Statewide Mobile Bat Acoustic Survey

2020

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Dear Volunteers –

We at the Ohio Division of Wildlife would like to express our deepest gratitude for the contributions you have made to our mobile acoustic bat survey program over the last ten years. Whether you participated every year or just this past year, your efforts are greatly appreciated. Since 2011, 891 mobile bat surveys were completed with your help. Such a large-scale, long-term project would not have been possible with just our staff alone! As we all know, bat populations are facing enormous pressure and these data will be instrumental in helping us monitor and protect the populations that remain in Ohio. Thank you again for giving up some of your evenings each summer to participate in this important program. We hope that you continue to participate in this project and other Division of Wildlife community science opportunities in the future.

Kendra S. Wecker
Chief, Division of Wildlife

1. Introduction

In 2011, the Ohio Division of Wildlife (ODOW) implemented a mobile acoustic monitoring program after White-nose Syndrome (WNS) was discovered in the state. WNS is a fungal infection caused by the pathogen *Psuedogymnoascus destructans (Pd)* that affects bats during winter hibernation. As the infection progresses, bats begin arousing from torpor more frequently, eventually causing death due to depletion of fat reserves and/or dehydration (Cryan et al. 2010; Verant et al. 2014). Infected bats that subsist through winter often have lower survival rates the following spring. In 2011, it was estimated that between 5.7-6.7 million bats in the eastern United States and Canada had died from WNS since its discovery in the U.S. in 2006; since the fungus has continued to move westward since then, this number is likely much higher today. Data from winter colony counts of two hibernacula in Ohio, one in Lawrence County and one in Preble County, have shown population losses of 99% for bats overwintering in those locations.

Ohio has 10 species of commonly found bats (Table 1), all of which are state-listed, and two of which are federally listed: the Indiana bat (*Myotis sodalis)* and the northern long-eared bat (*Myotis septentrionalis).* Six of these species have been confirmed susceptible to WNS infection and three more have been found with *Pd* spores. In July 2020, the 10th year of mobile acoustic surveys were completed with the help of volunteers for the purpose of continuing to monitor populations of bats throughout Ohio.

Common Name	**Scientific Name**	**Species Code**	**Frequency group**
Cave Bats			
Big Brown bat	*Eptesicus fuscus*	EPFU	Low
Tricolored bat	*Perimyotis subflavus*	PESU	Mid/high
Little brown bat	*Myotis lucifugus*	MYLU	High
Northern long-eared bat	*M. septen-trionalis*	MYSE	High
Indiana bat	*M. sodalis*	MYSO	High
Small-footed bat	*M. leibii*	MYLE	High

Common Name	**Scientific Name**	**Species Code**	**Frequency group**
Tree bats			
Hoary bat	*Lasiurus. cinereus*	LACI	Low
Silver-haired bat	*Lasionycteris noctivagans*	LANO	Low
Evening bat	*Nycticeius humeralis*	NYHU	Mid
Eastern red bat	*Lasiurus borealis*	LABO	Mid/high

Table 1 – Common names, scientific names, species codes, and frequency group for Ohio's common bats. Frequency groups are based on the minimum frequency of the bat's echolocation call. Some bats fall into two groups.

2. Methods

2.1. Data Collection

Bat calls were recorded using Anabat Secure Digital II units. Ultrasonic microphones were attached to the top of volunteers' vehicles using Anabat car mounts and directed off-center toward the back of the vehicle to prevent wind interference. The microphones were then connected to the Anabat system inside the vehicle. Data was recorded either to a Personal Digital Assistant (PDA, HQ iPaq) attached to the Anabat or to a compact flash card in the Anabat for those using a GPS mouse device.

The following data were catalogued at the beginning and end of each survey: temperature (°F), wind speed (mph), percent cloud cover (0, 25, 50, 75, 100%), time, moon visibility (yes/no), latitude, longitude, and odometer readings. Percentage of moon illuminated was determined later using moonpage.com.

Driving routes were approximately 30-mile loops on secondary roads and were driven at a speed of no more than 15 miles per hour. Most bats do not fly faster than this (Patterson and Hardin 1969; Schaub and Schnitzler 2007), so each bat pass can be considered one individual, allowing the number of bat passes to be used as an index of relative abundance (Roche et al. 2011). When originally planning routes, busy roads and highways were avoided whenever possible for the safety of volunteers and to minimize unnecessary noise interference. Volunteers were instructed to drive routes three times throughout the month of July, preferably on non-consecutive nights to minimize the possible impact of moon phase on bat activity. Surveys were conducted when temperatures were above 50°F, winds were less than ten miles per hour, and there was no precipitation or fog. All surveys began approximately 30 minutes after sunset and alternated driving direction (original or reverse) each survey.

2.2. Routes surveyed

A total of 26 routes were surveyed across Ohio in summer 2020. A map of locations can be found in appendix A and a summary of which routes have been completed each year can be found in appendix B.

2.3. Call Processing/Species Identification for 2020 data

Recorded bat calls were classified using Bat Call ID East (BCID, v. 2.8b) and Kaleidoscope Pro (Kpro, v. 5.3.9). The following modifications were made to the default settings in BCID: *Myotis leibii* was added as a potential species, the smoothness was changed to 30, the frequency was altered to a range of 5-60, the sweep was altered to a range of 1-70, the duration was altered to a range of 1-30, and minimum pulse number was two. All other filters were kept with the default standards in BCID. These parameters were tailored to Ohio bat calls by DOW staff and BCID. They were also set up to eliminate noise and interference while allowing the highest possible amount of bat calls to be identified. All other settings remained the default. In Kpro, the bats of North America 5.1.0 classifier was used and set to neutral/balanced and Ohio species were selected. The signal parameter setting was changed to 16-120 kHz. All other settings were left as default. Output from the two programs was compared and when both programs agreed on a species identification, it was accepted, except for calls identified as *Myotis* species or evening bats. The automated ID programs often mis-identify many red bat calls as evening bats or bats in the genus *Myotis*, so all calls identified as evening bats or Myotis species were manually vetted. Calls where the two programs did not agree were also manually vetted. All calls were examined briefly to look for presence of multiple bats since the automated programs will only assign an ID to one bat per call. When a species could not be determined, either by auto-ID or manual vetting, the call was classified as “unknown species.” All calls were also assigned a frequency group (low, mid, or high) based on the minimum frequency.

Survey effort was calculated by minutes driven per mile, and detection rate was calculated as bat calls detected per survey effort (bats/min/mi). Detection rate serves as a proxy for bat abundance and will be used interchangeably throughout.

3. Results

Of the 26 routes included in the 2020 survey, not all had three nights of surveys; the Clark, Licking, and Cuyahoga Valley National Park (CVNP) routes only had two surveys completed. Two other routes, Cincinnati and Delaware, likely had equipment issues because no calls were recorded despite the routes being completed according to the data sheets. The surveyors for the Delaware route kept track of bat passes picked up by the Anabat on their data sheet, so these estimates were used in data analysis but were considered unknown frequency and species. These circumstances brought the total number of surveys for 2020 to 72, with a combined survey time of 8,590 minutes. These surveys resulted in 4,523 total bat passes. Since 2011, DOW acoustic surveys have produced 58,377 bat passes from 891 surveys.

The average bat detection rate in 2020 was 16.31 bats/min/mi. The average detection rates by frequency group for low, mid, high, and unknown bats were 10.57, 4.32, 0.99, and 0.42 bats/min/mi, respectively. The route with the highest bat abundance was CVNP with an average detection rate of 54.51 bats/min/mi, followed by Vinton with an average detection rate of 39.72 bats/min/mi. The route with the lowest bat abundance was Kelley's Island with 1.25 bats/min/mi, followed by Waldo with 5.08 bats/min/mi.

Temperature does not appear to have had an impact on bat detection rate in 2020 (Fig. 1). There is some evidence that moon illumination had a negative impact on bat activity (Fig. 2), although the correlation is not very strong, and this analysis does not include cloud cover as a factor. Taking into account survey effort, the average number of bat detections was highest during week 3, July 15-21 (Fig. 3).

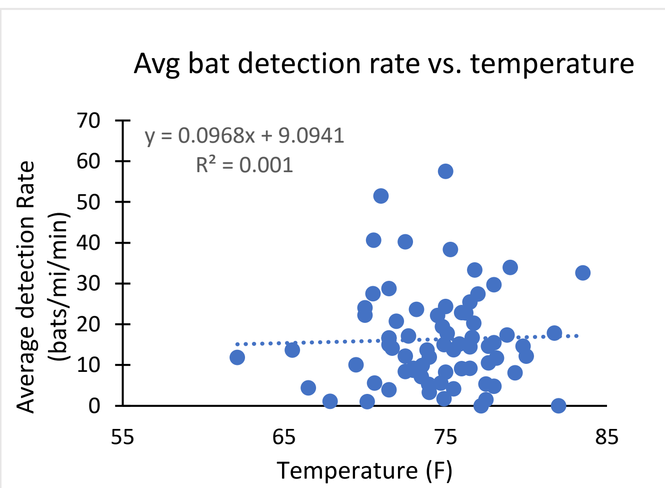

Figure 1: Average detection rate of all bats compared to average temperature on survey nights.

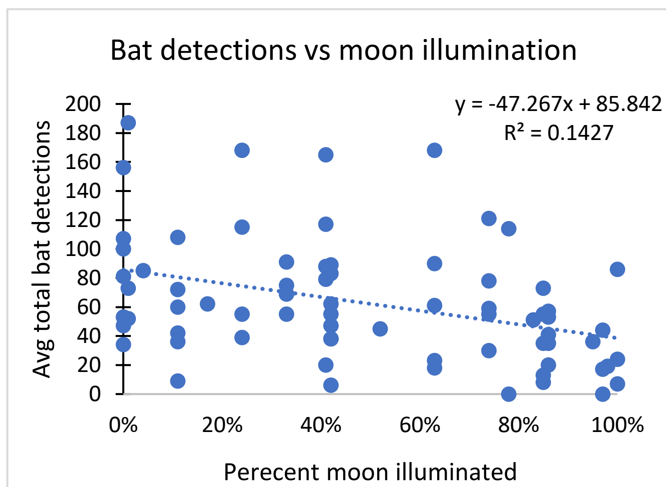

Figure 2: Average total bat detections for all routes compared to percentage of moon illuminated on survey nights.

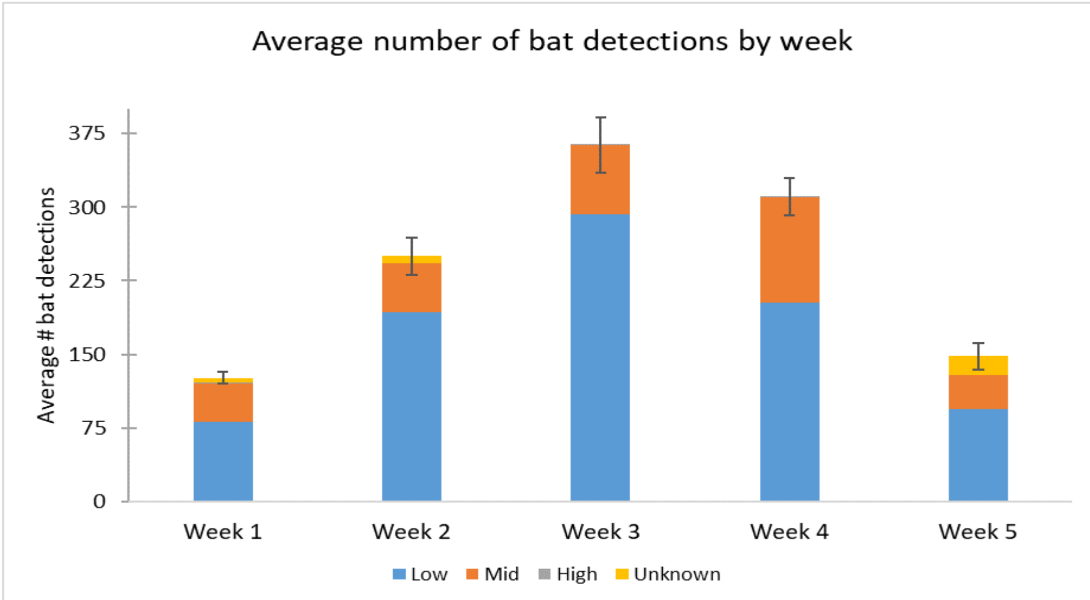

Figure 3: Average number of bat detections for each week in July, broken down by call frequency. Error bars represent one standard error. Week 1: July 1-7 (n=11), Week 2 (n=22): July 8-14, Week 3 (n=14): July 15-21, Week 4 (n=16): July 22-28, Week 5 (n=9): July 29 - Aug 4

Since 2011, overall bat abundance has declined 31% (Fig. 4) but there was an 11% increase in bat abundance from 2019 to 2020. An increase in the detection rate of low frequency bats in 2020 could be responsible for this increase (Fig. 5). Of the calls identified to species, big brown bats were the most commonly detected (Fig. 6). The ecoregion with the highest average bat detection in 2020 was the Erie Drift Plain (Fig. 7). In 2018 and 2019, the Western Allegheny Plateau ecoregion had the highest average bat detection. The ecoregion map can be found in appendix C.

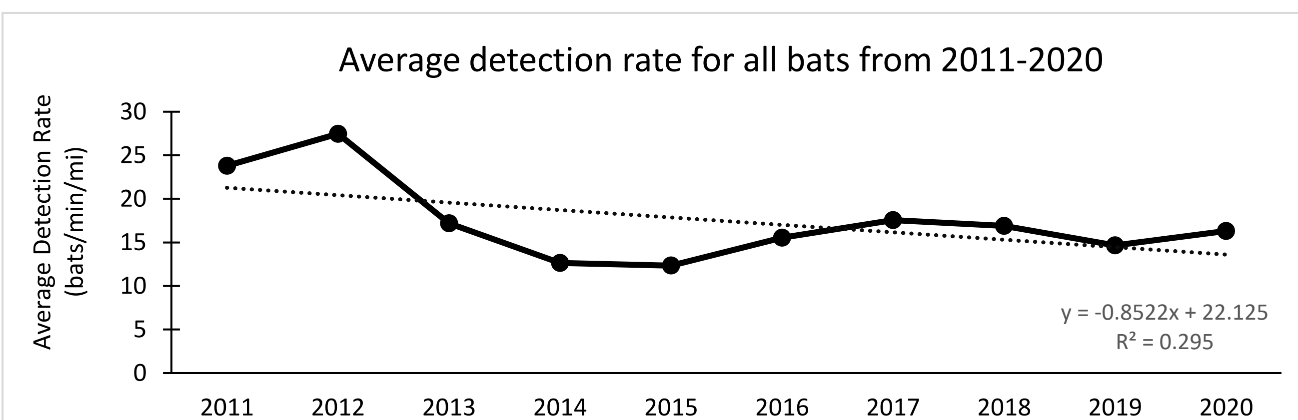

Figure 4: Average detection rate of all bats from all routes from 2011-2020. Dotted line represents an added trendline.

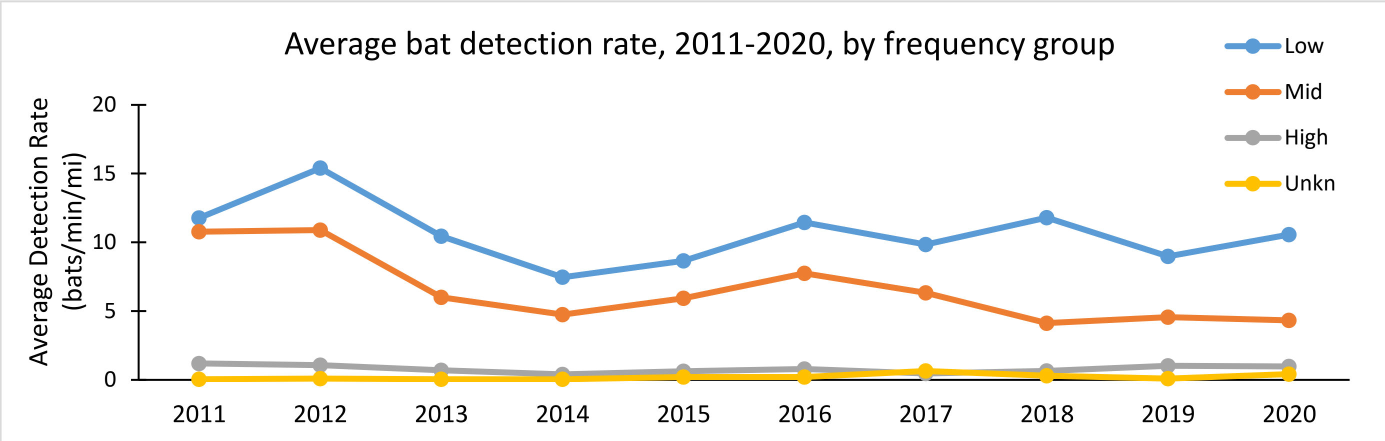

Figure 5: Average detection rate of bats from each frequency group – low, mid, high, and unclassified "unknown"– from all routes from 2011-2020. The dashed line represents the average detection rate from all routes combined.

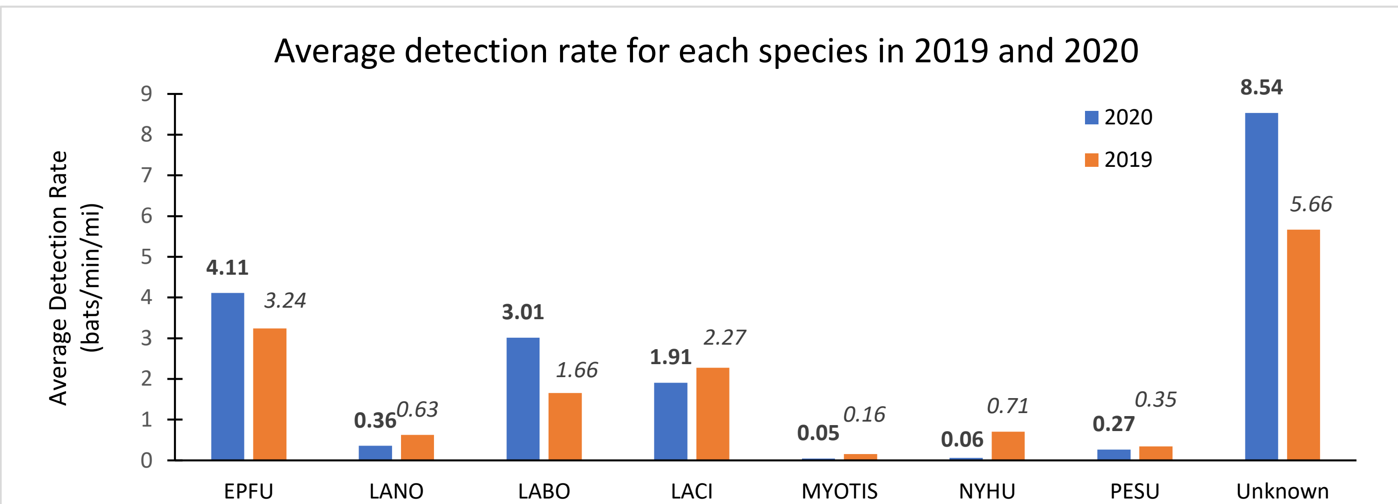

Figure 6: Average detection rate of each species of bat from all routes combined in 2019 and 2020. Italicized values are for 2019, bold values are for 2020.

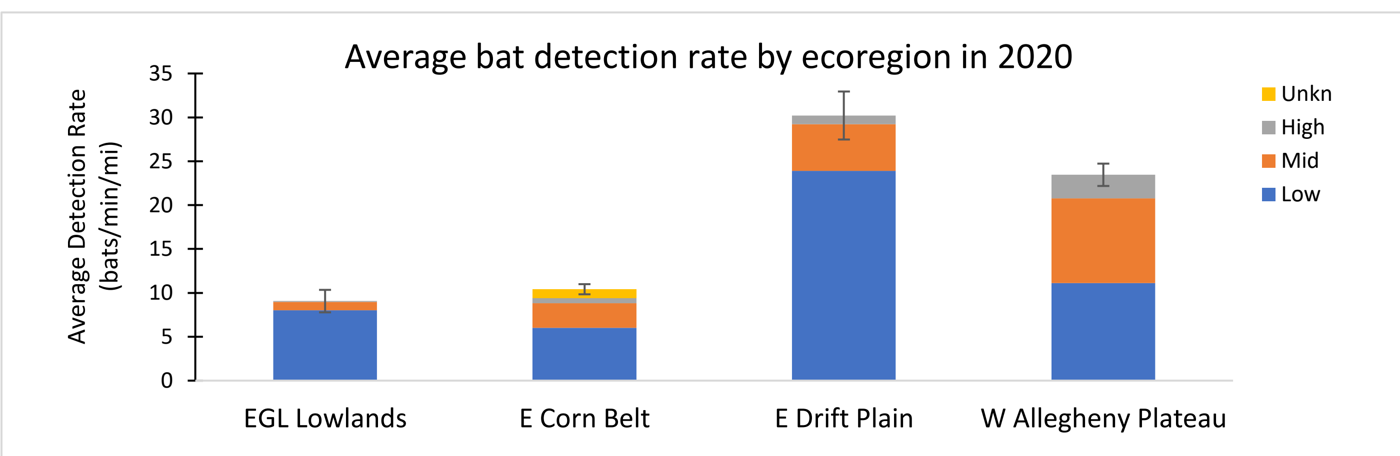

Figure 7: Bat detections in 2020 for all routes combined broken down by EPA designated level III ecoregions for Ohio. Error bars represent standard error. N routes = 3, 10, 5, and 5 from left to right.

4. Summary and Discussion

Overall bat abundance has been oscillating between a positive and negative trend since 2016. From 2019 to 2020, there was an increase in bat abundance, seemingly due to an increase in detections of low frequency bats. The CVNP route was added this year and likely accounts for this large increase in low frequency bats, as it had the highest bat detection rate of any route this year and the majority of those detections were low frequency calls. The detection rates of mid frequency and high frequency bats remained relatively unchanged compared to 2019. The small magnitude changes over the last four years may be evidence that the bat population is stabilizing around a new post-WNS population size. This pattern has been seen in bat colonies in New York. Dobny and Johnson (2018) observed a small colony of little brown bats from 2006-2017. The colony size decreased the first four years following WNS invasion but stabilized from 2010-2014 and then began increasing (Dobny and Johnson 2018). Langwig et al. (2012) also found evidence that surviving bat populations begin to stabilize about four years after WNS has become established in an area.

Of the calls that could be identified to species, big brown bats and red bats were the two species most commonly detected, which is not surprising. Although big brown bats can become infected with *Pd*, they do not seem as susceptible to mortality from WNS, perhaps because they are larger and hardier than *Myotis* and *Perimyotis* species. Our winter surveys have also found that many big brown bats hibernate in above ground hibernacula which are colder than underground hibernacula and may prohibit the growth of *Pd.* Red bats have been found to be carries of *Pd* fungus but do not seem to be susceptible to WNS, likely because they are migratory and do not hibernate in caves where *Pd* is found. Comparisons of mist-net data from pre- and post-WNS years suggests that that the composition of bat species in Ohio has shifted and that big brown bats and red bats are now the most abundant species on the landscape. The large number of "unknown" bats is due in part to the malfunctioning of the equipment for the Delaware route as well as the expected difficulty of assigning an identification to some calls.

Bat detections were highest in the 3rd and 4th weeks of the survey period, which corresponds to mid to late July. The increase in bat activity during this time is likely due to pups becoming volant. Pups are born between May and early July, depending on species, and are generally able to fly on their own by the end of July. This same pattern was found in 2019.

In 2018 and 2019, the highest abundance of bats was found in the Western Allegheny Plateau (WAPL) ecoregion. In 2020, more bats were detected in the Erie Drift Plains (EDP) ecoregion compared to the others. The detection rate for the WAPL was relatively unchanged between 2019 and 2020 (22.8 and 23.3 bats/min/mi, respectively) while the EDP increased from 16.4 bats/min/mi in 2019 to 30.1 bats/min/mi in 2020. The CVNP route is part of the EDP region and had the highest detection rate for bats in 2020. Removing CVNP from the ecoregion analysis still resulted in an increase in detection rate for the EDP at 21 bats/min/mi. The WAPL and EDP regions clearly encompass important summer habitat that is critical to conserve to help support bat populations.

Acoustic surveys have limitations and biases that should be acknowledged and taken into consideration when drawing conclusions from the data. First, some species, such as *Myotis* are more active in interior forests and are less likely to be recorded when doing mobile acoustic routes on roadways (Bertinussen and Altringham 2011). A combination of mobile surveys and stationary point surveys would be a better way to more comprehensively measure species abundances. Second, not all routes have been run for the same length of time and not all regions in Ohio are equally represented, potentially leading to over or under-representation of some species. Finally, and perhaps most importantly, identification of recorded calls to species is difficult because calls can vary widely even among individuals due to numerous factors such as clutter, presence of other individuals, social behavior, etc.

5. Future Research and Analysis

With the completion of the 10th summer of surveys in 2020, we have decided to revamp our mobile acoustic survey program to align with the North American Bat Monitoring Network (NAbat) protocols. NAbat is an international, multiagency program that seeks to create a continent-wide program to monitor bats at local to range-wide scales. NAbat will help provide reliable data to make effective conservation decisions to benefit the long-term viability of bat populations across the continent. As part of this change, the current routes will no longer be surveyed or will be updated to conform to NAbat standards beginning in 2021.

Over the last ten years, many changes and improvements have been made to the software used to identify bat calls. Because the data analysis tools and methods have changed from year to year, it is important for a final report to be compiled in which all the data is processed through the same programs and analyzed using standardized methods; this will give the most accurate understanding of changes in Ohio's bat population over the last ten years. We would also like to look more closely at data for temperature, moon illumination, and cloud cover. These factors have generally not significantly impacted bat activity on an annual scale but may show different patterns at a larger scale. We will be working on a more comprehensive report to dig deeper into the great set of long-term data this project has produced.

6. Literature Cited

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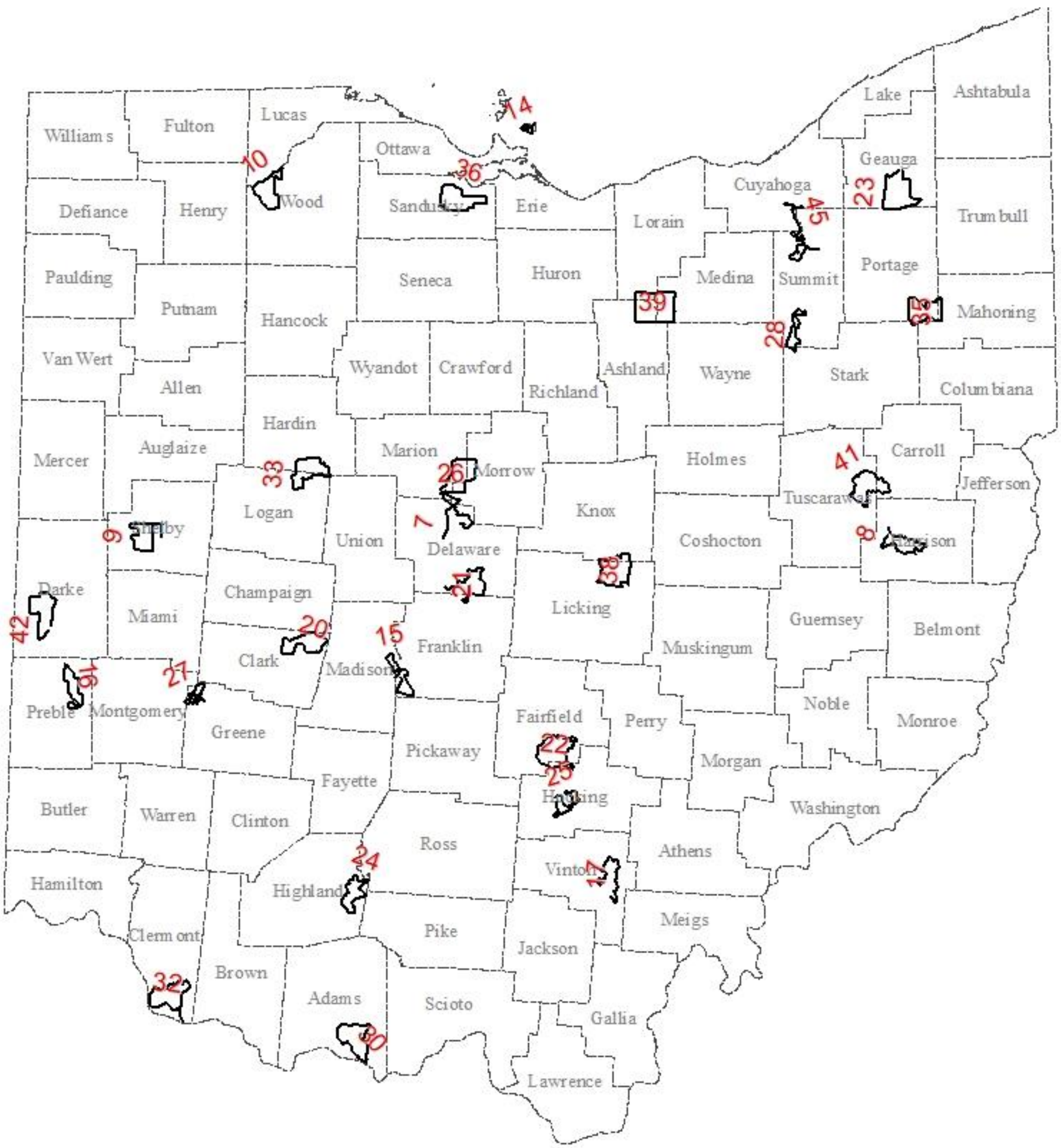
Appendix A – Map of routes used in data analysis for 2020. Cuyahoga Valley National Park rejoined the survey this year after not participating for several years. However, there is some confusion about the continuity of data between years with regards to CVNP and the former Cleveland Metro Parks routes, so CVNP was given a new route number (45) for the time being until this issue can be resolved.



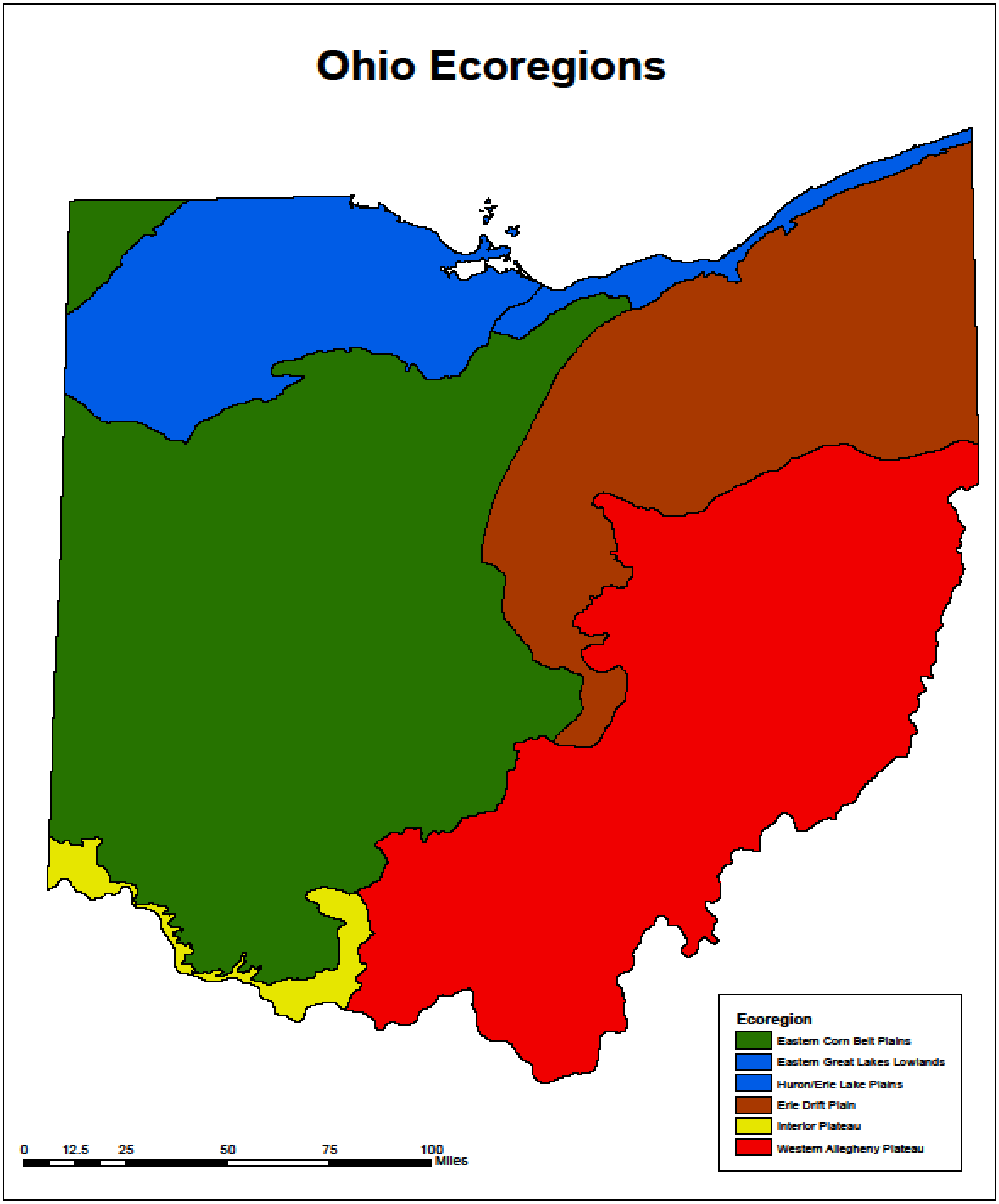
Appendix B – Number of surveys completed by year for each route.

Year	Route	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2011		3	2	4	2	5	4	3	3	3	3								
2012		3	3	3	3	4	4	3	3	3	3	2	1	2	1	3	3	3	
2013		2	2	4	4	4	3	3	3	3		2		1		3	3	3	4
2014		3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2015		4	3	4	4	4	5	4	3	3	4	1	1	1	3	4	3	4	3
2016		4	3	3	3	4	4	3	3	4	3	3			3	3	3	3	3
2017		4	3	4	4	3	3	3	3	3	3	3			3	3		3	3
2018								3	3	3	3	3			3	3	3	3	3
2019								3	3	3	3				3	3	2	3	3
2020								3	3	3	3				3	3	3	3	

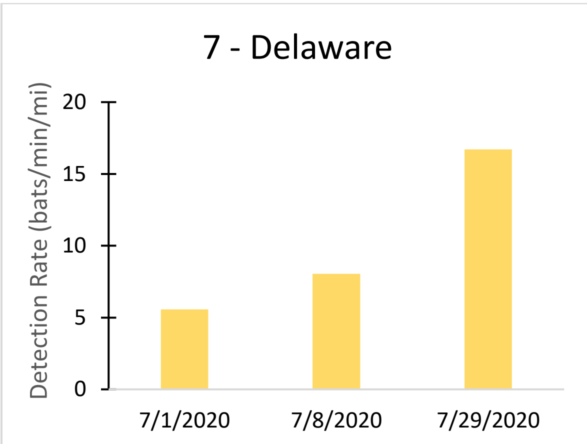
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
2013	3	3	3	3	3	2	2	3	2	3	4									
2014	1	3	3	3	3	3	4	3	3	4	3	3	3	3	3	3	3	3	3	
2015	2	3	3	3	4	2	3	3	3	3	3	3	4	4	4	3	3	3	3	5
2016	2	3	4	3	3	3	3	3	3	4	3	3	3	3	4	3	4	3	3	1
2017	1	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	4	3	3	3
2018	3	3	3	3	3	3	3	2	1	4	3	1	3	3	3	3	3	3	3	3
2019	3	2	3	3	3	2	3		3	3	3	3	3	3	3		2	2	1	3
2020		2	3	3		3	3	3	3	3		3		3	3		3	3		2

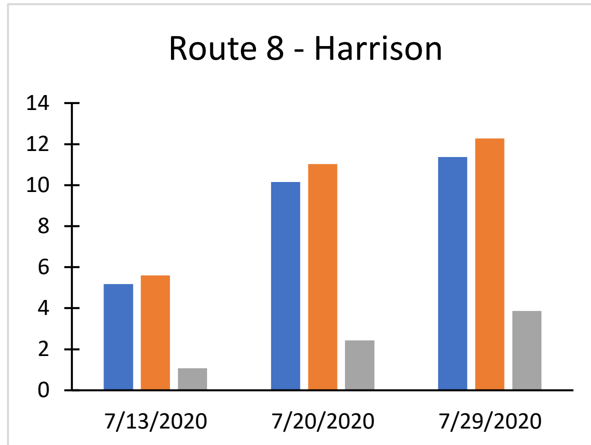
	39	40	41	42	43	44	45
2015	3	3					
2016	3	3	3				
2017	3	3	3	3			
2018	3	1	3			3	
2019	3	2	3	3		1	
2020	3			3			2

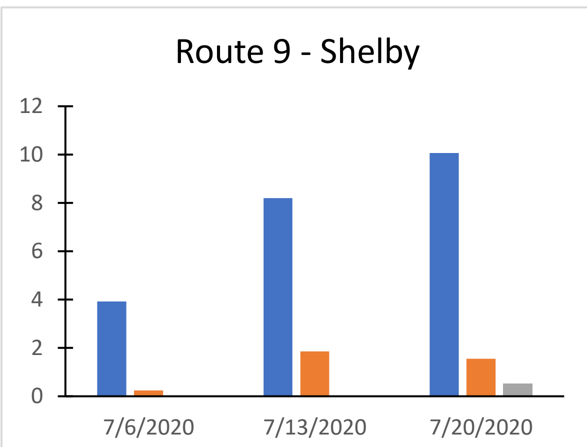
Appendix C – EPA designated level III Ecoregions for Ohio.

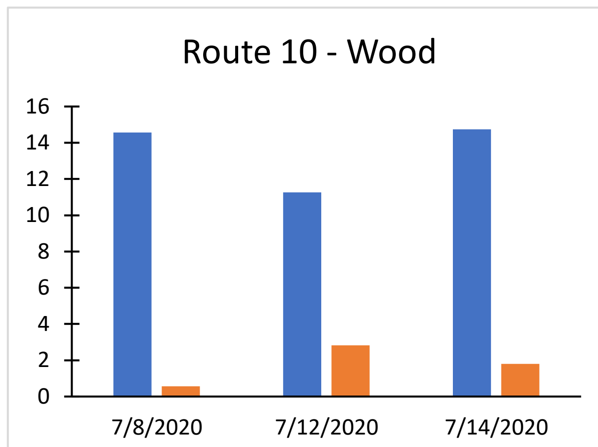


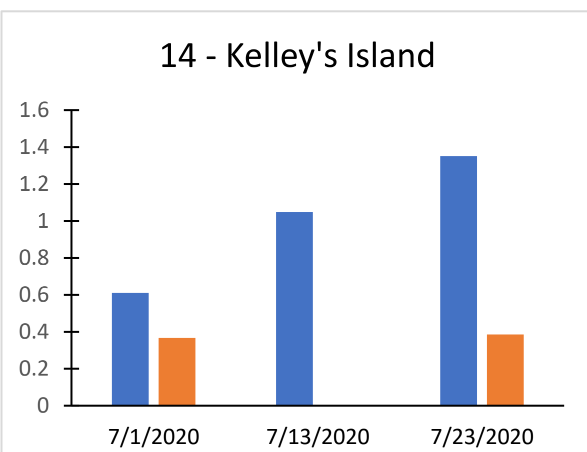
Appendix D - Breakdown of each route surveyed in 2020 into date-specific information. Low frequency bats are represented in blue, mid frequency bats are represented in orange, high frequency bats are represented in gray, and the unknown data are represented in yellow.

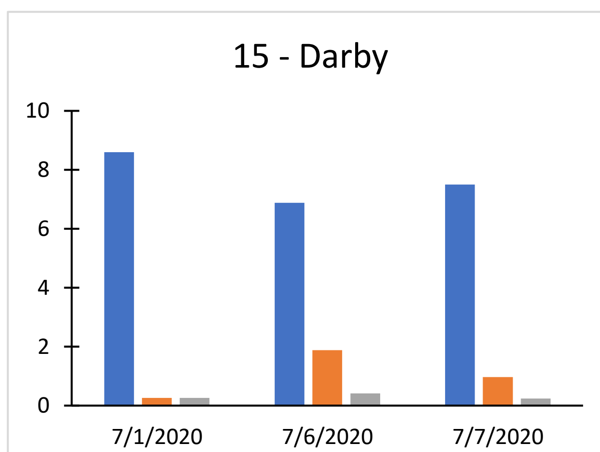


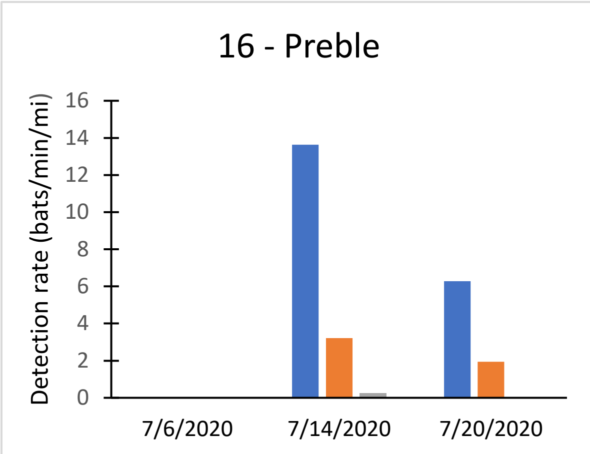


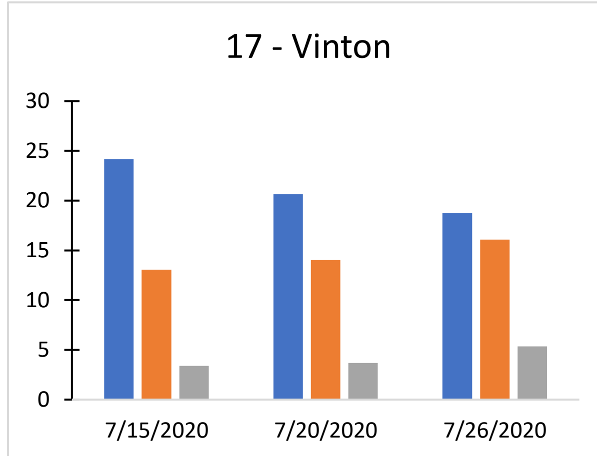


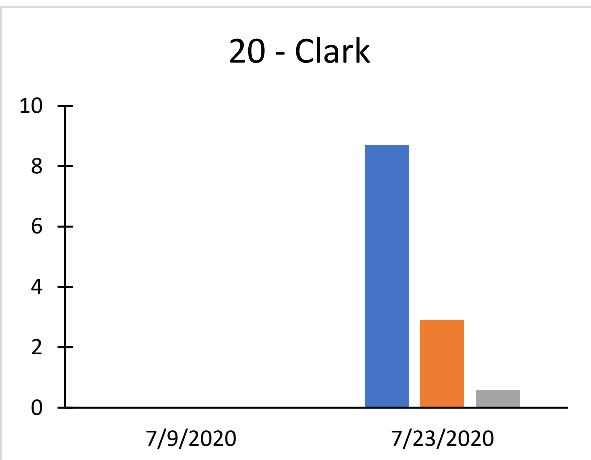


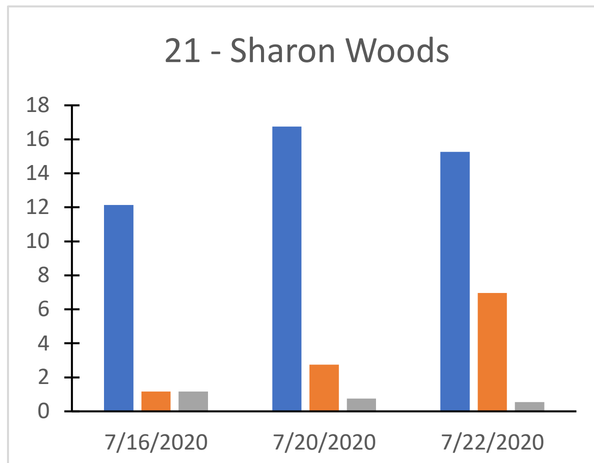


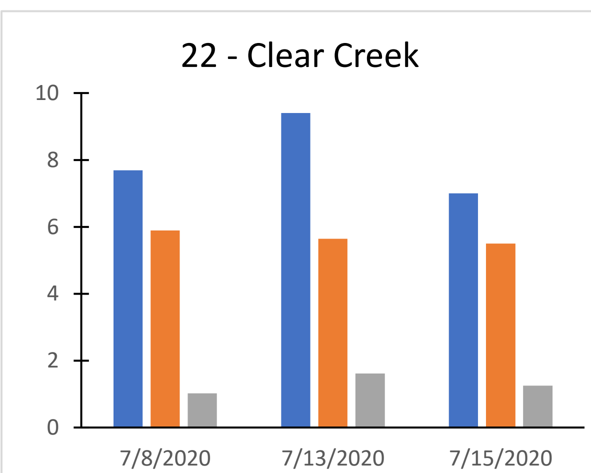


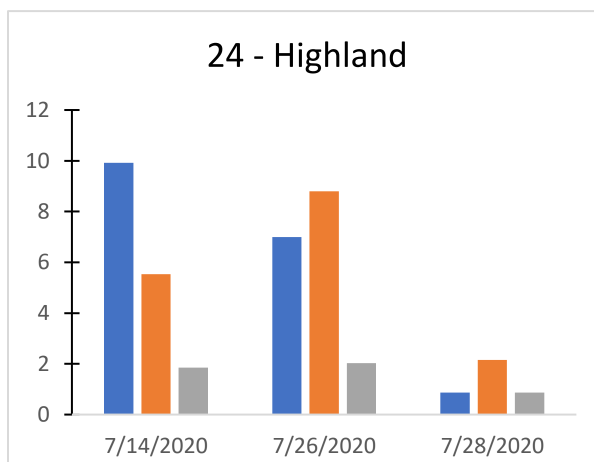

16 - Preble
Detection rate (bats/min/mi)
16
14
12
10
8
6
4
2
0
7/6/2020
7/14/2020
7/20/2020

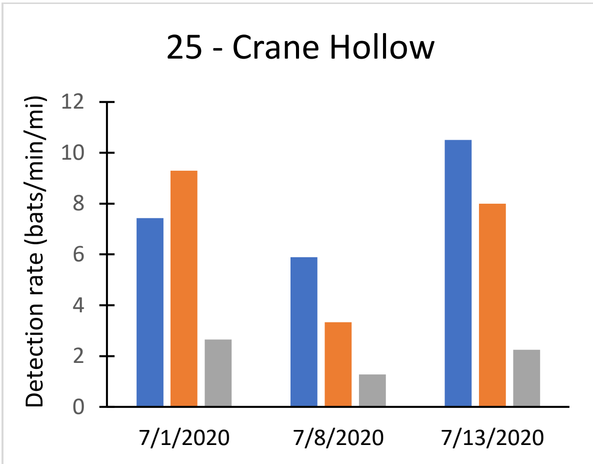

17 - Vinton
30
25
20
15
10
5
0
7/15/2020
7/20/2020
7/26/2020

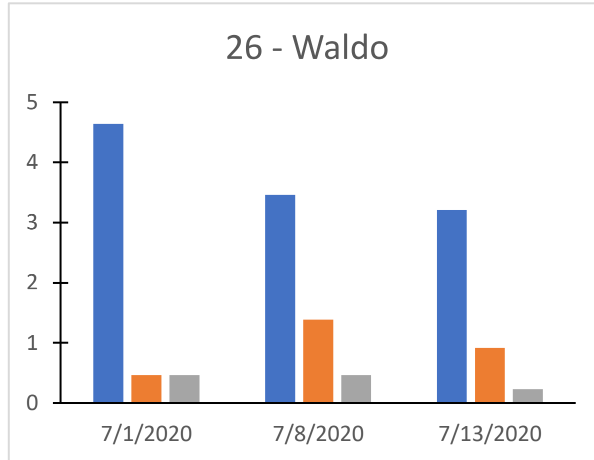

20 - Clark
10
8
6
4
2
0
7/9/2020
7/23/2020

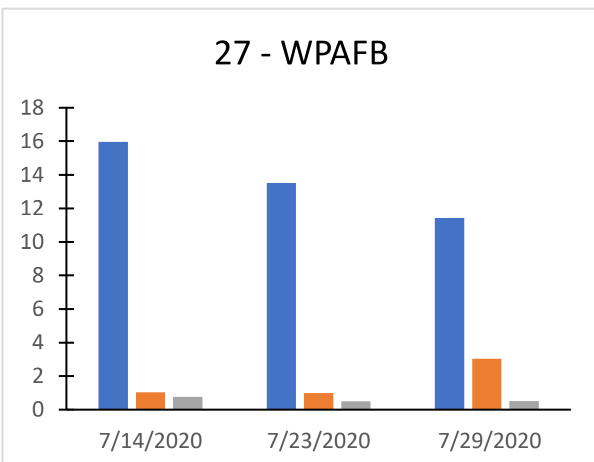

21 - Sharon Woods
18
16
14
12
10
8
6
4
2
0
7/16/2020
7/20/2020
7/22/2020

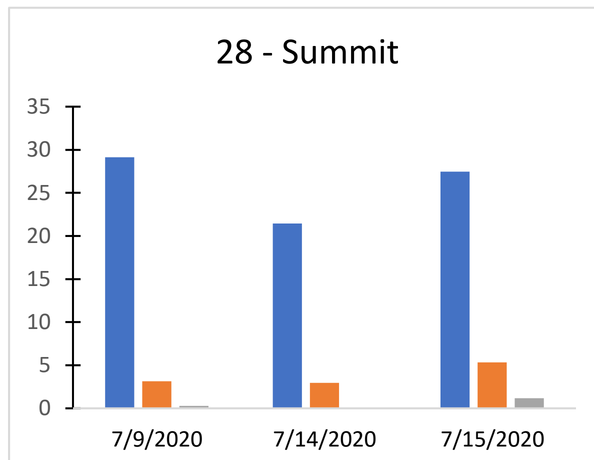

22 - Clear Creek
10
8
6
4
2
0
7/8/2020
7/13/2020
7/15/2020

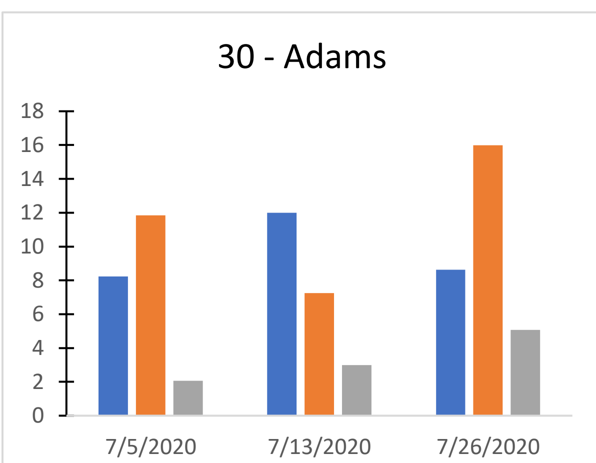

24 - Highland
12
10
8
6
4
2
0
7/14/2020
7/26/2020
7/28/2020

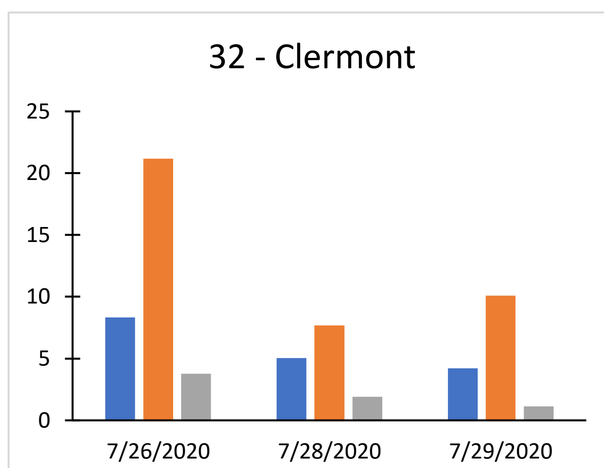

25 - Crane Hollow
Detection rate (bats/min/mi)
12
10
8
6
4
2
0
7/1/2020
7/8/2020
7/13/2020

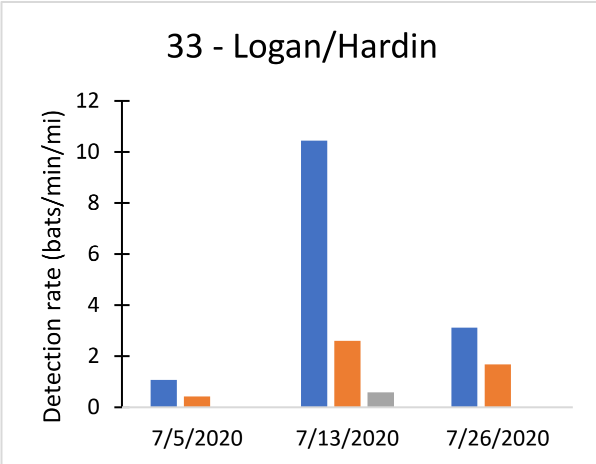

26 - Waldo
5
4
3
2
1
0
7/1/2020
7/8/2020
7/13/2020

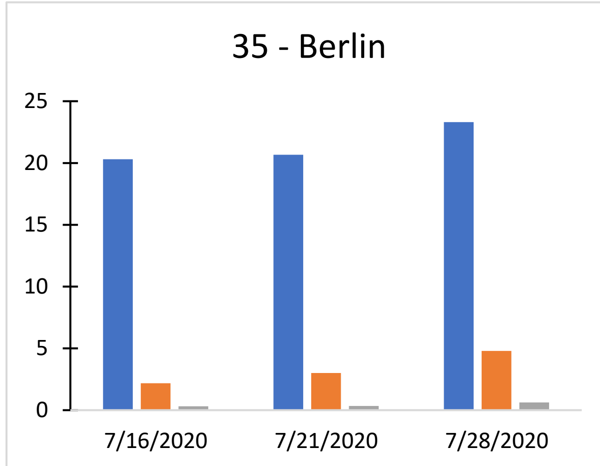

27 - WPAFB
18
16
14
12
10
8
6
4
2
0
7/14/2020
7/23/2020
7/29/2020

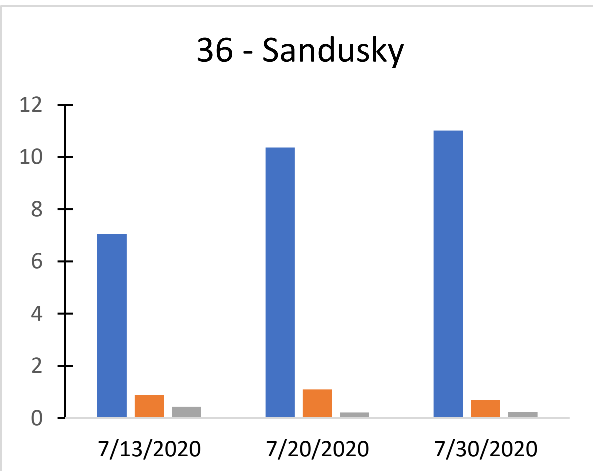

28 - Summit
35
30
25
20
15
10
5
0
7/9/2020
7/14/2020
7/15/2020

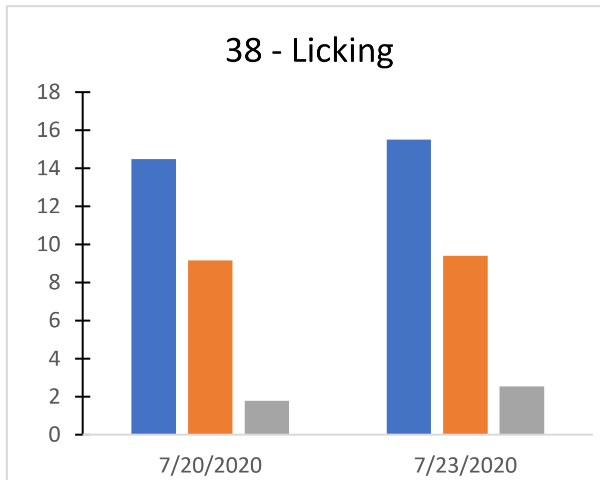

30 - Adams
18
16
14
12
10
8
6
4
2
0
7/5/2020
7/13/2020
7/26/2020

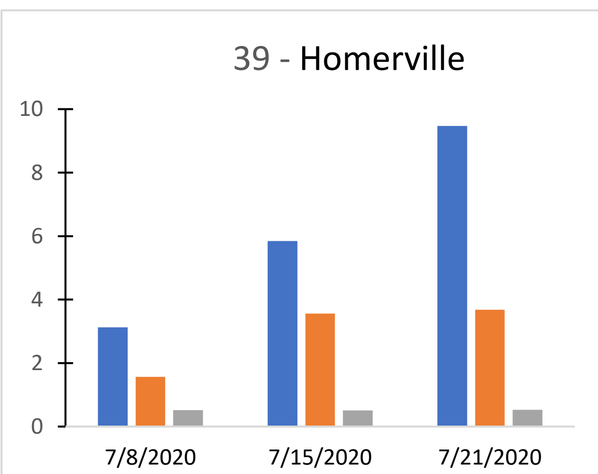

32 - Clermont
25
20
15
10
5
0
7/26/2020
7/28/2020
7/29/2020

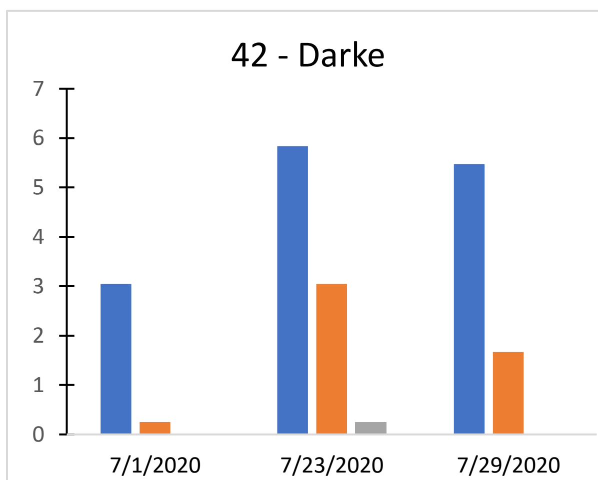

33 - Logan/Hardin
Detection rate (bats/min/mi)
0
2
4
6
8
10
12
7/5/2020
7/13/2020
7/26/2020

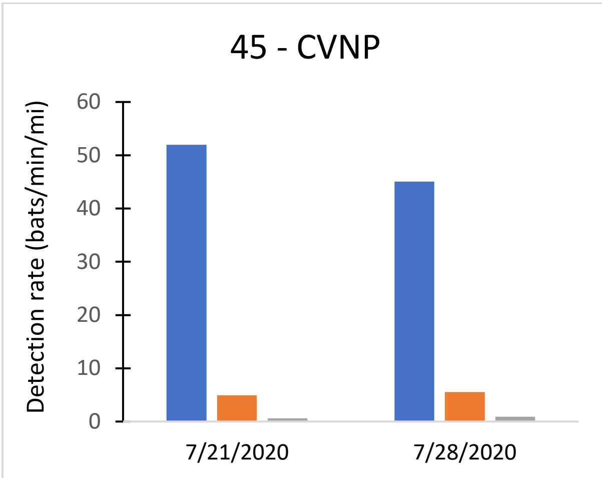

35 - Berlin
0
5
10
15
20
25
7/16/2020
7/21/2020
7/28/2020


36 - Sandusky
0
2
4
6
8
10
12
7/13/2020
7/20/2020
7/30/2020


38 - Licking
0
2
4
6
8
10
12
14
16
18
7/20/2020
7/23/2020

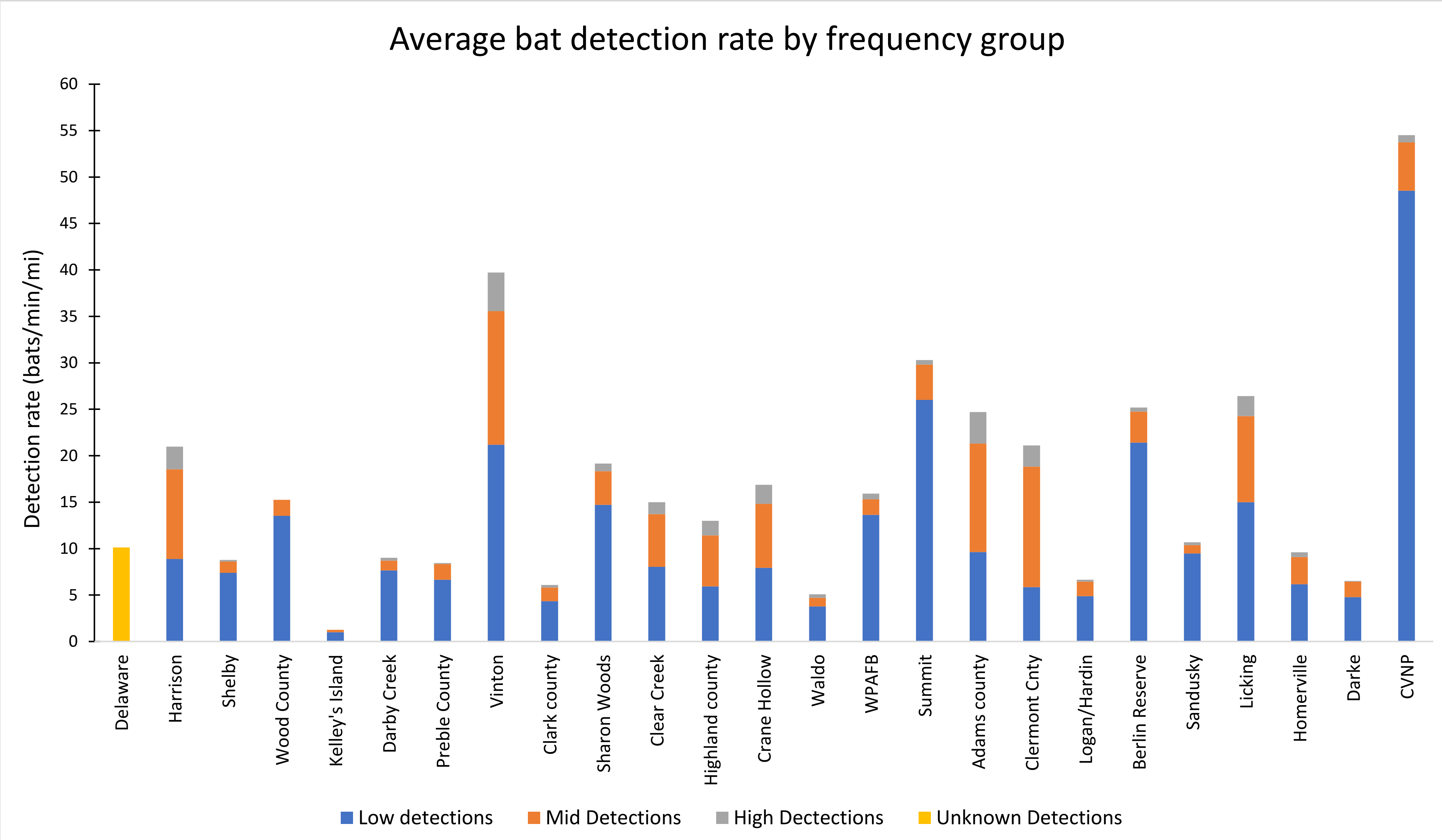

39 - Homerville
0
2
4
6
8
10
7/8/2020
7/15/2020
7/21/2020


42 - Darke
0
1
2
3
4
5
6
7
7/1/2020
7/23/2020
7/29/2020



45 - CVNP
Detection rate (bats/min/mi)
60
50
40
30
20
10
0
7/21/2020
7/28/2020

Appendix E – A comparison of the average detection rate of each bat frequency group for all routes completed in 2020.



Appendix F - Comparison of the average bat detection rate for the three routes that have been completed each year from 2011 to 2020.