WISCONSIN BAT PROGRAM- Driving Acoustic Bat Survey Report 2022

Wisconsin Department of Natural Resources
Bureau of Natural Heritage Conservation
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In Brief

- ***There were 101 acoustic bat driving surveys in 50 counties conducted by 38 surveyors that included staff from Wisconsin Department of Natural Resources, Bad River Natural Resources Department (Tribal), U.S. Forest Service and private citizens.***
- ***Central Sand Hills region, for the tenth year running, has consistently had the highest average bat calls per detector hour when compared to all other ecological landscapes.***
- ***In 2022, mean little brown bats recorded per kilometer/hour has remained unchanged since 2017, when the first effects of white-nose syndrome were observed in acoustic data.***

Introduction

In 2013, the Wisconsin Bat Program (WBP) expanded its offering of bat surveying opportunities by adding 38 predetermined driving bat surveys (transects; Appendix 1). The 2022 survey season marks the tenth year conducting acoustic driving surveys. This report summarizes the methods and results from the driving survey transects that were conducted in Wisconsin in 2022 and compares this year's data to the previous nine years.

Methods

To better understand statewide changes in bat populations, emphasis was placed on repeating the 38 driving transects which were developed in 2013 by WBP in each of the 16 ecological landscapes (Table 1; Appendix 1). In coordination with national bat monitoring efforts, the following protocols were adopted to ensure standardization and quality-controlled data (Loeb et al., 2015). Each acoustic driving transect ranged from 20 to 30 miles per survey and used an acoustic detection system that passively recorded bat activity by detecting ultrasonic echolocation calls emitted by bats as they forage and navigate across the landscape. These echolocation calls were recorded and saved using an ultrasonic detector (Anabat SD1/2, AnaSwift, Titley Scientific LLC, Columbia, MO). The call files (bat encounters) and their geospatial information were collected through one of two methods: 1) using a hand-held computer (personal data assistant - PDA) (PDA, Hewlett-Packard Company iPAQ models) with a Global Positioning System (GPS; Global Sat, BC-337) or 2) data was directly saved to a compact flash card in the ultrasonic detector which is equipped with a mouse GPS (Global Sat, BC-355S4).

Surveyed routes in 2022 were driven one to three times across a six-week window, beginning June 1 and ending July 15**.** Surveys began approximately 30 minutes after local sunset time and were driven at a target speed of 20 miles per hour. Routes were to be completed at least once during the three primary survey periods: June 1 - June 15, June 16 - June 30 and July 1- July 15, and a minimum of five days was required between replicates of the same transect. Routes were surveyed on evenings with weather conditions suitable for bat activity which included low wind speed (<30 mph), no precipitation and a daytime temperature of 50^{O}F or above (Loeb et al., 2015). Survey equipment included the roof-mounted microphone, an AnaBat SD1/2 bat detector, a hand-held computer to interface with the AnaBat SD1/2, a compact flash GPS unit to record the location of each acoustic file, and other appropriate items (instructions, route maps, datasheets, batteries and cables).

Acoustic files were analyzed using Titley Scientific AnalookW (Version 4.4a) (Corben 2018). Surveys were manually filtered to separate files containing bat encounters and ignore those files with only extraneous noise from insects, birds, wind, road noise, and other sources of static. All acoustic data were processed through manual examination by one staff member who has >16 years of experience in identifying Wisconsin bat species and had an extensive call library to use as reference. Files with bat encounters were categorized into one of the following species: hoary bat- LACI (*Lasiurus cinereus*), big brown bat - EPFU (*Eptesicus fuscus*), silver-haired bat - LANO (*Lasionycteris noctivagans*), eastern red bat - LABO (*L. borealis*), tricolored bat (or eastern pipistrelle) - PESU (*Perimyotis subflavus*), little brown bat - MYLU (*Myotis lucifugus),* northern long-eared bat- MYSE (*M. septentrionalis*), evening bat - NYHU (*Nycticeius humeralis*), or into species groups: big brown/silver-haired bat (EPFULANO), eastern pipistrelle/eastern red/evening bat (LABOPESUNYHU), little brown/northern long-eared bat (Myotis), low frequency and high frequency. Species are grouped together because their calls are similar, and some pass files do not contain enough detail to accurately assign a species. Low and high frequency bat passes were later grouped as unclassified encounters because one of the following scenarios: there were too few calls recorded to further separate, the calls were of low-quality recording (i.e., fragmented), the bat pass did not contain search-phase calls (calls used to identify species), or general uncertainty. To compare our results year-to-year and to other state-wide acoustic inventories, results were evaluated using metrics to account for variations in driving speeds among surveyors: bat encounters-per-detector-hour [bat encounters divided by survey time (hours)] and bat encounters-per-kilometer-hour [bat encounters divided by kilometers traveled per hour].

Table 1: Ecological Landscapes in Wisconsin and associated abbreviations.

Ecological Landscape	Abbreviation
Central Lake Michigan Coastal	CLMC
Central Sand Hills	CSH
Central Sand Plains	CSP
Forest Transition	FT
North Central Forest	NCF
Northeast Sands	NES
Northern Highland	NH
Northern Lake Michigan Coastal	NLMC
Northwest Lowlands	NWL
Northwest Sands	NWS
Southeast Glacial Plains	SGP
Southern Lake Michigan Coastal	SLMC
Southwest Savanna	SWS
Superior Coastal Plain	SCP
Western Coulee and Ridges	WCR
Western Prairie	WP

Results

In 2022, 101 surveys were conducted in 50 counties by 38 individuals from Wisconsin Department of Natural Resources, Bad River Natural Resources Department (Tribal), U.S. Forest Service and citizen volunteers. These 101 completed surveys add to an invaluable data set (Table 2) bringing the total completed driving surveys to 899 since 2013. In 2022, the mean survey length was 49.8 km (30.9 miles; range 30.5 km/18.5 miles – 73.6 km/45.7 miles). Surveyors traveled over 5,000 kilometers (3,100 miles) and surveyed 7,658.3 hectares (18,924.1 acres) (Appendix 3, Table 4).

Two survey routes - NWL1, SCP1 - were not surveyed in 2022, while NCF1 was attempted but no valid data were collected. At least one survey was completed in each of the 16 ecological landscapes (EL), resulting in valid data for 35 routes. In total, 17,320 files were recorded and of those files 4,915 (28.4%) were identified as bat encounters. A mean of 27.5 bat calls per detector-hour were recorded (range 4.8 – 90.3 bat calls/detector/hour). For 10 consecutive years, Central Sand Hills region had the highest average bat calls per detector hour (54.9, Figure 1) and the Southern Lake Michigan Coastal region had the lowest average bat calls per detector hour (12.8). Surveyors recorded a mean of 48.7 bats calls (files) per survey (range: 7-191 bat calls per survey). The number of surveys varied by week with the most surveys completed in July (3rd sampling period; Figure 2) and bats were more likely to be detected toward the end of the third sampling period (Figure 3), which can be attributed to population recruitment by recently-volant (flying) juveniles.

Of the 4,915 bat encounters, 1,601 (32.6%) were classified into species groups: high frequency group (335), low frequency group (502), big brown/silver-haired bat (508), eastern red/eastern pipistrelle/evening bat (239) and little brown/northern long-eared (17) because the bat passes have similar call characteristics to two or more species. The remaining 3,314 (67.4%) files were classified as big brown (1,015), hoary (1,163), eastern red (692), little brown (172), silver-haired bat (268) and evening bat (4). The northern long-eared bat and tricolored bat were not detected on acoustic driving transects in 2022. Among the 16 ecological regions, hoary bats (n=8 regions) were the most encountered species followed by the big brown bat (n=7) and the eastern red bat (n=1) (Figure 7). Of note, the little brown bat, which is highly susceptible to WNS, was the most encountered species in six ecological landscapes when the driving surveys began in 2013.

Table 2. Number of driving transects and surveyors by year.

Year	No. Driving Transects	No. Surveyors
2013	92	56
2014	78	45
2015	77	48
2016	71	50
2017	92	58
2018	96	55
2019	107	53
2020	73	28
2021	113	39
2022	101	38

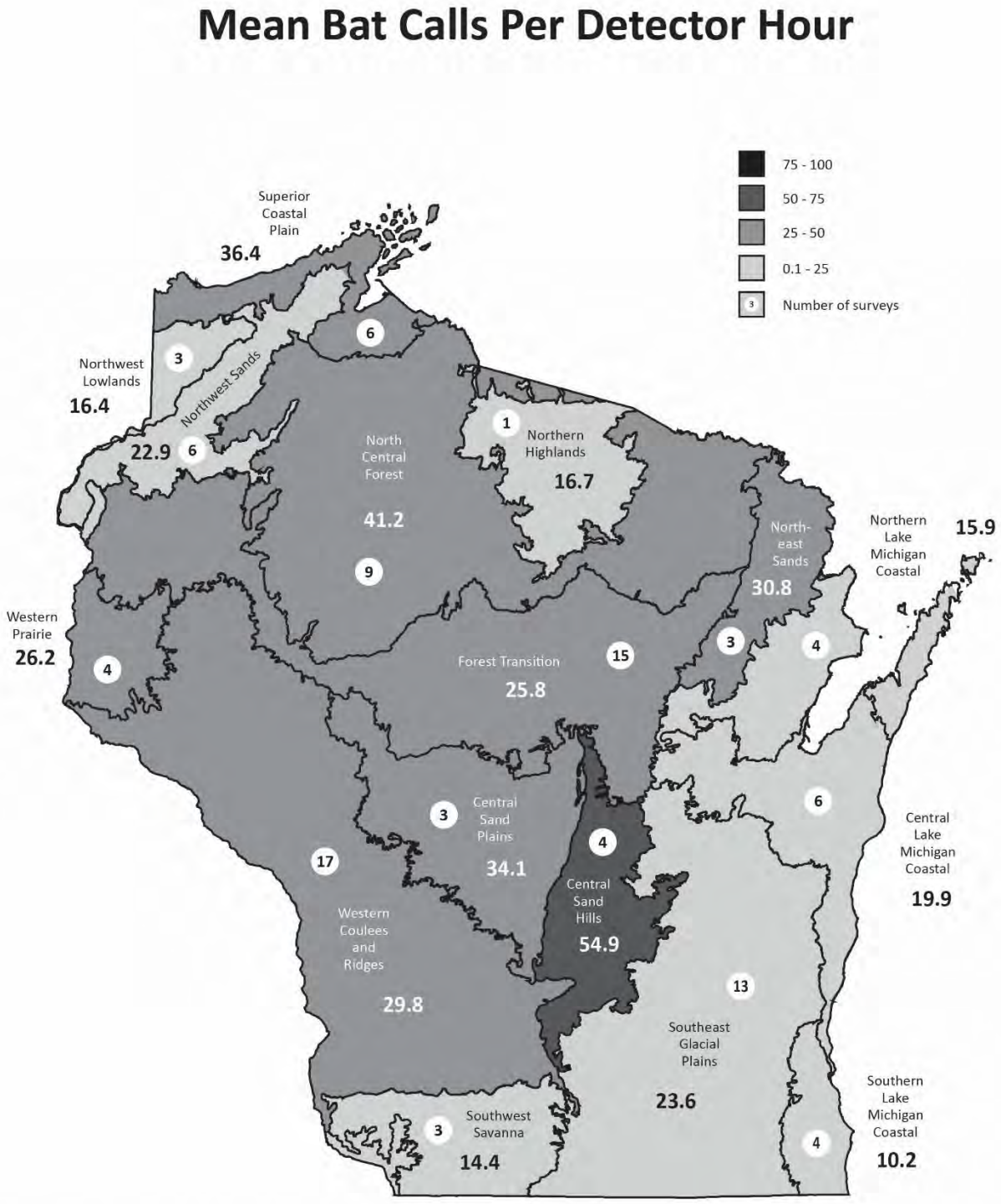


Figure 1. Central Sand Hills continues to have the highest mean bat calls per detector hour at 54.9 calls/detector/hour. Mean calls per detector hour across all landscapes was 27.5.

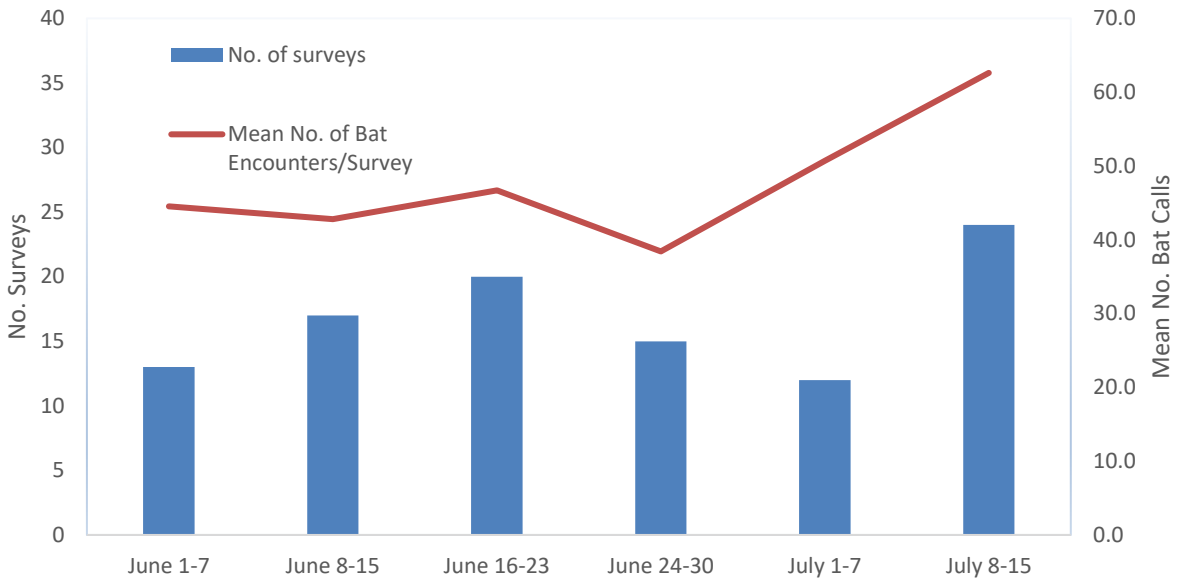


Figure 2. Total number of surveys by week and mean number of bat calls per survey by week (2022).

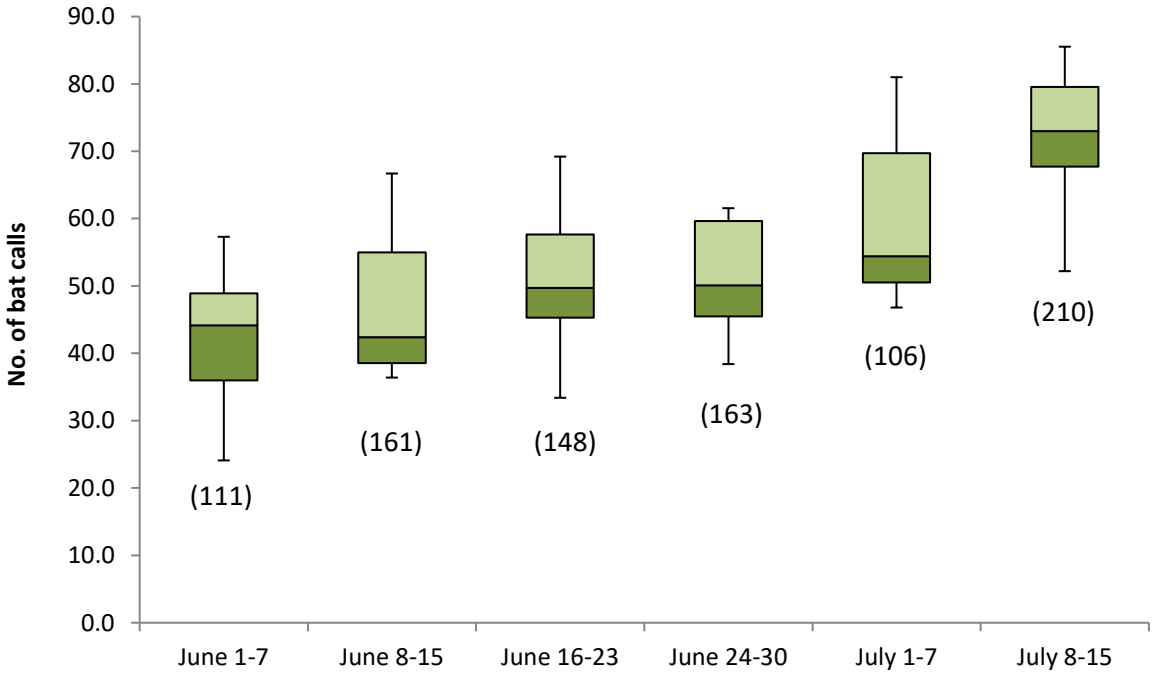


Figure 3. Comparison of mean bat calls per survey for 8-day period from 2013-2022 driving routes. Numbers in brackets indicate sample size (number of surveys). Boxes depict the 25th and 75th percentiles, lines within boxes mark the median, whiskers represent 95th and the 5th percentiles.

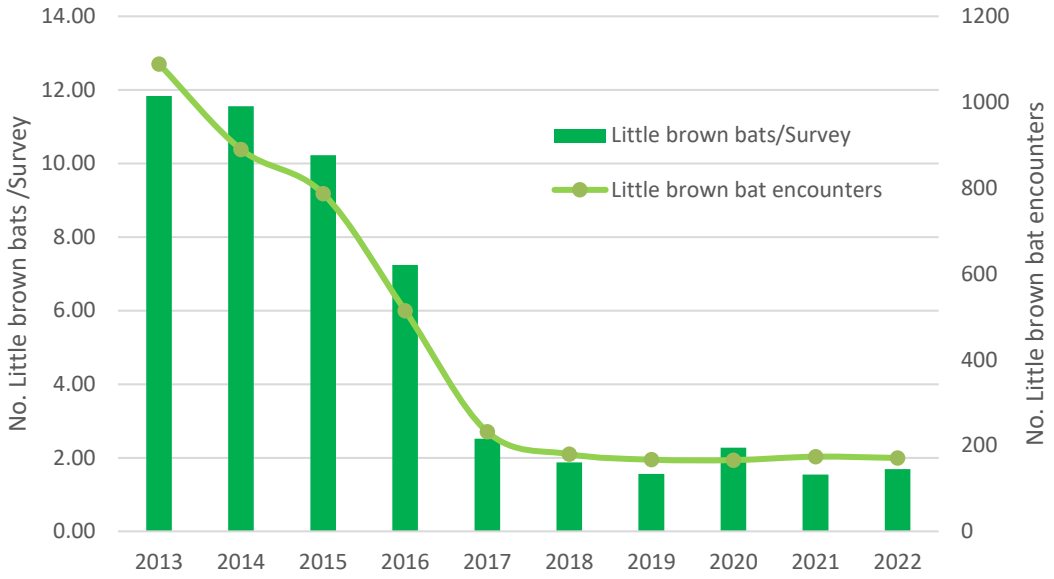


Figure 4. Yearly acoustic little brown encounters per survey (bats; left axis) and total little brown bat encounters on all surveys (line; right axis). Regardless of the presentation, both indices show the same general trend – a larger population or detection rate followed by declines, then reaching stabilization from 2017-2022.

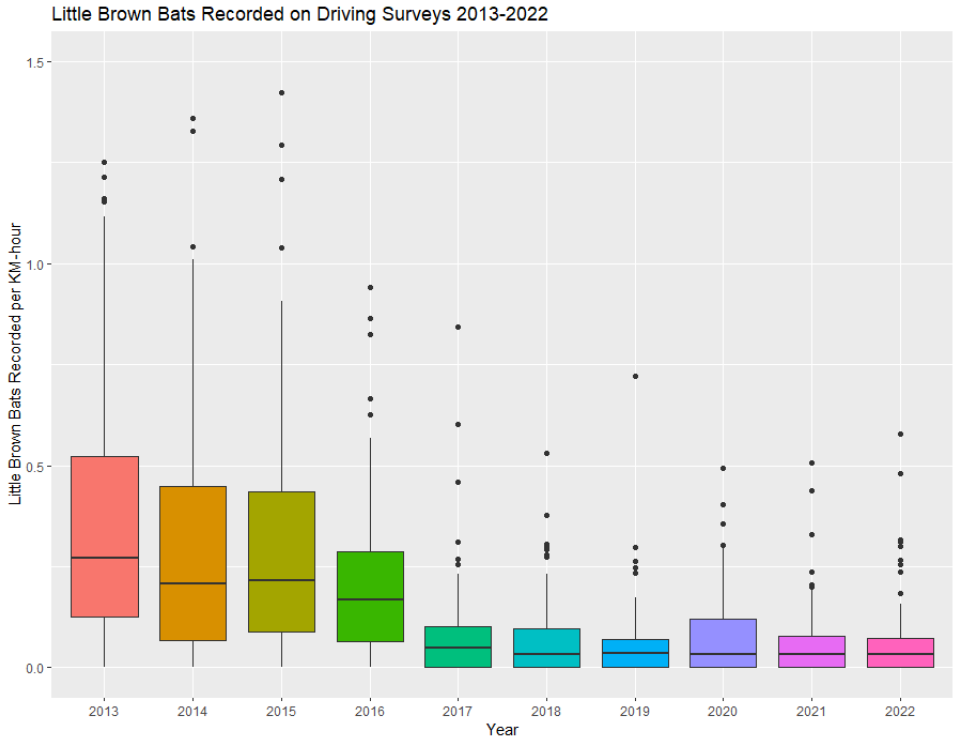


Figure 5. Little brown bat passes per kilometer hour by year. Little brown bat passes from driving transects in 2022 were significantly similar to years 2017-2021. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

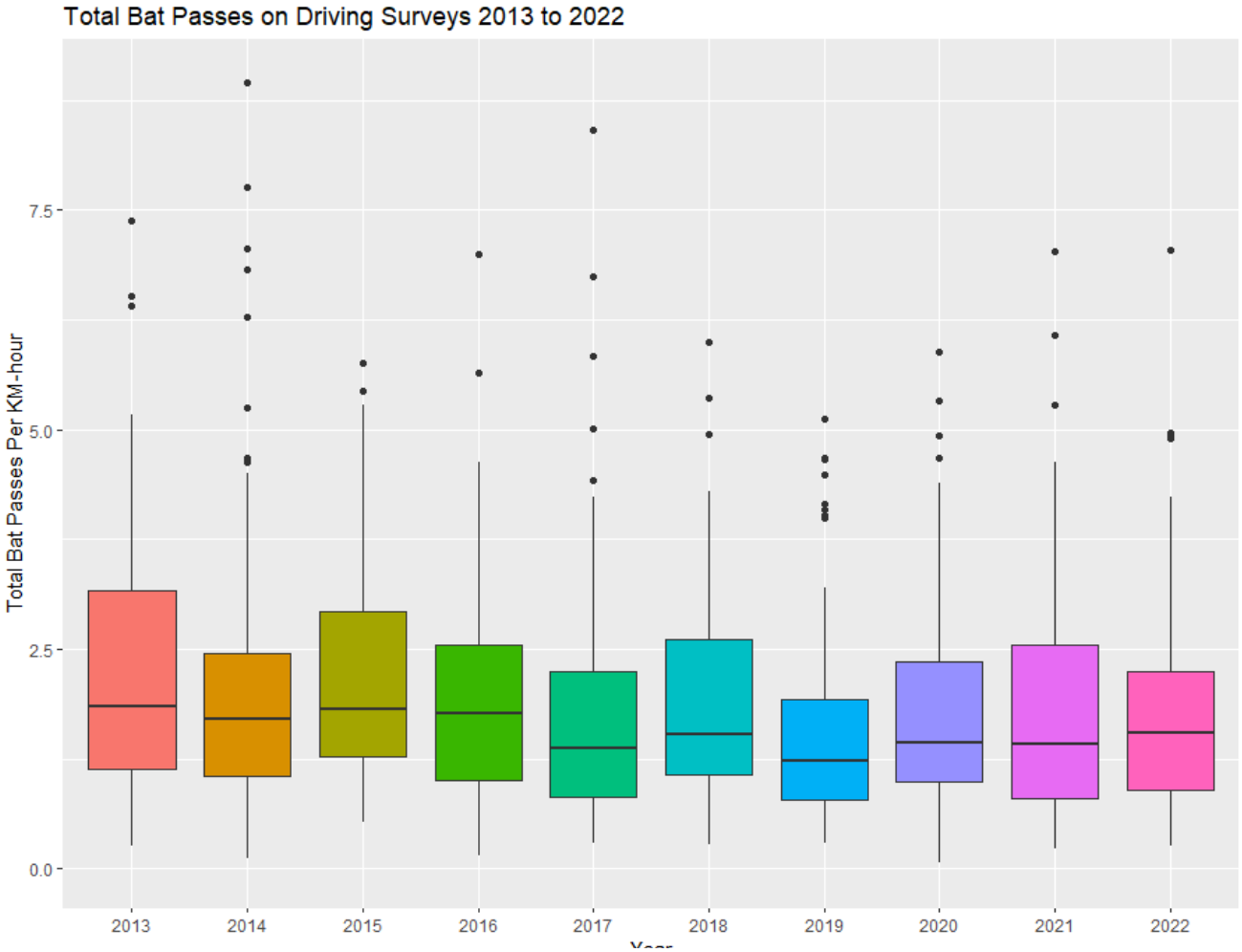


Figure 6. Total passes per kilometer hour by year. Total bat passes from driving transects in 2022 were not significantly different from previous years. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

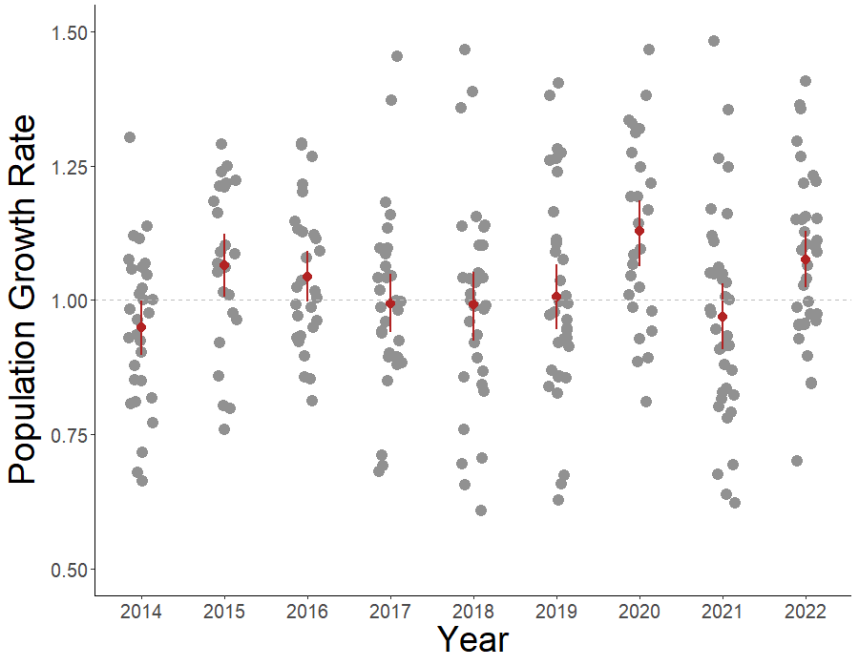


Figure 7. Yearly growth rate for little brown bats detected on acoustic driving surveys. The growth rate (lambda) was calculated from the change of calls per km-hr by year (year n/(year n-1)). Red dots indicate mean and whiskers show 95% confidence limits. Dotted line at 1 indicates stability and rates above/below indicate growing/declining populations. Historically, driving routes have been a poor detection tool for Myotis species, which could explain why dramatic changes aren't observed as in other datasets like winter hibernacula or summer roost counts. A small amount of jitter has been added along the x-axis to facilitate presentation.

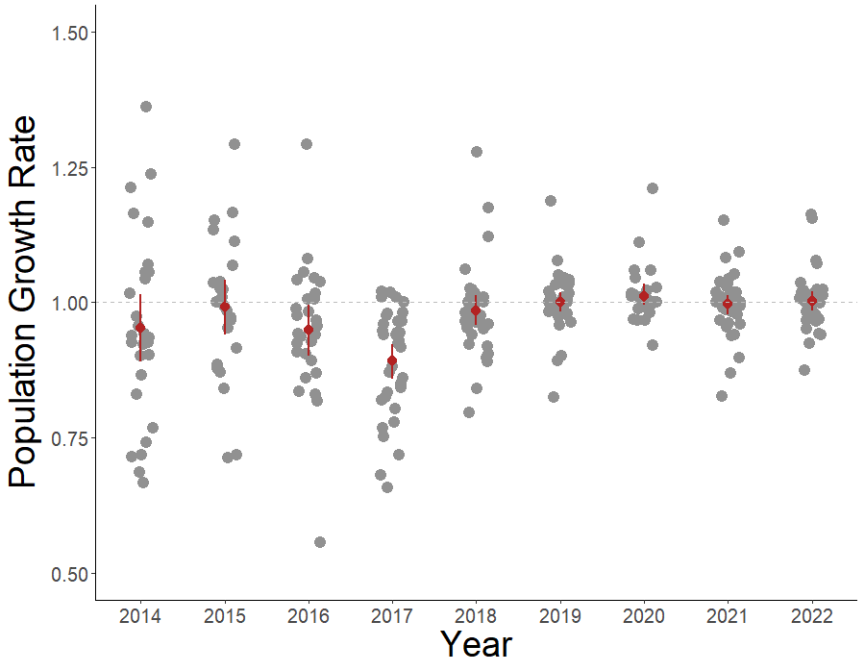


Figure 8. Yearly growth rate for all tree bat species (eastern red, hoary, evening and silver-haired bat) detected on acoustic driving surveys. The growth rate (lambda) was calculated from the change of calls per km-hr by year. Red dots indicate mean and whiskers show 95% confidence limits. Dotted line at 1 indicates stability and rates above/below indicate growing/declining populations The plot indicates some variation around stable growth rates notwithstanding of year. A small amount of jitter has been added along the x-axis to facilitate presentation.

Most Common Bat Species by Ecological Region

Figure 9. The most commonly encountered bat species by ecological region were the hoary bat (8), the big brown bat (7) and the eastern red bat (1) in 2022.

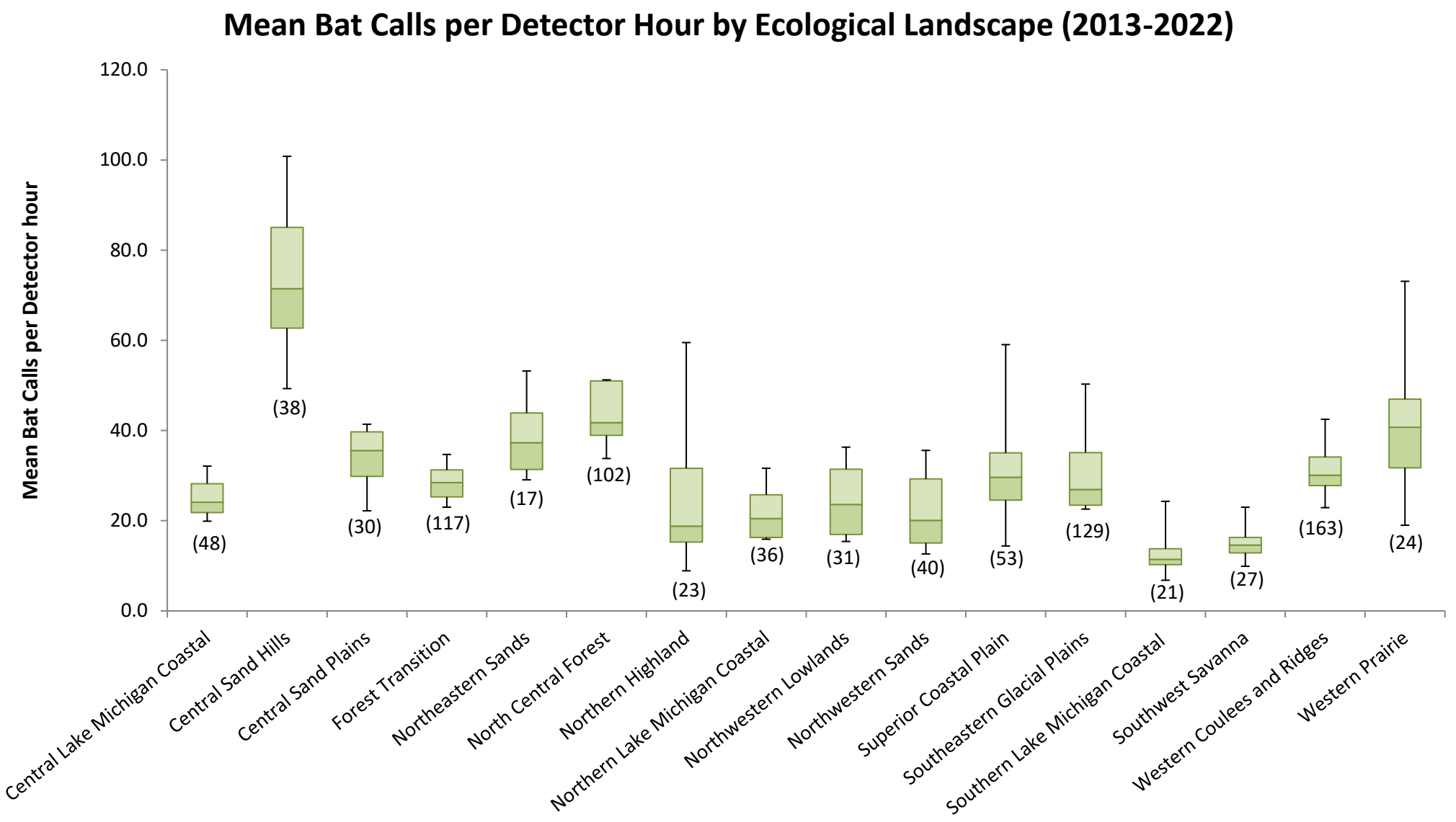


Figure 10. Mean bat calls per detector hour by ecological landscape (2013-2022). Bracketed numbers are total number of surveys per ecological landscape. A total of 899 acoustic driving surveys have been completed since 2013. Boxes depict the 25th and 75th percentiles, lines within boxes mark the median, whiskers represent 95th and the 5th percentiles.

Discussion

The 2022 season marked the tenth year the Wisconsin Bat Program used acoustic driving surveys as a method to monitor regional and statewide bat populations. The initial few years of monitoring were prior to Wisconsin's first detection of the deadly fungal disease known as white-nose syndrome (WNS) and these years prior - also known as baseline - served as an important permanent record of what was present before the effects of WNS were observed. Despite the dramatic drop in cave bat acoustic detections starting in 2017 (Figures 4 and 5), unexpectedly the total bat passes per kilometer hours (Figure 6) remained relatively constant, with no significant change noted. However, when the yearly growth rate for tree bat species was examined in Figure 8, there is a minor increase in the growth rate starting in 2018 followed by four years of a stable or slightly increasing population. It's possible that we are seeing tree bats filling-in some of the niches vacated by WNS-affected bats, but we still have more data to analyze to fully understand these possible shifts over time (Ford et al. 2011).

What's clear when looking at these data is that cave bat detections are down significantly when compared to baseline, which is not unexpected given the losses observed at both summer roost sites and in winter hibernation counts in Wisconsin. These declines exclude the big brown bat, which has fared much better with WNS then the three other cave bat species – tricolored, northern long-eared bat and the little brown bat. Throughout a 5-year span (2018-2022), the tricolored bat was only detected once in 2021. That's just one encounter out of 15,934 bat calls named to species. With the absence of this species from acoustic surveys the effects of WNS on this species are apparent in Wisconsin, but the losses extend beyond the State's borders and the bat was proposed to be listed under the Endangered Species Act (ESA) as Endangered by the US Fish and Wildlife Service (USFWS) in fall of 2022. Even harder to detect is the northern long-eared bat, which hasn't been observed on driving surveys since 2015. It's important to note that habitat use (using forested interiors) and echolocation intensity (whispering bat) can be attributed to low detectability of northern long-eared bat on traditional driving surveys, but severe declines of this species from WNS were also recognized by USFWS as the bats' federal status was reclassified as Endangered under the ESA in November 2022 and is set to take effect in spring of 2023. Finally, the USFWS is currently reviewing the status of the little brown bat because of threats from both WNS and wind energy facilities. After the significant drop in little brown bat detections in 2017 in Wisconsin (Figure 4), total detections for this species have remained relatively stable. To understand the full picture of loss and recovery, it may be important to survey acoustically using different methods (paddling, stationary or walking surveys) along rivers, lakes, streams and forested corridors as many of the WNS-affected bats are known to forage in these environments (Lacki 2007).

Of the remaining cave bat populations, where are they located? Are cave bats in the same regions where they were found before WNS arrived? When investigating the highest little brown bat/kilometer/hour rate for year one and year ten of driving surveys, a few landscapes stood out as having the highest rate of detection before and after WNS invasion. Worth noting is the disparity in detection rates between years one and ten in the top producing regions in Table 3. For example, for every eight kilometers traveled in the Western Coulee and Ridges (WCR) landscape in 2013 you would have encountered roughly 54 little brown bats, compared to 2022 where in the same landscape only

three little brown bats were encountered over the same distanced traveled. Despite the stark differences among years, WCR still remains one of the most likely regions to encounter little brown bats. With major riverine systems like the Wisconsin and Mississippi in WCR region, these resources could be supporting population recovery as we see in roost censuses of little brown bats in Wisconsin (WI Bat Program – 2022 Roost Report).

Table 3. Little brown bat detection rates comparison.

Little brown bat/KM/HR	2013	2022
Western Coulee and Ridges	6.80	0.37
North Central Forest	5.30	0.42
Southeast Glacial Plains	5.18	0.27
Central Sand Hills	4.89	0.52
Forest Transition	3.91	0.34
Northern Highland	2.58	0.04
Central Sand Plains	2.09	0.18
Northern Lake Michigan Coastal	1.85	0.27
Northwest Sands	1.29	0.08
Western Prairie	1.25	0.49
Superior Coastal Plain	1.06	0.10
Central Lake Michigan Coastal	0.81	0.06
Northwest Lowlands	0.75	0.02
Northeast Sands	0.62	0.18
Southwest Savanna	0.43	0.00
Southern Lake Michigan Coastal	0.31	0.02

After a self-audit in the winter of 2022, the Wisconsin Bat Program (WBP) maintained that acoustic bat driving transects were a Program priority given it is one of the only reliable methods to collect tree bat data on a statewide scale. The WBP will continue to use these surveys to estimate and evaluate species trends over time. On a national scale, the North American Bat Monitoring Program has already incorporated Wisconsin driving data into their summer occupancy analysis, creating occupancy probabilities for three cave bat species in Wisconsin. Closer to home, the WBP will use driving project data to help assess species status as part of the upcoming Wisconsin Wildlife Action Plan revision.

We are incredibly grateful thankful for all those who collected data for this project, whether it was for one year or all ten. Happy 10th anniversary!

Acknowledgements

The Wisconsin Bat Program would sincerely like to thank the following surveyors and coordinators for their dedication to the acoustic bat monitoring driving project: Boysen, S. De Zwarte, Jake Eager, A. Ewert, A. Fergus, E. Flores Gomez, N. and D. Gremban, B. Heeringa, J. Hillstead, L. Johnson, B. Johnston, A. Keen, N. Kilger, L. and J. Koyen, S. Rock, A. and M. Ledin, S. Lind, J. and P. Mariskanish, J. Miller, B. and E. Nevers, B. Paulan, B. Pauli, J. Redell, B. Schlitz, N. Schutt, M. Starzewski, T. Trapp, B. and J. Van Ryzin, B. and S. Volenec. We would also like to recognize Jill Rosenberg for website maintenance, Shari Koslowsky for grant support, Andrew Badje for his mapping services, Heather Kaarakka for graphic illustrations, analyzing data and creating graphs and plots. We also thank Species Management Section Chief Owen Boyle and Natural Heritage Conservation Bureau Direction Drew Feldkirchner for their support of this project. Mobile acoustic bat surveys in Wisconsin were funded by WNS Grants to States Program (S-1TW-1) and public contributions to the Wisconsin Bat Conservation fund.

Literature cited

Corben, C. 2018. AnalookW - an introduction to the software, user manual for AnaBat detectors. Retrieved from http://users.lmi.net/corben/Beta/.

Ford, W.M., Britzke E. R., Dobony C. A., Rodrigue J. L., and J. B. Johnson. 2011. Patterns of Acoustical Activity of Bats Prior to and Following White-Nose Syndrome Occurrence. Journal of Fish and Wildlife Management 1 December 2011; 2 (2): 125–134. doi: https://doi.org/10.3996/042011-JFWM-027

Frick W.F., Pollock J., Hicks AC, Langwig K., Reynolds D.S., Turner G., Butchkoski C. and T.H. Kunz. 2010. An emerging disease causes regional population collapse of a common North American bat species. Science 329: 679– 682.

Kurta, A., Foster R., Hough E., and L. Winhold. 2005. The evening bat (Nycticeius humeralis) on the northern edge of its range- a maternity colony in Michigan. Am. Midl. Nat., 154:264–267.

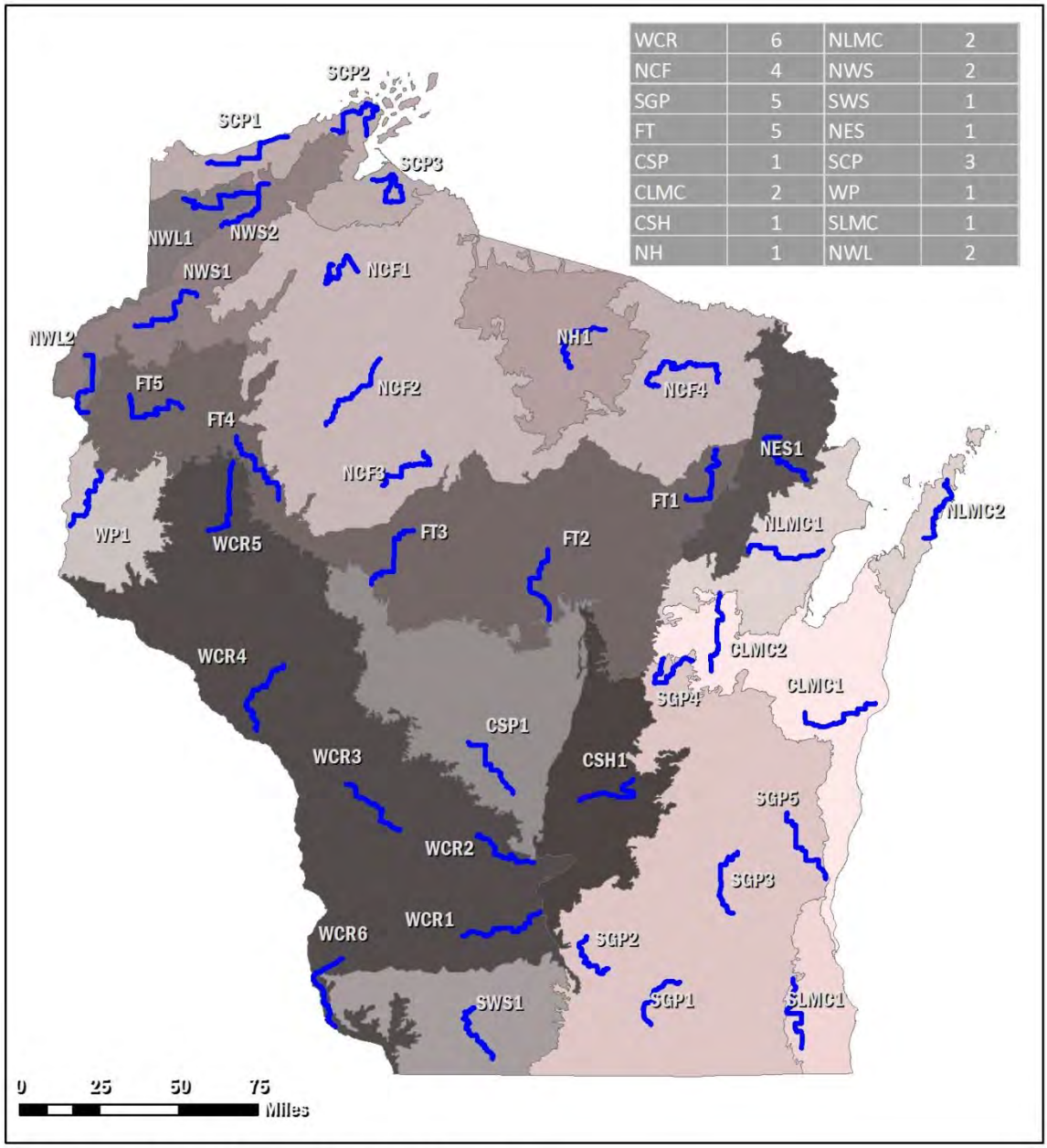
Lacki, M. J., Hayes, J. P., Kurta, A. & Tuttle, M. D. Bats in Forests: Conservation and Management (JHU Press, 2007).

Loeb, S.C., Rodhouse, T.J., Ellison, L.E., Lausen, C.L., Reichard, J.D., Irvine, K.M., Ingersoll, T.E., Coleman, J.T.H., Thogmartin, W.E., Sauer, J.R., Francis, C.M., Bayless, M.L., Stanley, T.R., and D.H. Johnson. 2015. A plan for the North American Bat Monitoring Program (NABat). General Technical Report SRS-208. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 112 p.

Whitby, M.D., Carter T.C., Britzke E.R., and S.M. Bergeson. 2014. Evaluation of Mobile Acoustic Techniques for Bat Population Monitoring. Acta Chiropterologica 2014 16 (1), 223-230.

Wisconsin Department of Natural Resources. 2022. Roost Monitoring Report. Wisconsin Department of Natural Resources, Madison, WI.

Appendix 1 Acoustic Bat Driving Transects by Ecological Landscape



Ecological Landscapes: Central Lake Michigan Coastal (CLMC), Central Sand Hills (CSH), Central Sand Plains (CSP), Forest Transition (FT), North Central Forest (NCF), Northeast Sands (NES), Northern Highland (NH), Northern Lake Michigan Coastal (NLMC), Northwest Lowlands (NWL), Northwest Sands (NWS), Southeast Glacial Plains (SGP), Southern Lake Michigan Coastal (SLMC), Southwest Savanna (SWS), Superior Coastal Plain (SCP), Western Coulees and Ridges (WCR) and Western Prairie (WP).

Appendix 2 (Figures 11-14) Bat species encounter by ecological landscape

Note: A map was not created for the evening bat due only a few statewide encounters. Maps for the tricolored bat and northern long-eared bat were also not created because these species were not detected in 2022.

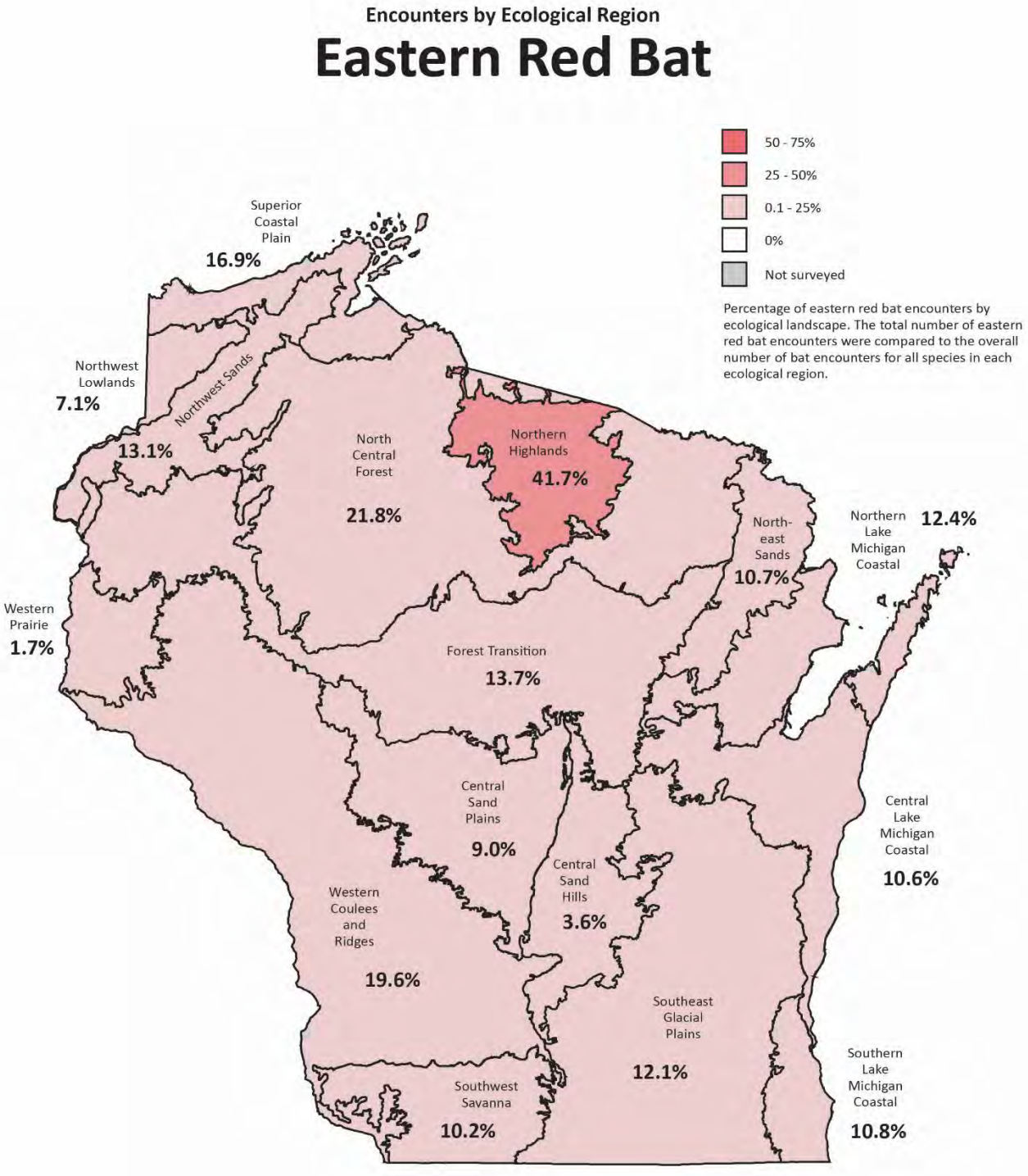


Figure 11. The eastern red bat had the highest encounter rate (41.7%) in the Northern Highlands Region and comprised 14.1% of all recorded bat passes during driving surveys in 2022.

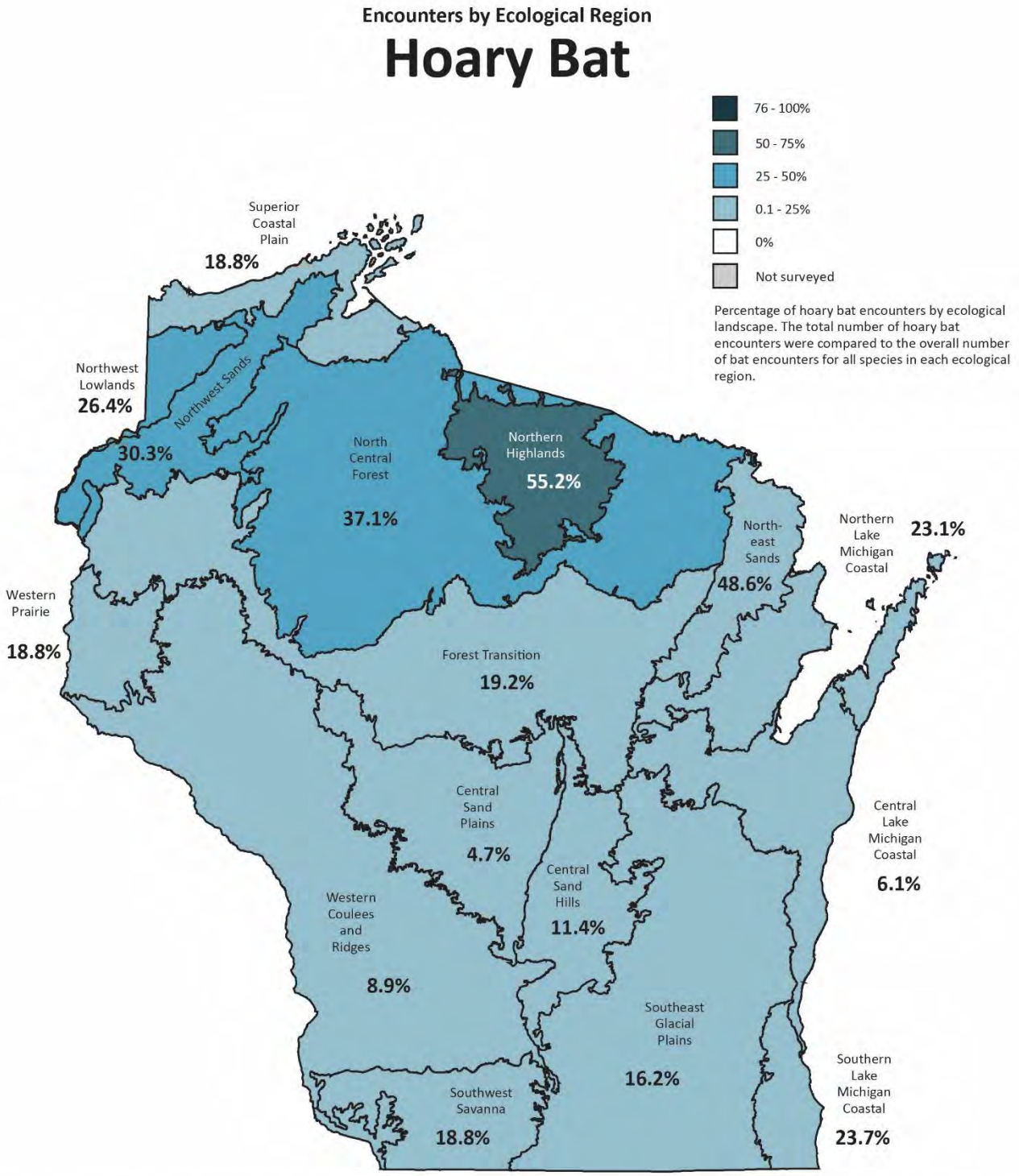


Figure 12. The hoary bat had the highest encounter percentage (55.2%) in Northern Highlands region and comprised 21.8% of all bat encounters during driving surveys in 2021.

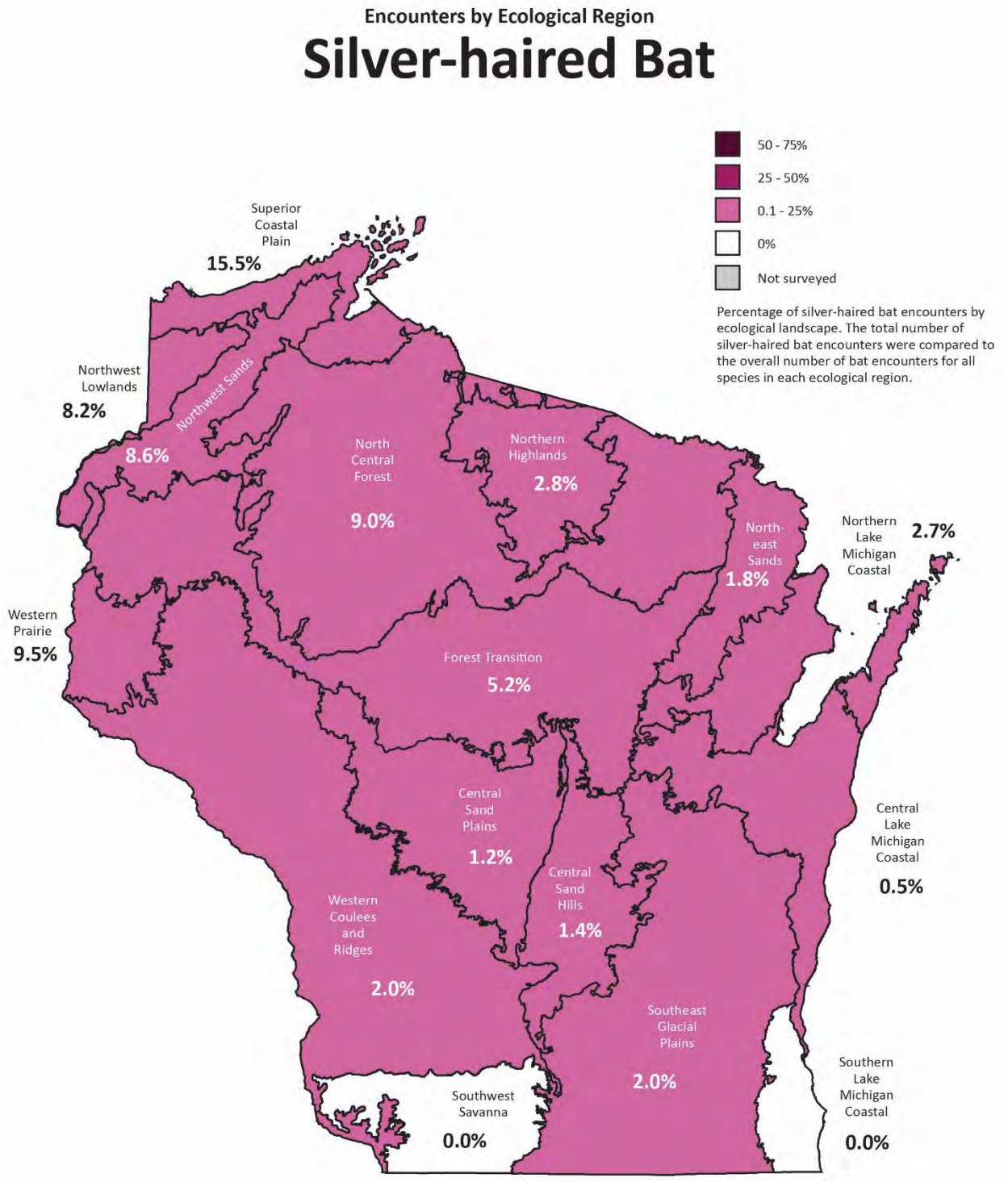


Figure 13. Silver-haired bat encounters accounted for 5.5% of all encounters recorded during driving surveys in 2022.

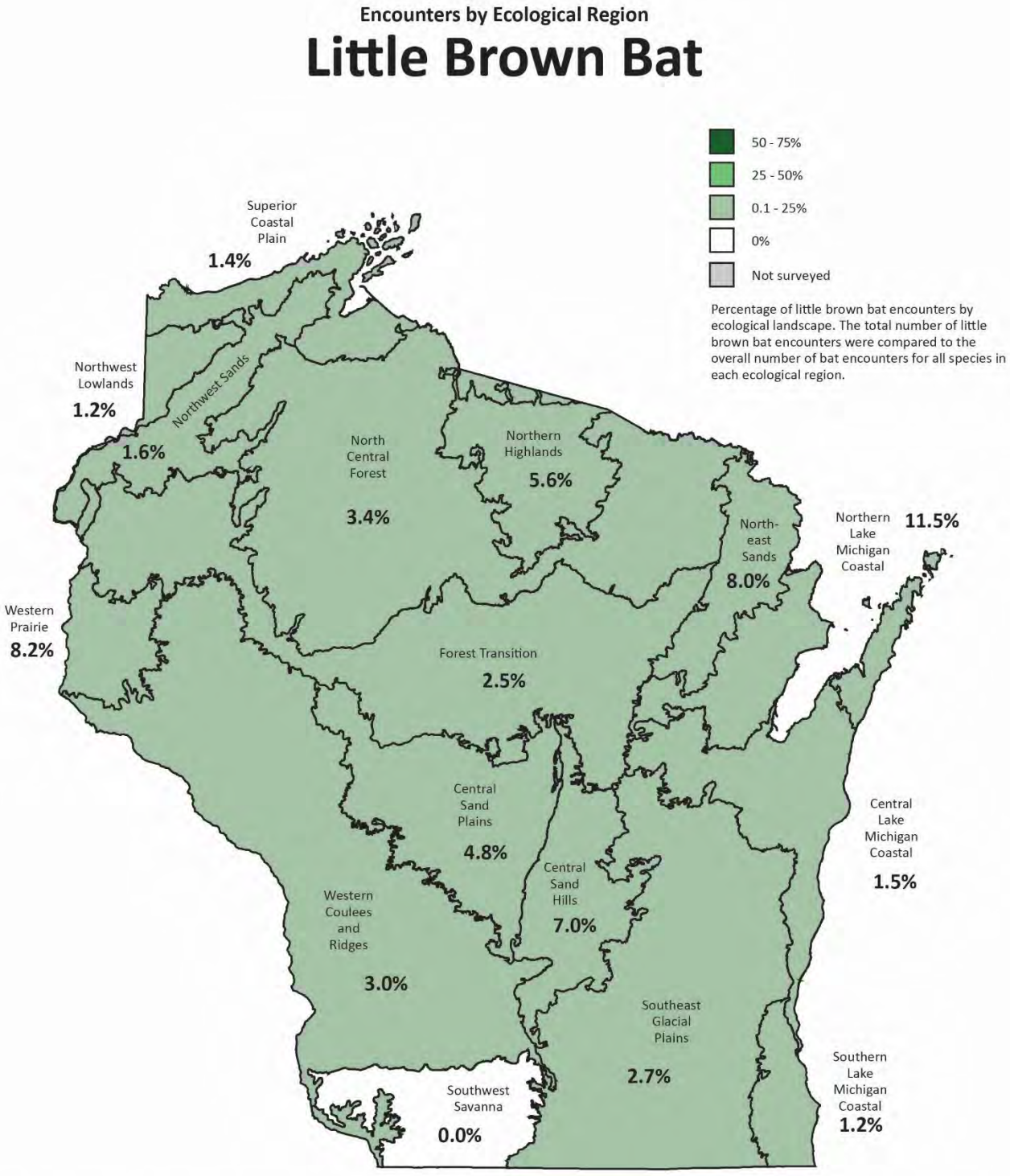


Figure 14. The little brown bat encounters accounted for 3.5% of all bat encounters recorded during driving surveys in 2022. Of note, little brown bat comprised 34.3% of all encounters in 2013 driving surveys.

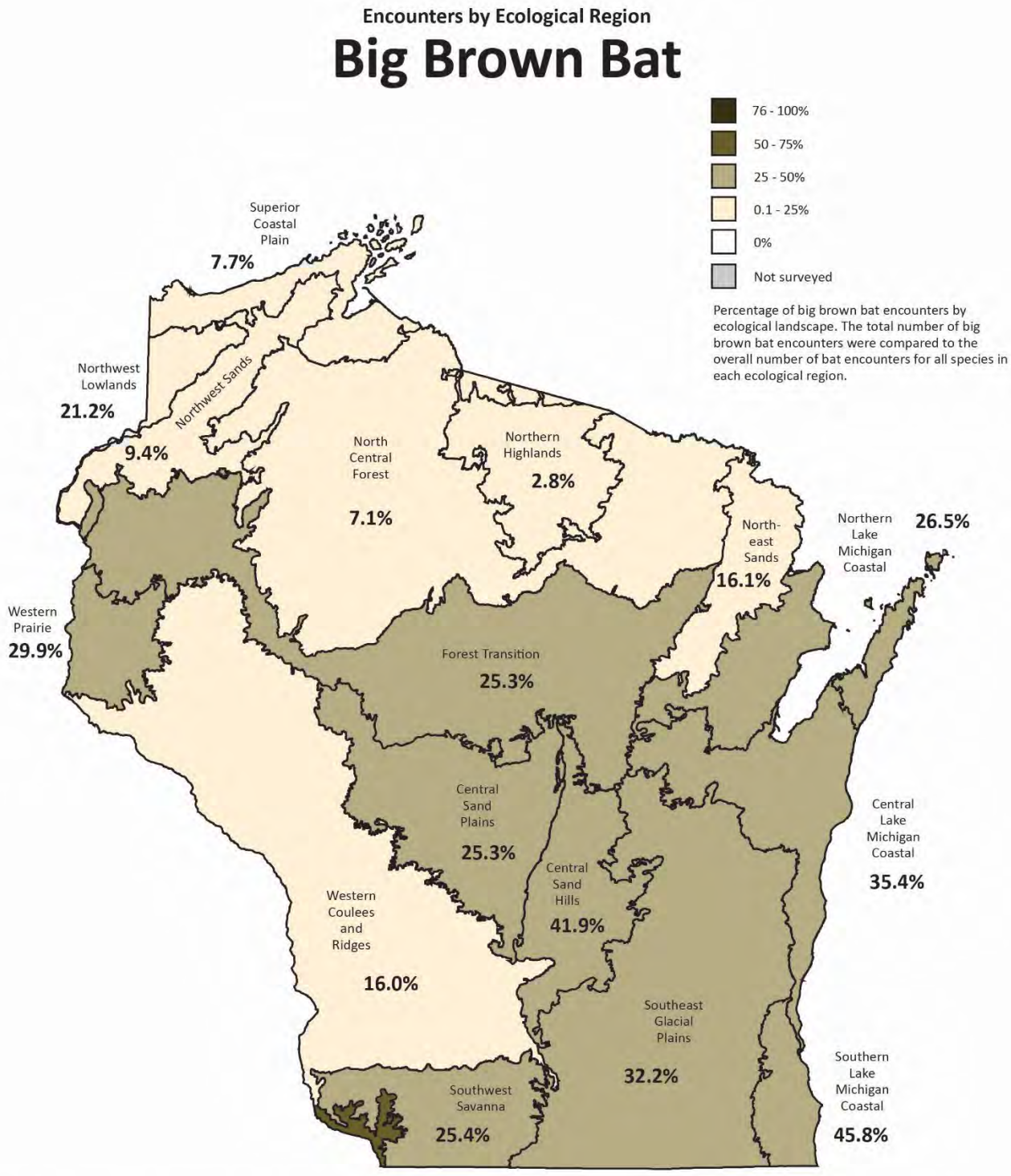


Figure 15. The big brown bat had the highest encounter rate (45.8%) in Southern Lake Michigan Coastal region, and comprised 20.7% of all bat encounters during driving surveys in 2022.

Appendix 3 Table 4. Total area surveyed in June-July 2022

Route	No. Surveys	Total Kilometers	Total Miles	Acres surveyed	Hectares surveyed
CLMC 1	3	143.3	89.0	539.5	218.3
CLMC 2	3	154.7	96.2	582.7	235.8
CSH 1	4	191.4	118.9	720.8	291.7
CSP 1	3	133.9	83.2	504.1	204.0
FT 1	3	150.1	93.2	565.1	228.7
FT 2	3	153.8	95.6	579.3	234.5
FT 3	3	145.0	90.1	546.1	221.0
FT 4	3	161.9	100.6	609.6	246.7
FT 5	3	151.7	94.3	571.3	231.2
NCF 2	3	162.8	101.2	613.2	248.2
NCF 3	3	145.5	90.4	547.9	221.7
NCF 4	3	200.7	124.7	756.0	305.9
NES 1	3	149.7	93.0	563.8	228.1
NH 1	1	47.7	29.6	179.6	72.7
NLMC 1	3	152.3	94.6	573.5	232.1
NLMC 2	1	47.3	29.4	178.1	72.1
NWL 2	3	138.5	86.1	521.7	211.1
NWS 1	3	150.6	93.6	567.2	229.5
NWS 2	3	142.6	88.6	536.9	217.3
SCP 2	3	177.6	110.4	669.0	270.7
SCP 3	3	159.6	99.1	600.9	243.2
SGP 1	2	84.2	52.3	316.9	128.3
SGP 2	3	117.8	73.2	443.6	179.5
SGP 3	3	142.6	88.6	537.0	217.3
SGP 4	3	136.0	84.5	512.1	207.2
SGP 5	2	103.7	64.4	390.4	158.0
SLMC 1	4	182.8	113.6	688.4	278.6
SWS 1	3	139.0	86.4	523.5	211.9
WCR 1	3	161.0	100.0	606.3	245.4
WCR 2	3	159.6	99.2	601.0	243.2
WCR 3	3	146.3	90.9	550.9	222.9
WCR 4	2	95.7	59.5	360.4	145.8
WCR 5	3	142.5	88.5	536.6	217.2
WCR 6	3	155.2	96.4	584.3	236.5
WP 1	4	198.2	123.1	746.3	302.0
Total	**101**	**5025**	**3122**	**18924.1**	**7658.3**
Mean	**2.9**	**143.6**	**89.2**	**540.7**	**218.8**

AnaBat Acoustic Transects (USFS Protocol 2012):[Transect length (miles) x 5280 feet/1 mile x Width of the AnaBat field of detection* (feet)] divided by 43,560 feet/acre = X acres

*Assuming a 50 foot field of detection

Appendix 4. The following Figures (16-18) depict Wisconsin's migratory tree bat species (excluding Evening bat).

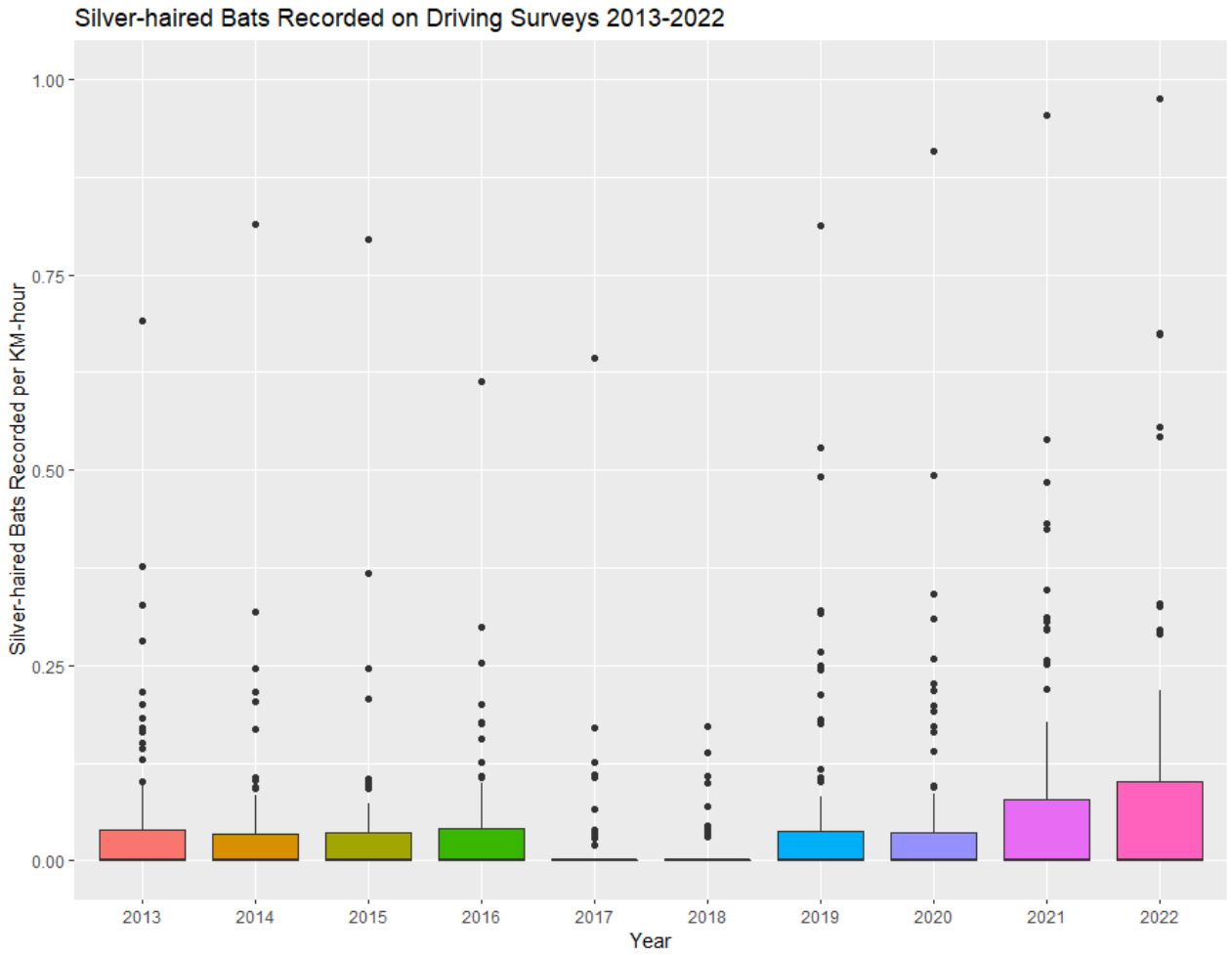


Figure 16. Silver-haired bat passes per kilometer hour by year. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

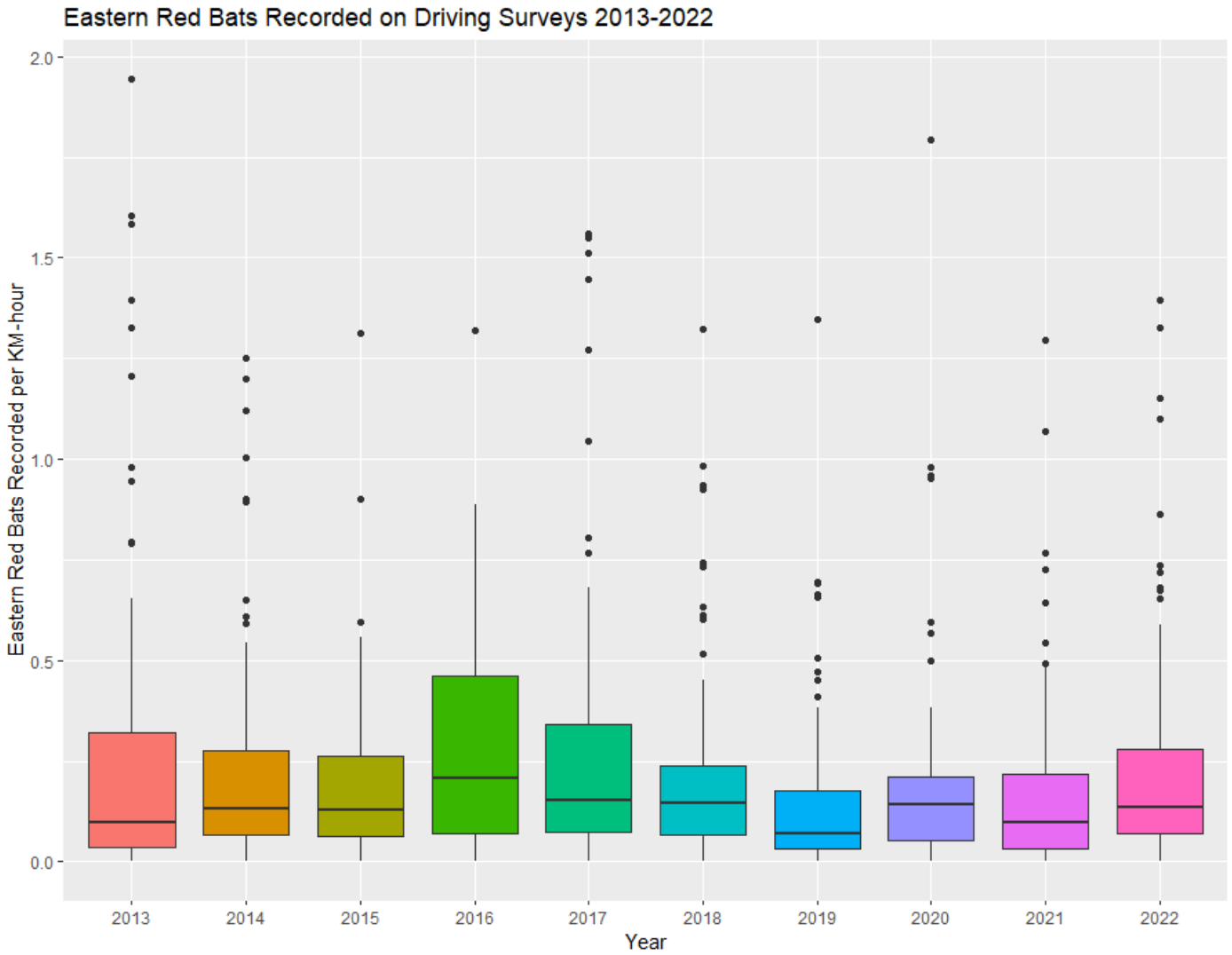


Figure 17. Eastern red bat passes per kilometer hour by year. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

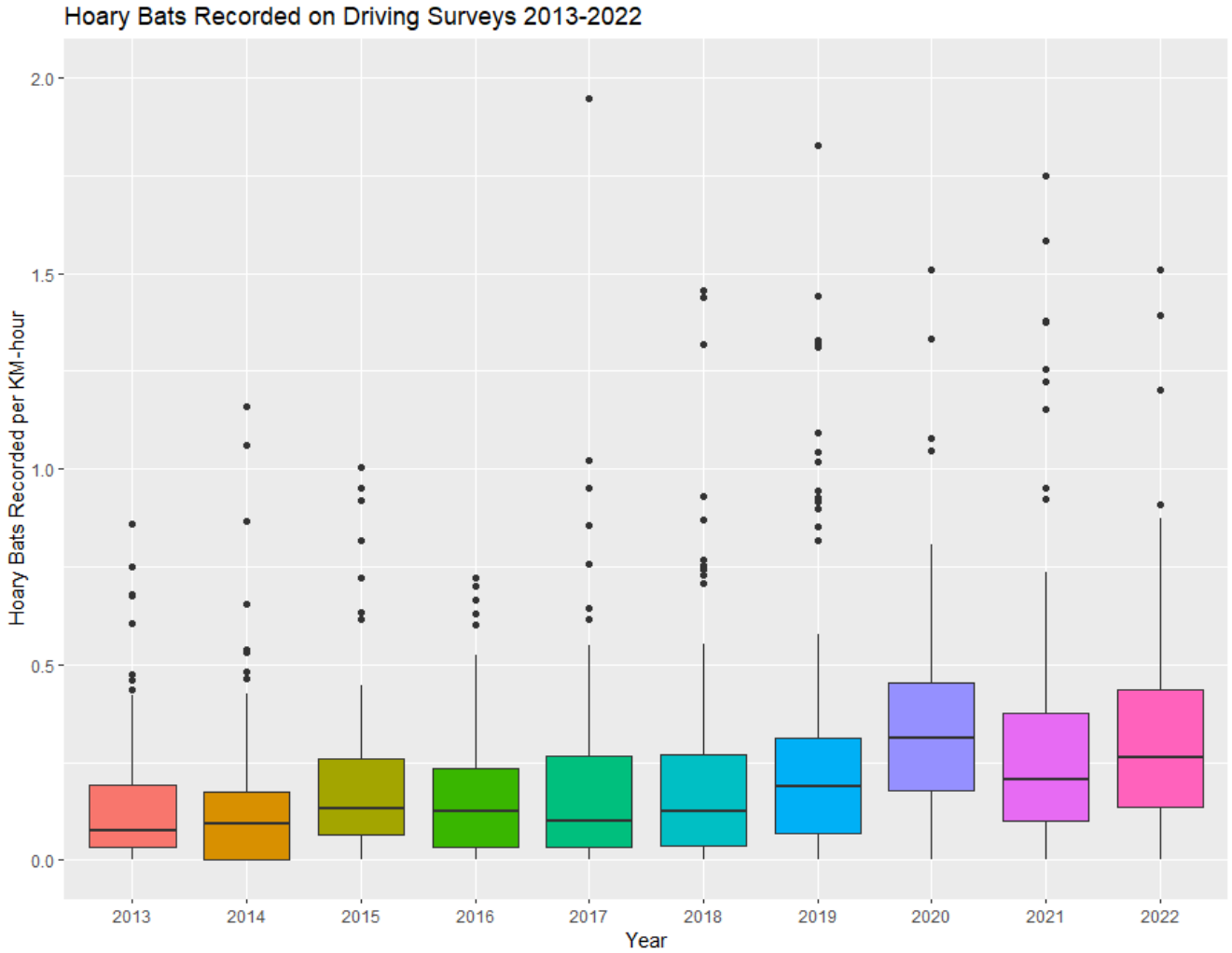


Figure 18. Hoary bat passes per kilometer hour by year. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range. Hoary bat passes per km/hr were significantly higher in 2020 than previous years, but not statistically significantly different from 2022 which is also significantly higher than 2013-2019.