2012 Indiana Mobile Acoustic Bat Survey Program

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INTRODUCTION

Twelve of the 13 bat species identified from Indiana are currently listed as endangered or special concern by the Indiana Department of Natural Resources (IDNR). Whereas winter populations of cave-dwelling bats have been regularly monitored in Indiana since the early 1980s, less is known about their summer range and the status of non-cave hibernating bats. As hibernacula surveys provide abundance estimates only for cave-dwelling bats, it is necessary to employ supplementary methods to gather information on summer bat populations for all resident species. With additional threats to bats from wind farm development and White-nose Syndrome (WNS), and given the biologic, economic, and intrinsic value of bats, it is prudent to monitor both their winter and summer populations to aid future conservation efforts.

Recent advances in acoustics technology for wildlife monitoring provide a relatively inexpensive means to gather data on bat populations across large geographic areas. The IDNR conducted pilot mobile acoustic surveys for summer bat populations in 2011 and completed the first summer of statewide surveying in 2012. This report summarizes the methods and results from mobile acoustic bat surveys that were conducted in Indiana in 2012.

METHODS

Indiana's mobile acoustic bat surveys collect data on summer bat populations by attaching an ultrasonic microphone to the roof of a vehicle and driving a predefined route. Echolocation calls detected during surveys are processed and saved by a bat detector and hand-held computer. Data are then analyzed using a quantitative automated process to identify species or species groups, when possible, and to determine relative numbers of bats in the survey areas. The same routes are driven annually, thus allowing analysis of population trends at both spatial and temporal scales.

Surveyed routes in 2012 were each driven two to four times across a six-week window beginning 26 May and terminating 7 July. Surveys began approximately 20 minutes after local sunset time and were driven at a target speed of 15 to 18 mph. Routes were between 25.1 and 29.1 miles in length (mean = 27.1) with one route per county. Start and end points for each route alternated between successive surveys. For example, if a route was driven north-to-south for the first survey, it was then driven south-to-north for the next survey. Surveys were not begun in temperatures below 55° F or in the event of rain or strong, steady winds. Survey equipment included the roof-mounted microphone, an Anabat SD2 bat detector, a Hewlett Packard iPAQ211 hand-held computer to interface with the Anabat SD2, a compact flash GPS unit to record the location of each acoustic file, and other pertinent items (instructions, route maps, datasheets, thermometer, vehicle GPS navigation unit, batteries and cables).

Acoustic files were analyzed using a combination of Titley Scientific AnalookW (version 3.8.17) filters developed by the IDNR and Bat Call Identification, Inc. (BCID version 10) software. A general bat call filter was first used to isolate files containing bat calls and omit those with only extraneous noise from insects, birds, wind, road noise, and other sources of static. Files with bat calls were then filtered into one of the following six species or species group categories: (1) hoary (*Lasiurus cinereus*), (2) hoary/big brown (*Eptesicus fuscus*)/silver-haired (*Lasionycteris noctivagans*), (3) eastern red (*L. borealis*)/ evening (*Nycticeius humeralis*), (4) eastern pipistrelle

Table 1: AnalookW filter values for each of the six filter groups. Call fragments were ignored if less than 1.5 µs and joined if gaps between pulses were less than 2.0 µs. All other filter variables were left at default values.

Species/Group Filter	Smoothness	Fc (kHz)	Sc (OPS)	Fmin (kHz)	Fmax (kHz)	Sweep (kHz)	Dur (ms)	Minimum call rate (pulses per second)
All Bats	15	16-60	1-550	16-60	17-120	2-100	1-100	-
Hoary	15	16-20	1-150	16-60	17-120	2-100	3-100	2
Hoary/Big Brown/Silver-haired	15	20-29	1-150	16-60	17-120	2-100	3-100	2
Eastern Red/Evening	15	32-39.5	1-45	16-60	17-120	2-100	3-100	2
Eastern Pipistrelle	15	40-50	1-35	16-60	17-120	2-100	3-100	2
***Myotis* spp.**	15	39.5-50	55-550	16-60	17-120	2-100	1-7	2

Table 2: Accuracy assessment of species and species group classification methods against a known call library. The call library included files containing multiple species and calls of suspect quality recorded in a variety of conditions and geographic locations. Egregious identification errors in the accuracy assessment (*e.g.*, eastern pipistrelle identified as hoary) are predominantly the result of multiple species present in that particular call file and therefore are generally not true misidentifications.

	Hoary	Big Brown / Silver-haired	Eastern Red	Evening	Eastern Pipistrelle	*Myotis* spp.	Total
Hoary	56	9	0	0	1	2	**68**
Big Brown/Silver-haired	3	100	0	0	1	0	**104**
Eastern Red	0	0	19	10	2	18	**49**
Evening	0	0	6	48	5	9	**68**
Eastern Pipistrelle	0	0	3	0	62	7	**72**
***Myotis* spp.**	0	0	1	1	4	239	**245**
Unclassified Bat Call	4	10	1	2	0	4	**21**
Missed Bat Call	11	1	0	0	1	0	**13**
Total	**74**	**120**	**30**	**61**	**76**	**279**	**640**
Species Accuracy	**75.7%**	**83.3%**	**63.3%**	**78.7%**	**81.6%**	**85.7%**	**-**
Overall Accuracy	**-**	**-**	**-**	**-**	**-**	**-**	**81.9%**

(*Perimyotis subflavus*), (5) *Myotis* spp., and (6) unclassified (Table 1). Unclassified calls were those that passed only the general bat call filter and were of poor quality or short duration such that ability to identify a species or species group was highly suspect. Call files identified as either hoary/big brown/silver-haired or eastern red/evening were then analyzed using BCID. The resulting identifications were grouped into one of seven final categories: (1) hoary, (2) big brown/silver-haired, (3) eastern red, (4) evening, (5) eastern pipistrelle, (6) *Myotis* spp., and (7) unclassified. Results were evaluated using a detector-hour (rather than a per-mile) metric to mitigate for variations in driving speeds among surveyors. An accuracy assessment was also performed by applying the methods to a known call library (Table 2).

RESULTS

In 2012, 198 surveys were conducted by seven IDNR staff members and 15 contracted surveyors in 57 of Indiana's 92 counties (Figure 1). Of those surveys, 181 returned complete acoustics data. Partial or incomplete data were salvaged from the remaining 17 surveys that were truncated due to equipment failure/misuse (*n* = 11), rain (*n* = 3), or road closure/route detour (*n* = 3). The effort yielded 34,809 acoustic files, of which 11,270 contained echolocation calls of bats. Surveys had a mean of 33.3 bat calls per detector-hour, with a minimum of 2.1 (Benton on 30 May) and a maximum of 101.1 (Greene on 5 July) (Figure 2). The number of call files per completed survey had a mean of 57.7 and ranged from 4 (Adams on 26 May, Benton on 30 May) to 177 (Crawford on 3 July). The number of bat calls per survey trended upward from the beginning of the survey window in late May until the

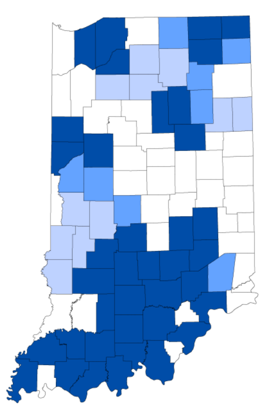

Figure 1: Total number of surveys per county, 2012. Dark blue = 4, blue = 3, light blue = 2, white = not surveyed.

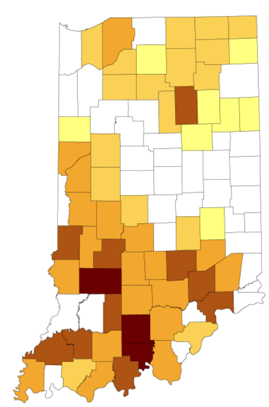

Figure 2: Mean number of bat calls per detector-hour, 2012. Brown: 60-75, dark orange: 45-60, orange: 30-45, light orange: 15-30, yellow: 0-15, white: not surveyed.

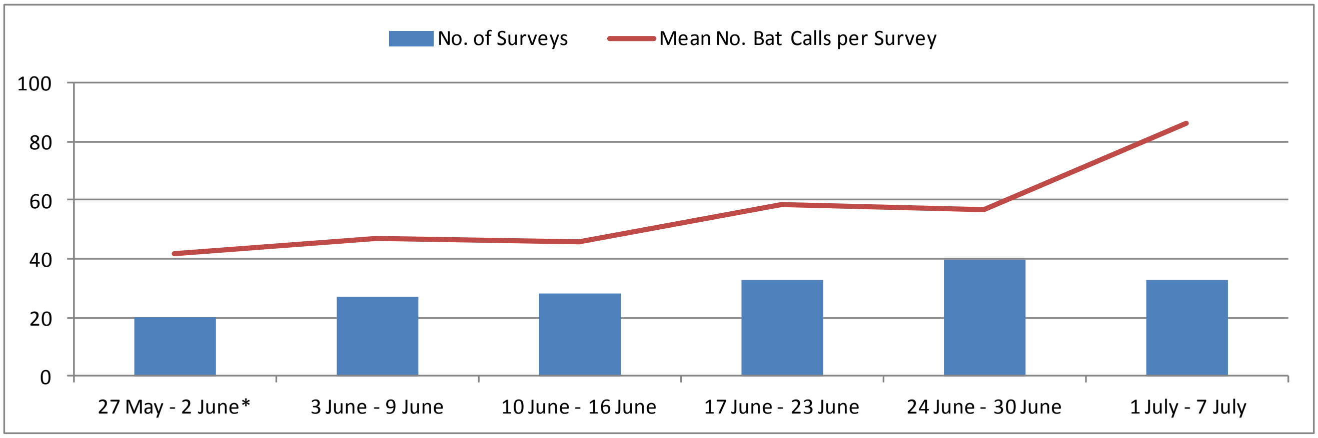

Figure 3: Total number of surveys by week and average number of bat calls per survey by week, 2012. Partial surveys (n = 17) excluded. * One survey on 26 May is included for the week of 27 May - 2 June.

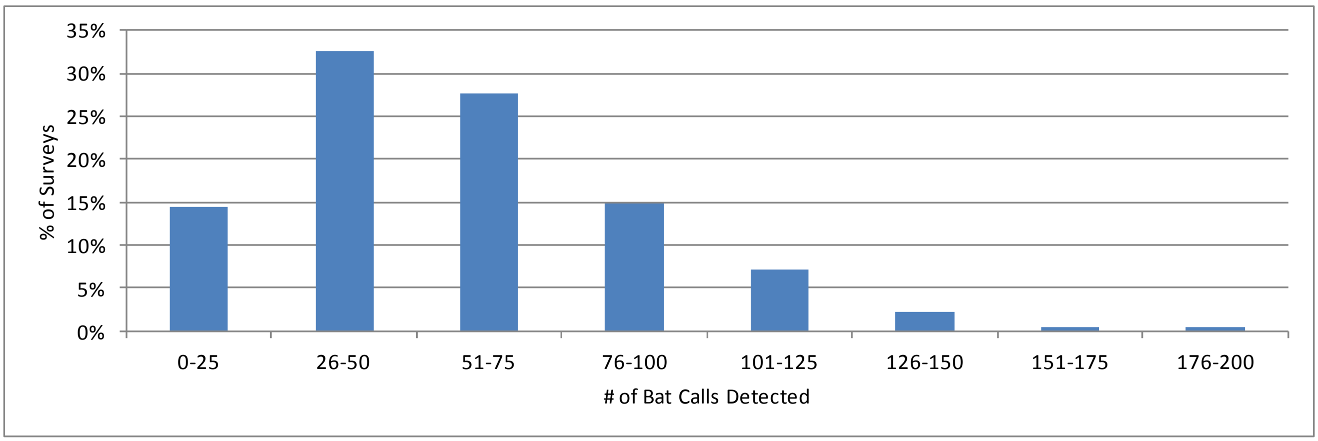

Figure 4: Number of bat calls detected, 2012. Partial surveys (n = 17) excluded.

completion of surveying in early July (Figure 3). Nearly a third of completed surveys (32.6%) had between 26 and 50 bat calls detected, while 27.6% of completed surveys had between 51 and 75 bat calls detected (Figure 4) (Table 3).

Analysis labeled 2,783 files (24.7%) unclassified because they consisted of poor-quality sequences with few or fragmented pulses and could not be confidently identified to species or species group. The remaining 8,487 files were classified as eastern pipistrelles (20.8%), big brown/silver-haired bats (19.8%), eastern red bats (17.9%), evening bats (16.0%), *Myotis* spp. (15.2%), and hoary bats (10.2%). Eastern pipistrelles were the most abundant species or species group in three of seven natural region areas (Bluegrass, Highland Rim and Shawnee Hills, Southern Bottomlands and Southern Lowlands), eastern red bats were most abundant in one natural region (Grand Prairie), and the big brown/silver-haired group was most abundant in three natural region areas (Black Swamp and Central Till Plain, Northern Lakes, Northwestern Morainal) (Figure 5) (Table 4).

Compared to identifications using BCID exclusively, the methods used for this analysis produced a net increase in correct identifications of 6.9% (from 75.0% to 81.9%), an increase in correct identifications in four of the six species classifications (excluding unclassified), and a decrease in the omission error in five of the six species classifications (excluding unclassified).

DISCUSSION

There was a general trend of more bats per detector-hour in the southern region of Indiana compared to the northern region, perhaps due to the greater proportion of agricultural lands in northern Indiana. Calls of eastern pipistrelles were regularly detected in southern counties while they were nearly or entirely absent from surveys conducted in northern counties, a pattern which reflects the established range of this species (Whitaker and Mum-

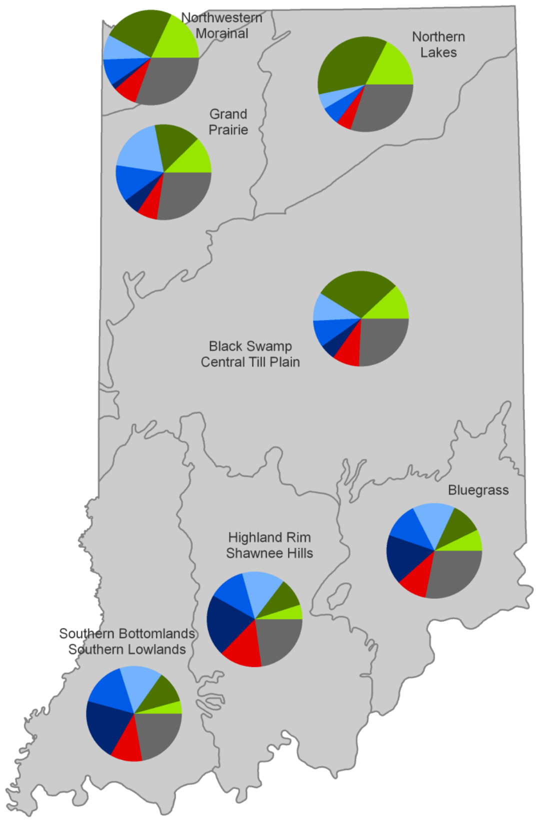

Figure 5: Percentage species representation by natural region areas, 2012. Light green = hoary, dark green = big brown/silver-haired, light blue = eastern red, blue = evening, dark blue = eastern pipistrelle, red = *Myotis* spp., gray = unclassified.

ford 2009) and also serves to corroborate the automated identification method employed. Most calls identified as big brown/silver-haired bats are likely big brown bats because silver-haired bats are an "uncommon spring and fall migrant" (Whitaker and Mumford 2009). Hoary, big brown/silver-haired, eastern red, evening, and *Myotis* spp. bats appeared relatively evenly distributed across the state, although hoary and big brown/silver-haired bats comprised a higher percentage of species representation in northern Indiana, whereas eastern red, evening, and *Myotis* spp. bats appeared more abundant in the south. The acoustics data generally agree with known ranges of these species in Indiana as described by Whitaker and Mumford (2009): the hoary bat "occurs throughout Indiana but is probably uncommon" and "appears to show a definite tendency to roost in areas where trees are scattered and have openings below their crowns"; the eastern red bat "occurs throughout Indiana" and is "an abundant summer resident in many sections of the state"; and *Myotis* spp. bats have diverse distributions but generally occur throughout the state. One discrepancy is the comparable number of evening bats to eastern reds. The evening bat is considered an "uncommon summer resident in Indiana and is most abundant in the southern part of the state" (Whitaker and Mumford 2009). The relatively high number of evening bats is perhaps a result of misidentifications of eastern reds as these two species have considerable overlap in call characteristics.

Although 2012 was the first year for statewide surveying, a subset of these data may be compared to the limited data collected in 2011. Eighteen counties, mostly in the southern half of Indiana, were surveyed between 26 May and 7 July in both 2011 and 2012. Of these, 14 (78%) experienced a decline in the number of bat calls per detector-hour. Looking at species representation explicitly in the Highland Rim and Shawnee Hills natural regions (the only natural regions with substantial data from both survey years), the percentage of eastern pipistrelles dropped from 30.2% in 2011 to 20.9% in 2012, while calls of *Myotis* spp. bats dropped from 17.1% in 2011 to 14.5% in 2012 (Figure 6). Although these observations are derived from limited data from only two consecutive summers, it is per-

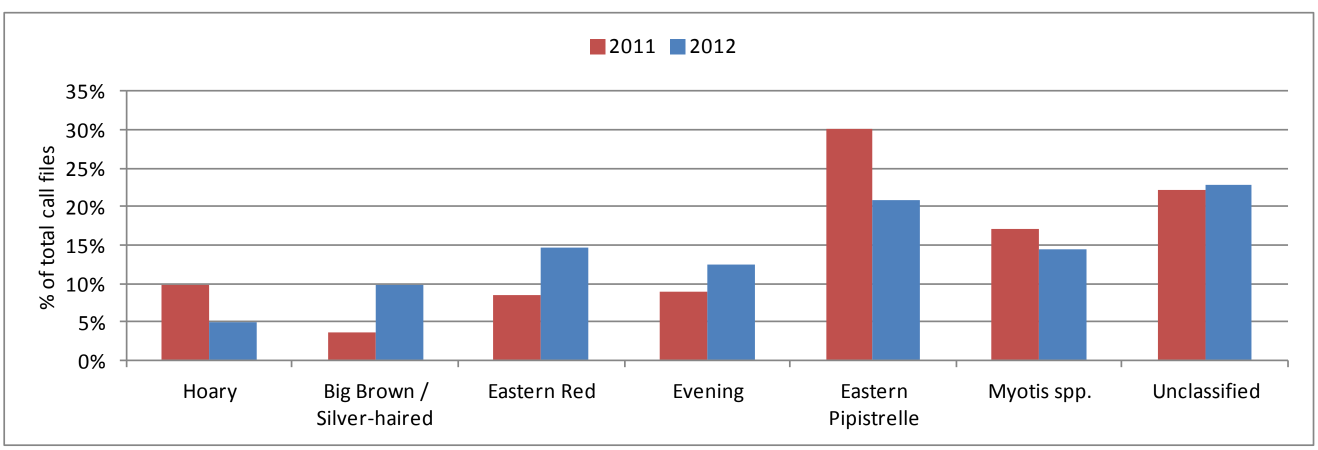

Figure 6: Percentage species representation in the Highland Rim and Shawnee Hills natural regions in 2011 and 2012.

Table 3: Mobile acoustic bat surveys (n = 198) conducted in Indiana, May-July 2012. * Denotes a survey with incomplete data.

County	No. Surveys	Total Miles	Total Detector-hours	Mean Speed (mph)	Total Calls Detected	Mean Calls per Detector-hour
Adams	2	53.6	3.38	15.8	17	5.0
Bartholomew	4	104.0	6.30	16.5	376	59.7
Benton	4	111.2	7.40	15.0	65	8.8
Brown	4	109.2	6.90	15.8	308	44.6
Clark	4	110.4	6.92	16.0	195	28.2
Clay	2	55.0	3.42	16.1	124	36.3
Crawford	4	104.0	7.32	14.2	497	67.9
Decatur	4	106.8	6.67	16.0	206	30.9
Dekalb	3*	63.6	4.57	13.9	60	13.1
Dubois	4	104.0	6.00	17.3	264	44.0
Elkhart	3*	64.9	4.12	15.8	78	18.9
Fountain	3*	62.4	4.33	14.4	155	35.8
Fulton	2	54.2	3.37	16.1	79	23.5
Gibson	4*	83.3	4.85	17.2	241	49.7
Grant	4	102.0	6.55	15.6	66	10.1
Greene	4**	110.9	6.88	16.1	430	62.5
Harrison	4	113.2	7.88	14.4	254	32.2
Hendricks	3	83.4	5.35	15.6	128	23.9
Huntington	3*	66.1	4.58	14.4	57	12.4
Jackson	4	106.4	6.70	15.9	294	43.9
Jefferson	4*	105.5	6.13	17.2	283	46.1
Jennings	4	106.4	6.45	16.5	306	47.4
Kosciusko	2	57.8	3.67	15.8	68	18.5
Lagrange	4*	92.3	6.00	15.4	155	25.8
LaPorte	4	102.8	6.37	16.1	195	30.6
Lawrence	4	112.4	6.97	16.1	235	33.7
Marshall	2*	38.4	2.33	16.5	32	13.7
Martin	4	115.2	7.22	16.0	360	49.9
Miami	4	112.8	7.60	14.8	196	25.8
Monroe	4	100.8	6.25	16.1	253	40.5
Montgomery	3	77.7	4.97	15.6	118	23.8
Morgan	4	108.4	6.40	16.9	238	37.2
Noble	4	105.6	6.88	15.3	163	23.7
Orange	4*	100.6	6.23	16.1	411	65.9
Owen	4	108.0	6.63	16.3	391	58.9
Parke	2	58.2	3.80	15.3	158	41.6
Perry	4**	101.2	6.73	15.0	334	49.6
Pike	4**	70.0	4.17	16.8	225	54.0
Porter	4	100.8	6.57	15.4	149	22.7
Posey	4	105.6	6.43	16.4	232	36.1
Pulaski	2	51.0	3.02	16.9	67	22.2
Putnam	2	57.4	3.55	16.2	154	43.4
Ripley	3*	90.3	5.03	17.9	163	32.4
Rush	4	110.4	6.93	15.9	99	14.3
Shelby	4	113.6	7.42	15.3	186	25.1
Spencer	4	104.4	7.58	13.8	275	36.3
Starke	4	114.4	7.17	16.0	164	22.9
Steuben	4*	99.5	6.27	15.9	134	21.4
Sullivan	2	56.2	4.18	13.4	153	36.6
Tippecanoe	4	114.0	7.52	15.2	150	20.0
Vigo	2	53.8	3.45	15.6	173	50.1
Wabash	4	113.2	7.03	16.1	331	47.1
Warren	4	106.4	7.07	15.1	267	37.8
Warrick	4	109.6	7.40	14.8	188	25.4
Washington	4	108.0	6.40	16.9	219	34.2
Wells	2	54.8	3.63	15.1	43	11.8
Whitley	3	75.3	5.25	14.3	108	20.6
Total	**198**	**5181.4**	**330.18**	**-**	**11270**	**-**
Mean	**3.47**	**90.9**	**5.79**	**15.7**	**197.7**	**33.3**

Table 4: Mean number of species or species groups detected per survey during mobile acoustic surveys in Indiana, May-July 2012. Data are listed in an approximate north-to-south direction by, and within, natural region. Incomplete surveys (n = 17) excluded.

County	No. Surveys	Hoary	Big Brown / Silver-haired	Eastern Red	Evening	Eastern Pipistrelle	*Myotis* spp.	Unclassified	All Bats
Northwestern Morainal Natural Region									
LaPorte	4	7.8	14.0	4.5	3.8	0.8	4.5	13.5	**48.8**
Porter	4	7.8	6.8	2.8	4.0	0.8	2.5	12.8	**37.3**
Northern Lakes Natural Region									
Steuben	3	2.7	13.7	1.7	1.0	0.0	1.7	12.3	**33.0**
Lagrange	3	5.7	21.0	2.7	2.7	0.0	2.3	11.0	**45.3**
Elkhart	2	4.5	11.0	0.5	0.5	0.5	2.0	9.5	**28.5**
Noble	4	9.3	15.0	2.0	3.0	0.8	0.8	10.0	**40.8**
Marshall	1	6.0	1.0	0.0	1.0	0.0	1.0	12.0	**21.0**
Kosciusko	2	7.5	10.0	2.0	3.5	0.5	0.0	10.5	**34.0**
Whitley	3	7.3	9.0	1.0	3.3	0.7	3.7	11.0	**36.0**
Fulton	2	5.0	10.5	5.0	4.0	0.0	2.0	13.0	**39.5**
Grand Prairie Natural Region									
Starke	4	3.3	5.0	10.8	5.5	1.8	3.0	11.8	**41.0**
Pulaski	2	4.0	9.5	5.5	4.0	0.5	1.5	8.5	**33.5**
Benton	4	2.5	2.3	2.3	1.8	0.8	0.5	6.3	**16.3**
Tippecanoe	4	7.8	8.5	4.0	4.0	1.0	1.5	10.8	**37.5**
Warren	4	6.5	7.5	15.3	9.0	6.0	6.8	15.8	**66.8**
Black Swamp and Central Till Plain Natural Regions									
Dekalb	2	4.5	9.0	1.0	1.0	0.5	0.5	12.0	**28.5**
Adams	2	2.0	1.0	0.5	1.0	0.0	1.0	3.0	**8.5**
Huntington	2	4.5	7.5	0.0	0.5	0.5	1.5	4.0	**18.5**
Wells	2	2.0	13.0	1.0	1.0	0.5	1.5	2.5	**21.5**
Wabash	4	6.0	34.0	8.0	6.8	4.8	6.0	17.3	**82.8**
Miami	4	8.5	13.3	6.5	4.0	1.8	3.3	11.8	**49.0**
Grant	4	3.8	5.5	1.3	1.5	0.8	0.3	3.5	**16.5**
Fountain	2	2.5	11.0	7.0	7.5	3.5	13.5	18.0	**63.0**
Montgomery	3	6.0	5.0	3.3	5.0	4.3	4.7	11.0	**39.3**
Hendricks	3	4.3	5.3	3.0	4.0	4.0	6.3	15.7	**42.7**
Rush	4	3.0	8.0	3.0	3.0	0.8	1.3	5.8	**24.8**
Bluegrass Natural Region									
Shelby	4	2.5	13.3	4.0	6.0	3.8	4.3	12.8	**46.5**
Decatur	4	2.8	6.3	7.0	6.5	10.0	5.8	13.3	**51.5**
Ripley	2	8.5	4.0	6.5	5.5	8.5	6.5	21.0	**60.5**
Jennings	4	6.5	5.5	11.8	10.3	18.8	6.8	17.0	**76.5**
Jefferson	3	5.7	3.0	12.0	8.7	7.3	6.7	18.0	**61.3**
Clark	4	1.3	5.5	8.5	6.0	7.5	5.0	15.0	**48.8**
Highland Rim and Shawnee Hills Natural Regions									
Putnam	2	4.0	8.5	7.5	5.5	18.5	15.5	17.5	**77.0**
Morgan	4	5.3	5.0	10.0	7.3	7.0	9.3	15.8	**59.5**
Owen	4	8.3	9.8	11.0	12.5	13.8	16.5	26.0	**97.8**
Monroe	4	5.5	8.3	4.0	6.5	18.5	6.0	14.5	**63.3**
Brown	4	4.8	10.5	13.0	10.5	15.0	7.8	15.5	**77.0**
Bartholomew	4	5.3	16.3	8.0	11.8	15.8	12.3	24.8	**94.0**
Greene	2	2.5	4.5	13.5	8.5	21.0	19.0	20.5	**89.5**
Jackson	4	2.5	6.8	15.0	10.0	12.8	9.8	16.8	**73.5**
Lawrence	4	1.5	3.5	9.5	9.0	11.8	9.8	13.8	**58.8**
Martin	4	3.5	7.0	12.8	9.5	21.5	16.5	19.3	**90.0**
Washington	4	2.3	2.5	8.8	8.8	11.8	8.8	12.0	**54.8**
Orange	3	3.3	8.7	15.3	16.0	30.0	13.3	25.3	**112.0**
Dubois	4	4.0	10.3	10.3	7.0	12.5	8.0	14.0	**66.0**
Crawford	4	3.3	7.5	21.8	17.3	30.8	17.5	26.3	**124.3**
Harrison	4	1.8	3.5	12.3	8.8	11.8	10.5	15.0	**63.5**
Perry	2	6.5	14.5	11.0	16.0	16.0	12.5	17.0	**93.5**
Southern Bottomlands and Southern Lowlands Natural Regions									
Parke	2	6.5	12.0	11.0	9.0	15.5	6.0	19.0	**79.0**
Vigo	2	3.0	7.5	9.5	10.5	25.0	4.5	26.5	**86.5**
Clay	2	2.0	2.0	10.0	11.5	16.0	8.5	12.0	**62.0**
Sullivan	2	5.5	9.0	12.5	8.5	18.5	8.0	14.5	**76.5**
Gibson	3	3.3	8.0	11.0	17.3	8.7	6.7	16.7	**71.7**
Pike	2	1.5	9.5	14.5	15.5	16.0	12.0	22.5	**91.5**
Warrick	4	2.0	2.0	5.5	5.8	12.8	7.3	11.8	**47.0**
Spencer	4	1.8	4.8	11.0	9.5	14.3	12.3	15.3	**68.8**
Posey	4	3.3	15.8	8.8	12.0	7.3	3.0	8.0	**58.0**

haps indicative of declining numbers of cave-dwelling bats as a result of WNS, which was first detected in Indiana in 2011. Additional data, however, collected during subsequent years are needed to make more meaningful interpretations of long-term trends in summer bat populations statewide.

The use of filters allowed for acoustic files to be pre-grouped by known variable parameters representative of typical bat calls of a particular species or species group. Although many characteristics of bat calls overlap among species (*e.g.*, little brown and Indiana bats, eastern red and evening bats) and no automated acoustic identification process is completely accurate, the use of filters does ensure that each call is assigned to a particular species or species group based on an established set of typical or characteristic call parameters. Pre-filtering acoustic files before using BCID also allowed for greater accuracy in the identification of bat calls compared to using BCID exclusively. The call library used for the accuracy assessment included files from a wide geographic area which potentially confounded the results due to geographic variations in call characteristics (Murray et al. 2001). The library also contained files with multiple species as well as call files of suspect quality recorded in a variety of environmental conditions. Some studies (*e.g.*, Britzke et al. 2001, Britzke et al. 2011) report accuracy rates of > 90% for call sequences of species or species groups. However, these accuracy assessments and other related studies are often done with calls recorded in near-ideal conditions that may not always be representative of the typical mobile surveying environment. Britzke et al. (2011) recorded calls "in open areas to permit extended visual contact, increase the length and quality of call sequences, and eliminate potential impacts of structural clutter on echolocation calls". Murray et al. (2001) transported bats to a predetermined release site and usually released them in large, open areas 100 to 300 meters in diameter. The nature of mobile surveying and the fixed position of the roof-mounted microphone also prevent the flight of bats from being tracked, unlike a surveyor holding the detector in an open field and following bat movements with the microphone. Additionally, the 2011 Britzke study reported overall accuracy rates for individual call pulses (rather than sequences) ranging from 76% to 87%, which are comparable to the overall 81.9% accuracy rate for this analysis.

There are limitations inherent to the use of both filters and automated identification software. Neither differentiates between multiple bat calls in a single acoustic file or isolates a single bat that has produced a call that spans across multiple files. Breaks in pulses can also cause filters or BCID to incorrectly identify the upper portion of a broken pulse as an entirely separate bat call. Methods used in the analysis first identified lower-frequency call files and progressed to files containing only higher-frequency pulses, which eliminated the erroneous identification of broken pulses as separate, higher-frequency bats. This process, however, also introduced a small bias for lower-frequency calls because any file containing multiple species was identified as the lowest-frequency bat. The quality of a recorded call also varies substantially dependent upon the environment in which the bat is flying as well as whether it is producing search phase, approach phase, or feeding buzz pulses at the time the call was recorded. Some species, such as the northern long-eared bat, are also more difficult to detect because they emit lower amplitude pulses within higher-frequency calls which attenuate more rapidly. Calls of eastern red bats, while often easily identified by manual examination, pose a particular challenge to automated identification processes due to their erratic changes in frequency which produce pulses and sequences similar to other species, in particular the evening bat. Despite these limitations, the ability to identify a species or species group from acoustic files using automated identification software is imperative due to the potentially enormous volume of data and to ensure repetitive consistency in the standards applied.

Mobile acoustic bat surveys are also subject to the same environmental variables as most field studies. Temperature, humidity, wind velocity, cloud cover, road noise, and moon phase and visibility are just some of the factors that can affect nightly bat activity. Variations in surveyor behavior can also impact data collection. Data has been collected for these variables for each survey, and while different analyses could be performed to investigate the impact of any one of these factors on bat activity, the primary purpose of this study is not to focus on survey-specific conditions and results, but to identify general trends in Indiana's summer bat populations.

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