic identification (AutoID) of the audio files, importing the results of the AutoID, performing a manual identification of a subset of audio files, and importing the results of the manual ID. Finally, Normandeau was tasked with summarizing the AutoID results and performing some basic statistics.

This report summarizes the results of 2015 data collection and analysis of the AutoID and manual ID along with some additional supporting statistics about the number of audio files collected.

This report is organized into the following sections:

- Audio File Inventory Summary: lists the number of audio files for each park and the results of initial processing and organizing (before automatic identification)
- Deployment Summary: summarizes the number of deployments and deployment-nights per park
- AutoID Summary: summarizes the results of the automatic identification
- Manual Vetting Summary: summarizes the comparison of manual identifications to the automatic identifications
- Appendix: lists some tables too long for the report main body
- Supplementary Documents: lists the documents that have more detailed information about some aspects of the data processing and documents with tables too large for this report

The results in this summary report are presented, in general, by park. Presenting the results by each site/deployment within a park is generally not very informative due to the large number of sites/deployments within each park. Tables of summary statistics for individual sites/deployments will be provided in supplementary documents.

Table 1 lists the parks where the data were collected for the 2015 season along with the abbreviations used throughout this report for those parks.

Table 1-1. Parks where acoustic monitoring was performed during the 2015 monitoring season

Abbreviation	Name	State
SLBE	Sleeping Bear Dunes National Lakeshore	MI
PIRO	Pictured Rocks National Lakeshore	MI
APIS	Apostle Islands National Lakeshore	WI
ISRO	Isle Royale National Park	MI
VOYA	Voyageurs National Park	MN

NOTE: for all tables and graphs in this report, the parks are ordered from southern-most to northern-most.

The report is not intended to be high-level analysis of the resulting data. Instead, it is intended to be a very basic summary of the numbers and species of bat calls at various parks, as determined by the AutoID. In addition it provides a basic analysis of the validity of automatic identification as compared to manual identification. A more advanced statistical comparison and detailed analysis is outside of the scope of this report.

Raw Data Provided:

The raw data provided by the National Park Service (NPS) for this analysis are audio files (sound recording in WAV file format). These audio files were organized into folders by location (park, site within park) and recording date.

The National Park Service also supplied an initial Access database (Microsoft Access 2010) which was expanded upon to include the information extracted from the supplied audio files.

2 Audio File Inventory Summary

This section presents the results of the initial audio file processing, done before the files were run through the automatic species identification classifier.

A thorough, detailed account of the data processing methods and settings is given in a separate document: the “Data Management Plan.”

The audio files were organized into folders by location (park, site within park) and date. **For these results the recording “date” extends from the evening (after 5:00PM) of the actual date through the following morning (before noon).** Any files recorded after 5:00PM have the same date as the recording date, while any files recorded before noon have the previous day’s date.

- File recorded at 7:00PM on 6/2 has “Date” value of 6/2
- File recorded at 7:00AM on 6/2 has “Date” value of 6/1

Also during this process every audio file was analyzed by the SoX program to determine that the file was in fact an audio file, was not corrupted, and to optionally extract file parameters such as duration and number of channels. The audio file inventory and the results of the initial audio file processing were not stored in the original NPS Access database, but were instead stored in a supplementary table created by Normandeau.

The numbers of audio files for the 2015 recording period are listed in Table 2-1. The same data in terms of percent are shown in Table 2-2. The column “Total” lists the total number of audio files collected for each park. The remaining columns show how the audio files were classified for analysis.

Analyzed Files

- **Analyzed Summer:** If at least 4 days of the deployment occurred in the range 6/1-8/15, all files for that deployment were classified as summer season files and analyzed

Excluded from analysis:

- **Spring & Fall:** If less than 4 days of the deployment occurred in the range 6/1-8/15, all the files for that deployment were classified as either spring or fall
- **Short Deployment (Summer):** If a summer season deployment was < 4 days total, no files were analyzed from that deployment
- **Extra Night (Summer):** If a summer season deployment had > 16 nights, the files in the nights beyond 16 were not analyzed. Generally, the nights not analyzed were taken from the end of the deployment, unless the deployment started before 6/1, then the nights not analyzed were taken from the beginning of the deployment.
- **Short Night (Summer):** Nights with recording time < 6 hours were not analyzed
- **Long Duration (Summer):** Audio files with length > 15 seconds were not analyzed. The choice of 15 seconds is somewhat arbitrary, but files longer than this are usually the result of bad settings on the equipment used to collect the call data, tend to be noise files or have calls from multiple bats, and slow down the auto classification process considerably.

Table 2-1. Audio file classification for analysis for 2015: Numbers of Files

Park	Total	Summer	Spring	Fall	Short Deploy ¹	Extra Night ²	Short Night ³	Long Duration ⁴	Bad File
SLBE	37743	30826	0	3838	1354	261	625	839	0
PIRO	165174	165174	0	0	0	0	0	0	0
APIS	128829	100644	0	16075	0	11457	0	652	1
ISRO	22513	15431	0	1770	124	2474	29	2685	0
VOYA	28361	23306	0	3217	1534	0	247	50	7
Total	382620	335381	0	24900	3012	14192	901	4226	8

¹ Deployment < 4 days² Files in nights beyond 16 nights³ Recording time < 6 hours⁴ Audio file length > 15 seconds

Table 2-2. Audio file classification for analysis for 2015: Percent of Files.

Park	Total	Summer	Spring	Fall	Short Deploy	Extra Night	Short Night	Long Duration	Bad File
SLBE	100	82	0	10	4	1	2	2	0
PIRO	100	100	0	0	0	0	0	0	0
APIS	100	78	0	12	0	9	0	1	~0
ISRO	100	69	0	8	1	11	~0	12	0
VOYA	100	82	0	11	5	0	1	~0	~0
Total	100	88	0	7	1	4	~0	1	~0

Note: In tables displaying percentages, values sometimes appear not sum to 100% due to the displayed precision.

3 Deployment Summary

3.1.1 Deployments

Within each park, detectors were deployed at a given location (site) for a given length of time. A ‘deployment’ is defined as the site combined with time period the detector was deployed.

Table 3-1 lists the number of deployments per season as well the number of short deployments for each park. Figure 3-1 graphically depicts the number of deployments by season. Almost all deployments were in the summer season but 4 of the 5 parks had a number of deployments in the fall. No parks had deployments in the spring. There were some short deployments as shown in the table. The number of deployments in the summer season ranged from as few as 7 for ISRO to as many as 26 for PIRO.

Table 3-1. Deployments (Sites) By Park and Season

Park	Total	Summer	Spring	Fall	Short Deploy	Date Range
SLBE	31	24	0	5	2	06/24-09/12
PIRO	26	26	0	0	0	05/27-08/18
APIS	34	21	0	13	0	06/04-10/16
ISRO	10	7	0	2	1	07/10-08/26
VOYA	21	9	0	8	4	07/06-09/15

¹ Short Deploy: summer deployments < 4 days, not analyzed

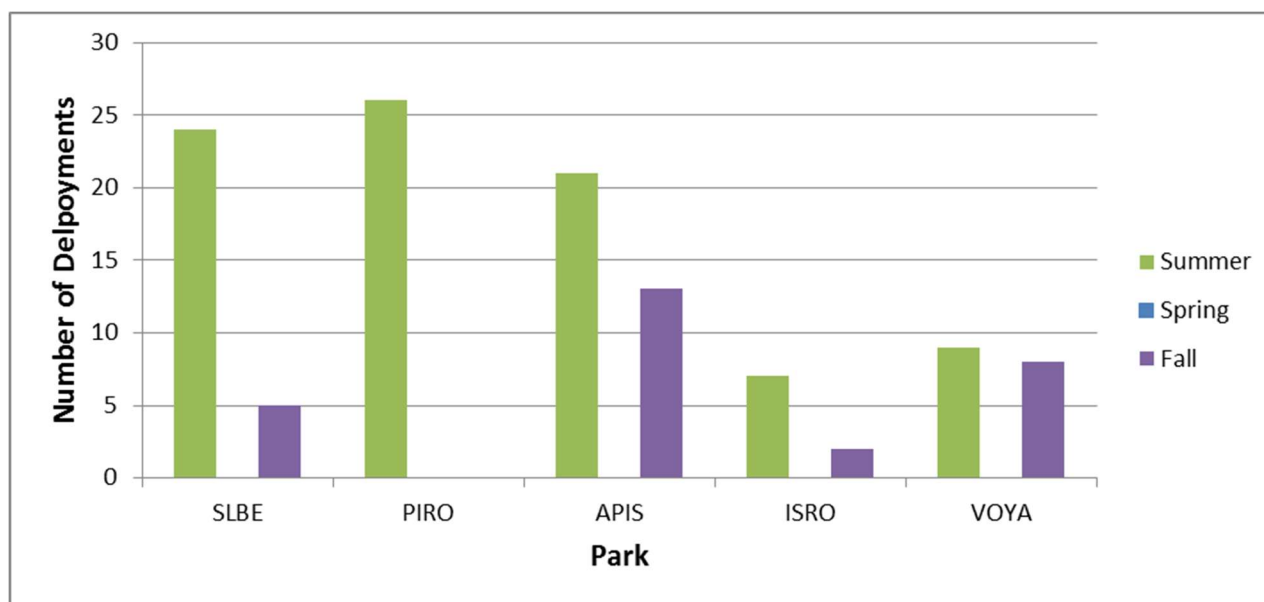


Figure 3-1. Deployments (Sites) By Park and Season

For the summer season (6/1-8/15), the number of deployments per day is shown in Figure 3-2. The table for this data is given Table 9-1 in Appendix A because it is too big to show here. The dates shown in the figure that occur outside of the summer range belong to deployments that are considered ‘summer deployments’. If a deployment had at least 4 days in the summer date range, then all dates of the deployment were analyzed as summer dates.

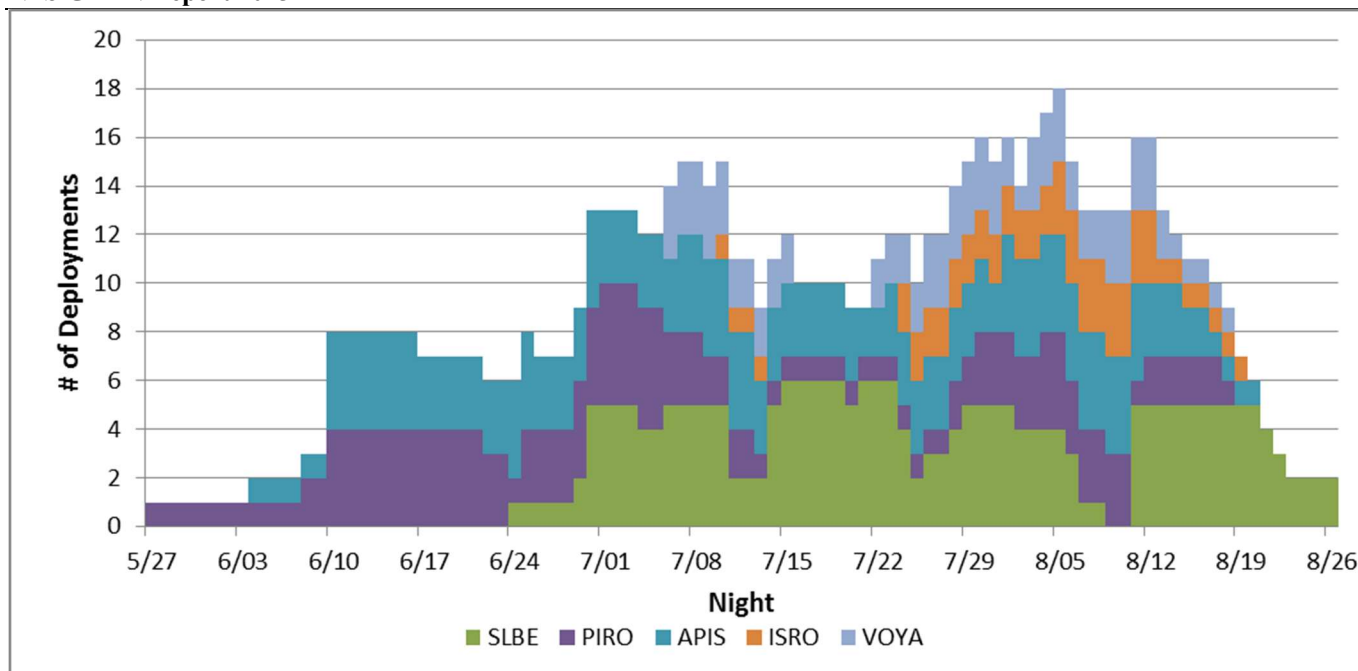


Figure 3-2. Number of Deployments by Date, during the Summer season

3.1.2 Deployment Nights

The number of 'deployment-nights' for a park is the sum of the number of nights for each deployment. For example if a park had 3 deployments of 11, 6 and 10 nights, the number of deployment-nights for that park is 27 (11+6+10). Even if the deployments overlap and occurred on many of the same nights, the number of deployment-nights is still 27. If a park has 3 deployments on the same night, that would be 3 deployment-nights not 1.

Table 3-2 lists and Figure 3-3 shows the deployment-nights for each park. A few notes about the night counts:

- Nights for deployments less than 4 days are NOT counted
- Nights beyond the 16th night for single deployment are NOT counted
- Nights at the beginning or end of a deployment with a recording time of < 6 hours, are not counted.

Most deployment-nights occurred during the summer season with 4 of 5 parks having a notable number of deployment-nights in the fall. There were no spring deployments.

Table 3-2. Deployment-Nights by Park and Season

Park	Summer	Spring	Fall
SLBE	246	0	52
PIRO	204	0	0
APIS	236	0	103
ISRO	59	0	10
VOYA	88	0	62

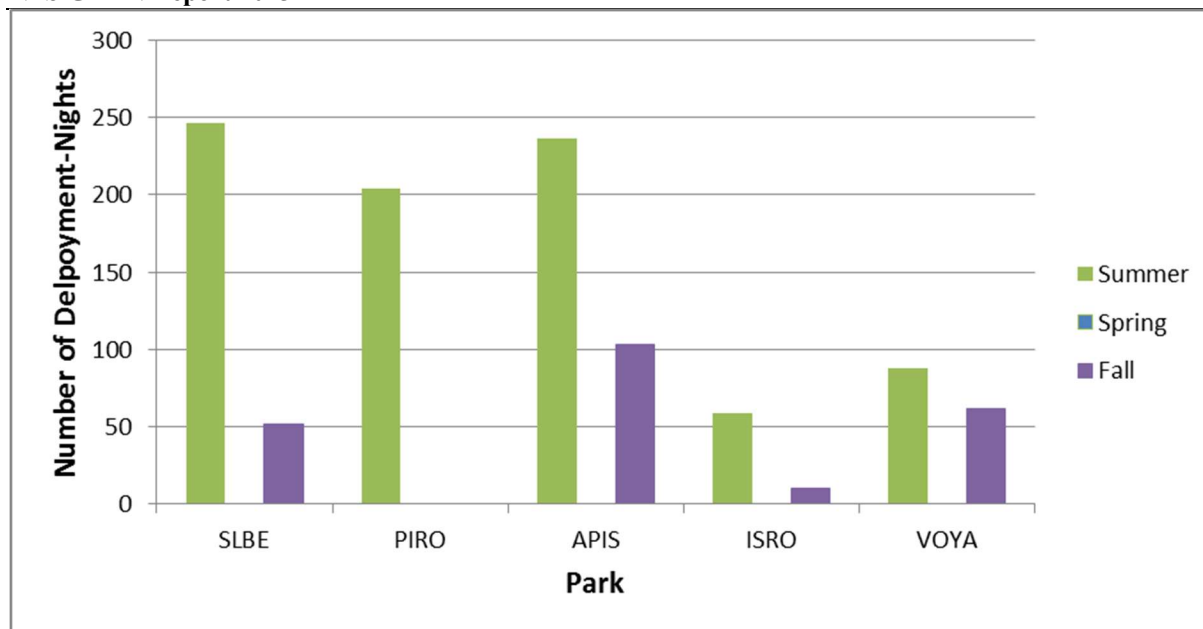


Figure 3-3. Deployment-Nights by Park and Season

4 Auto-ID Summary

The Wildlife Acoustics Kaleidoscope Pro software (KPro) version 4.0.0 was used to remove non-bat noise files and to identify all bats to species using a built in auto classifier. Guidelines for use of auto classifier programs defined in the USFWS 2018 Indiana bat summer survey protocol (U.S. Fish and Wildlife Service. 2018) were followed. KPro has three options for setting the sensitivity of the classifier: -1 More Sensitive (Liberal); 0 Balanced (Neutral), and +1 More Accurate (Conservative). For this analysis the “-1 More Sensitive (Liberal)” setting was used, as suggested in the USFWS guidelines.

First, full spectrum audio files were converted to zero-cross files. In this process KPro classified some files as ‘Noise’ and did not create a zero-cross file. Also a very small number of files (10 or less per park) experienced other various errors and were not converted to zero-cross.

Second, KPro was run again to analyze the zero-cross files and produce an identification (ID): either ‘Noise’, ‘NoID’ (unknown bat call), or a specific species ID.

The bat biologists assembled a list of possible bat species for each park, as shown in Table 4-1. Those were the only species, for that park, that KPro considered in the automatic identification. The baseline analysis includes only species that have been documented within each park’s boundaries. The expanded analysis includes species that have been documented within each park’s boundaries as well as species that have been reported in nearby areas.

From this point forward, the term “Auto ID”, refers to the automatic identification of the audio file via the KPro program.

4.1 Species to be considered for Auto ID

The following tables show the species that that KPro considered for each park. For the 2015 data, both a ‘baseline’ and an ‘expanded’ species analysis were done. Both analyses were done in the exact same manner, only changing the species KPro could consider in making an ID. Table 4-1 shows the species considered for Auto ID in the baseline (●) and the expanded (✱) analyses.

Table 4-1. Bat Species considered by KPro analysis, for each Park

Park	EPFU ¹	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	●	●	●	●	●	●	✱		✱
PIRO	●	●	●	●	●	●			✱
APIS	●	●	●	●	●	●			✱
ISRO	●	●	●	●	●	●			✱
VOYA	●	●	●	●	●	●			✱

¹ See Table 4-2 for bat species abbreviations

● : baseline AutoID analysis

✱ : expanded AutoID analysis

Table 4-2. Bat species abbreviations used in this analysis

Abbreviation	Scientific Name	Common Name
EPFU	<i>Eptesicus fuscus</i>	Big Brown Bat
LABO	<i>Lasiurus borealis</i>	Eastern Red Bat
LACI	<i>Lasiurus cinereus</i>	Hoary Bat
LANO	<i>Lasionycteris noctivagans</i>	Silver-haired Bat
MYLU	<i>Myotis lucifugus</i>	Little Brown Bat
MYSE	<i>Myotis septentrionalis</i>	Northern Long-eared Bat
MYSO	<i>Myotis sodalis</i>	Indiana Bat
NYHU	<i>Nycticeius humeralis</i>	Evening Bat
PESU	<i>Perimyotis subflavus</i>	Tri-colored Bat

4.1.1 Calls vs. Noise

Table 4-3 shows the numbers of specific IDs compared to unknown bat calls and noise for the Summer season files analyzed using the baseline species analysis. The table columns show:

- Number of files analyzed (Audio Files)
- Number of files ID'd as a specific species (Species ID)
- Number of files ID'd as a bat but could not determine species (No Id)
- Number of files ID'd as Noise (includes files labeled as noise during the conversion from full spectrum to zero-cross)
- Files that KPro could not analyze (KPro fail)

The last four columns of the table show the percentages of files for each general result. For APIS and VOYA at least 88% of files were ID'd to species with almost all the rest of the files ID'd as Noise. Only a very small number of files were ID'd as unknown bat call sequences.

Both PIRO and ISRO had very high percentage of noise files, while SLBE had a moderately high percentage of noise files.

None of the park had files that failed to be analyzed by KPro (%KPro Fail = 0).

Figure 4-1 and Figure 4-2 are plots of the data shown in Table 4-3.

Table 4-3. Number and Percent of Files By Park: Call Sequences vs. Noise, Summer Only, Baseline Analysis

Park	#Audio File	#Species Id	#No Id	#Noise	#KPro Fail ¹	%Species Id	%No Id	%Noise	%KPro Fail
SLBE	30826	16390	204	14232	0	53.2	0.7	46.2	0
PIRO	165174	9015	379	155780	0	5.5	0.2	94.3	0
APIS	100644	94670	461	5513	0	94.1	0.5	5.5	0
ISRO	15431	3231	70	12130	0	20.9	0.5	78.6	0
VOYA	23306	20665	202	2439	0	88.7	0.9	10.5	0
Total	335381	143971	1316	190094	0	42.9	0.4	56.7	0

¹ Files that KPro could not process (sometimes bad header, sometimes for unknown reasons)

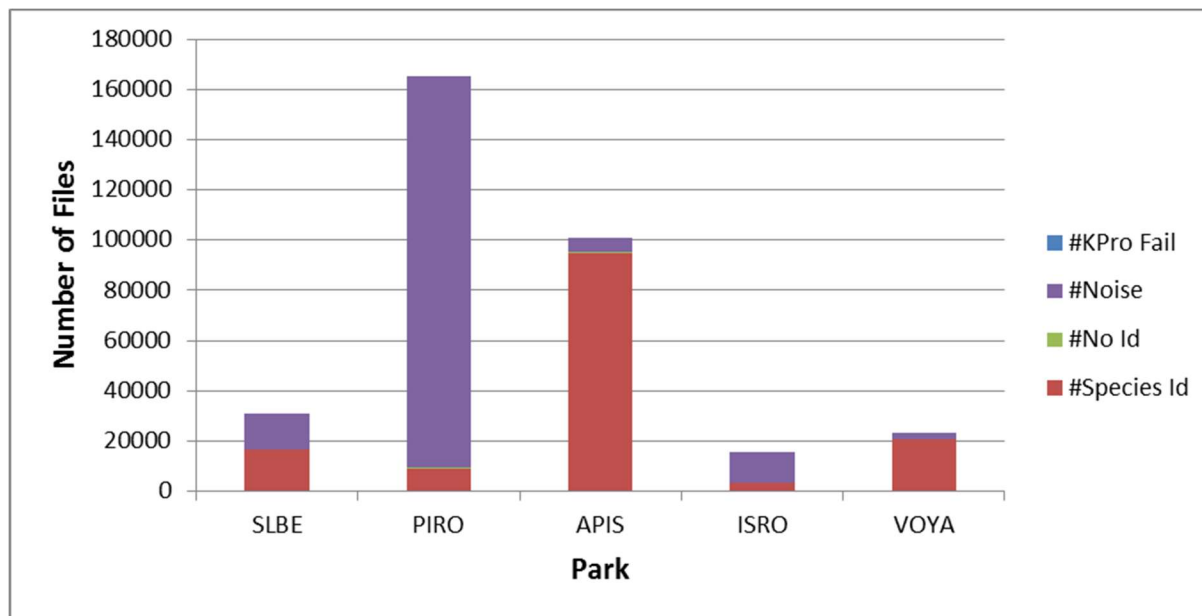


Figure 4-1. Number of Files By Park: Call Sequences vs. Noise, Summer Only, Baseline Analysis

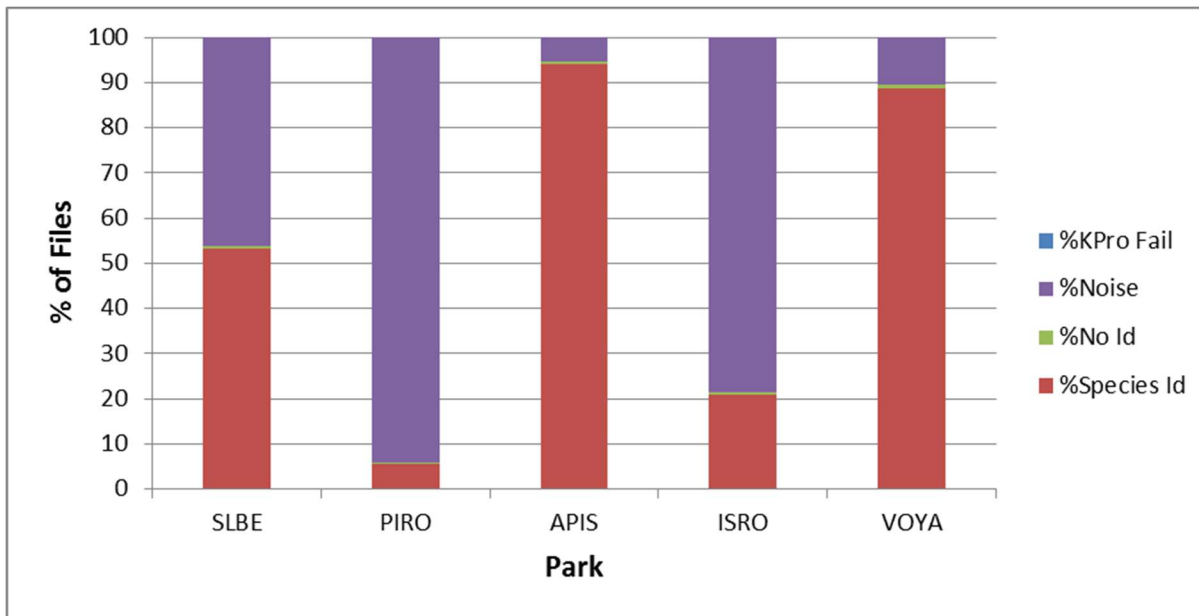


Figure 4-2. Percent of Files by Park: Call Sequences vs. Noise, Summer Only, Baseline Analysis

Table 4-4 shows the numbers of specific IDs compared to unknown bat call sequences and noise for the Summer season files analyzed using the expanded species analysis. Figure 4-3 and Figure 4-4 are plots of the data shown in Table 4-4. Compared to the baseline species analysis a small number (339) of call sequences were reclassified as No Id, while the number of noise files stayed the same. Table 4-5 shows the difference between the expanded (Table 4-4) and baseline (Table 4-3) analysis results.

Table 4-4. Number and Percent of Files By Park: Call Sequences vs. Noise, Summer Only, Expanded Analysis

Park	#Audio File	#Species Id	#No Id	#Noise	#KPro Fail	%Species Id	%No Id	%Noise	%KPro Fail
SLBE	30826	16272	322	14232	0	52.8	1	46.2	0
PIRO	165174	9005	389	155780	0	5.5	0.2	94.3	0
APIS	100644	94503	628	5513	0	93.9	0.6	5.5	0
ISRO	15431	3213	88	12130	0	20.8	0.6	78.6	0
VOYA	23306	20639	228	2439	0	88.6	1	10.5	0
Total	335381	143632	1655	190094	0	42.8	0.5	56.7	0

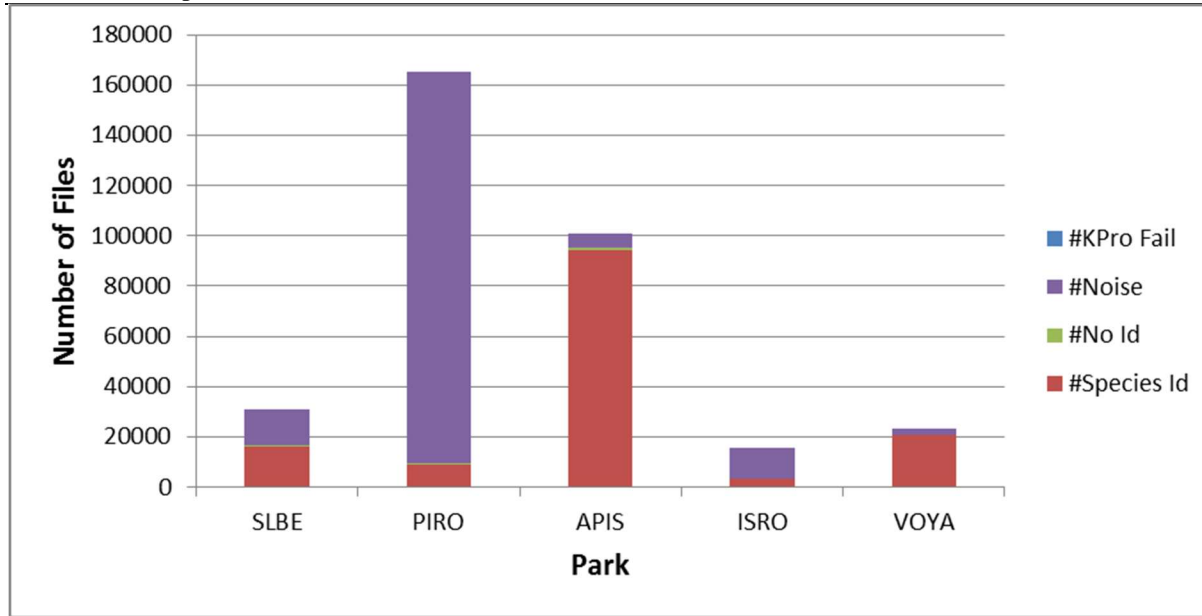


Figure 4-3. Number of Files By Park: Call Sequences vs. Noise, Summer Only, Expanded Analysis

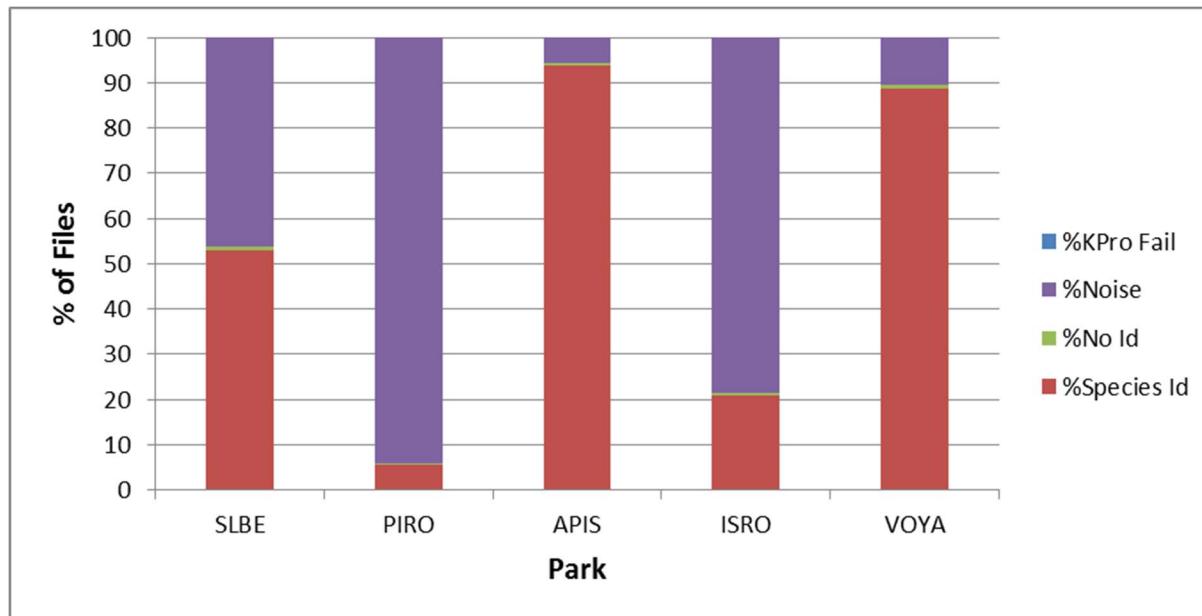


Figure 4-4. Percent of Files by Park: Call Sequences vs. Noise, Summer Only, Expanded Analysis

Table 4-5. Difference in Number and Percent of Files By Park: Call Sequences vs. Noise, Summer Only. Differences were calculated by subtracting Baseline Analysis values from Expanded Analysis values.

Park	#Audio File	#Species Id	#No Id	#Noise	#KPro Fail	%Species Id	%No Id	%Noise	%KPro Fail
SLBE	0	-118	118	0	0	-0.4	0.3	0	0
PIRO	0	-10	10	0	0	0	0	0	0
APIS	0	-167	167	0	0	-0.2	0.1	0	0
ISRO	0	-18	18	0	0	-0.1	0.1	0	0
VOYA	0	-26	26	0	0	-0.1	0.1	0	0
Total	0	-339	339	0	0	-0.1	0.1	0	0

4.1.2 Calls by Species

Table 4-6 shows the total number of files identified to each species by KPro (summer season only), using the baseline species analysis and Figure 4-5 graphs the table data.

Table 4-7 shows the total number of files identified to each species by KPro (summer season only), using the expanded species analysis and Figure 4-6 graphs the table data.

Table 4-8 shows the change in species ID from the baseline to the expanded species analysis.

Table 4-6. Number of Files AutoID'd to each Species by Park, Summer only, Baseline Analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	1671	4575	2282	1233	6451	178	na	na	na	16390
PIRO	468	1339	1466	2948	2498	296	na	na	na	9015
APIS	3189	12632	3129	12069	62203	1448	na	na	na	94670
ISRO	37	425	35	149	2238	347	na	na	na	3231
VOYA	618	1414	827	1441	15520	845	na	na	na	20665
All Parks	5983	20385	7739	17840	88910	3114	na	na	na	143971

na: species was not considered in the analysis

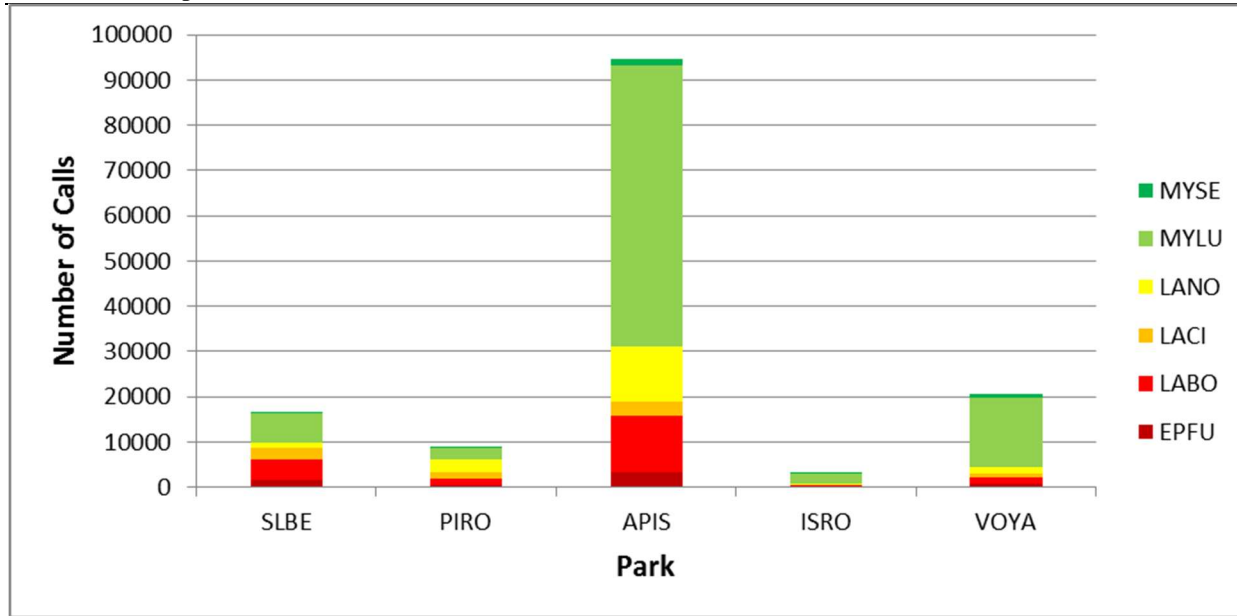


Figure 4-5. Number of Files AutoID'd to each Species by Park, Baseline Analysis

Table 4-7. Number of Files AutoID'd to each Species by Park, Summer only, Expanded Analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	1676	4043	2283	1230	6174	132	623	na	111	16272
PIRO	466	1303	1468	2949	2497	298	na	na	24	9005
APIS	3195	11798	3136	12087	62410	1480	na	na	397	94503
ISRO	37	394	35	149	2229	348	na	na	21	3213
VOYA	620	1383	829	1440	15484	853	na	na	30	20639
All Parks	5994	18921	7751	17855	88794	3111	623	0	583	143632

na: species was not considered in the analysis

Highlighted cells are species and park combinations added in the expanded analysis

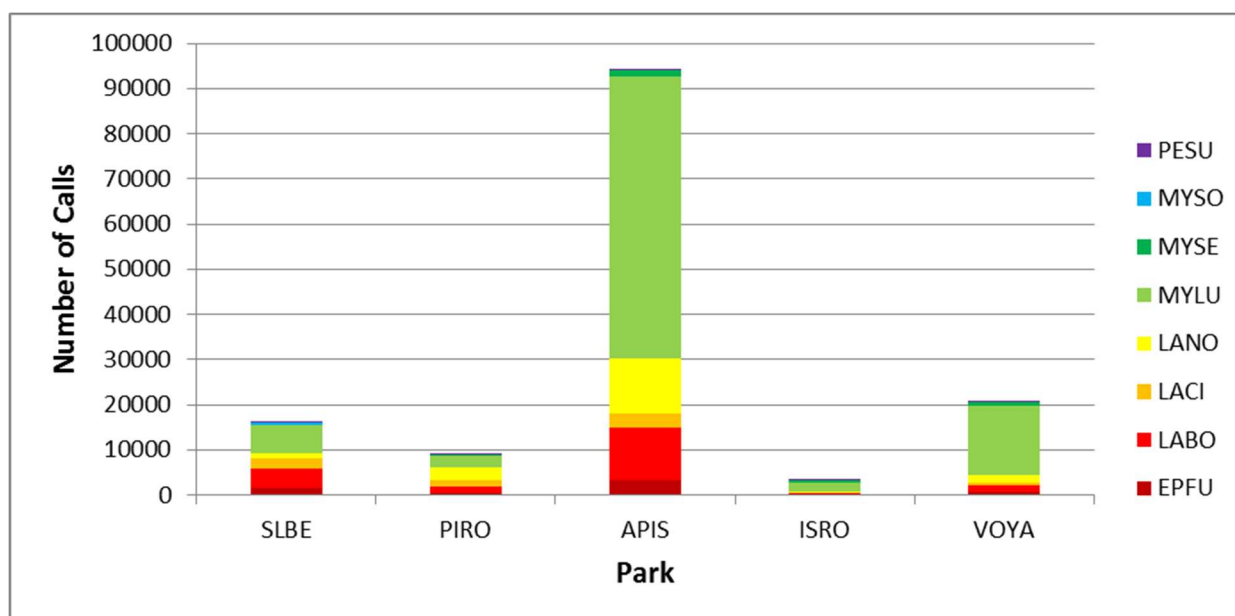


Figure 4-6. Number of Files AutoID'd to each Species by Park, Expanded Analysis

Table 4-8. Difference in Number of Files AutoID'd to each Species by Park, Summer only. Differences were calculated by subtracting Baseline Analysis values from Expanded Analysis values.

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	5	-532	1	-3	-277	-46	623	na	111	-118
PIRO	-2	-36	2	1	-1	2	na	na	24	-10
APIS	6	-834	7	18	207	32	na	na	397	-167
ISRO	0	-31	0	0	-9	1	na	na	21	-18
VOYA	2	-31	2	-1	-36	8	na	na	30	-26
Total	11	-1464	12	15	-116	-3	623	0	583	-339

na: species was not considered in the analysis

Highlighted cells are species and park combinations added in the expanded analysis

Table 4-9 shows the number of files per deployment-night identified to each species by KPro (summer season only), using the baseline species analysis and Figure 4-7 graphs the table data.

Table 4-10 shows the number of files per deployment-night identified to each species by KPro (summer season only), using the expanded species analysis and Figure 4-8 graphs the table data.

Table 4-11 shows the change in species ID per deployment-night from the baseline to the expanded species analysis.

Table 4-9. Number of Files per Deployment-Night AutoID'd to each Species by Park, Summer Only, Baseline Analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	6.8	18.6	9.3	5.0	26.2	0.7	na	na	na	66.6
PIRO	2.3	6.6	7.2	14.5	12.2	1.5	na	na	na	44.2
APIS	13.5	53.5	13.3	51.1	263.6	6.1	na	na	na	401.1
ISRO	0.6	7.2	0.6	2.5	37.9	5.9	na	na	na	54.8
VOYA	7.0	16.1	9.4	16.4	176.4	9.6	na	na	na	234.8
All Parks	7.2	24.5	9.3	21.4	106.7	3.7	na	na	na	172.8

na: species was not considered in the analysis

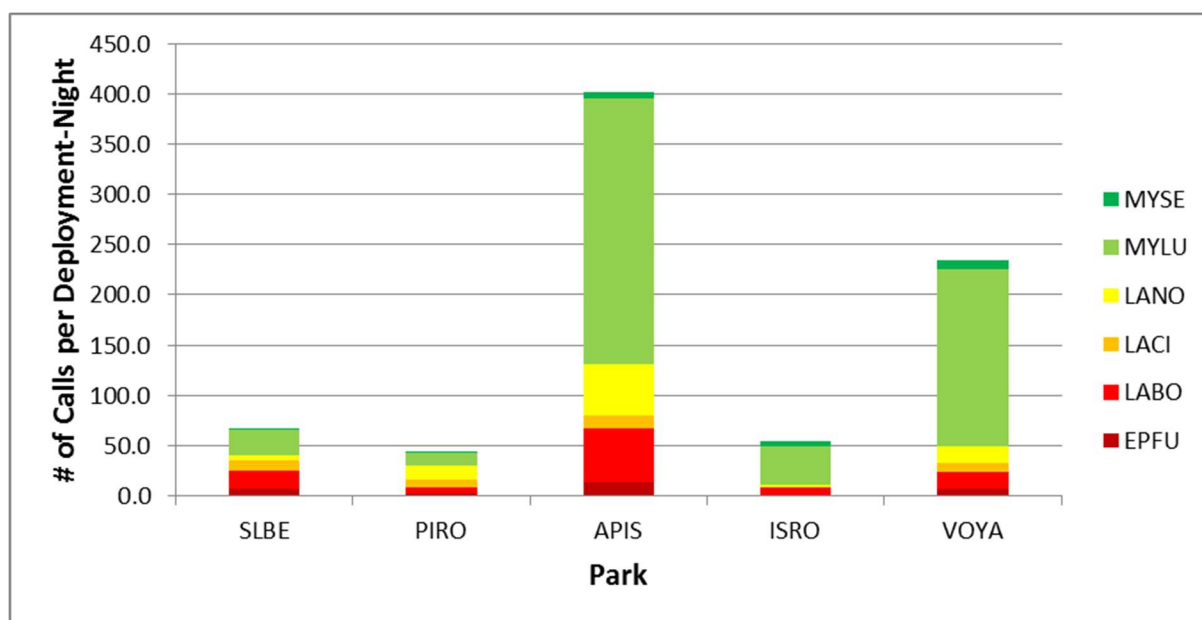


Figure 4-7. Number of Files per Deployment-Night AutoID'd to each Species by Park, Summer Only, Baseline Analysis

Table 4-10. Number of Files per Deployment-Night AutoID'd to each Species by Park, Summer Only, Expanded Analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	6.8	16.4	9.3	5.0	25.1	0.5	2.5	na	0.5	66.1
PIRO	2.3	6.4	7.2	14.5	12.2	1.5	na	na	0.1	44.1
APIS	13.5	50.0	13.3	51.2	264.4	6.3	na	na	1.7	400.4
ISRO	0.6	6.7	0.6	2.5	37.8	5.9	na	na	0.4	54.5
VOYA	7.0	15.7	9.4	16.4	176.0	9.7	na	na	0.3	234.5
All Parks	7.2	22.7	9.3	21.4	106.6	3.7	2.5	na	0.7	172.4

na: species was not considered in the analysis

Highlighted cells are species and park combinations added in the expanded analysis

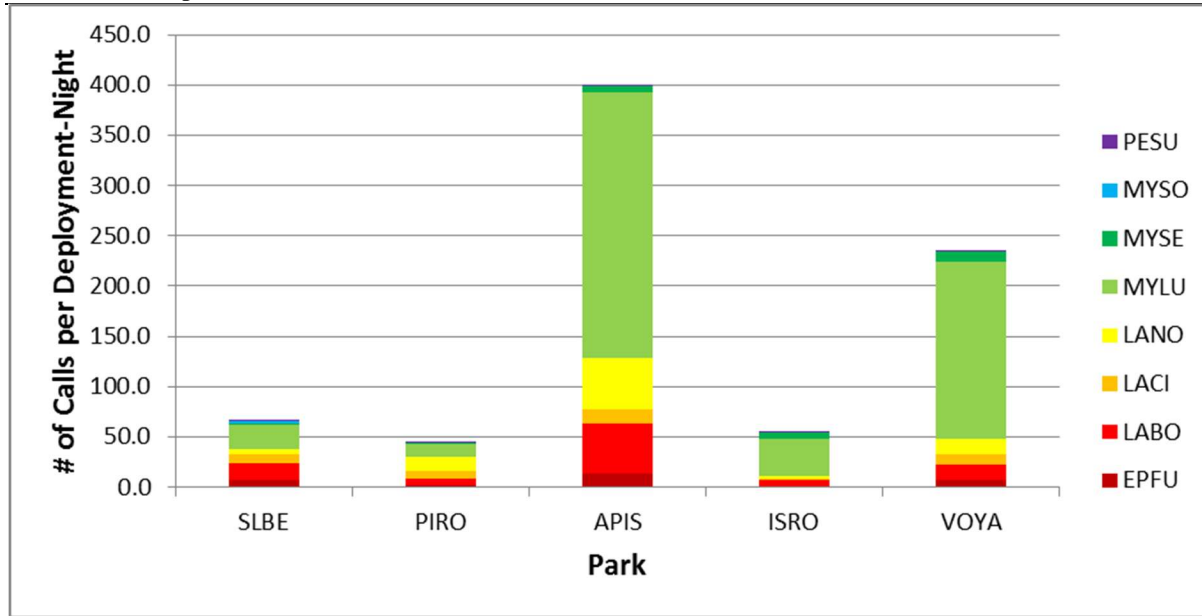


Figure 4-8. Number of Files per Deployment-Night AutoID'd to each Species by Park, Summer Only, Expanded Analysis

Table 4-11. Difference in Number of Files per Deployment-Night AutoID'd to each Species by Park, Summer Only. Differences were calculated by subtracting Baseline Analysis values from Expanded Analysis values.

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	0.0	-2.2	0.0	0.0	-1.1	-0.2	2.5	na	0.5	-0.5
PIRO	0.0	-0.2	0.0	0.0	0.0	0.0	na	na	0.1	-0.1
APIS	0.0	-3.5	0.0	0.1	0.8	0.2	na	na	1.7	-0.7
ISRO	0.0	-0.5	0.0	0.0	-0.1	0.0	na	na	0.4	-0.3
VOYA	0.0	-0.4	0.0	0.0	-0.4	0.1	na	na	0.3	-0.3
All Parks	0.0	-1.8	0.0	0.0	-0.1	0.0	2.5	na	0.7	-0.4

na: species was not considered in the analysis

Highlighted cells are species and park combinations added in the expanded analysis

4.1.3 Nightly Patterns of Activity

Figure 4-9 shows the total number of call sequences recorded for each date and species, for the baseline species analysis. This is the combined number of call sequences for all deployments in all parks on that date, during the summer season only.

Figure 4-10 shows the number of call sequences recorded per deployment-night for each date and species, for the baseline species analysis. Again this is for all parks combined and during the summer season only.

Figure 4-11 and Figure 4-12 show the total number of call sequences and call sequences per deployment-night, respectively, recorded for each date and species, for the expanded species analysis. This is for all parks combined.

Figure 4-13 and Figure 4-14 show the changes in species ID from the baseline to the expanded analysis for total number of call sequences and call sequences per deployment-night, respectively. This is for all parks combined.

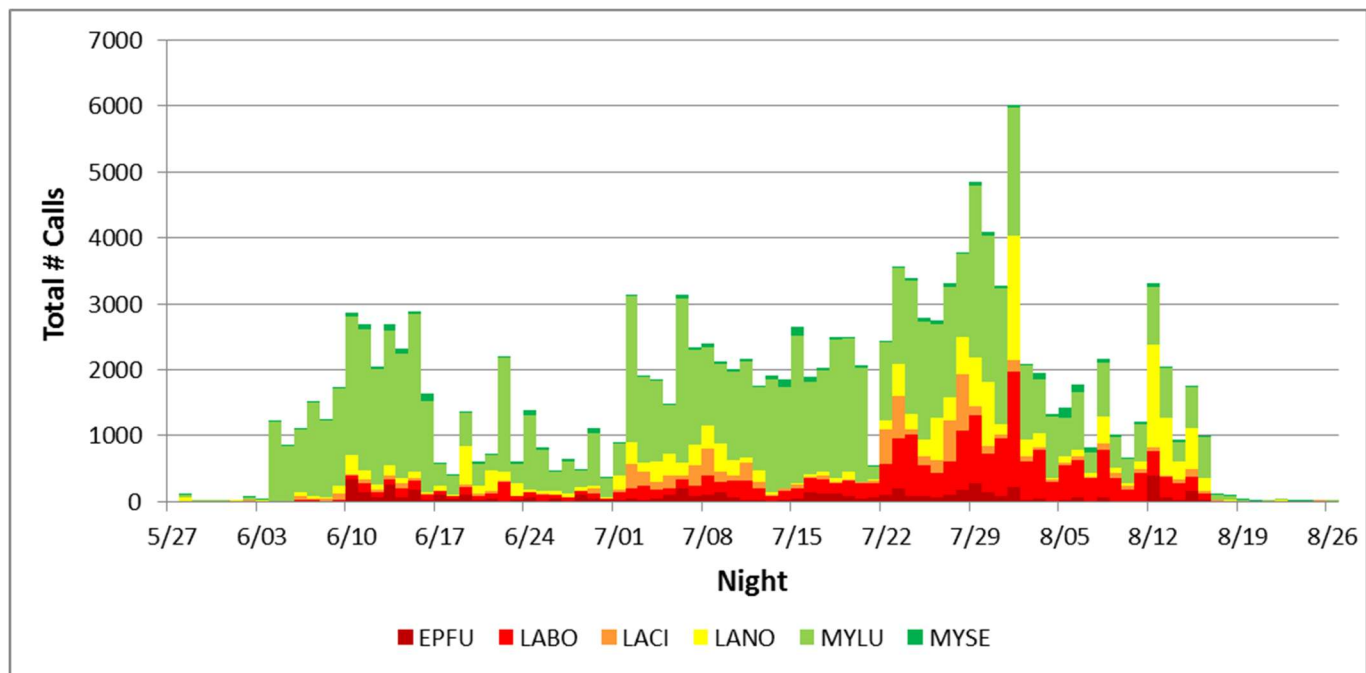


Figure 4-9. Total number of Call Sequences Recorded (All Parks Combined), for each Date and Species (Summer only), Baseline Analysis

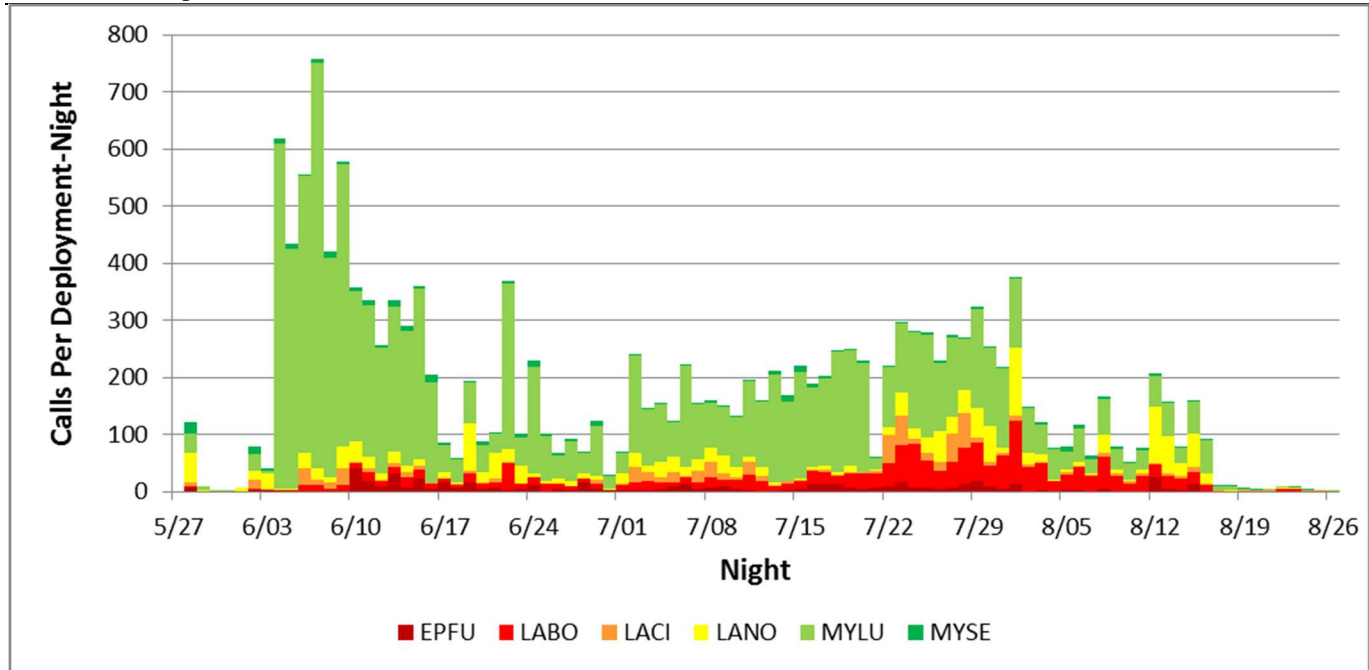


Figure 4-10. Number of Call Sequences Recorded per Deployment-Night (All Parks Combined), for each Date and Species (Summer only), Baseline Analysis

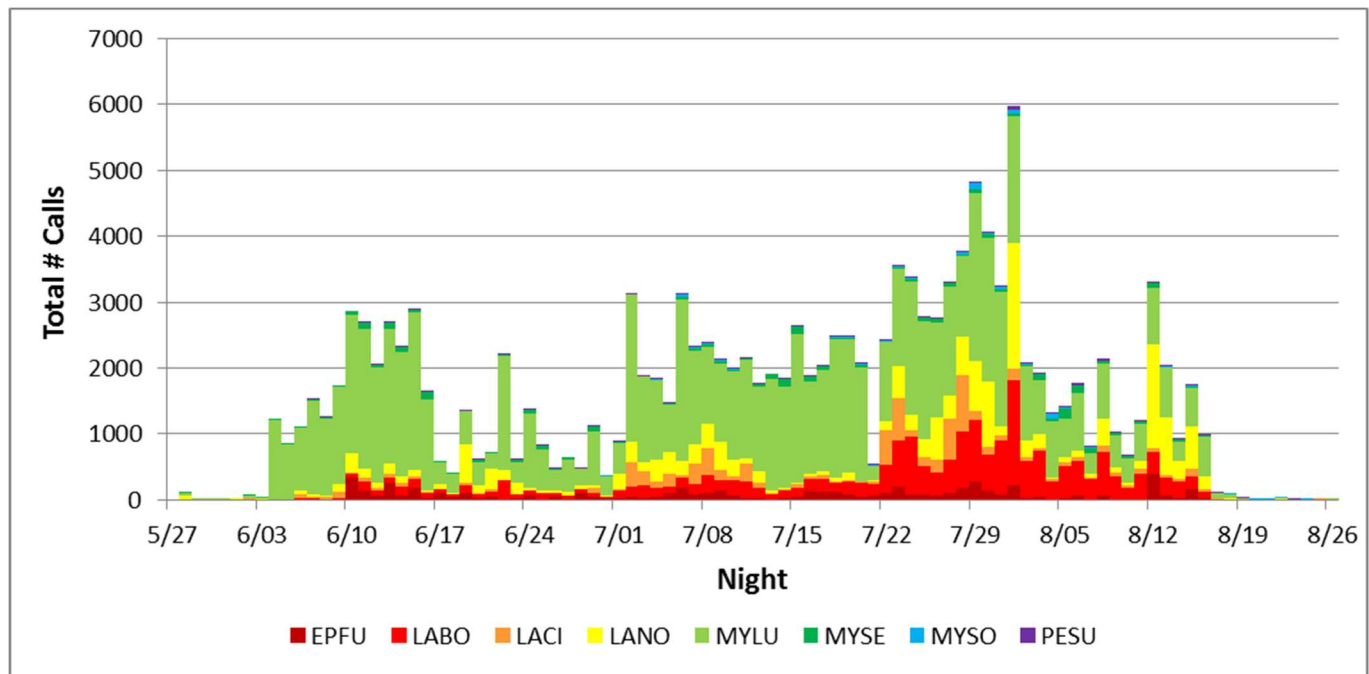


Figure 4-11. Total number of Call Sequences Recorded (All Parks Combined), for each Date and Species (Summer only), Expanded Analysis

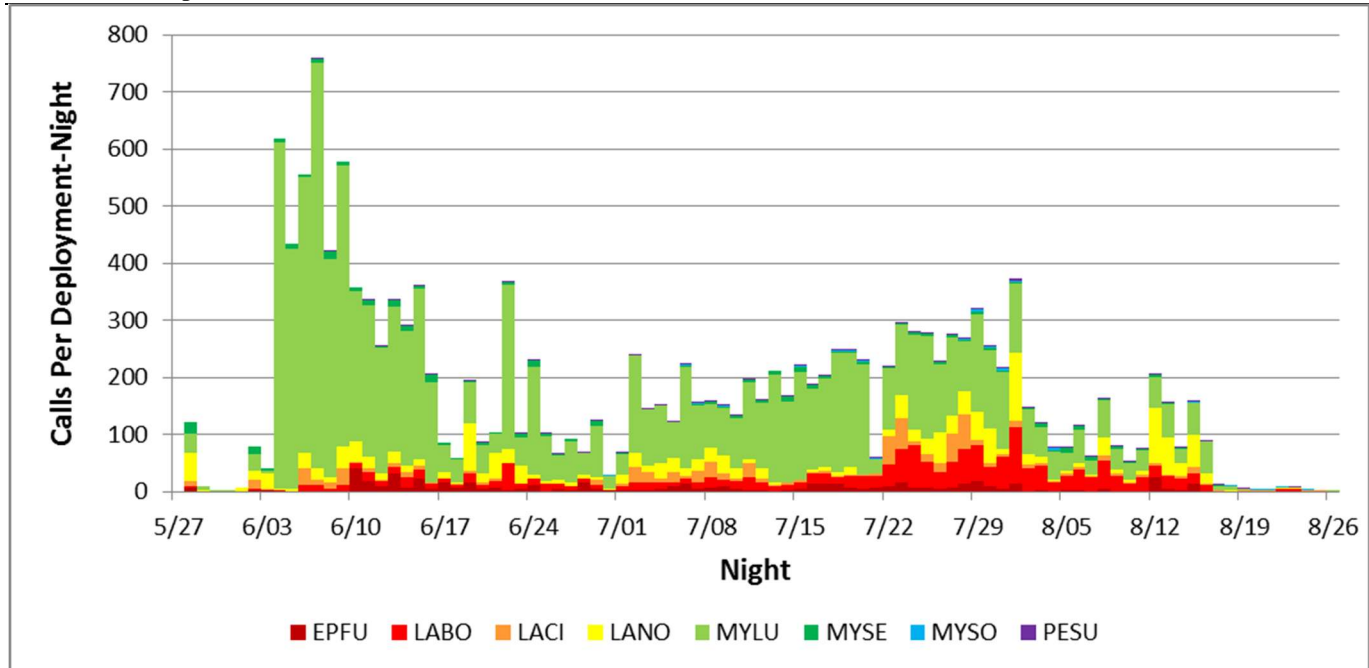


Figure 4-12 Number of Call Sequences Recorded per Deployment-Night (All Parks Combined), for each Date and Species (Summer only), Expanded Analysis

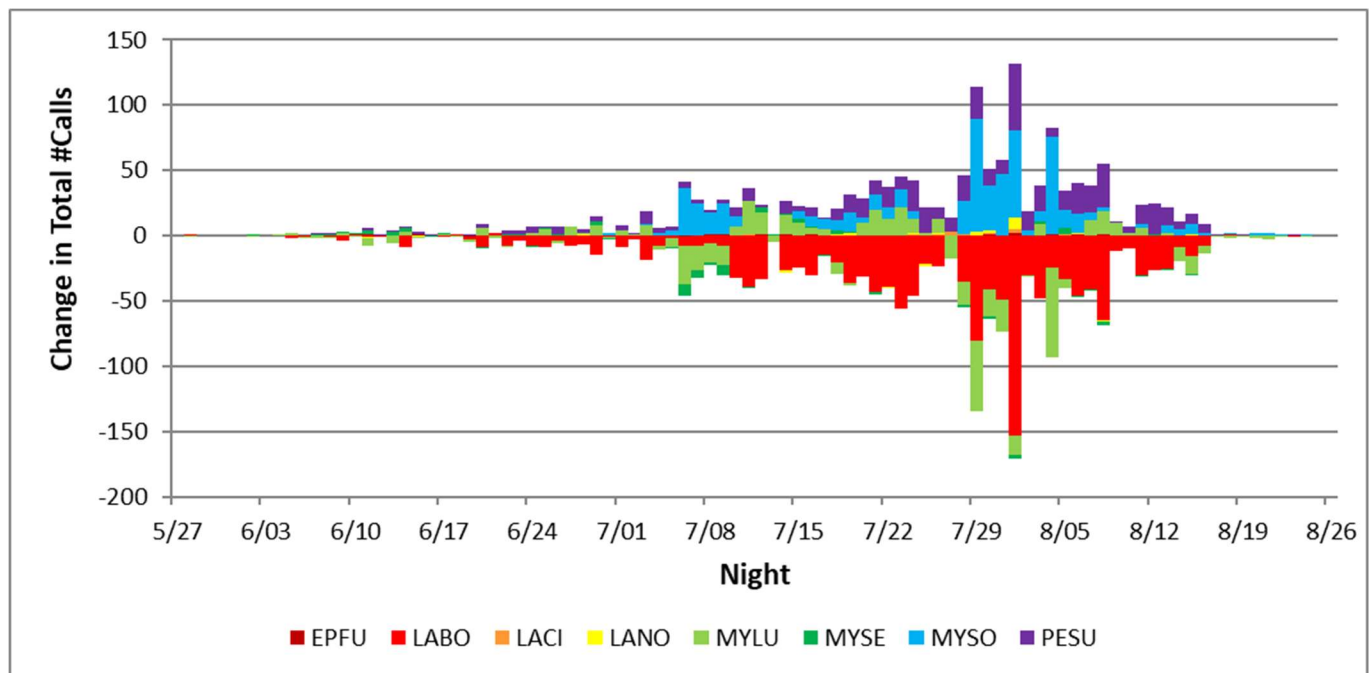


Figure 4-13. Difference in Total number of Call Sequences Recorded (All Parks Combined), for each Date and Species (Summer only. Differences were calculated by subtracting Baseline Analysis values from Expanded Analysis values.

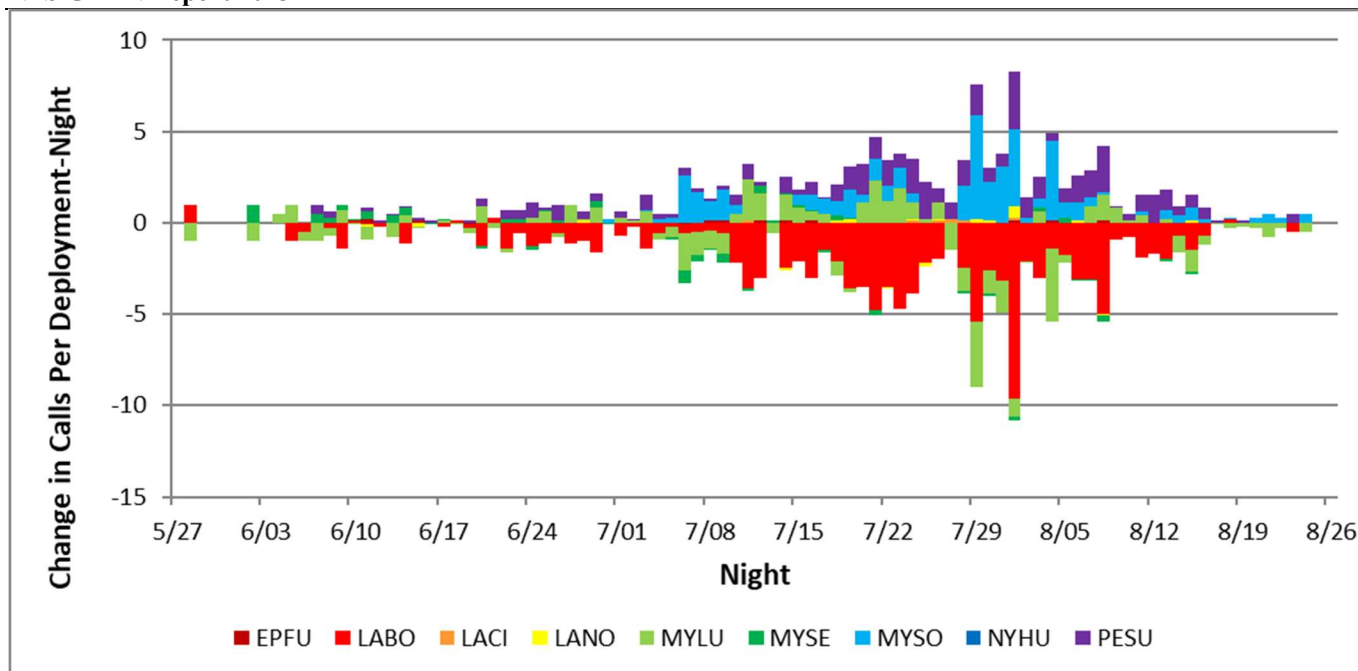


Figure 4-14. Difference in Number of Call Sequences Recorded per Deployment-Night (All Parks Combined), for each Date and Species (Summer only). Differences were calculated by subtracting Baseline Analysis values from Expanded Analysis values.

Figure 4-15 and Figure 4-16 show the total number of call sequences and the number of call sequences per deployment-night, respectively, for each date and park with all species combined. This helps illustrate the pattern of total bat activity.

Because the following graphs do not show individual species IDs, the graphs are essentially same for both the baseline and expanded analysis. Therefore only one set of graphs for the baseline analysis is shown. (There are very small differences between baseline and expanded analysis graphs due to the changes in ID from a particular species to No ID, but those differences are not apparent on the graphs).

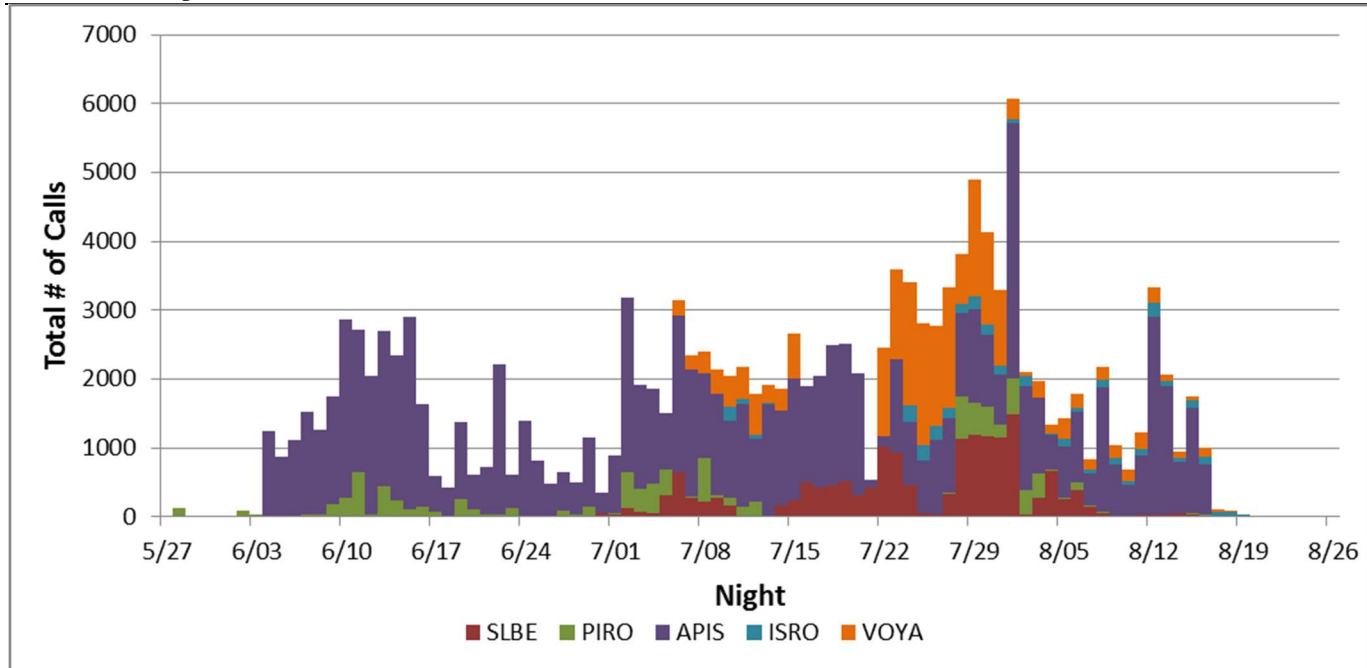


Figure 4-15. Total number of Call Sequences Recorded (All Species Combined), for each Date and Park (Summer only), Baseline Analysis.

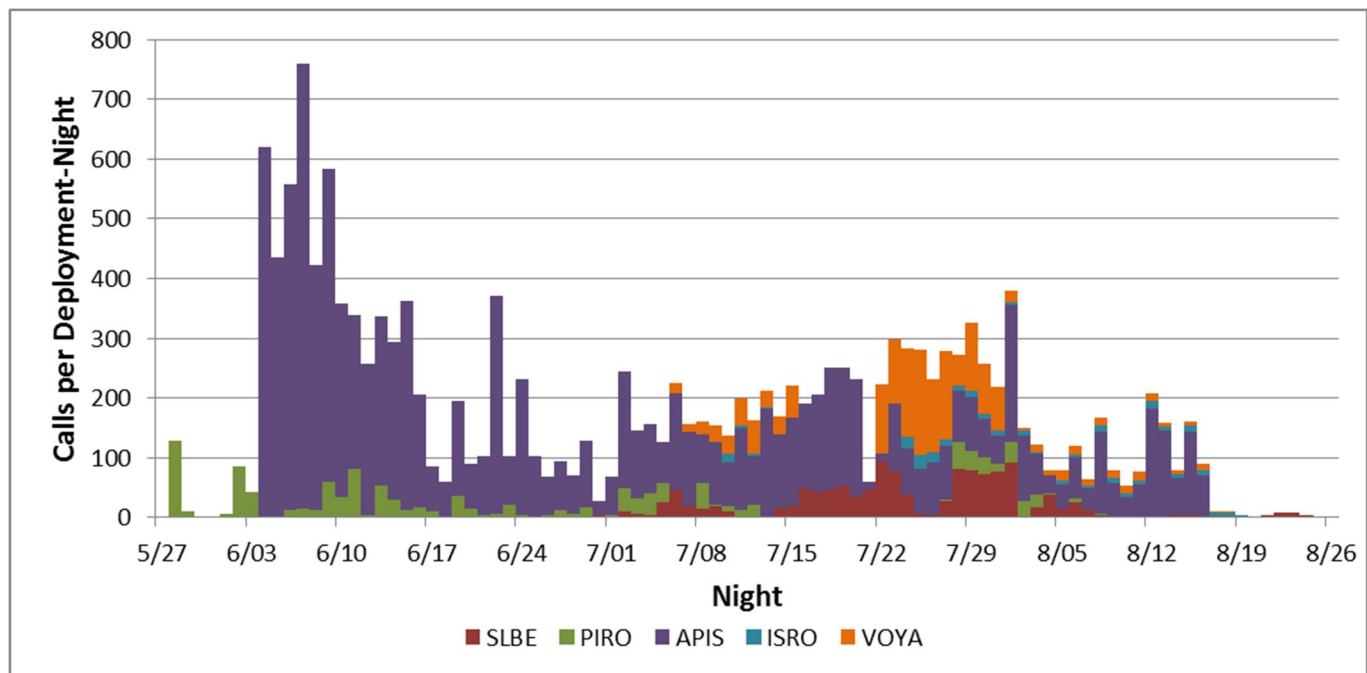


Figure 4-16. Number of Call Sequences Recorded Per Deployment-Night (All Species Combined), for each Date and Park (Summer only), Baseline Analysis.

4.1.4 Percent of Deployments & Deployment-Nights with Calls

Table 4-12 lists the percent of deployments while Table 4-13 lists the percent of deployment-nights where each species was present, for the baseline species analysis. This is for the summer season only. Figure 4-17 plots the data in Table 4-13.

Similarly, Table 4-14 lists the percent of deployments while Table 4-15 lists the percent of deployment-nights where each species was present, for the expanded species analysis. This is for the summer season only. Figure 4-18 plots the data in Table 4-15.

To better highlight the differences in percentages, the table cells are highlighted using a continuous color scale based on the cell values as follows:



Table 4-12. Percent of Deployments each species was present, by Park (Summer Only), Baseline Analysis

Park	Deploy-ments	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	24	88	83	88	83	88	54	na	na	na
PIRO	26	73	58	77	77	73	65	na	na	na
APIS	21	76	86	81	86	86	76	na	na	na
ISRO	7	86	100	86	100	100	100	na	na	na
VOYA	9	100	100	100	100	100	100	na	na	na

na: species was not considered in the analysis

Table 4-13. Percent of Deployment-Nights each species was present, by Park (Summer Only), Baseline Analysis

Park	Deploy-Nights	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	246	55	55	63	47	58	22	na	na	na
PIRO	204	32	32	40	52	47	29	na	na	na
APIS	236	61	78	58	72	80	61	na	na	na
ISRO	59	32	88	32	75	93	85	na	na	na
VOYA	88	77	93	94	100	100	91	na	na	na

na: species was not considered in the analysis

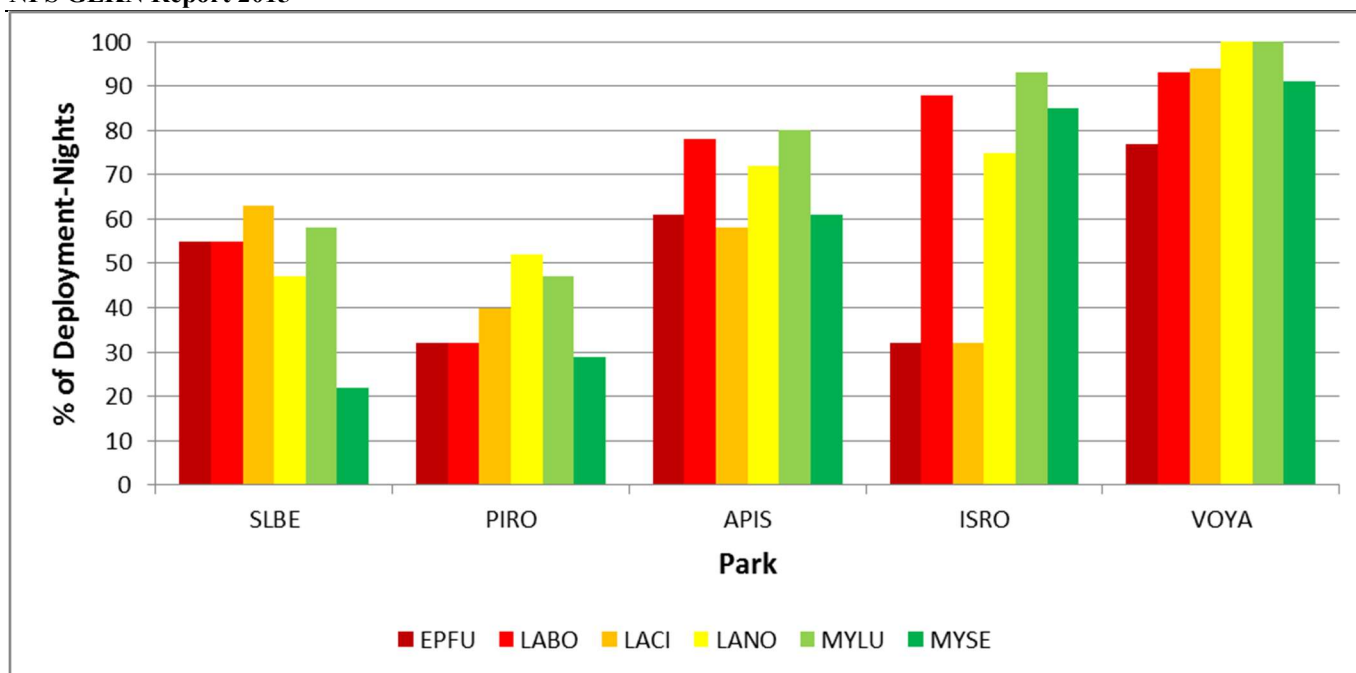


Figure 4-17. Percent of Deployment-Nights each species was present, by Park (Summer only), Baseline Analysis

Table 4-14. Percent of Deployments each species was present, by Park (Summer Only), Expanded Analysis

Park	Deploy-ments	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	24	88	83	88	83	88	58	67	na	33
PIRO	26	73	58	77	77	73	65	na	na	15
APIS	21	76	86	81	86	86	76	na	na	76
ISRO	7	86	100	86	100	100	100	na	na	71
VOYA	9	100	100	100	100	100	100	na	na	67

na: species was not considered in the analysis

Table 4-15. Percent of Deployment-Nights each species was present, by Park (Summer Only), Expanded Analysis

Park	Deploy-ments	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	246	55	54	63	47	53	20	37	na	13
PIRO	204	32	32	40	52	46	29	na	na	5
APIS	236	62	78	58	72	80	62	na	na	41
ISRO	59	32	86	32	75	93	85	na	na	27
VOYA	88	77	92	94	100	100	91	na	na	22

na: species was not considered in the analysis

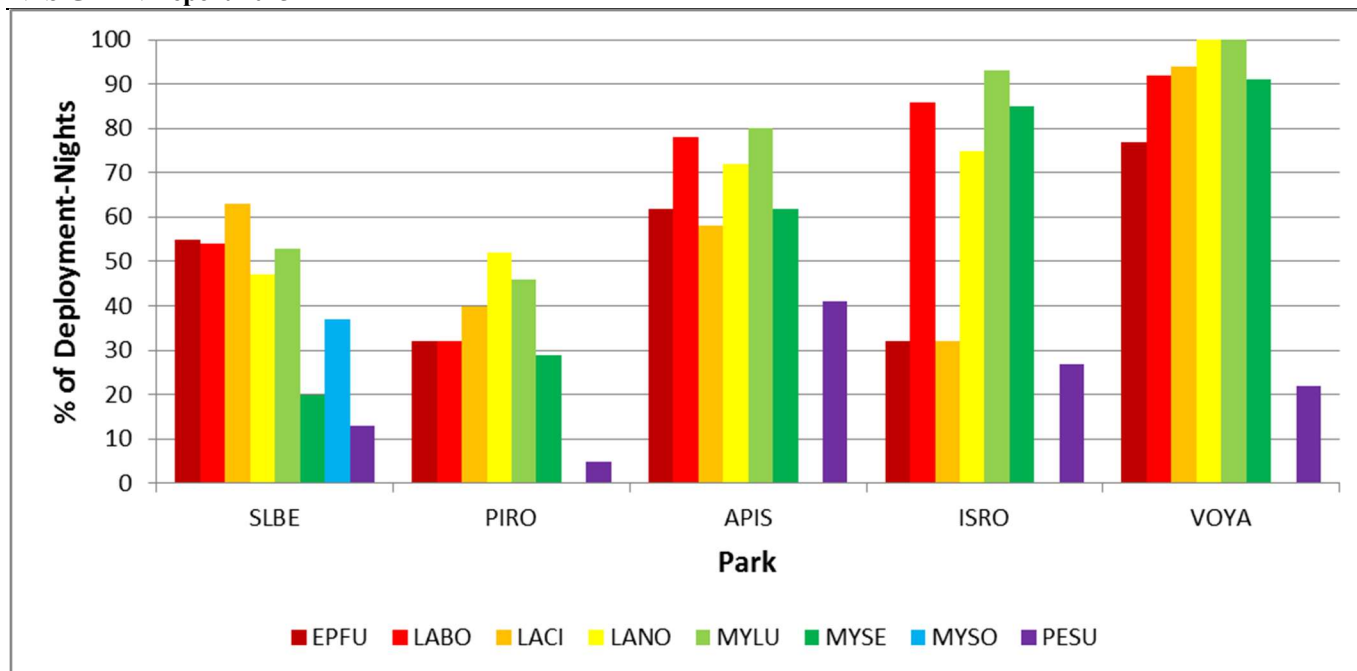


Figure 4-18. Percent of Deployment-Nights each species was present, by Park (Summer only), Expanded Analysis

5 Manual Vetting Summary

5.1.1 Manual Vetting/QC of KPro results

To manually vet the KPro IDs, at least 1% of identified (to species) files were chosen for manual vetting. To be sure that all parks and all species were proportionally represented in the manual vetting, files were NOT randomly selected at large, but instead 1% of files from within a given park and species group were randomly selected with a minimum of 10 files selected for each park and species group.

For example, if Park A had 5000 LABO and 6000 MYSO files, while Park B had 10000 LABO and 3000 MYSO files, the number of files selected for manual vetting would be 50 LABO files and 60 MYSO files from Park A and 100 LABO files and 30 MYSO files from Park B. In addition, if Park C had 500 LABO files, then 10 LABO files would be selected for manual vetting.

Table 5-1 shows the number of files selected for manual vetting, for each park and species, for the baseline analysis

Table 5-1. Number of files manually vetted for species and park, Baseline analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
SLBE	17	46	23	12	65	10	na	na	na	173
PIRO	10	13	15	29	25	10	na	na	na	102
APIS	32	126	31	121	622	14	na	na	na	946
ISRO	10	10	10	10	22	10	na	na	na	72
VOYA	10	14	10	14	155	10	na	na	na	213
All Parks	79	209	89	186	889	54	na	na	na	1506

For the expanded analysis, an additional manual vetting was done on the additional park/species combinations added in the expanded analysis. The numbers of files manually vetted for the additional park/species combinations in the expanded analysis are show in Table 5-2.

Table 5-2. Number of additional files manually vetted for species and park, Expanded Analysis

Park	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
SLBE	-	-	-	-	-	-	10	na	10
PIRO	-	-	-	-	-	-	na	na	10
APIS	-	-	-	-	-	-	na	na	10
ISRO	-	-	-	-	-	-	na	na	10
VOYA	-	-	-	-	-	-	na	na	10

The files were renamed to strip any information from the file names and the files were placed into folders that indicated the possible species that were supplied to KPro for that file. This ensured that the manual analysis performed by biologists was a blind test with no information about the sites or files besides resident species.

Manual analysis was then performed using several call viewing programs: SonoBat Viewer, Binary Acoustic Technologies SCANR, and Callviewer. Baseline call identification trees and prior knowledge or call shape, durations, and lengths were used to identify bats.

The auto classifier program, KPro, only identifies bats to singular species. Biologists were allowed to ID call sequences as species groups, such as EPFU/LANO or LABO/NYHU.

For the 2015 data, a single biologist performed all manual identifications.

5.1.2 Definition of ‘Agreement’

The KPro species identifications were restricted to a single species with the possible species for a given park as listed in Table 4-1. Species groups and unknown species were not allowed in the KPro identifications. The manual species identifications were restricted to the same species as the KPro identifications; however in addition, the manual id allowed call sequences to be identified as species groups, unknown, unknown high frequency, unknown low frequency, unknown Myotis or no bat.

Table 5-3 shows the different manual identifications that were returned by the bat biologist in this study and the KPro identifications that would be considered to be in agreement.

Table 5-3. Manual ID and KPro ID conventions for agreement

Manual ID (species IDs by manual vetter)	KPro ID in ‘agreement’	KPro ID in ‘partial- agreement’
EPFU	EPFU	
EPFU/LANO		EPFU or LANO
LABO	LABO	
LABO/MYLU		LABO or MYLU
LACI	LACI	
LANO	LANO	
MYLU	MYLU	MYSE or MYSO
MYSE	MYSE	MYLU or MYSO
MYsp (unknown Myotis)		MYLU, MYSE or MYSO
NYHU	NYHU	
PESU	PESU	
UNKN_HIFREQ		MYLU, MYSE or MYSO
UNKN_LOWFREQ		
NOBAT (not a bat)		

5.1.3 Agreement: Number of Call Sequences

Table 5-4 shows a matrix comparing the manual and KPro identifications. Cells that are highlighted in green are the agreements and cells that are highlighted in orange are the partial agreements for Myotis species. Cells highlighted in light red are the most common disagreements for a given KPro ID.

Table 5-5 shows the manual vetting results for species added in the expanded analysis.

Table 5-4. Manual Vetting Results – Number of Call Sequences, Baseline Analysis

ManualID ¹	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	All Species
EPFU	17	0	1	2	2	0	na	na	na	22
EPFU/LANO	26	2	1	50	5	0	na	na	na	84
LABO	0	111	0	1	33	0	na	na	na	145
LACI	0	2	54	4	2	0	na	na	na	62
LANO	10	3	2	90	3	0	na	na	na	108
MYLU	4	24	1	3	568	28	na	na	na	628
MYSE	0	0	0	0	1	3	na	na	na	4
MYsp	1	0	0	0	36	9	na	na	na	46
UNKN_HIFREQ	3	54	0	3	232	13	na	na	na	305
UNKN_LOFREQ	18	13	28	32	7	1	na	na	na	99
NOBAT	0	0	2	1	0	0	na	na	na	3
Total	79	209	89	186	889	54	na	na	na	1506

¹MYsp: unknown Myotis; UNKN_HIFREQ: unknown high frequency bat call sequence; UNKN_LOFREQ: unknown low frequency bat call sequence; NOBAT: not a bat

: cells in light green are exact matches

: cells in light orange are partial matches

: cells in light red are most common disagreement

Table 5-5. Manual Vetting Results – Number of Call Sequences, Expanded Analysis Species

ManualID ¹	MYSO	PESU
EPFU/LANO	0	3
LABO	2	14
LABO/MYLU	0	1
LACI	0	1
LANO	0	1
MYLU	3	4
MYsp	1	6
PESU	0	1
UNKN_HIFREQ	2	19
UNKN_LOFREQ	2	0
Total	10	50

¹MYsp: unknown Myotis; UNKN_HIFREQ: unknown high frequency bat call sequence; UNKN_LOFREQ: unknown low frequency bat call sequence

: cells in light green are exact matches

: cells in light orange are partial matches

: cells in light red are most common disagreement

5.1.4 Agreement: Percent

For the baseline analysis, Table 5-6 and Table 5-7 show the agreement between the manual and KPro identifications for non-Myotis species and Myotis species, respectively.

For the additional species considered in the expanded analysis, Table 5-8 and Table 5-9 show the agreement between the manual and KPro identifications for non-Myotis species and Myotis species, respectively.

Table 5-6. Manual Vetting of KPro ID: Percent Agreement for non-Myotis, Baseline Analysis

KPro ID	Total Vetted	# Agree ¹	% Agree	Most Common Disagreements
EPFU	79	43	54.4	UNKN_LOFREQ
LABO	209	111	53.1	UNKN_HIFREQ, MYLU
LACI	89	54	60.7	UNKN_LOFREQ
LANO	186	140	75.3	UNKN_LOFREQ

¹Includes both exact and partial agreements

Table 5-7. Manual Vetting of KPro ID: Percent Agreement for Myotis, Baseline Analysis

KPro ID	Total Vetted	# of Files			% of Files			Most Common Disagreements
		Exact Species	Other Myotis or High Freq.	All Myotis or High Freq.	Exact Species	Other Myotis or High Freq.	All Myotis or High Freq.	
MYLU	889	568	269	837	63.9	30.3	94.2	LABO
MYSE	54	3	50	53	5.6	92.6	98.1	UNKN_LOFREQ
All Myotis	943	571	319	890	60.6	33.8	94.4	

Table 5-8. Manual Vetting of KPro ID: Percent Agreement for non-Myotis, Expanded Analysis

KPro ID	Total Vetted	# Agree ¹	% Agree	Most Common Disagreements
PESU	50	1	2.0	UNKN_HIFREQ, LABO

¹Includes both exact and partial agreements

Table 5-9. Manual Vetting of KPro ID: Percent Agreement for Myotis, Expanded Analysis

KPro ID	Total Vetted	# of Files			% of Files			Most Common Disagreements
		Exact Species	Other Myotis or High Freq.	All Myotis or High Freq.	Exact Species	Other Myotis or High Freq.	All Myotis or High Freq.	
MYSO	10	0	6	6	0.0	60.0	60.0	UNKN_LOFREQ, LABO

6 Conclusion and Observations

The purpose of this report was simply to summarize the results of 2015 GLKN acoustic monitoring effort and not to make conclusions about the ecological significance of the results.

For the 2015 Summer season (6/1/15-8/15/15), 335,381 audio files were analyzed from 5 national parks. These were collected at 87 distinct locations during 833 deployment-nights. Using the auto-classifier Kaleidoscope-Pro (KPro), audio files were identified to species or classified as noise or unknown bat. Both a baseline species analysis and an expanded species analysis were performed using the auto-classifier.

For the baseline analysis, overall ~43% of the audio files were identified to species, while ~57% were found to be noise. Less than 1% were found to be bat call sequences that could not be identified to species. The PIRO park had an unusually high number of noise files with 94% being classified as noise and only 5.5% of files identified to species. The ISRO park also had a high number of noise files with 79% being classified as noise and about 21% of files identified to species. The remaining parks had 53-94% of audio files identified to species with 5-46% classified as noise. It is not known why the PIRO park had such a high number of noise files; however the equipment and recording settings used there are different than at the remaining parks and this may be a contributing factor. In particular, a high-pass filter was not used at PIRO which may have permitted low frequency noises to be recorded. For the ISRO and SLBE parks, the high noise levels may be due the use of older detectors (Song Meter 2) and less sensitive microphones, which were not used at any of the other parks; or to inexperience with equipment settings, as this was the first year data was collected. The expanded species analysis did not reclassify any noise files to species or vice versa; however, the expanded analysis did reclassify a small number files (~0.1%) from a specific species to an unidentifiable bat. It is not known why there was a slight increase in unidentifiable files with the expanded species analysis.

The expanded species analysis did not substantially reclassify species identifications as compared to the baseline analysis. For most park and species combinations, there was less than 1% change in the number of calls reclassified. The biggest change was for the SLBE park, where ~3% of the calls were reclassified from LABO to MYSO and ~1.7% of calls were reclassified from MYLU to MYSO. LABO call characteristics vary a great deal and overlap with call characteristics for a great many species, thus misclassification of a species as LABO or vice versa tends to be the most common misclassification by KPro.

For call sequences identified by KPro as a *Myotis* species, in the baseline analysis 97% were identified as MYLU while 3% were identified as MYSE. For the expanded analysis, in which MYSO was allowed to be considered for the SLBE park, a number of call sequences were reclassified as MYSO. For the expanded analysis 96% were identified as MYLU while ~3% were identified as MYSE and <1% were identified as MYSO.

The baseline analysis KPro identification was quality controlled by manually vetting about 1% of the files identified to species. Additionally, species/park combinations added to the expanded analysis were separately quality controlled by manually vetting 1% of the files identified to the expanded species.

In the baseline analysis, for call sequences identified by KPro as non-*Myotis* species, the KPro and manual identifications had an agreement (including both exact and partial) in the range of 53-75%. For call sequences identified by KPro as EPFU, LACI, or LANO, the most common disagreement with the manual identification was for a manual identification of UNKN_LOFREQ, indicating the manual vetter could not distinguish among low frequency species for that call. For call sequences identified by KPro as LABO, the most common disagreement with the manual identification was MYLU or UNKN_HIFREQ, indicating the manual vetter could not distinguish among high frequency species for that call.

In the baseline analysis, for call sequences identified by KPro as *Myotis* species, ~94% were identified as some type of *Myotis* by the manual reviewer. Exact agreement between automated and manual id's was ~64% for MYLU and ~6% for MYSE. Only ~6% of calls identified by KPro as MYLU or MYSE were identified manually as non-*Myotis* species, with the most common disagreement being a manual identification of LABO.

In the expanded analysis, for call sequences identified by KPro as non-*Myotis* species, manual identification did not agree well with the KPro identification. For the call sequences identified by KPro as PESU, only 1 out of 50 (2%) were manually identified as PESU, with the most common disagreements being manual identifications of LABO or UNKN_HIFREQ. The one call file that was identified as PESU by both automated and manual methods occurred at the MD-01 site location in the APIS park. In the expanded analysis, for call sequences identified by KPro as *Myotis* species (MYSO), 6 of 10 (60%) were manually identified as some type of *Myotis* with the most common disagreements being LABO or UNKN_LOFREQ.

In evaluating the call files included in the 2015 dataset the analyst considered several characteristics of the call sequence before attempting to make a species classification (e.g., see Parsons and Szewczak 2009). First, the analyst considered whether the sequence likely represented a search-phase call sequence. The characteristics of search-phase call sequences vary by species, but as a general rule search-phase sequences tend to consist of regular sound pulses that tend to be consistent in call structure and sound intensity. As insectivorous bats move their sound production from search-phase to actively pursuing insects or investigating objects (approach- and terminal-phase) they tend to emit sound pulses more rapidly and produce substantially more pulses per second. This shift from search-phase to approach- and terminal-phase calls is also often accompanied by a change in call structure and timing (Murray et al. 2001, Gordon and ter Hofstede 2018). For example, approach- and terminal-phase calls in North American vespertilionid bats tend to become shorter with more frequency modulated characteristics (Murray et al. 2001). Bat call analysts are generally encouraged not to make species identity determinations using non-search-phase call sequences unless there is no ambiguity in the species identity of a given call sequence (Murray et al. 2001, Parsons and Szewczak 2009). Analysts are also encouraged to only make species determinations if the sound quality of a file produces clean, non-saturated call sequences that do not show distortions caused by refractions and/or echoes caused by nearby vegetation and solid surfaces (Parsons and Szewczak 2009).

In this set of 2015 call files there were numerous call sequences that clearly consisted of approach- and terminal-phase call sequences. There were also numerous call sequences that were of relatively poor quality and therefore could only be classified into high- or low-frequency categories. In these cases the analyst did not make a species determination and generally classified the call file as UNKN_HIFREQ or UNKN_LOFREQ. For example, it can be very difficult or impossible to confidently classify some *Myotis* and migratory tree bat call sequences (e.g., eastern red bats, *Lasiurus borealis*) when the bats are in an approach- or terminal-phase of call production. In these cases, and when the call files were of poorer sound quality, the analyst classified the call sequence as high- or low-frequency, but did not attempt to classify the call sequence to species, because such determinations would likely be unreliable.

Based on the data tables presented in this report, there was nothing highly unusual about distribution of species (as determined by KPro identification) among the parks or the relative nightly activity throughout the season. A thorough analysis is, of course, needed to quantify this observation, correct for discrepancies between KPro and manual identification and compare these results with bat species prevalence reported in the general literature. This is an ongoing study with five years of data collection so far completed (2015-2019).

7 Literature Cited:

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- Murray, K. L., E. R. Britzke, and L. W. Robbins. 2001. Variation in search-phase calls of bats. *Journal of Mammalogy* 82:728–737.
- Parsons, S., and J. M. Szewczak. 2009. Detecting, recording, and analyzing the vocalizations of bats. Pages 91–111. In: T. H. Kunz and S. Parsons, editors. *Ecological and behavioral methods for the study of bats*, 2nd Edition. The Johns Hopkins University Press, Baltimore, Maryland, USA.

8 Supplementary Documents

The following documents contain detailed information and data that are important to the 2015 reporting of results, but are too big to be included in this report and are better provided as supplementary documents:

- [*Data Management Plan.docx*](#)
 - Detailed information about the procedures for data management and processing as well as step-by-step instruction for automatic identification using KPro.
- [*tables_2015_SpeciesCalls_byParkSiteNight_AutoID.xlsx*](#)
 - Number of call sequences for each species (as ID'd by KPro for both baseline and expanded species lists) for each site and night combination
 - Total number of call sequences for each species (as ID'd by KPro for both baseline and expanded species lists) for each site with all nights combined
 - Number of call sequences per deployment-night for each site, for each species (as ID'd by KPro for both baseline and expanded species lists)
- [*tables_2015_AudioFile_Classification_byParkSite.xlsx*](#) Audio file classification (bad files, short deployment fields, etc.) for each Park and site.
- [*tables_2015_CallsvsNoise_byParkSite.xlsx*](#) Number and percent files ID'd as bats and noise files for each Park and site.

9 APPENDIX

Table 9-1. Number of Deployments By Date, during the Summer season (Figure 3-2)

Night	All	SLBE	PIRO	APIS	ISRO	VOYA
5/27/2015	1	0	1	0	0	0
5/28/2015	1	0	1	0	0	0
5/29/2015	1	0	1	0	0	0
5/30/2015	1	0	1	0	0	0
5/31/2015	1	0	1	0	0	0
6/1/2015	1	0	1	0	0	0
6/2/2015	1	0	1	0	0	0
6/3/2015	1	0	1	0	0	0
6/4/2015	2	0	1	1	0	0
6/5/2015	2	0	1	1	0	0
6/6/2015	2	0	1	1	0	0
6/7/2015	2	0	1	1	0	0
6/8/2015	3	0	2	1	0	0
6/9/2015	3	0	2	1	0	0
6/10/2015	8	0	4	4	0	0
6/11/2015	8	0	4	4	0	0
6/12/2015	8	0	4	4	0	0
6/13/2015	8	0	4	4	0	0
6/14/2015	8	0	4	4	0	0
6/15/2015	8	0	4	4	0	0
6/16/2015	8	0	4	4	0	0
6/17/2015	7	0	4	3	0	0
6/18/2015	7	0	4	3	0	0
6/19/2015	7	0	4	3	0	0
6/20/2015	7	0	4	3	0	0
6/21/2015	7	0	4	3	0	0
6/22/2015	6	0	3	3	0	0
6/23/2015	6	0	3	3	0	0
6/24/2015	6	1	1	4	0	0
6/25/2015	8	1	3	4	0	0
6/26/2015	7	1	3	3	0	0
6/27/2015	7	1	3	3	0	0
6/28/2015	7	1	3	3	0	0
6/29/2015	9	2	4	3	0	0
6/30/2015	13	5	4	4	0	0
7/1/2015	13	5	5	3	0	0
7/2/2015	13	5	5	3	0	0
7/3/2015	13	5	5	3	0	0
7/4/2015	12	4	5	3	0	0
7/5/2015	12	4	5	3	0	0

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7/6/2015	14	5	3	3	0	3
7/7/2015	15	5	3	4	0	3
7/8/2015	15	5	3	4	0	3
7/9/2015	14	5	2	4	0	3
7/10/2015	15	5	2	4	1	3
7/11/2015	11	2	2	4	1	2
7/12/2015	11	2	2	4	1	2
7/13/2015	9	2	1	3	1	2
7/14/2015	11	5	1	3	0	2
7/15/2015	12	6	1	3	0	2
7/16/2015	10	6	1	3	0	0
7/17/2015	10	6	1	3	0	0
7/18/2015	10	6	1	3	0	0
7/19/2015	10	6	1	3	0	0
7/20/2015	9	5	1	3	0	0
7/21/2015	9	6	1	2	0	0
7/22/2015	11	6	1	2	0	2
7/23/2015	12	6	1	3	0	2
7/24/2015	12	4	1	3	2	2
7/25/2015	10	2	1	3	2	2
7/26/2015	12	3	1	3	2	3
7/27/2015	12	3	1	3	2	3
7/28/2015	14	4	2	3	2	3
7/29/2015	15	5	2	3	2	3
7/30/2015	16	5	3	3	2	3
7/31/2015	15	5	3	2	2	3
8/1/2015	16	5	3	4	2	2
8/2/2015	14	4	3	4	2	1
8/3/2015	16	4	3	4	2	3
8/4/2015	17	4	4	4	2	3
8/5/2015	18	4	4	4	3	3
8/6/2015	15	3	3	4	3	2
8/7/2015	13	1	3	4	3	2
8/8/2015	13	1	3	4	3	2
8/9/2015	13	0	3	4	3	3
8/10/2015	13	0	3	4	3	3
8/11/2015	16	5	1	4	3	3
8/12/2015	16	5	2	3	3	3
8/13/2015	13	5	2	3	1	2
8/14/2015	12	5	2	3	1	1
8/15/2015	11	5	2	2	1	1
8/16/2015	11	5	2	2	1	1
8/17/2015	10	5	2	1	1	1
8/18/2015	9	5	1	1	1	1

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8/19/2015	7	5	0	1	1	0
8/20/2015	6	5	0	1	0	0
8/21/2015	4	4	0	0	0	0
8/22/2015	3	3	0	0	0	0
8/23/2015	2	2	0	0	0	0
8/24/2015	2	2	0	0	0	0
8/25/2015	2	2	0	0	0	0
8/26/2015	2	2	0	0	0	0

Table 9-2. Number of Calls Per Deployment-Night (All Parks Combined), for each Species, Baseline Analysis (Figure 4-10)

Night	EPFU	LABO	LACI	LANO	MYLU	MYSE
5/27/2015	0	0	0	0	0	0
5/28/2015	8	1	8	50	34	20
5/29/2015	1	0	0	3	5	0
5/30/2015	0	1	0	0	1	0
5/31/2015	0	0	0	0	1	0
6/1/2015	0	0	0	7	0	0
6/2/2015	3	2	16	15	30	14
6/3/2015	3	0	2	28	4	3
6/4/2015	0	2.5	1.5	2	604	8.5
6/5/2015	0	2.5	0	3	420	8
6/6/2015	1.5	11	29	26.5	485	3
6/7/2015	0.5	10.5	10	20.5	710	6.5
6/8/2015	0.3	5	11.7	7.7	383.7	11.7
6/9/2015	1.7	10.7	29.3	38	493.3	6
6/10/2015	42	7	3.8	35.1	262.2	7.1
6/11/2015	17.6	17.2	6.4	19.2	265.6	9.6
6/12/2015	9.1	8.8	4	9.8	220.8	3.1
6/13/2015	32.8	9.5	8.2	18.8	255	11.1
6/14/2015	8.4	17.6	8.5	11.2	235.4	9.5
6/15/2015	23	15.8	5.9	11.8	299.5	4.9
6/16/2015	4.4	9.1	2.2	1.4	173.4	13.9
6/17/2015	15.6	7.6	1	10	46.9	4.3
6/18/2015	7.4	4.9	0.7	3.3	41	2.6
6/19/2015	16	17.1	3.3	83.6	72.6	2.1
6/20/2015	4.1	9.6	3.7	17	47.7	5.4
6/21/2015	7.7	9.7	4.9	46.1	32.4	1.9
6/22/2015	3	47.7	1	24	288.5	4.5
6/23/2015	5.3	8.3	1	30.5	49.5	7.5
6/24/2015	10.8	14.5	0.2	6.7	186.5	11.7
6/25/2015	1.2	13	0.9	4.5	77.9	5
6/26/2015	5.7	8.7	0.6	7.4	42.1	3

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6/27/2015	2.6	7.7	0.4	7.6	69.6	5.3
6/28/2015	15.6	7.7	0.9	7.3	36.6	1.7
6/29/2015	5.4	8.4	7.9	5.3	88.6	8.3
6/30/2015	1.8	1.2	1	1.8	21.5	0.4
7/1/2015	2.5	8.8	2.5	17.3	36.1	0.4
7/2/2015	3.6	12.5	27.9	24.7	170.9	0.1
7/3/2015	2.4	15.5	17.1	11.2	98.9	0.1
7/4/2015	4.2	11.8	8.4	26.8	101.6	0.1
7/5/2015	8.5	8.6	16.4	26.7	61.8	0.3
7/6/2015	13.9	10.9	3.4	14.2	177.9	3.4
7/7/2015	5.5	10.9	20.7	19.9	95.8	2.5
7/8/2015	6.9	19	27.1	24.3	78.5	3.4
7/9/2015	9.6	12	11	30.9	85.1	3.4
7/10/2015	4.1	17.5	4.5	16.7	88.6	2.4
7/11/2015	2.5	27.2	23.3	7.5	133.2	2.6
7/12/2015	1.7	17.3	7.8	16.2	115	2
7/13/2015	1	8.7	2.8	3	190	6.9
7/14/2015	2.4	12.4	3.3	1.3	138.6	10.4
7/15/2015	4.5	13.1	4.3	2	186.4	10.1
7/16/2015	13.8	21.7	2.3	4.8	139.9	6.9
7/17/2015	13.3	20.7	4.9	6	153.3	5.2
7/18/2015	13.3	14	3.2	4.8	210.5	2.9
7/19/2015	8.1	23.3	2.1	12.3	201.5	1.9
7/20/2015	5.9	25.6	2.3	0.2	191.2	5.6
7/21/2015	7.1	25	3.9	1.7	21.4	0.7
7/22/2015	9.6	41.5	48.5	13	107	1.4
7/23/2015	16.5	63.9	52.8	40.4	120.9	2.7
7/24/2015	7.9	76.8	7.2	19.2	167.4	3.9
7/25/2015	8.2	46.2	13.5	26.6	179.1	5.1
7/26/2015	5.3	30.8	16	54.6	117.9	4.6
7/27/2015	8.2	43.5	50.7	29.6	139.3	3.9
7/28/2015	13.8	63.1	61.1	40.6	89.1	2.4
7/29/2015	19.2	67.6	9.1	49.9	173.5	3.7
7/30/2015	9.1	36.1	7.6	61.3	137.9	3.2
7/31/2015	6.1	57.3	4.9	9.4	137.7	2.3
8/1/2015	14.3	109	10.9	117.8	121.2	2.4
8/2/2015	1.4	42.4	5	18.4	80.4	1.6
8/3/2015	2.4	47.2	2.6	12.8	51.4	5.4
8/4/2015	0.7	16.9	2.1	1.9	53.8	2.5
8/5/2015	1.8	28.6	2.9	5.1	32.6	7.9
8/6/2015	3.9	38.4	3.7	6.5	58.8	7.1
8/7/2015	0.9	26.5	2.3	3.3	24	6
8/8/2015	5.4	55.1	7.2	31.9	63.2	3.5
8/9/2015	1.3	26.6	5.3	5.8	36.4	3.5

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8/10/2015	1	13.3	3.7	3.2	28.5	2.4
8/11/2015	0.5	26.2	4.7	7.1	35.1	2.4
8/12/2015	25.1	22.3	3.6	97.5	54.2	4.1
8/13/2015	5.3	23.2	2.5	66.7	58.3	1
8/14/2015	2.1	21.9	4.1	22.8	25.1	1.8
8/15/2015	14.5	19.2	10.6	57.6	55.7	1.5
8/16/2015	1.7	10.2	3.2	17.4	56.9	0.6
8/17/2015	0.2	0.9	1.3	1	6.5	1.3
8/18/2015	0.2	0.4	0.4	1	6.7	1.1
8/19/2015	0.3	0.9	0.9	0	2.3	0.1
8/20/2015	0.3	0.8	0.7	0	0.8	0.2
8/21/2015	0.8	0.8	1	0.5	1	0
8/22/2015	1.7	4	0.3	0.7	1.3	0
8/23/2015	0.5	4.5	0	2.5	0	0.5
8/24/2015	0	1	1	0	2	0.5
8/25/2015	0	0.5	0.5	0	0	0
8/26/2015	0	1	0.5	0	0.5	0

Table 9-3. Number of Calls Per Deployment-Night (All Parks Combined), for each Species, Expanded Analysis (Figure 4-12)

Night	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU
5/27/2015	0	0	0	0	0	0	0	0	0
5/28/2015	8	2	8	50	33	20	0	0	0
5/29/2015	1	0	0	3	5	0	0	0	0
5/30/2015	0	1	0	0	1	0	0	0	0
5/31/2015	0	0	0	0	1	0	0	0	0
6/1/2015	0	0	0	7	0	0	0	0	0
6/2/2015	3	2	16	15	29	15	0	0	0
6/3/2015	3	0	2	28	4	3	0	0	0
6/4/2015	0	2.5	1.5	2	604.5	8.5	0	0	0
6/5/2015	0	1.5	0	3	421	8	0	0	0
6/6/2015	1.5	10.5	29	26.5	484.5	3	0	0	0
6/7/2015	0.5	10.5	10	20.5	709	7	0	0	0.5
6/8/2015	0.3	4.7	11.7	7.7	383.3	12	0	0	0.3
6/9/2015	1.7	9.3	29.3	38	494	6.3	0	0	0
6/10/2015	42	7.1	3.8	35.1	262.1	7.2	0	0	0
6/11/2015	17.8	17.1	6.4	19.1	264.9	10	0	0	0.2
6/12/2015	9.1	8.6	4	9.8	220.8	3.1	0	0	0.1
6/13/2015	32.8	9.5	8.2	18.8	254.2	11.5	0	0	0.1
6/14/2015	8.4	16.5	8.5	11.2	235.8	9.9	0	0	0.1
6/15/2015	23.1	15.8	5.9	11.6	299.4	4.9	0	0	0.2
6/16/2015	4.4	9.1	2.2	1.4	173.4	13.8	0	0	0.1
6/17/2015	15.6	7.4	1	10	47	4.4	0	0	0
6/18/2015	7.4	5	0.7	3.3	40.9	2.6	0	0	0

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6/19/2015	15.9	16.9	3.3	83.6	72.3	2.1	0	0	0.1
6/20/2015	4.1	8.3	3.7	17	48.6	5.3	0	0	0.4
6/21/2015	7.7	10	4.9	46.1	32.1	1.9	0	0	0
6/22/2015	3	46.3	1	24	288.3	4.7	0	0	0.5
6/23/2015	5.3	7.7	1	30.5	49.5	7.7	0	0	0.5
6/24/2015	10.8	13.2	0.2	6.7	186.8	11.5	0	0	0.8
6/25/2015	1.2	11.9	0.9	4.5	78.5	5.1	0	0	0.1
6/26/2015	5.7	8.1	0.6	7.4	41.9	3.1	0	0	0.9
6/27/2015	2.6	6.6	0.4	7.6	70.6	5.3	0	0	0
6/28/2015	15.6	6.7	0.9	7.4	36.7	1.7	0	0	0.4
6/29/2015	5.4	6.8	7.9	5.3	89.4	8.7	0	0	0.4
6/30/2015	1.8	1.2	1	1.8	21.5	0.3	0.2	0	0
7/1/2015	2.5	8.1	2.5	17.3	36.4	0.4	0	0	0.3
7/2/2015	3.6	12.3	27.9	24.7	171	0.1	0	0	0.1
7/3/2015	2.4	14.1	17.1	11.2	99.5	0.1	0.1	0	0.8
7/4/2015	4.2	11.2	8.4	26.8	101.3	0.1	0.2	0	0.3
7/5/2015	8.5	8.4	16.4	26.7	61.2	0.2	0.3	0	0.2
7/6/2015	13.8	10.4	3.4	14.2	175.9	2.7	2.6	0	0.4
7/7/2015	5.5	10.4	20.7	19.9	94.5	2.2	1.7	0	0.2
7/8/2015	7	18.6	27.1	24.3	77.5	3.3	1.1	0	0.1
7/9/2015	9.7	11.4	11	30.9	84	2.9	1.7	0	0.2
7/10/2015	4.1	15.3	4.5	16.7	89.1	2.4	0.5	0	0.5
7/11/2015	2.5	23.6	23.4	7.5	135.5	2.5	0	0	0.8
7/12/2015	1.8	14.3	7.8	16.2	116.5	2.4	0	0	0.2
7/13/2015	1	8.7	2.8	3	189.4	7	0	0	0
7/14/2015	2.5	9.9	3.3	1.2	140	10.5	0	0	0.9
7/15/2015	4.5	11	4.3	2	187.2	10.3	0.5	0	0.3
7/16/2015	13.9	18.7	2.3	4.8	140.4	7	0.8	0	0.7
7/17/2015	13.3	19.2	4.9	6	153.8	5.1	0.8	0	0.1
7/18/2015	13.3	11.9	3.2	4.9	209.7	3.2	0.8	0	0.9
7/19/2015	8.1	19.7	2.1	12.5	201.3	2	1.5	0	1.3
7/20/2015	5.9	22.1	2.3	0.2	192.3	5.6	0.4	0	1.7
7/21/2015	7.1	20.2	3.9	1.7	23.7	0.4	1.2	0	1.2
7/22/2015	9.6	38	48.5	12.9	108.2	1.4	0.8	0	1.4
7/23/2015	16.5	59.2	52.8	40.4	122.8	2.7	1.1	0	0.8
7/24/2015	7.9	72.9	7.3	19.3	168.3	3.9	0.5	0	1.9
7/25/2015	8.2	44	13.5	26.4	179.3	5.1	0	0	2
7/26/2015	5.3	28.8	16.1	54.7	118.8	4.6	0	0	0.8
7/27/2015	8.2	43.5	50.9	29.6	137.8	3.9	0	0	0.9
7/28/2015	13.8	60.6	61.2	40.6	87.9	2.2	1.9	0	1.4
7/29/2015	19.2	62.2	9.1	50.1	169.9	3.7	5.7	0	1.7
7/30/2015	9.1	33.5	7.6	61.4	136.6	3.1	2.1	0	0.8
7/31/2015	6.1	54.1	4.9	9.4	136	2.3	3.1	0	0.7
8/1/2015	14.4	99.4	11.1	118.4	120.2	2.2	4.2	0	3.2

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8/2/2015	1.4	40.3	5	18.4	80.3	1.6	0.3	0	1.1
8/3/2015	2.4	44.2	2.6	12.8	52	5.6	0.5	0	1.2
8/4/2015	0.8	15.5	2.1	1.9	49.8	2.5	4.4	0	0.4
8/5/2015	1.8	26.8	2.9	5.1	32.2	8.2	0.8	0	0.8
8/6/2015	3.9	35.3	3.7	6.6	58.8	7	1	0	1.5
8/7/2015	0.9	23.4	2.3	3.3	24.9	5.9	0.5	0	1.5
8/8/2015	5.5	50.1	7.2	31.8	64.6	3.2	0.2	0	2.5
8/9/2015	1.3	25.7	5.3	5.8	37.2	3.5	0	0	0.1
8/10/2015	1	12.5	3.7	3.2	28.6	2.4	0	0	0.4
8/11/2015	0.5	24.3	4.7	7.1	35.5	2.4	0.2	0	0.9
8/12/2015	25.1	20.6	3.6	97.5	54.2	4.1	0	0	1.5
8/13/2015	5.3	21.2	2.5	66.7	58.5	0.9	0.5	0	1.1
8/14/2015	2.1	21.2	4.1	22.8	24.2	1.8	0.4	0	0.5
8/15/2015	14.5	17.7	10.6	57.7	54.5	1.4	0.7	0	0.7
8/16/2015	1.7	9.5	3.2	17.4	56.4	0.6	0.2	0	0.6
8/17/2015	0.2	0.9	1.3	1	6.4	1.3	0	0	0.1
8/18/2015	0.2	0.6	0.4	1	6.4	1.1	0.1	0	0
8/19/2015	0.3	0.9	0.9	0	2.1	0.1	0	0	0.1
8/20/2015	0.3	0.8	0.7	0	0.5	0.2	0.3	0	0
8/21/2015	0.8	0.8	1	0.5	0.2	0	0.5	0	0
8/22/2015	1.7	4	0.3	0.7	1	0	0.3	0	0
8/23/2015	0.5	4	0	2.5	0	0.5	0	0	0.5
8/24/2015	0	1	1	0	1.5	0.5	0.5	0	0
8/25/2015	0	0.5	0.5	0	0	0	0	0	0
8/26/2015	0	1	0.5	0	0.5	0	0	0	0

Table 9-4. Total number of Calls Recorded (All Species Combined), for each Date and Park (Summer only) (Figure 4-15)

Night	SLBE	PIRO	APIS	ISRO	VOYA
5/27/2015	0	0	0	0	0
5/28/2015	0	129	0	0	0
5/29/2015	0	11	0	0	0
5/30/2015	0	2	0	0	0
5/31/2015	0	1	0	0	0
6/1/2015	0	7	0	0	0
6/2/2015	0	85	0	0	0
6/3/2015	0	42	0	0	0
6/4/2015	0	5	1234	0	0
6/5/2015	0	2	867	0	0
6/6/2015	0	27	1088	0	0
6/7/2015	0	31	1490	0	0
6/8/2015	0	40	1230	0	0
6/9/2015	0	182	1567	0	0

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6/10/2015	0	277	2596	0	0
6/11/2015	0	657	2063	0	0
6/12/2015	0	40	2015	0	0
6/13/2015	0	437	2259	0	0
6/14/2015	0	244	2099	0	0
6/15/2015	0	105	2797	0	0
6/16/2015	0	140	1502	0	0
6/17/2015	0	69	533	0	0
6/18/2015	0	8	415	0	0
6/19/2015	0	253	1118	0	0
6/20/2015	0	105	518	0	0
6/21/2015	0	35	688	0	0
6/22/2015	0	44	2178	0	0
6/23/2015	0	127	492	0	0
6/24/2015	5	15	1369	0	0
6/25/2015	1	3	820	0	0
6/26/2015	4	22	457	0	0
6/27/2015	0	87	571	0	0
6/28/2015	1	42	453	0	0
6/29/2015	17	130	1002	0	0
6/30/2015	53	0	309	0	0
7/1/2015	33	16	836	0	0
7/2/2015	136	518	2532	0	0
7/3/2015	75	341	1493	0	0
7/4/2015	61	423	1385	0	0
7/5/2015	308	374	834	0	0
7/6/2015	660	0	2258	0	233
7/7/2015	283	18	1840	0	214
7/8/2015	229	622	1226	0	326
7/9/2015	283	27	1475	0	362
7/10/2015	170	109	1119	201	447
7/11/2015	20	120	1505	59	483
7/12/2015	5	223	911	49	603
7/13/2015	2	4	1628	25	259
7/14/2015	174	0	1363	0	325
7/15/2015	235	0	1773	0	654
7/16/2015	501	0	1405	0	0
7/17/2015	428	0	1623	0	0
7/18/2015	461	2	2038	0	0
7/19/2015	525	1	1988	0	0
7/20/2015	320	1	1762	0	0
7/21/2015	432	0	110	0	0
7/22/2015	1032	0	141	0	1279
7/23/2015	927	1	1359	0	1301

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7/24/2015	464	0	913	243	1790
7/25/2015	61	0	761	221	1771
7/26/2015	42	0	1074	206	1451
7/27/2015	335	17	1082	145	1757
7/28/2015	1132	624	1202	125	741
7/29/2015	1185	480	1352	183	1694
7/30/2015	1169	429	1048	147	1338
7/31/2015	1153	182	737	127	1093
8/1/2015	1490	519	3705	67	285
8/2/2015	32	362	1514	132	59
8/3/2015	281	347	1095	9	234
8/4/2015	667	17	504	28	119
8/5/2015	267	5	744	114	311
8/6/2015	393	104	1024	67	203
8/7/2015	152	18	463	49	154
8/8/2015	48	23	1803	122	178
8/9/2015	0	24	734	95	181
8/10/2015	0	6	450	67	165
8/11/2015	31	0	854	93	250
8/12/2015	43	1	2864	211	212
8/13/2015	30	1	1875	64	88
8/14/2015	53	7	734	70	80
8/15/2015	38	10	1526	120	65
8/16/2015	22	7	739	114	115
8/17/2015	9	1	0	72	33
8/18/2015	11	6	0	58	14
8/19/2015	15	0	0	18	0
8/20/2015	17	0	0	0	0
8/21/2015	16	0	0	0	0
8/22/2015	25	0	0	0	0
8/23/2015	16	0	0	0	0
8/24/2015	10	0	0	0	0
8/25/2015	2	0	0	0	0
8/26/2015	4	0	0	0	0

Table 9-5. Number of Calls Per Deployment-Night Per Night (All Species Combined), for each Park (Figure 4-16)

Night	SLBE	PIRO	APIS	ISRO	VOYA
5/27/2015	0	0	0	0	0
5/28/2015	0	129	0	0	0
5/29/2015	0	11	0	0	0
5/30/2015	0	2	0	0	0
5/31/2015	0	1	0	0	0

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6/1/2015	0	7	0	0	0
6/2/2015	0	85	0	0	0
6/3/2015	0	42	0	0	0
6/4/2015	0	2.5	617	0	0
6/5/2015	0	1	433.5	0	0
6/6/2015	0	13.5	544	0	0
6/7/2015	0	15.5	745	0	0
6/8/2015	0	13.3	410	0	0
6/9/2015	0	60.7	522.3	0	0
6/10/2015	0	34.6	324.5	0	0
6/11/2015	0	82.1	257.9	0	0
6/12/2015	0	5	251.9	0	0
6/13/2015	0	54.6	282.4	0	0
6/14/2015	0	30.5	262.4	0	0
6/15/2015	0	13.1	349.6	0	0
6/16/2015	0	17.5	187.8	0	0
6/17/2015	0	9.9	76.1	0	0
6/18/2015	0	1.1	59.3	0	0
6/19/2015	0	36.1	159.7	0	0
6/20/2015	0	15	74	0	0
6/21/2015	0	5	98.3	0	0
6/22/2015	0	7.3	363	0	0
6/23/2015	0	21.2	82	0	0
6/24/2015	0.8	2.5	228.2	0	0
6/25/2015	0.1	0.4	102.5	0	0
6/26/2015	0.6	3.1	65.3	0	0
6/27/2015	0	12.4	81.6	0	0
6/28/2015	0.1	6	64.7	0	0
6/29/2015	1.9	14.4	111.3	0	0
6/30/2015	4.1	0	23.8	0	0
7/1/2015	2.5	1.2	64.3	0	0
7/2/2015	10.5	39.8	194.8	0	0
7/3/2015	5.8	26.2	114.8	0	0
7/4/2015	5.1	35.2	115.4	0	0
7/5/2015	25.7	31.2	69.5	0	0
7/6/2015	47.1	0	161.3	0	16.6
7/7/2015	18.9	1.2	122.7	0	14.3
7/8/2015	15.3	41.5	81.7	0	21.7
7/9/2015	20.2	1.9	105.4	0	25.9
7/10/2015	11.3	7.3	74.6	13.4	29.8
7/11/2015	1.8	10.9	136.8	5.4	43.9
7/12/2015	0.5	20.3	82.8	4.5	54.8
7/13/2015	0.2	0.4	180.9	2.8	28.8
7/14/2015	15.8	0	123.9	0	29.5

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7/15/2015	19.6	0	147.8	0	54.5
7/16/2015	50.1	0	140.5	0	0
7/17/2015	42.8	0	162.3	0	0
7/18/2015	46.1	0.2	203.8	0	0
7/19/2015	52.5	0.1	198.8	0	0
7/20/2015	35.6	0.1	195.8	0	0
7/21/2015	48	0	12.2	0	0
7/22/2015	93.8	0	12.8	0	116.3
7/23/2015	77.2	0.1	113.2	0	108.4
7/24/2015	38.7	0	76.1	20.2	149.2
7/25/2015	6.1	0	76.1	22.1	177.1
7/26/2015	3.5	0	89.5	17.2	120.9
7/27/2015	27.9	1.4	90.2	12.1	146.4
7/28/2015	80.9	44.6	85.9	8.9	52.9
7/29/2015	79	32	90.1	12.2	112.9
7/30/2015	73.1	26.8	65.5	9.2	83.6
7/31/2015	76.9	12.1	49.1	8.5	72.9
8/1/2015	93.1	32.4	231.6	4.2	17.8
8/2/2015	2.3	25.9	108.1	9.4	4.2
8/3/2015	17.6	21.7	68.4	0.6	14.6
8/4/2015	39.2	1	29.6	1.6	7
8/5/2015	14.8	0.3	41.3	6.3	17.3
8/6/2015	26.2	6.9	68.3	4.5	13.5
8/7/2015	11.7	1.4	35.6	3.8	11.8
8/8/2015	3.7	1.8	138.7	9.4	13.7
8/9/2015	0	1.8	56.5	7.3	13.9
8/10/2015	0	0.5	34.6	5.2	12.7
8/11/2015	1.9	0	53.4	5.8	15.6
8/12/2015	2.7	0.1	179	13.2	13.2
8/13/2015	2.3	0.1	144.2	4.9	6.8
8/14/2015	4.4	0.6	61.2	5.8	6.7
8/15/2015	3.5	0.9	138.7	10.9	5.9
8/16/2015	2	0.6	67.2	10.4	10.5
8/17/2015	0.9	0.1	0	7.2	3.3
8/18/2015	1.2	0.7	0	6.4	1.6
8/19/2015	2.1	0	0	2.6	0
8/20/2015	2.8	0	0	0	0
8/21/2015	4	0	0	0	0
8/22/2015	8.3	0	0	0	0
8/23/2015	8	0	0	0	0
8/24/2015	5	0	0	0	0
8/25/2015	1	0	0	0	0
8/26/2015	2	0	0	0	0