ODNR, Division of Wildlife
Mobile Bat Acoustic Surveys
2018 Report

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Introduction

Despite the ecological importance of bats, they remain some of the most understudied mammals. Of the 1,150 bat species recognized by The International Union for Conservation of Nature (IUCN), 17% are categorized as "data deficient" and 21% are categorized as "threatened" or "near threatened" (IUCN Redlist Summary Statistics 2018; Welch and Beaulieu 2018). Because bats serve as important pollinators, seed dispersers, and insect controllers, ecosystems around the world could be greatly impacted by diminishing populations of these animals.

Population declines in bats can be attributed to a variety of factors, including changing landscapes, human persecution, disease, and wind energy development (Frick et al. 2017; Langwig et al. 2015; López-Baucells et al. 2018; Meyer et al. 2016; Muscila et al. 2018; Muylaert et al. 2016). Significant population declines are often not detected early because data on population size and density is difficult to estimate for bats (Frick 2013). Recovery from serious population declines is a slow process since females typically only give birth to one or two pups a year (Barclay and Harder 2003). The use of acoustic recorders to detect bats provides one method to quantify bat activity and relative abundance and can be useful for helping monitor population trends over time.

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. It is estimated that over 6 million bats in the eastern United States and Canada have died from WNS since its discovery in the U.S. in 2006.

Ohio has 11 species of 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 2018, the 8th 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
Tri-colored bat	*Perimyotis subflavus*	PESU	Mid
Little brown bat	*Myotis lucifugus*	MYLU	Myotis
Northern Long-eared	*M. septen-trionalis*	MYSE	Myotis
Indiana bat	*M. sodalis*	MYSO	Myotis
Small-footed bat	*M. leibii*	MYLE	Myotis

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

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

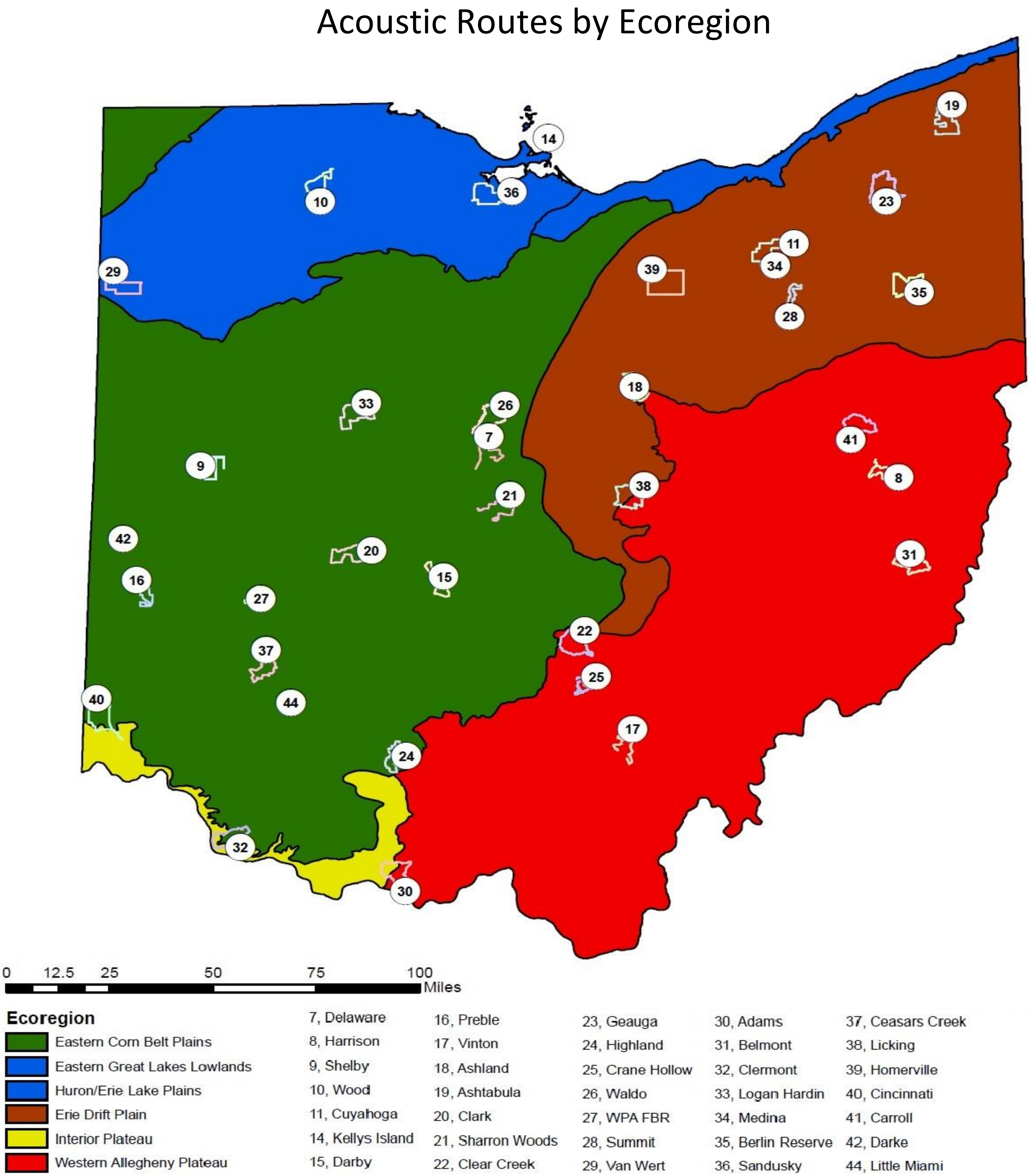

Fig. 1 – Map of Ohio showing locations of the 35 acoustic routes for 2018 and EPA designated level III ecoregions.

Methods

In 2011, the DOW developed a standardized protocol for a mobile acoustic bat survey (modified from modified from Britzke and Herzog (2009)). The first year's survey consisted of nine routes. As the program grew, more routes were added, reaching a high of 42 in 2017. In 2018, 35 routes were surveyed (Fig. 1).

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 should represent one individual, allowing the number of bat passes to be used as an index of relative abundance (Roche et al. 2011). Busy roads and highways were avoided for volunteer safety and to avoid unnecessary noise interference. Volunteers were instructed to drive routes three times throughout the month of July on non-consecutive nights. Surveys were always 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. Route locations were randomly determined based on volunteer availability and interest. In order to standardize the protocol, each volunteer received training with the equipment and a step-by-step instruction binder to use as a reference when conducting the surveys (Brown 2018).

The following data was catalogued at the beginning and end of each survey: temperature (°F), wind speed (mph), percent cloud cover, time, moon visibility, latitude, longitude, and odometer readings.

Bat calls were recorded using Anabat™ Secure Digital II units. 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. Most geographical references were recorded with a Compact Flash GPS card with the PDA kit. Five routes (7, 20, 26, 38, and 42) used GPS mouse units instead (Brown 2018).

Data Analysis Protocol

Except for two routes, recorded bat calls were classified using Bat Call ID East (BCID), Kaleidoscope, and Echoclass. Raw data was not received for the Summit and Berlin routes, only final analysis from Kaleidoscope, so the calls could not be run through the remaining programs. Classification of species in BCID was done using the following alterations: *Myotis leibii* (eastern small-footed bat) was added to the species identification list, 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, and the duration was altered to a range of 1-30. Classification of species in Kaleidoscope was carried out using the default species classifiers for Ohio. Classification of species in Echoclass was done using the first species set. Output from the three programs was compared; when two programs agreed on a species identification, it was accepted. If two or more programs disagreed on a species identification, or when the call was labeled as "unknown" by two or more programs, it was manually vetted. 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 myotis, Table 1) based on the minimum frequency. Calls where frequency could not be determined due to too few pulses or other uncertainties (e.g. potentially two overlapping bat calls) were classified as "unknown frequency." Calls could have a known frequency group and an unknown species, but not vice versa.

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

Level III ecoregion shapefiles were obtained from the EPA website to analyze bat abundance by Ohio ecoregion.

Results

Of the 35 routes completed for the 2018 survey, 34 were used in analyses; one route (Darke County) was completed, but there was no saved data found on the recorder. One route (Waldo) only had two complete surveys and three routes (Wright-Patterson Air Force Base (WPAFB), Adams county, and Cincinnati) only had one complete survey, bringing the total number for 2018 to 96 surveys and 11,558 combined survey minutes. These surveys resulted in 5,964 total bat passes. Forty-four percent of the recorded files needed manual vetting to determine species after being run through the three auto-ID programs. Of these 44%, 13% were found to not contain bat calls (usually insect calls or other noise). Since 2011, DOW acoustic surveys have produced 45,054 bat passes from 736 surveys.

Mean bat detection rate in 2018 was 16.88 detections/mile. The detection rate, by frequency group, for low, mid, *Myotis,* and unknown bats were 11.80, 4.13, 0.56, and 0.33 detections/mile, respectively. The route with the highest bat abundance was Cuyahoga with 40.56 detections/mile. The route with the lowest bat abundance was WPAFB with 0.7 detections/mile. However, this route was only surveyed one time. The route with the next lowest abundance was Kelley's Island (1.67 detections/mile).

From 2011 to 2014, bat abundance declined. This trend reversed in 2014, and bat abundance increased through 2017, although the overall trend since 2011 remained negative (Fig. 2). This upward trend did not continue this year; bat abundance declined 3.9% from 2017 to 2018, leading to an overall 29.07% decline in bat abundance since 2011. The reversal of the trend could be due to a decline in mid-frequency bats, whose overall abundance has started to decline again over the last two years (Fig. 3). Since 2011, two mid-frequency bats, *L. borealis and P. subflavus*, have seen the most negative trend in abundance amongst all Ohio bats (Fig. 4, Table 2.) Out of the five level III ecoregions in Ohio, one (interior plateau) does not currently contain any acoustic routes. Of the remaining four, the Western Allegheny Plateau had the highest overall bat detection from 2011-2018 (Fig. 5). This region also had a higher percentage of mid-frequency bats compared to other regions (Fig. 6).

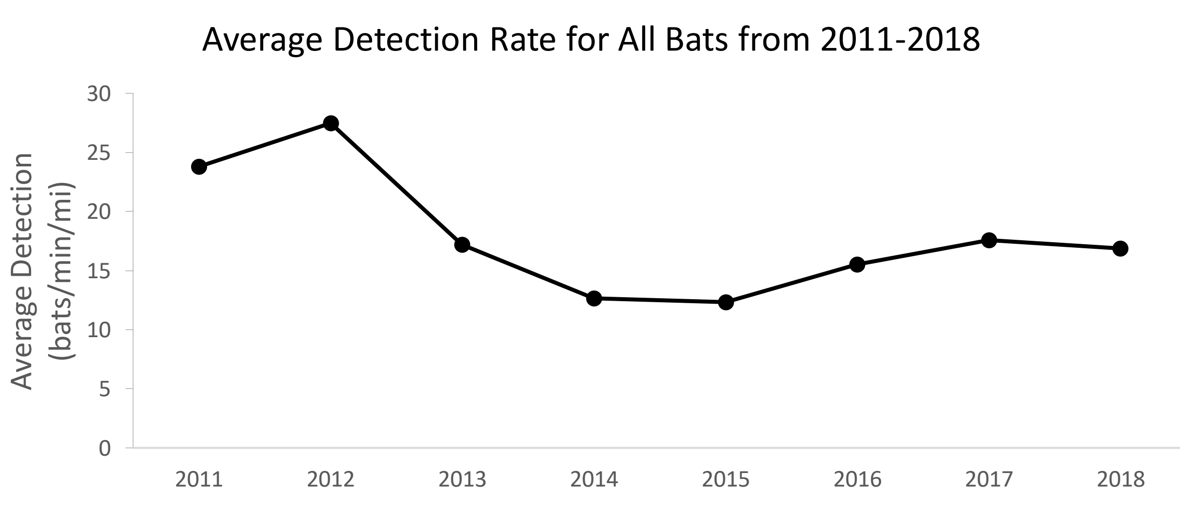

Fig. 2 – Average overall detection rate for all bats from all routes from 2011-2018.

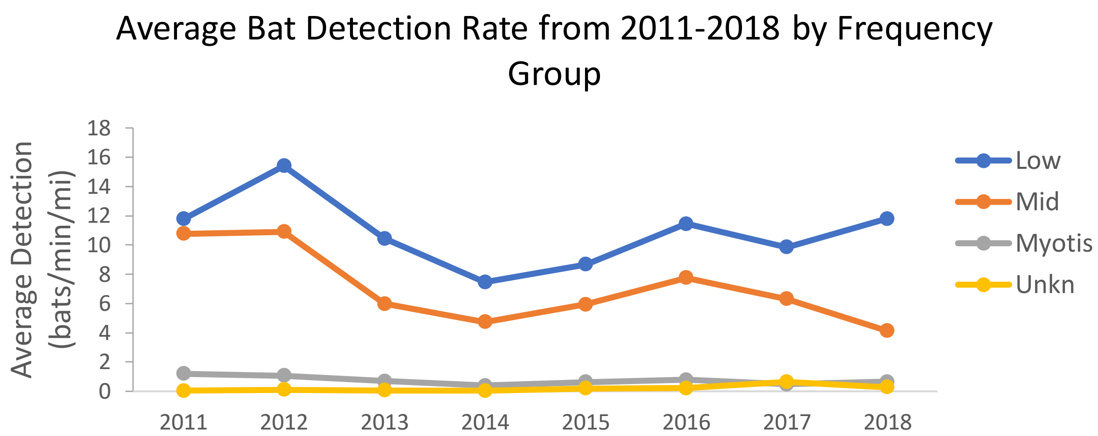

Fig. 3 – Average detection rate of each frequency group – low, mid, *Myotis*, and unclassified "unknown" bats– from all routes from 2011-2018.

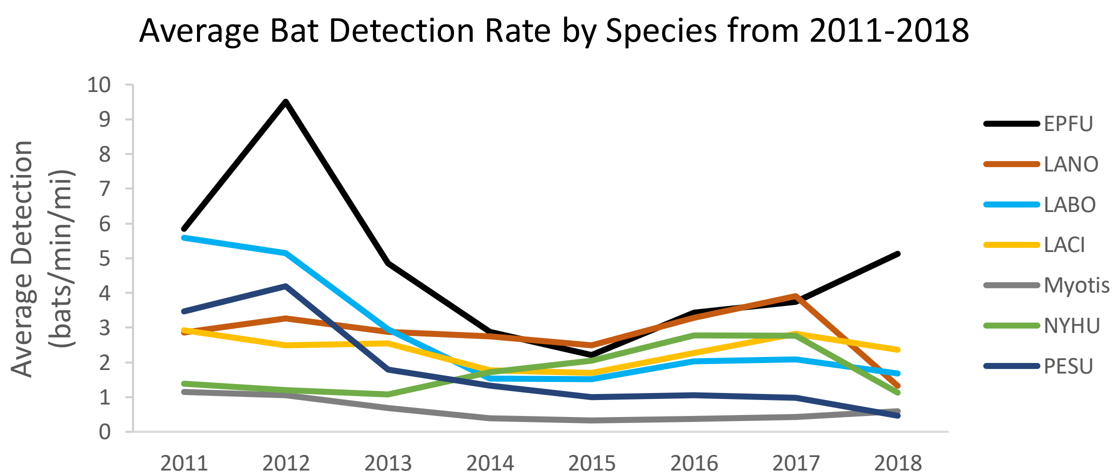

Fig. 4 – Average bat detection rate for 6 bat species and all *Myotis* species combined for all routes from 2011-2018. See Table 1 for species codes.

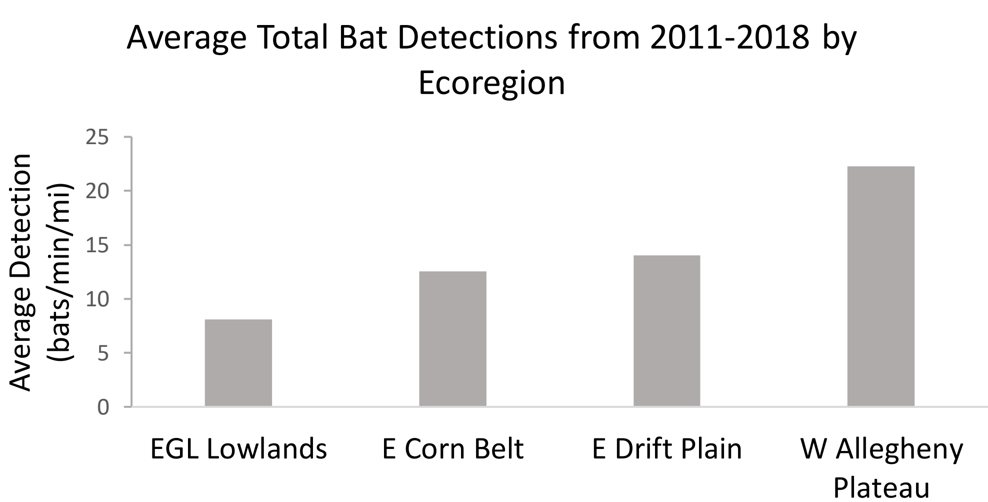

Fig.5 – Average bat detections for all species and all routes from 2011-2018 by EPA level III ecoregion classification.

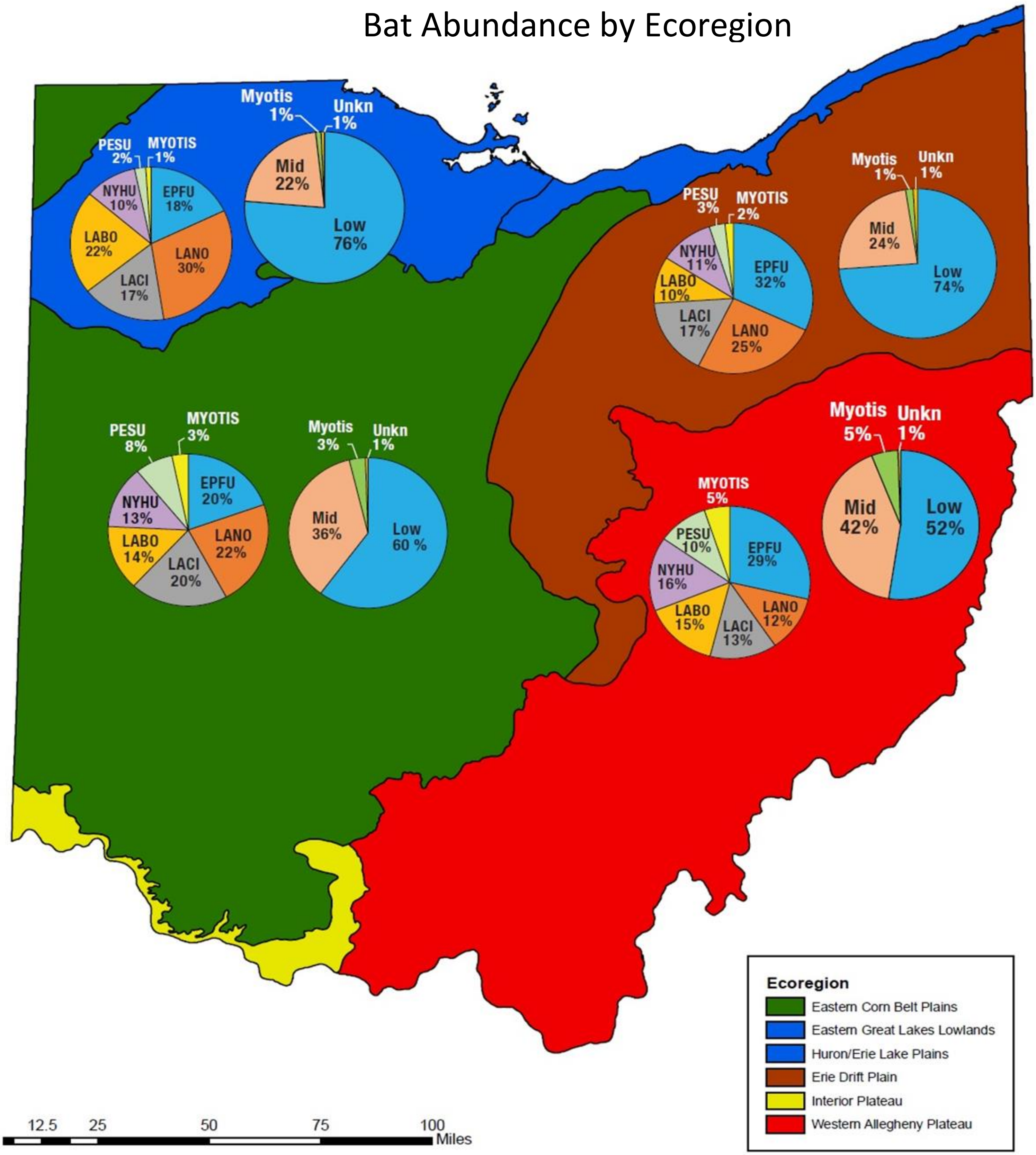

Fig. 6 – Breakdown of bat abundances by ecoregion, both by frequency group and species group.

Discussion

Despite seeing increases over the last three years, overall bat abundance declined slightly in 2018. Some evidence indicates this may be due to declines in abundance of mid-frequency bats, specifically red bats and tri-colored bats. Tri-colored bats are known to be one of the species most affected by WNS, so populations may be continuing to suffer widespread mortality from the disease. Red bats have been found to carry the fungal spores of *Pd* but have not been confirmed to be vulnerable to WNS infection thus far. However, red bats are migratory, making them one of the bat species more likely to be impacted by wind energy facilities (Kunz et al. 2007).

When comparing bat abundance across ecoregions, the Western Allegheny Plateau (WAP) region had higher bat abundance than the other three regions that were surveyed and potentially significantly higher abundance than the Eastern Great Lakes Lowlands. Approximately 30-40% of the WAP is forested and a network of streams and tributaries of the Ohio River are found in this region (Landscope 2018). WAP forests are mostly hardwood and mixed oak. Oak trees are particularly important to some bat species because they provide ideal roosts and support the larvae of several moths upon which bats feed. The WAP also contains hills and caves where bats are more likely to hibernate. In contrast, the Eastern Great Lakes Lowlands (EGLL) region is transitional between the northern taiga and the southern temperate deciduous forests. Forests in this region contain more softwood species, like pine and hemlock, although there are hardwoods such as maple and oak. The terrain is relatively flat and may not offer many suitable options for winter hibernacula. The remaining two ecoregions, the Erie Drift Plain (EDP) and Eastern Corn Belt Plains (ECBP) seem to support a moderate abundance of bats. Both contain good foraging habitat, with the ECBP being comprised mostly of cropland and the EDP containing a large number of wetlands.

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. Even with three different auto-ID programs used in 2018, nearly half of the recorded calls still needed to be manually vetted. It should be noted for this report in particular that, prior to 2015, species IDs were not manually vetted, meaning the conclusions from the species' level data should be viewed skeptically. A future goal of this project is to eventually reexamine all previous data to increase confidence in species specific analyses.

The goal of the DOW acoustic monitoring program is to monitor changes in bat abundance over time in Ohio. However, the opportunity exists to join a larger, continent-wide monitoring effort called NABat. This program spans all of North America and is designed to standardize various types of bat surveys so that data can be analyzed across large scales. This is especially important now as WNS continues to spread, more wind energy facilities are being built, and urbanization increases. We are looking into opportunities to convert a selection of some of our current mobile routes to the NABat protocol in the coming years so that we can contribute to this effort.

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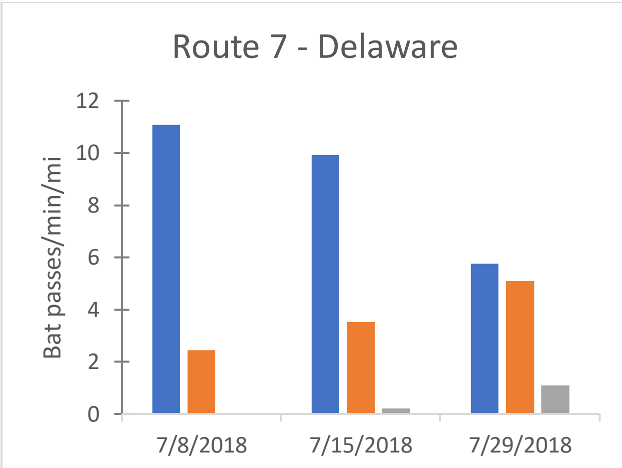
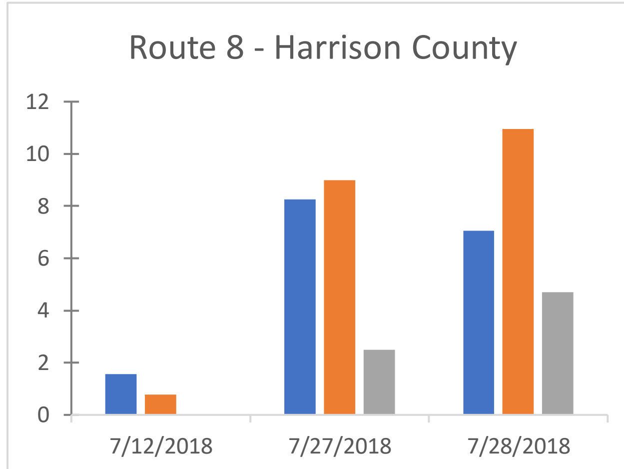
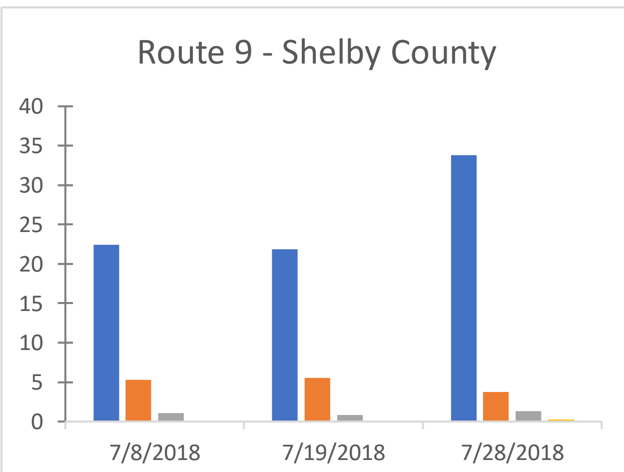
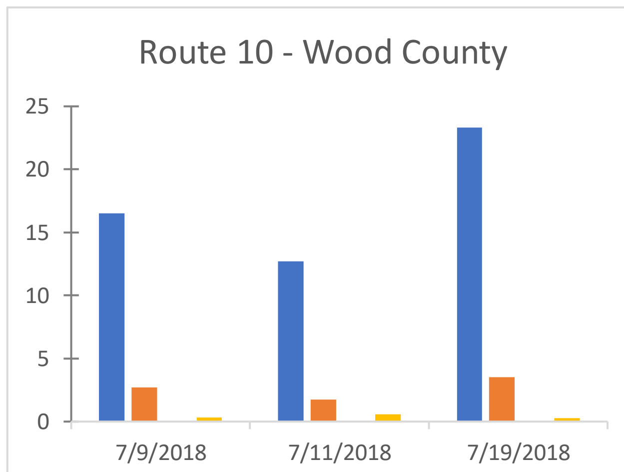
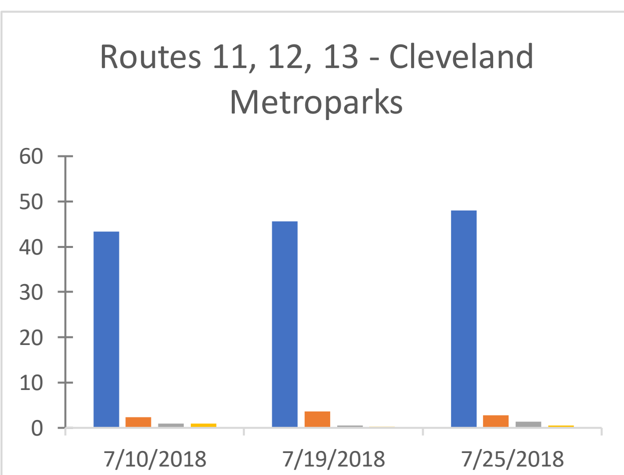
Appendix A: The breakdown of each route surveyed in 2018 into date-specific and route-specific information. Low frequency bats are indicated in blue, mid frequency bats are indicated in orange, *Myotis* bats are indicated in gray, and the unknown data are indicated in yellow. Route 42 is not included as the equipment did not save the information properly this year.

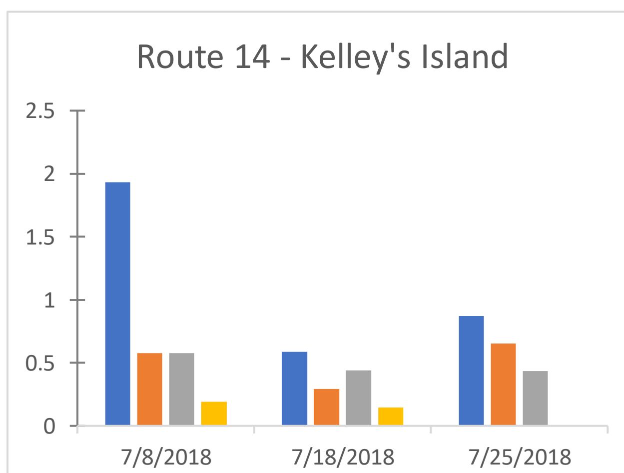


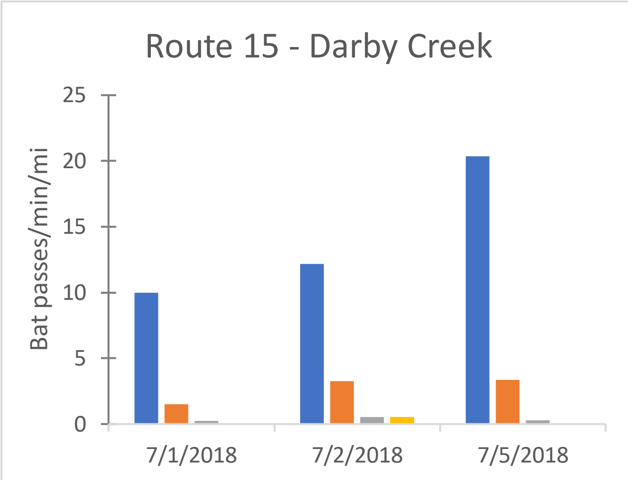


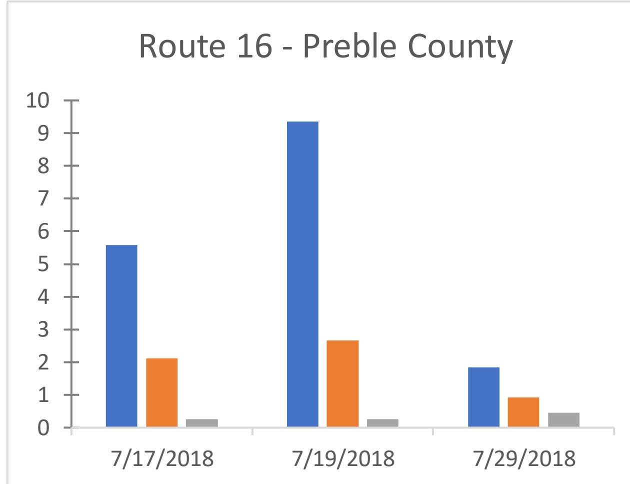


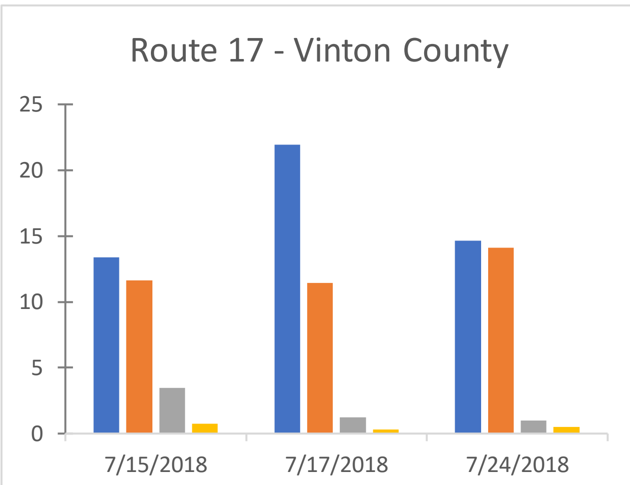


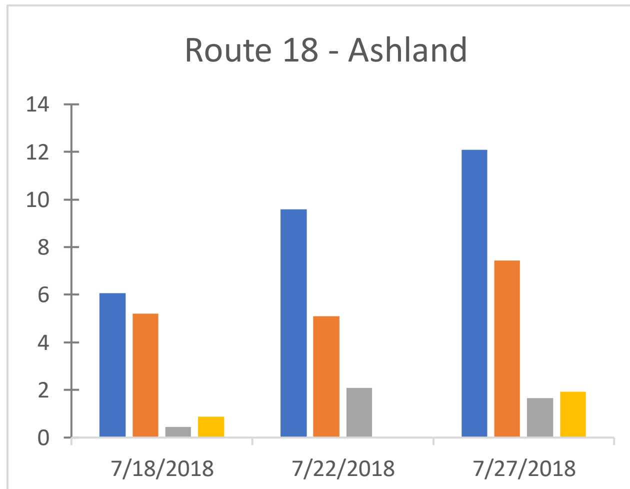


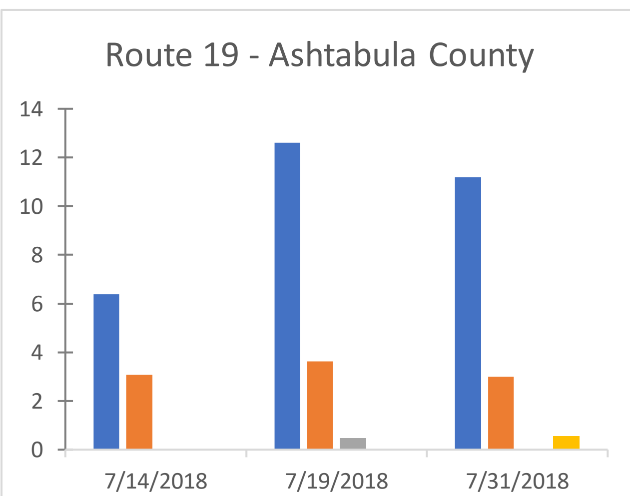


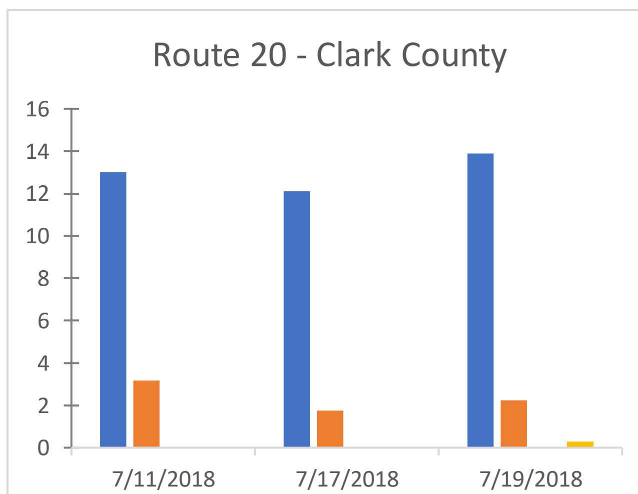

Route 15 - Darby Creek
Bat passes/min/mi
25
20
15
10
5
0
7/1/2018
7/2/2018
7/5/2018

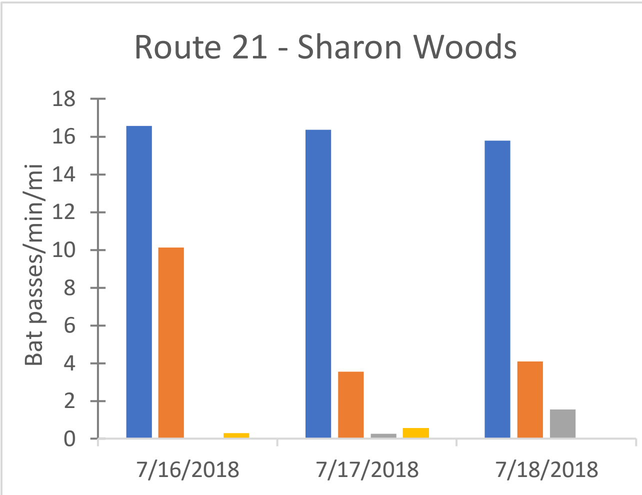

Route 16 - Preble County
10
9
8
7
6
5
4
3
2
1
0
7/17/2018
7/19/2018
7/29/2018

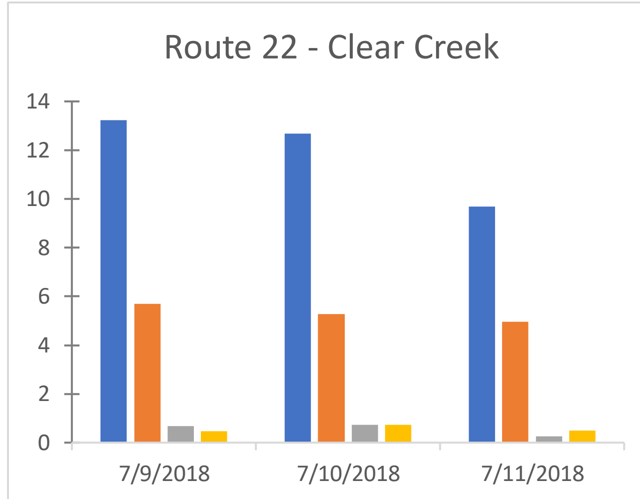

Route 17 - Vinton County
25
20
15
10
5
0
7/15/2018
7/17/2018
7/24/2018

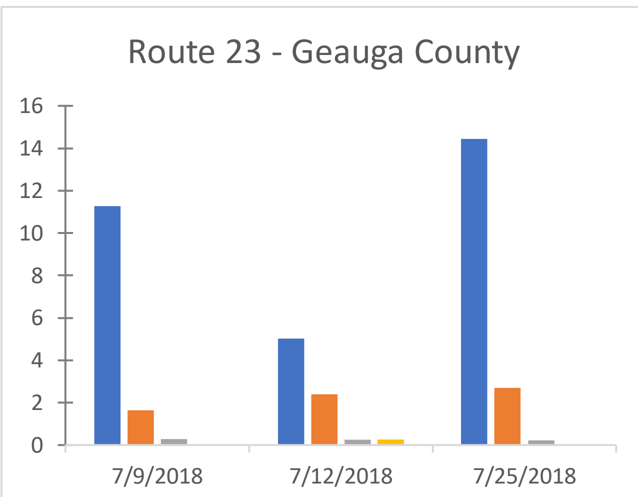

Route 18 - Ashland
14
12
10
8
6
4
2
0
7/18/2018
7/22/2018
7/27/2018

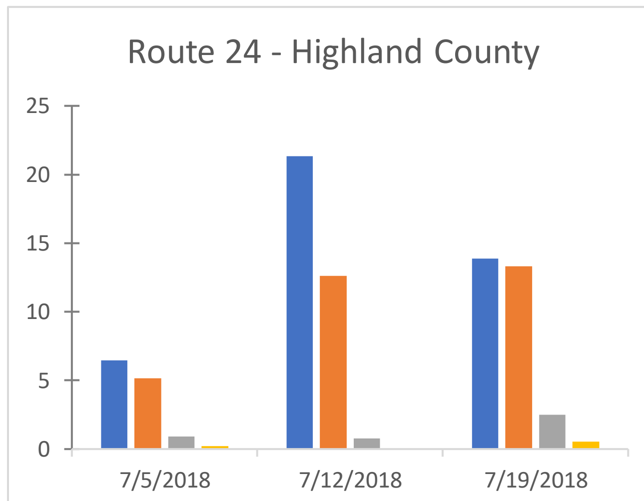

Route 19 - Ashtabula County
14
12
10
8
6
4
2
0
7/14/2018
7/19/2018
7/31/2018

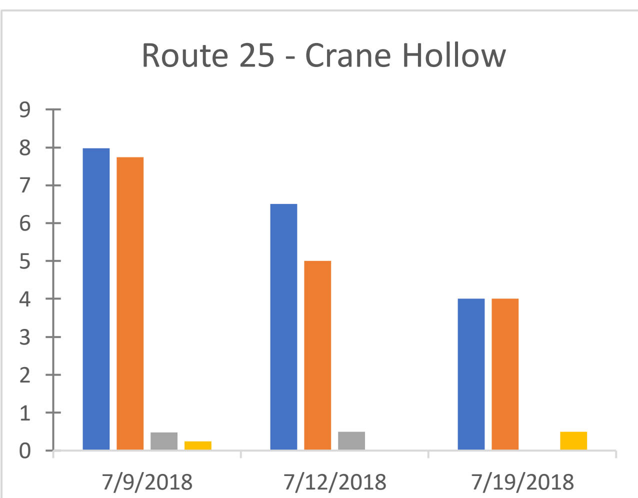

Route 20 - Clark County
16
14
12
10
8
6
4
2
0
7/11/2018
7/17/2018
7/19/2018

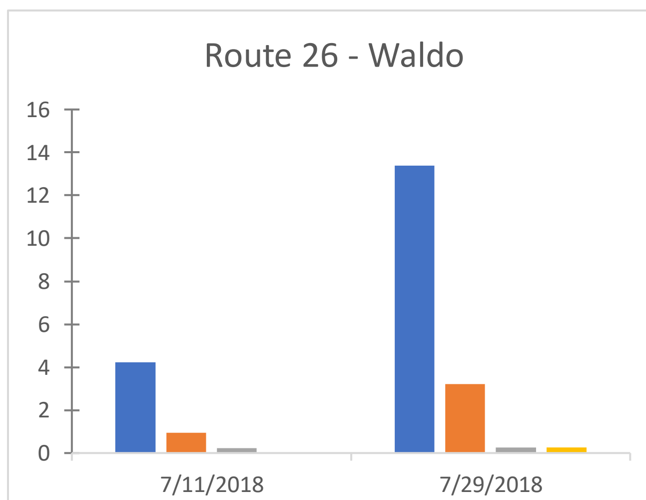

Route 21 - Sharon Woods
Bat passes/min/mi
0
2
4
6
8
10
12
14
16
18
7/16/2018
7/17/2018
7/18/2018

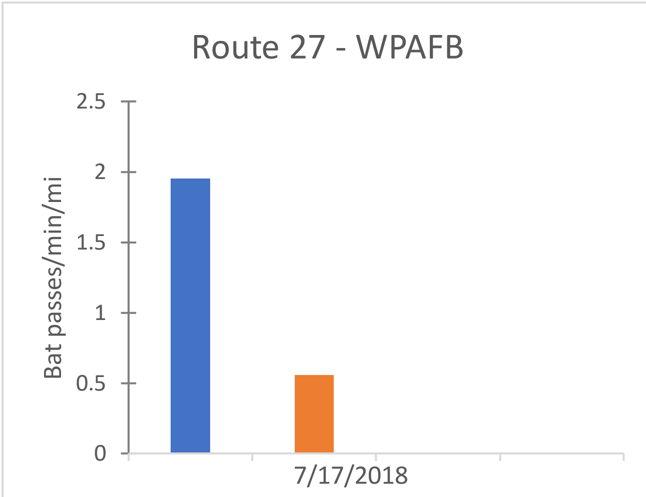

Route 22 - Clear Creek
0
2
4
6
8
10
12
14
7/9/2018
7/10/2018
7/11/2018

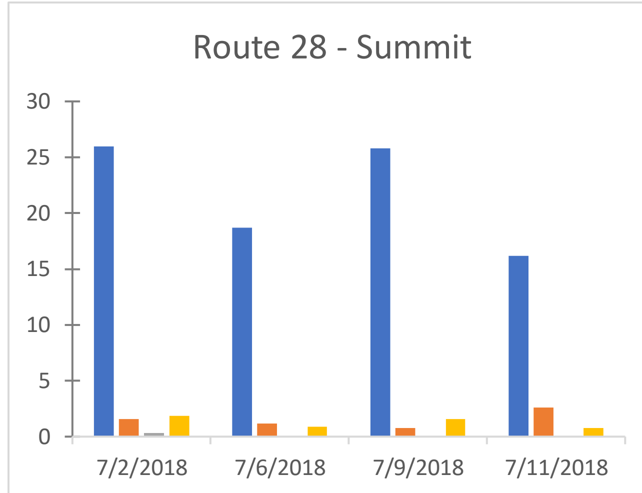

Route 23 - Geauga County
0
2
4
6
8
10
12
14
16
7/9/2018
7/12/2018
7/25/2018

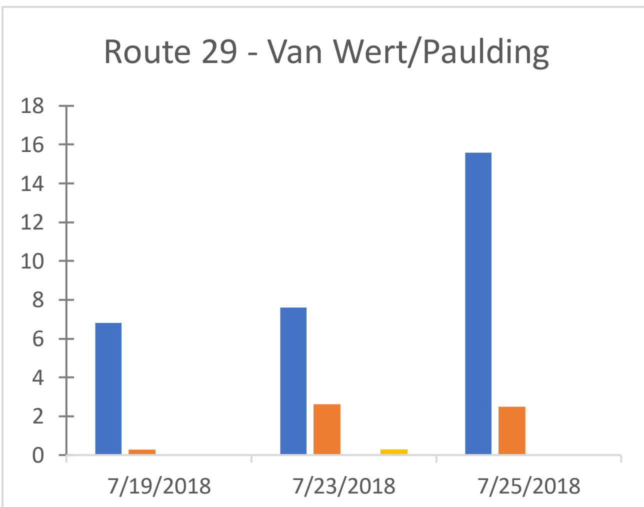

Route 24 - Highland County
0
5
10
15
20
25
7/5/2018
7/12/2018
7/19/2018

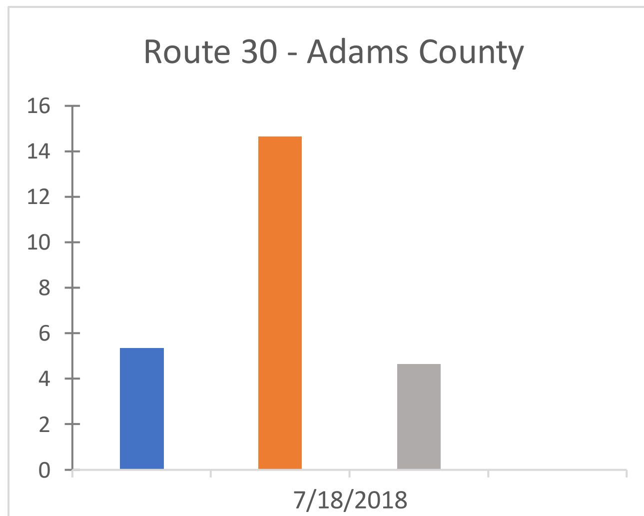

Route 25 - Crane Hollow
0
1
2
3
4
5
6
7
8
9
7/9/2018
7/12/2018
7/19/2018

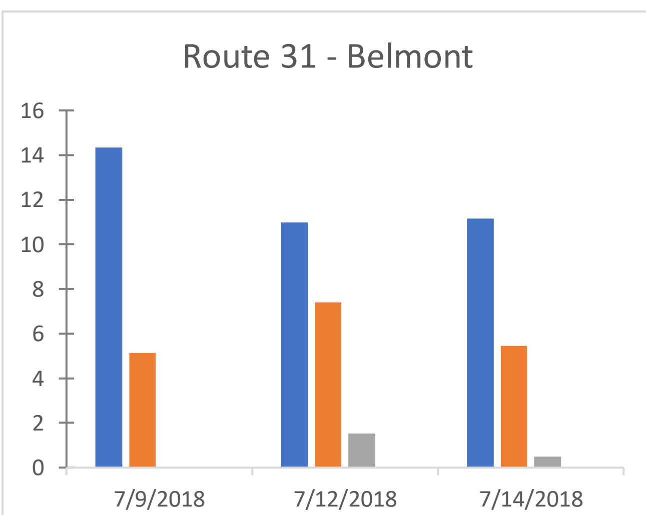

Route 26 - Waldo
0
2
4
6
8
10
12
14
16
7/11/2018
7/29/2018

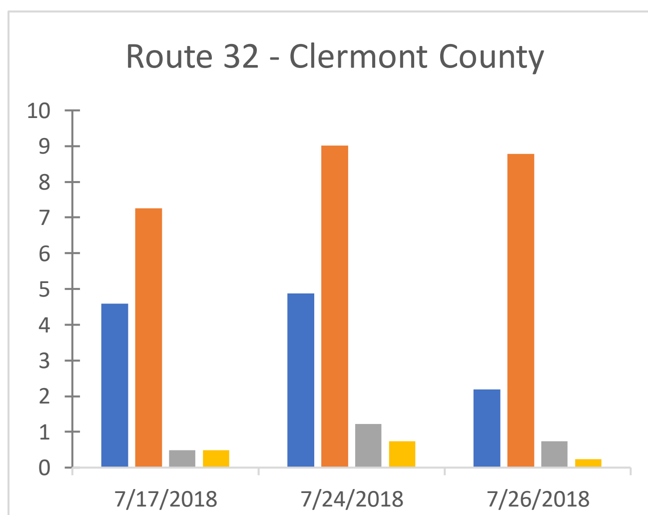

Route 27 - WPAFB
Bat passes/min/mi
2.5
2
1.5
1
0.5
0
7/17/2018

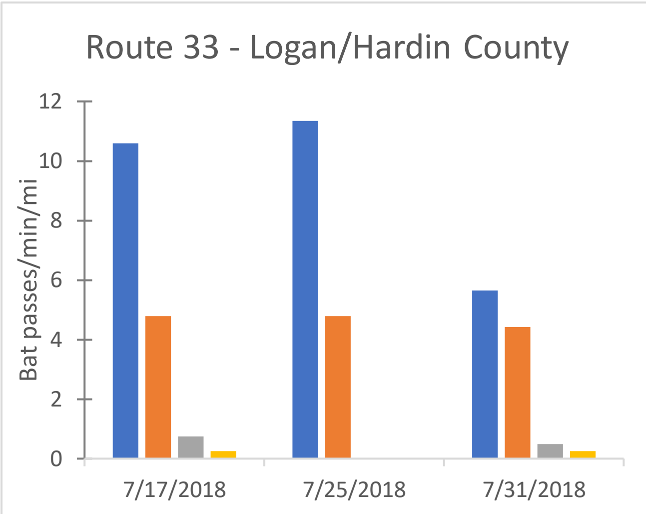

Route 28 - Summit
30
25
20
15
10
5
0
7/2/2018
7/6/2018
7/9/2018
7/11/2018

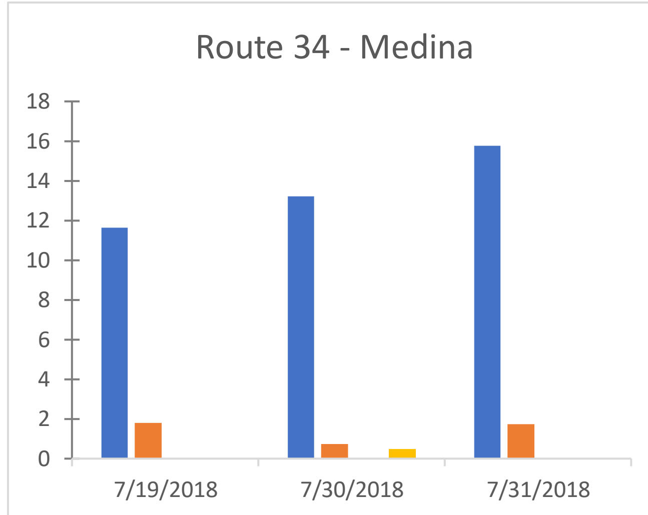

Route 29 - Van Wert/Paulding
18
16
14
12
10
8
6
4
2
0
7/19/2018
7/23/2018
7/25/2018

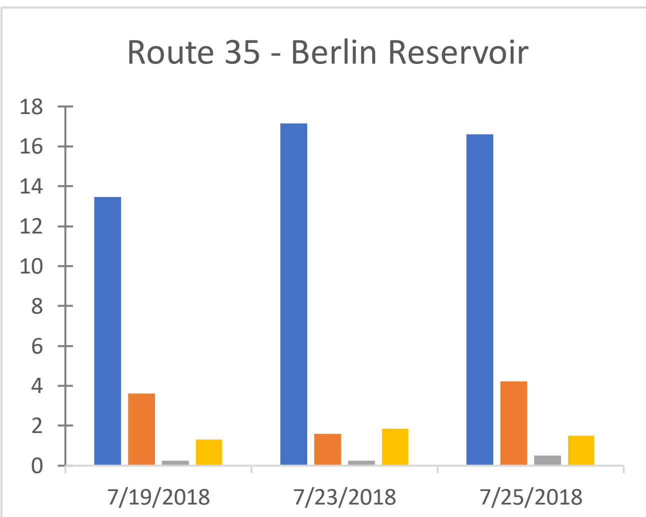

Route 30 - Adams County
16
14
12
10
8
6
4
2
0
7/18/2018

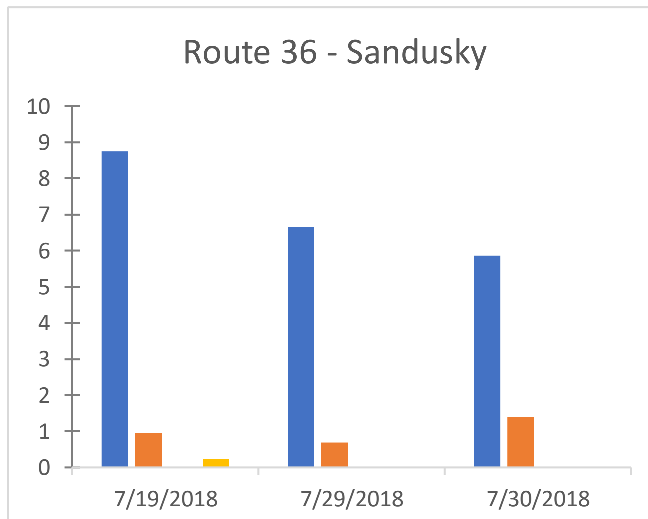

Route 31 - Belmont
16
14
12
10
8
6
4
2
0
7/9/2018
7/12/2018
7/14/2018

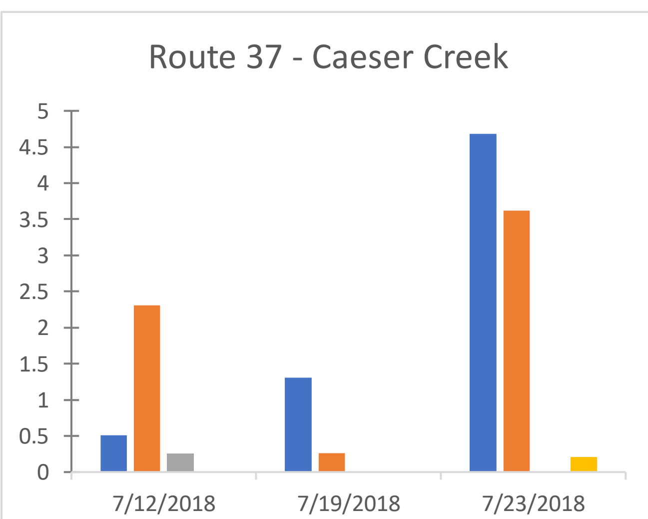

Route 32 - Clermont County
10
9
8
7
6
5
4
3
2
1
0
7/17/2018
7/24/2018
7/26/2018

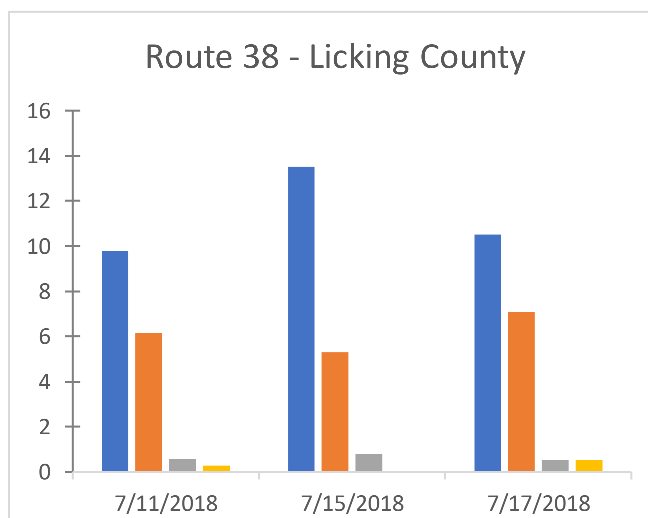

Route 33 - Logan/Hardin County
Bat passes/min/mi
12
10
8
6
4
2
0
7/17/2018
7/25/2018
7/31/2018

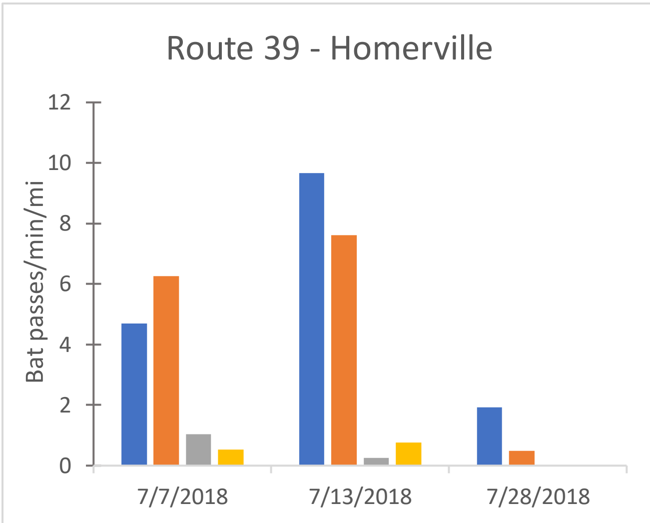

Route 34 - Medina
18
16
14
12
10
8
6
4
2
0
7/19/2018
7/30/2018
7/31/2018

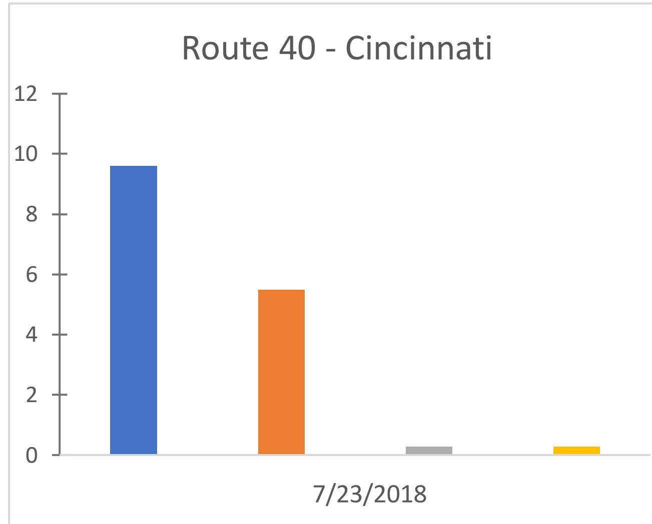

Route 35 - Berlin Reservoir
18
16
14
12
10
8
6
4
2
0
7/19/2018
7/23/2018
7/25/2018

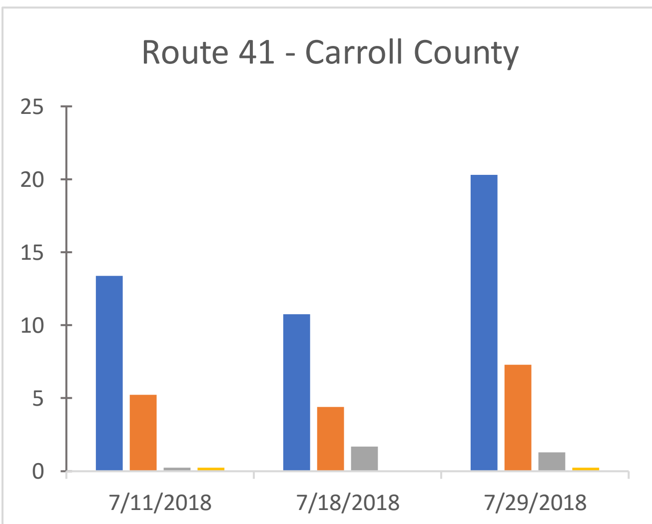

Route 36 - Sandusky
10
9
8
7
6
5
4
3
2
1
0
7/19/2018
7/29/2018
7/30/2018

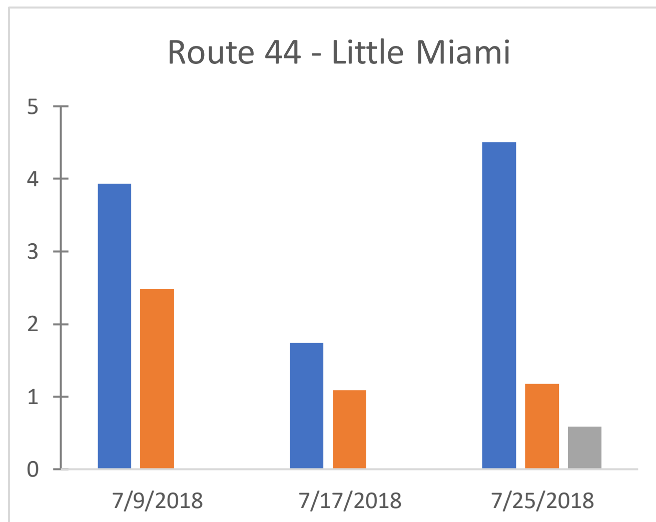

Route 37 - Caeser Creek
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
7/12/2018
7/19/2018
7/23/2018


Route 38 - Licking County
16
14
12
10
8
6
4
2
0
7/11/2018
7/15/2018
7/17/2018

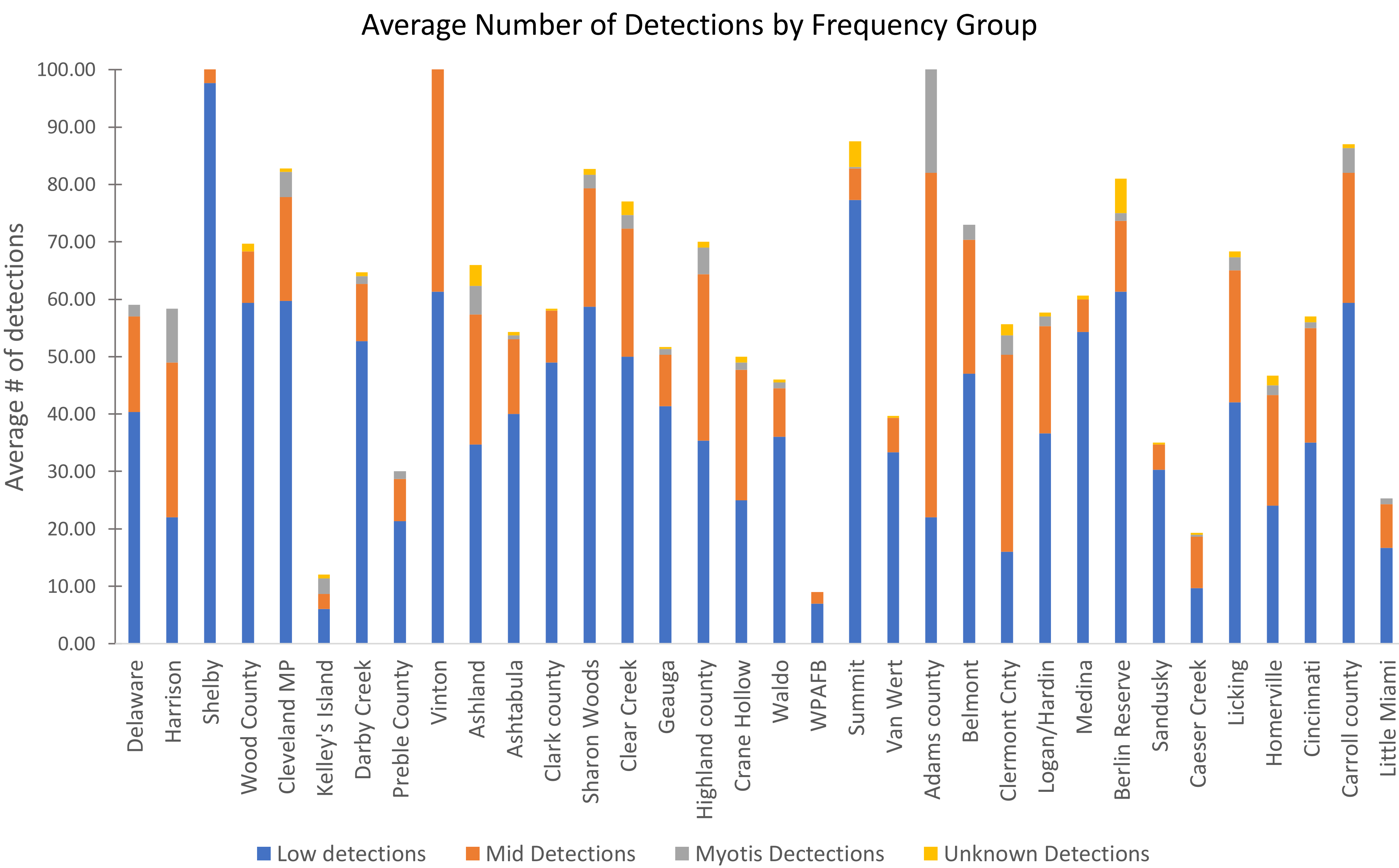

Route 39 - Homerville
Bat passes/min/mi
12
10
8
6
4
2
0
7/7/2018
7/13/2018
7/28/2018


Route 40 - Cincinnati
12
10
8
6
4
2
0
7/23/2018

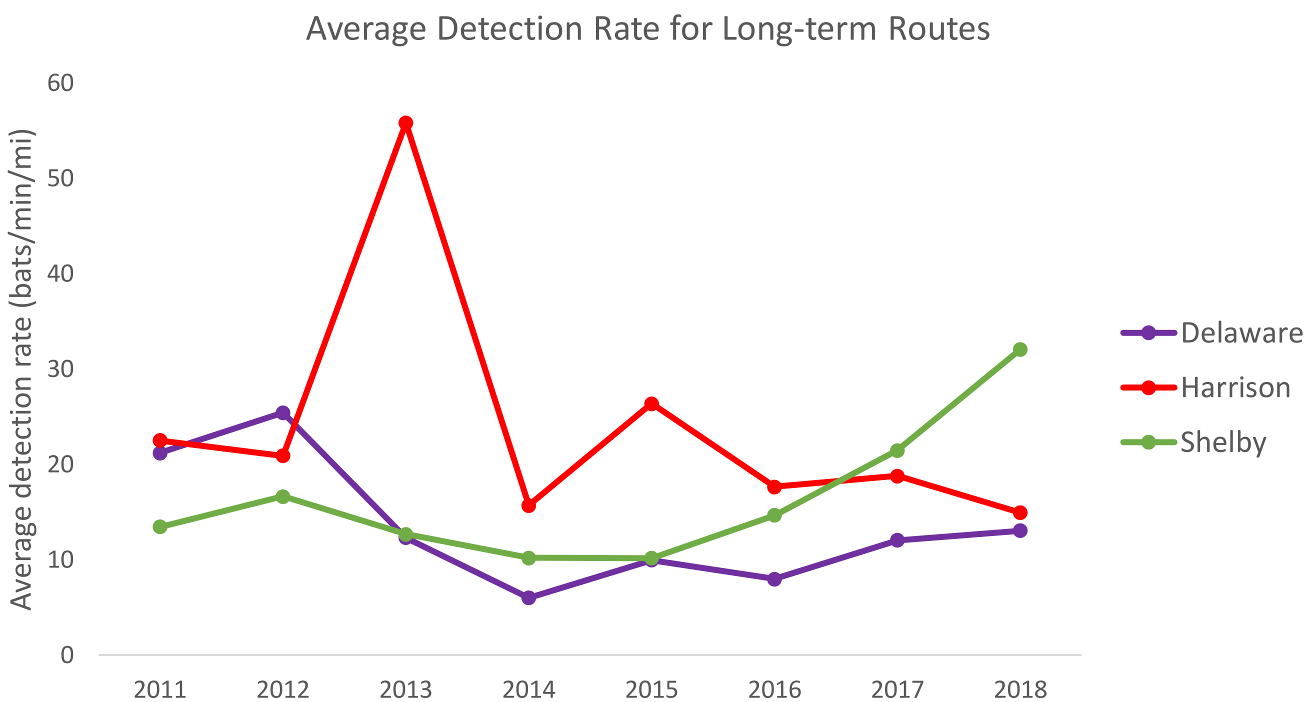

Route 41 - Carroll County
25
20
15
10
5
0
7/11/2018
7/18/2018
7/29/2018


Route 44 - Little Miami
5
4
3
2
1
0
7/9/2018
7/17/2018
7/25/2018

Appendix B: A comparison of the average number of bat detections for each frequency group amongst all routes run in 2018



Appendix C: Comparison of the average detection rate for the remaining three routes that have been run each year from 2011 and 2018.



Appendix D: Number of surveys performed for each route from 2011 to 2018.

	'11	'12	'13	'14	'15	'16	'17	'18
Route								
1	3	3	2	3	4	4	4	
2	2	3	2	3	3	3	3	
3	4	3	4	4	4	3	4	
4	2	3	4	3	4	3	4	
5	5	4	4	3	4	4	3	
6	4	4	3	3	5	4	3	
7	3	3	3	3	4	3	3	3
8	3	3	3	3	3	3	3	3
9	3	3	3	3	3	4	3	3
10	3	3		3	4	3	3	3
11		2	2	3	1	3	3	3
12		1		3	1			
13		2	1	3	1			
14		1		3	3	3	3	3
15		3	3	3	4	3	3	3
16		3	3	3	3	3		3
17		3	3	3	4	3	3	3
18			4	3	3	3	3	3
19			3	1	2	2	1	3
20			3	3	3	3	3	3
21			3	3	3	4	3	3
22			3	3	3	3	3	3
23			3	3	4	3	3	3
24			2	3	2	3	3	3
25			2	4	3	3	3	3
26			3	3	3	3	3	2
27			2	3	3	3	3	1
28			3	4	3	4	4	4
29			4	3	3	3	3	3
30				3	3	3	3	1
31				3	4	3	3	3
32				3	4	3	3	3
33				3	4	4	3	3
34				3	3	3	3	3
35				3	3	4	4	3
36				3	3	3	3	3
37				3	3	3	3	3
38					5	1	3	3
39					3	3	3	3
40					3	3	3	1
41						3	3	3
42							3	
43								
44								3
Total	**32**	**47**	**75**	**112**	**128**	**122**	**120**	**96**