WISCONSIN BAT PROGRAM- Driving Acoustic Bat Survey Report 2021

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Bureau of Natural Heritage Conservation
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In Brief

- ***There were 113 acoustic bat driving surveys in 51 counties conducted by 39 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 nineth year running, has consistently had the highest average bat calls per detector hour (67.5) when compared to all other ecological landscapes.***
- ***In 2021, mean little brown bats recorded per kilometer/hour has remained unchanged since 2017, when the first visible 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 2021 survey season marks the nineth year conducting acoustic driving surveys. This report summarizes the methods and results from the driving survey transects that were conducted in Wisconsin in 2021 and compares this year's data to the previous seven 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 2021 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 >15 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 or species group categories: hoary bat- LACI (*Lasiurus cinereus*), big brown bat - EPFU (*Eptesicus fuscus*), silver-haired bat - LANO (*Lasionycteris noctivagans*), eastern red bat - LABO (*L. borealis*), eastern pipistrelle (or tricolored bat) - PESU (*Perimyotis subflavus*), little brown bat - MYLU (*Myotis lucifugus),* northern long-eared bat- MYSE (*M. septentrionalis*), evening bat - NYHU (*Nycticeius humeralis*), big brown/silver-haired bat, eastern pipistrelle/eastern red/evening bat, little brown/northern long-eared bat, low frequency and high frequency. 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 mitigate 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 2021, 113 surveys were conducted in 51 counties by 39 individuals from Wisconsin Department of Natural Resources, Bad River Natural Resources Department (Tribal), U.S. Forest Service and citizen volunteers. These 113 completed surveys add to an impressive data set (Table 2) bringing the total completed driving surveys to 798 since 2013 (Figure 8). In 2021, the mean survey length was 50.3 km (30.7 miles; range 36.6 km/22.5 miles – 73.5 km/45.7 miles). Surveyors traveled over 5,500 kilometers (3,400 miles) and surveyed 8,513.6 hectares (21,037.4 acres) (Appendix 3; Table 4).

There was at least one survey completed for each designed route in the 16 ecological landscapes (EL), resulting in valid data for all 38 routes. In total, 23,588 files were recorded and of those files 5,841 (24.8%) were identified as bat encounters. All told, a mean of 29.3 bat calls per detector-hour was recorded (range 1.1 – 97.3 bat calls/detector/hour) (Table 3). For nine consecutive years, Central Sand Hills region had the highest average bat calls per detector hour (67.5, Figure 1) and the Southern Lake Michigan Coastal region had the lowest average bat calls per detector hour (6.8). Surveyors recorded a mean of 51.7 bats calls (files) per survey (range: 7-205 bat calls per survey). The number of surveys varied by week (Figure 2) and bats were more likely to be detected toward the end of the third sampling period (Figure 3), which is likely related to population recruitment by recently-volant (flying) juveniles.

Of the 5,841 bat encounters, 1,893 (32.4%) were classified into species groups: high frequency group (362), low frequency group (681), big brown/silver-haired bat (581), eastern red/eastern pipistrelle/evening bat (235) and little brown/northern long-eared (34) because the bat passes have similar call characteristics to two or more species. The remaining 3,948 (67.6%) files were classified as big brown (1,648), hoary (1,274), eastern red (515), little brown (174), silver-haired bat (327), evening bat (9) and eastern pipistrelle/tricolored bat (1). The northern long-eared bat was not detected on acoustic driving transects in 2021. Among the 16 ecological regions, big brown bats (n=9 regions) were the most encountered species followed by the hoary bat (n=6) and the silver-haired 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

Mean Bat Calls Per Detector Hour

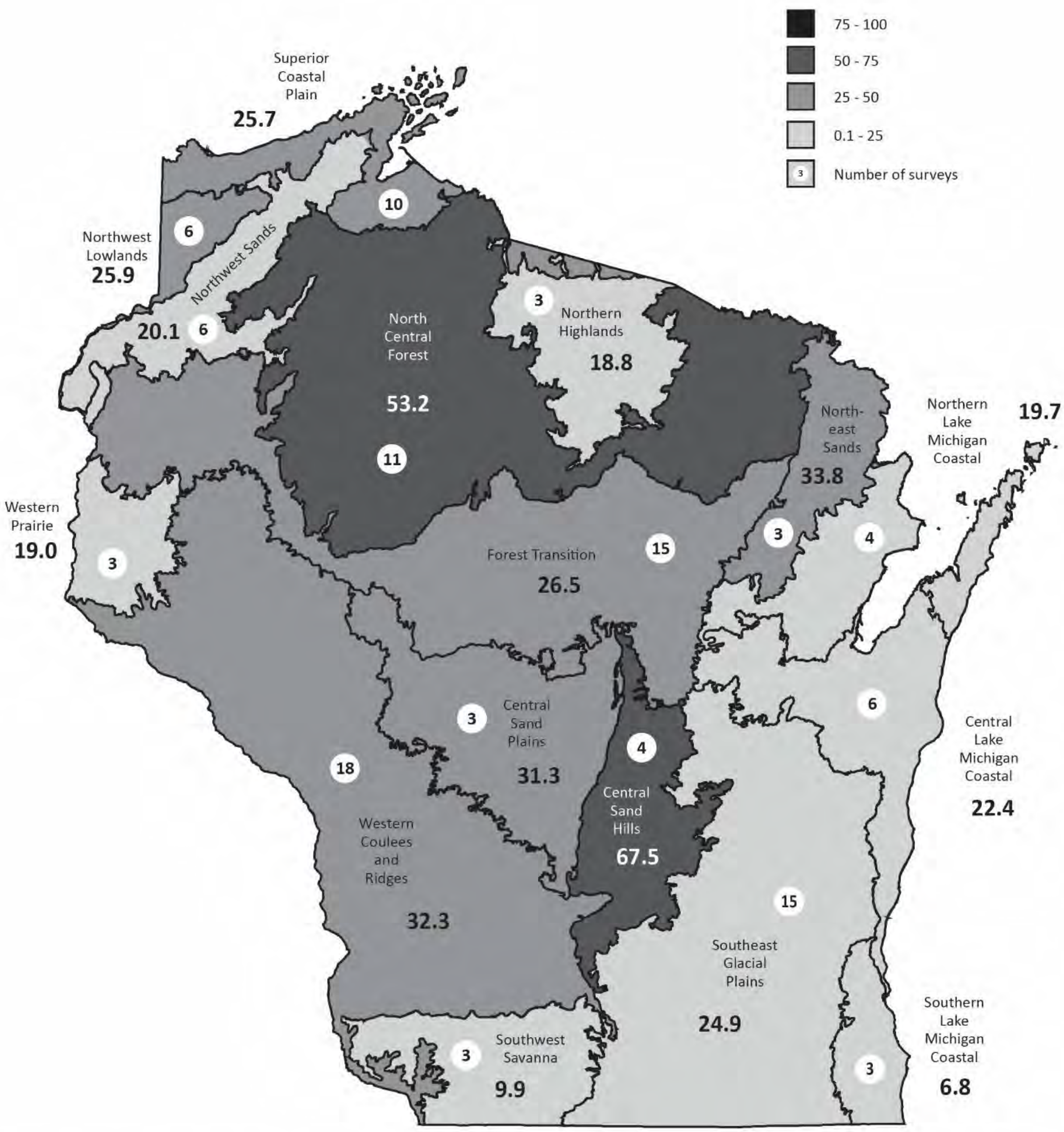

Figure 1. For the ninth year in a row, the highest mean bat calls per detector hour was the Central Sand Hills at 67.5 calls/detector/hour. Mean calls per detector hour across all landscapes was 29.3.

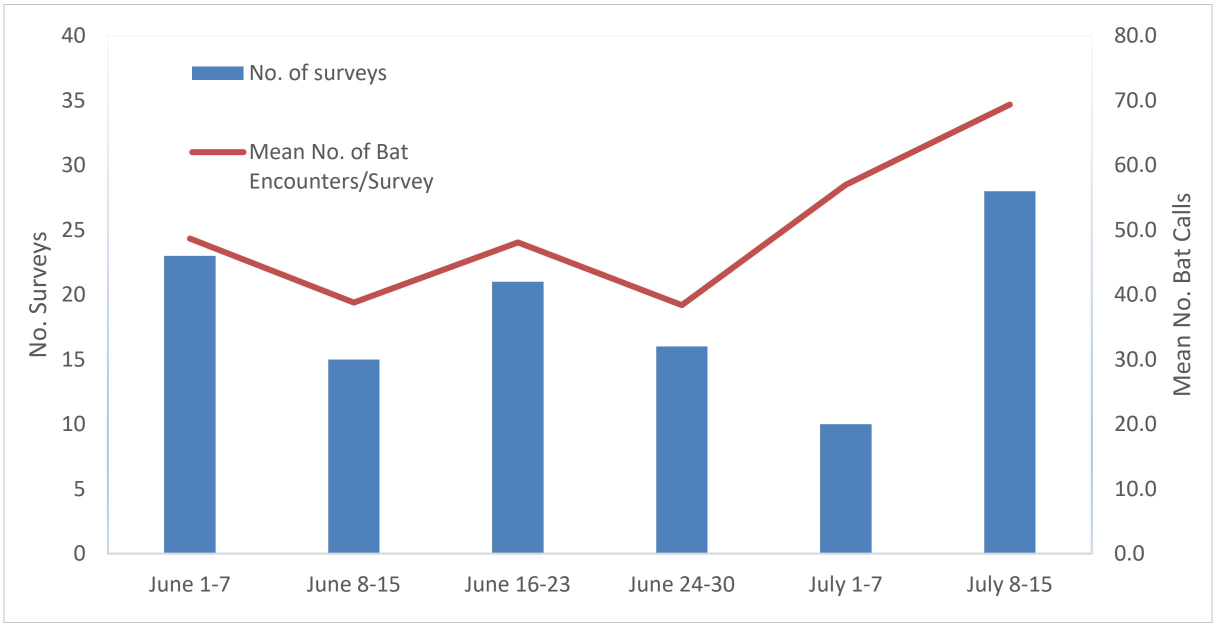

Figure 2. Total number of surveys by week and mean number of bat calls per survey by week (2021).

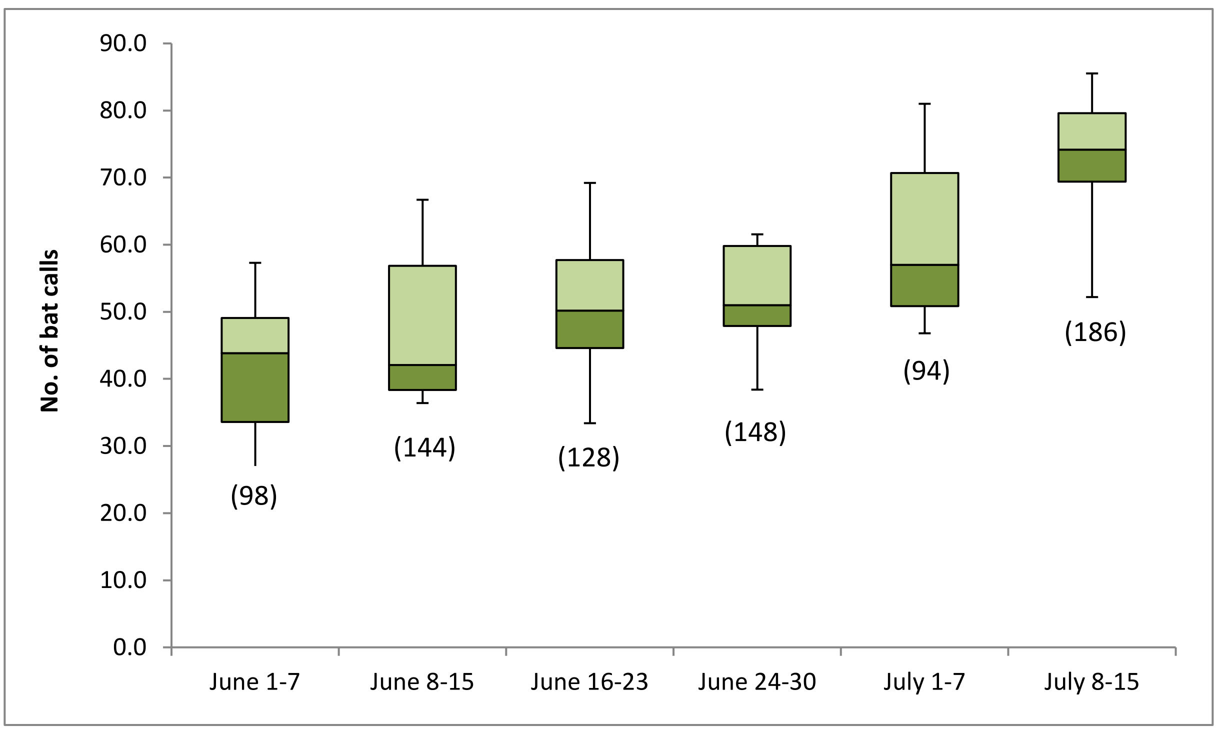

Figure 3. Comparison of mean bat calls per survey for 8-day period from 2013-2021 driving routes. Numbers in brackets indicate sample size (number of surveys). Boxes depict the 25th and 75th percentiles, lines within boxes mark the median, whiskers represent 95th and the 5th percentiles.

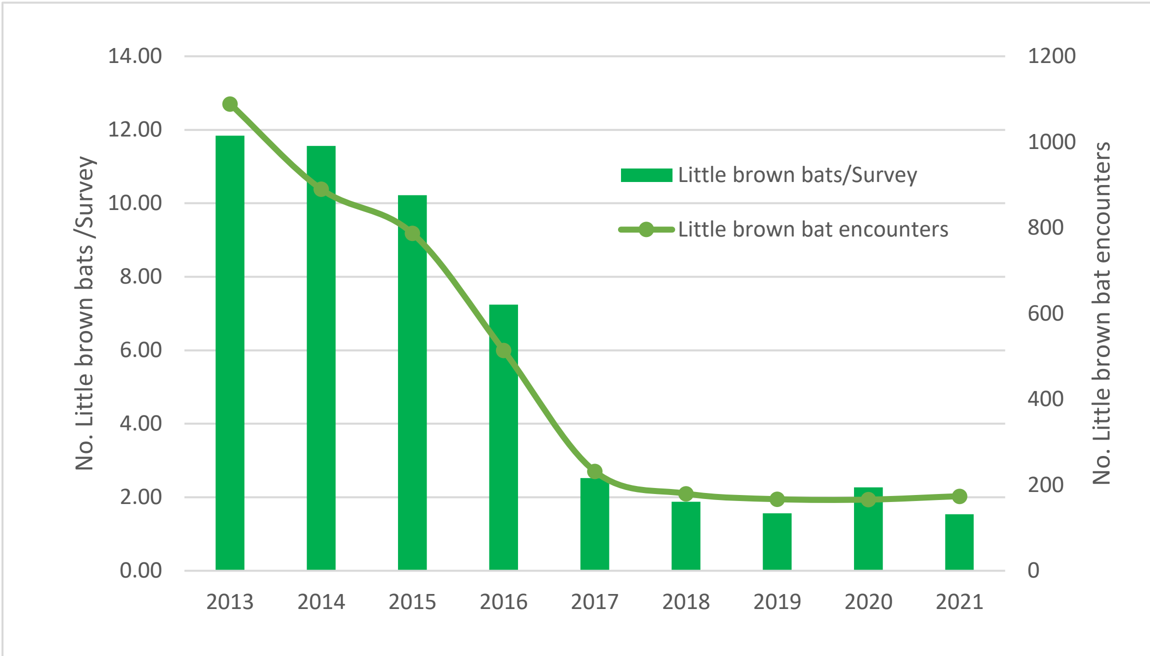

Figure 4. Yearly acoustic little brown encounters per survey (bats; left axis) and total little brown bat encounters on all surveys (line; right axis). Regardless of the presentation, both indices show the same general trend – a larger population or detection rate followed by declines, then reaching stabilization from 2017-2021.

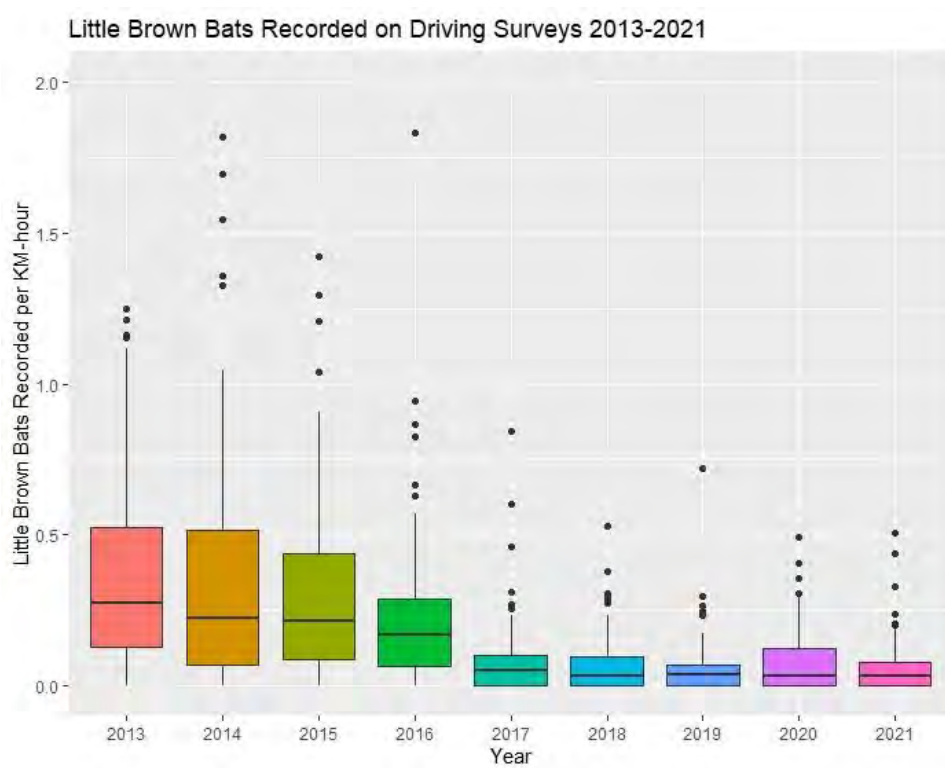

Figure 5. Little brown bat passes per kilometer hour by year. Little brown bat passes from driving transects in 2021 were significantly similar to years 2017-2020. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

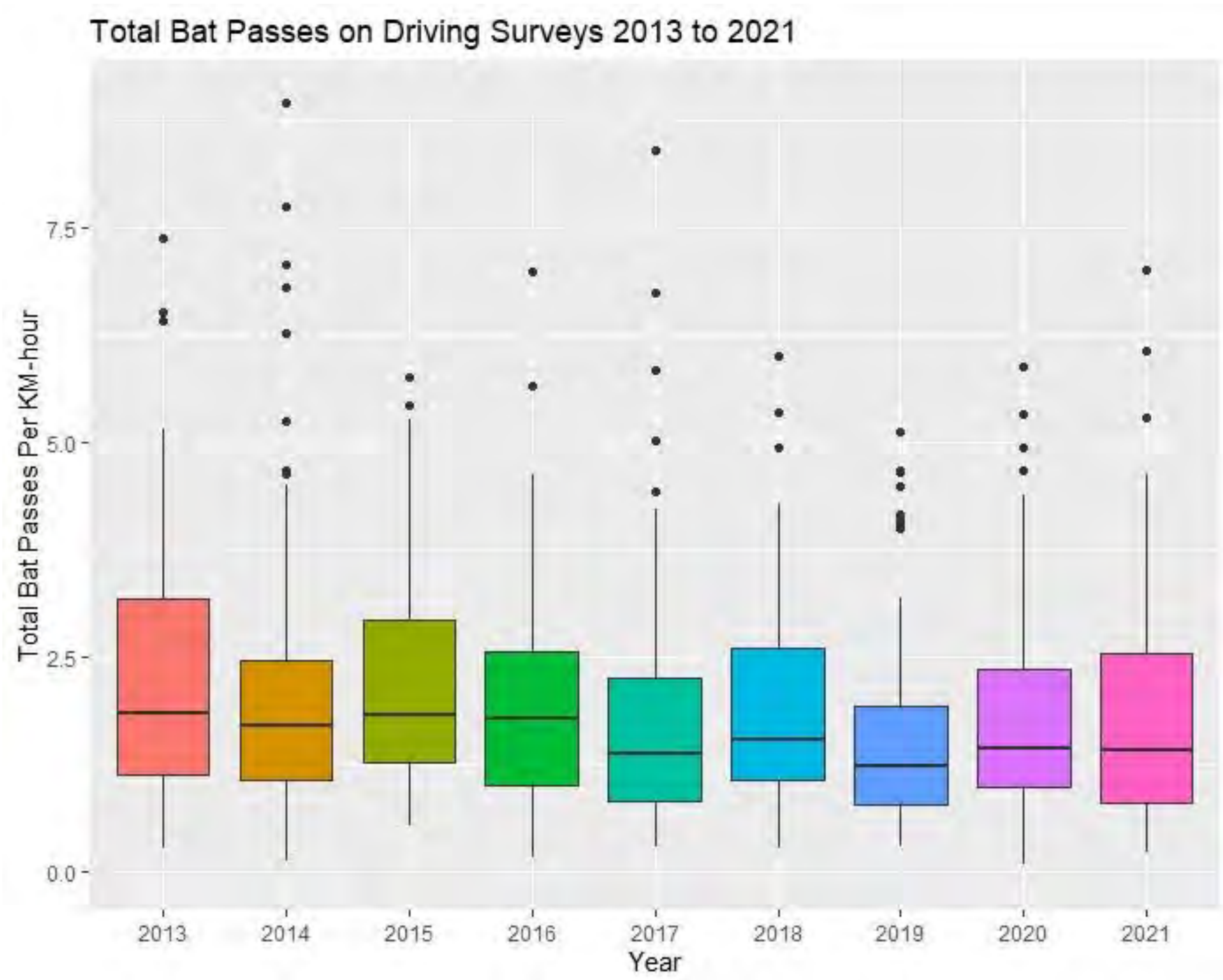

Figure 6. Total passes per kilometer hour by year. Total bat passes from driving transects in 2021 were not significantly different from previous years. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

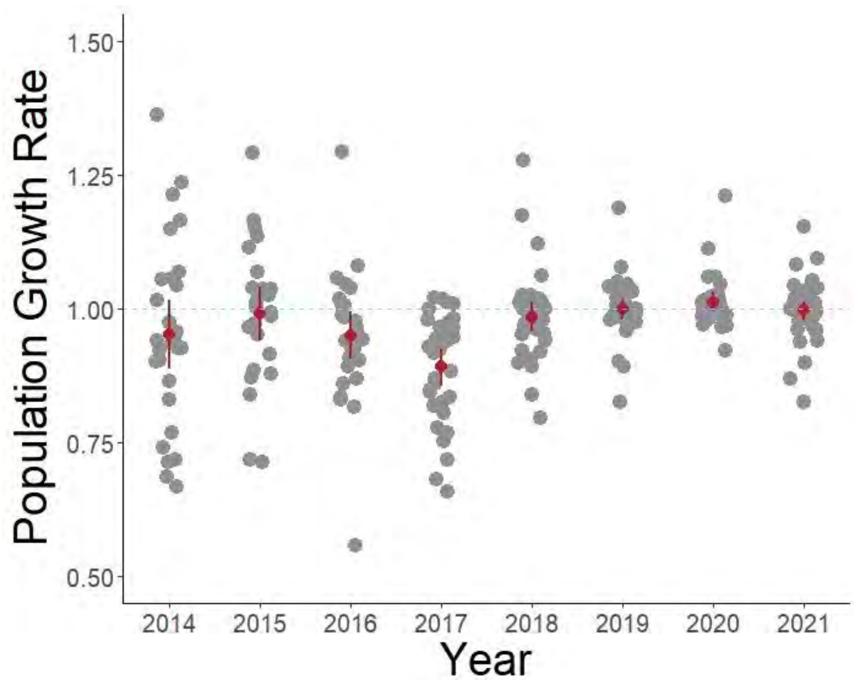

Figure 7. Yearly growth rate for little brown bats detected on acoustic driving surveys. The growth rate (lambda) was calculated from the change of calls per km-hr by year (year n/(year n-1)). Red dots indicate mean and whiskers show 95% confidence limits. Dotted line at 1 indicates stability and rates 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.

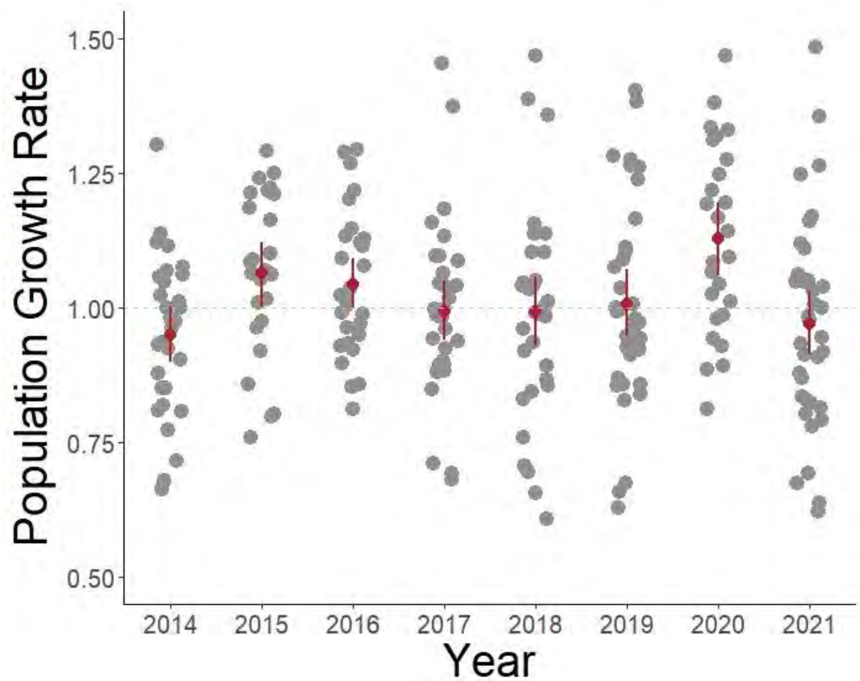

Figure 8. Yearly growth rate for all tree bat species (eastern red, hoary, evening and silver-haired bat) detected on acoustic driving surveys. The growth rate (lambda) was calculated from the change of calls per km-hr by year. Red dots indicate mean and whiskers show 95% confidence limits. Dotted line 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

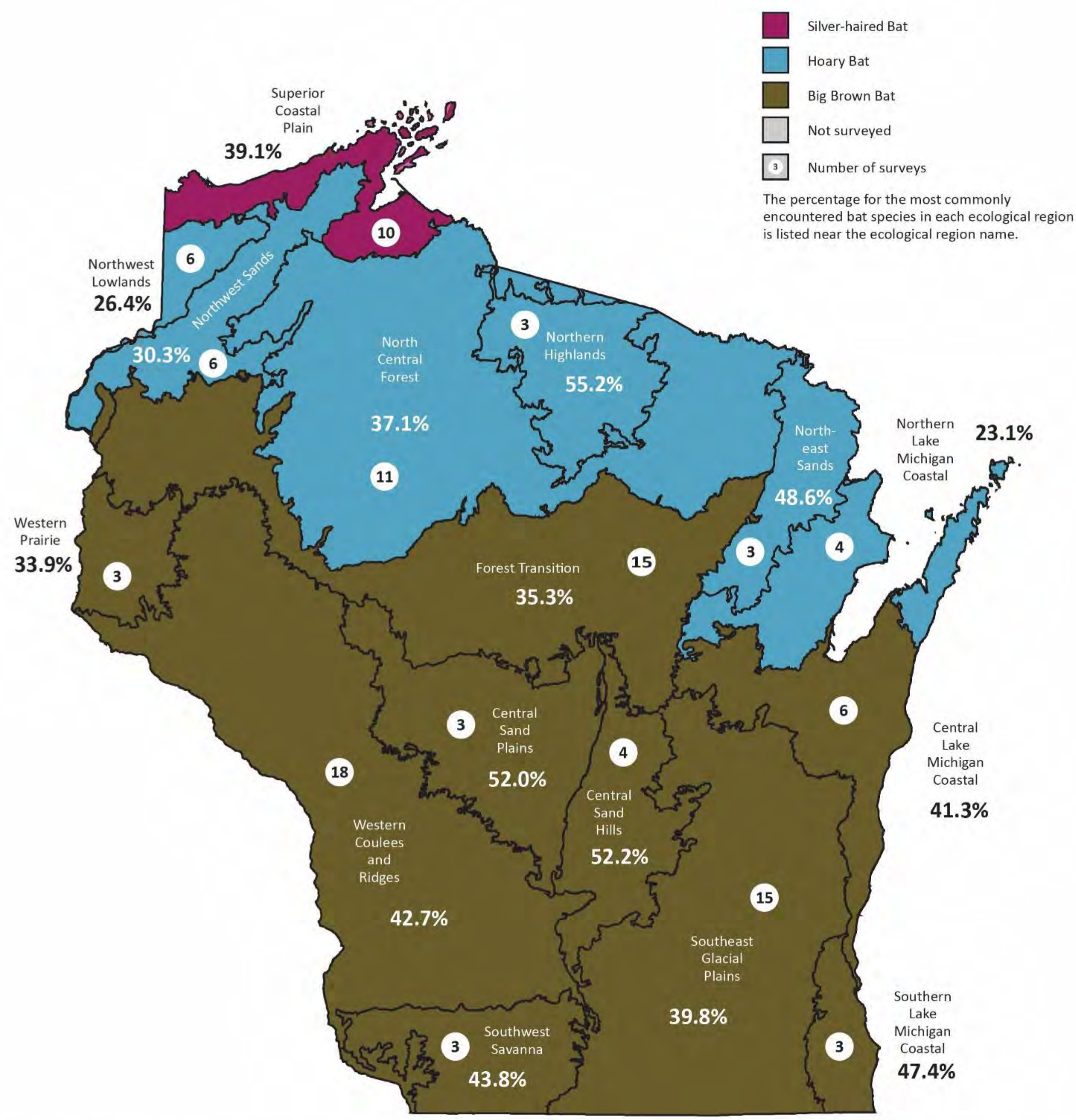

Figure 9. The most commonly encountered bat species by ecological region were hoary bat (6) and the big brown bat (9) in 2021.

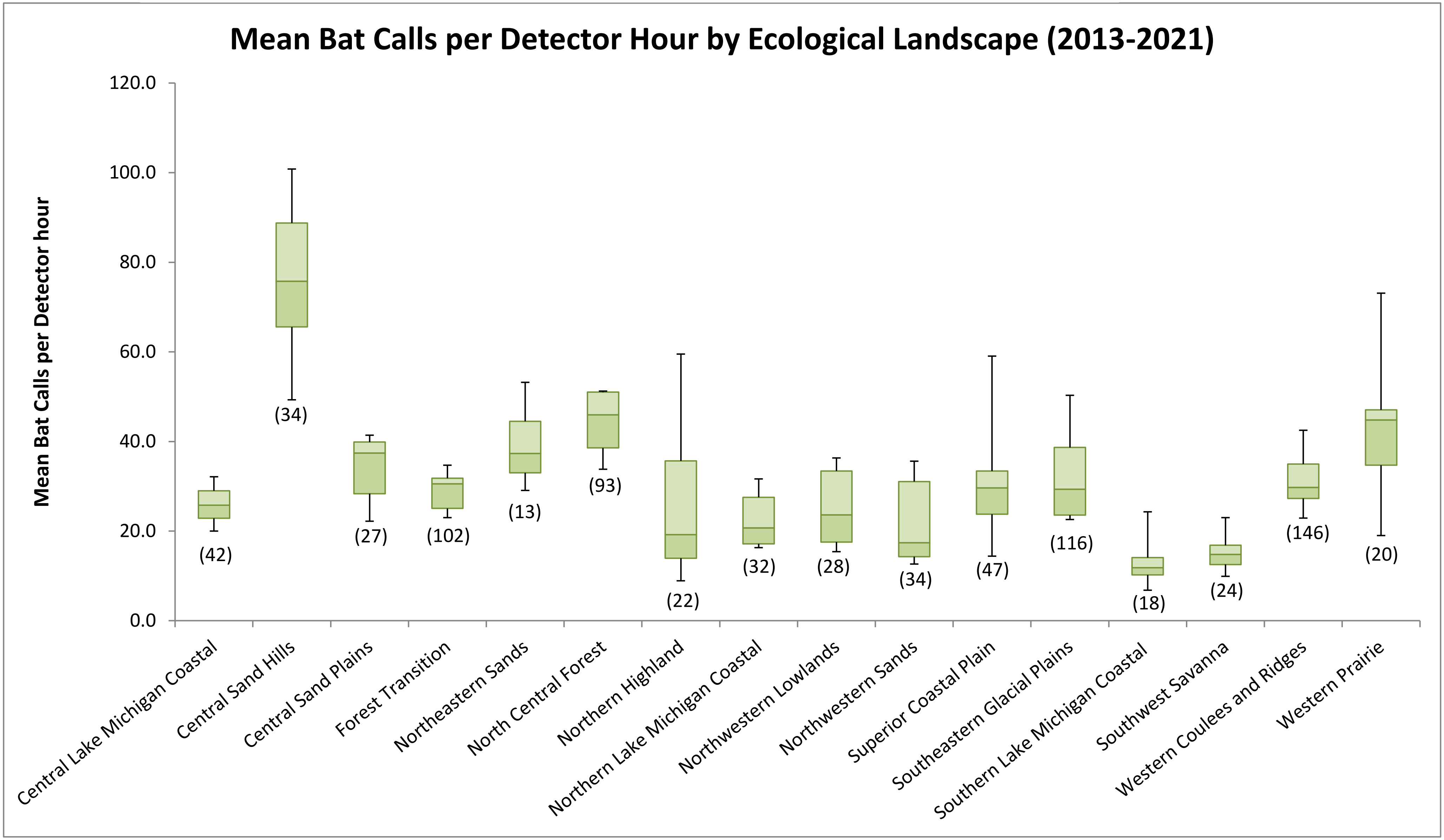

Figure 10. Mean bat calls per detector hour by ecological landscape (2013-2021). Bracketed numbers are total number of surveys per ecological landscape. A total of 798 acoustic driving surveys have been completed since 2013. Boxes depict the 25th and 75th percentiles, lines within boxes mark the median, whiskers represent 95th and the 5th percentiles.

Discussion

Prior to 2020, the eastern pipistrelle or tricolored bat had not been observed on an acoustic driving transect since 2018. In 2021, the eastern pipistrelle was only detected on one survey (Figure 16). There was just one detection out of 3,948 bat calls manually named to species. The northern long-eared bat has not been detected on driving transects since 2015, which is a combination of the deadly effects of white-nose syndrome (USFWS 2016), low detectability (whispering bat) and habitat use (forest interior); all of which play important roles in determining this species presence through acoustic surveys (Whitby et al., 2014). Little brown bat detections (Figures 4 and 5) have remained consistently low since 2017, which was the first year where detection rates were statistically significantly lower than the previous years 2013-2016, although acoustic driving surveys may be a poor estimate for Myotis activity (Figure 7). The hoary bat detection rate (Figure 20) describes a species that is now back to a "normal" detection rate because in 2020, the rates were statistically higher than previous years. For the remaining species, no news is good news. The big brown bat, eastern red bat, silver-haired bat and evening bat were encountered at similar rates to previous years, and no significant changes were observed. For the tree bats, Figure 8 which represents yearly growth rates from the change in calls per km/hr by year, indicates some variation around stable growth rates regardless of the year.

Table 3. A comparison of mean number of bat calls per detector hour by ecological landscape (2013-2021), including total number of surveys completed in each year in parentheses. N/A signifies data are not available. Last column represents the standard deviation (SD) and standard error (SE) for each row.

Ecological Landscape	2013	2014	2015	2016	2017	2018	2019	2020	2021	SD (SE)
CLMC	27.0 (4)	27.5 (3)	32.1 (3)	20.0 (4)	23.7 (5)	23.3 (6)	30.5 (6)	34.5 (5)	22.4 (6)	3.9 (1.3)
CSH	81.3 (3)	75.4 (3)	100.8 (3)	96.2 (3)	76.1 (3)	65.3 (6)	49.3 (3)	65.8 (5)	67.5 (4)	16.8 (5.3)
CSP	40.2 (3)	38.8 (3)	39.6 (3)	41.4 (3)	25.4 (3)	35.0 (3)	22.2 (3)	36.1 (3)	31.3 (3)	6.8 (2.3)
FT	30.4 (12)	32.9 (10)	30.7 (12)	23.0 (9)	30.7 (11)	34.7 (11)	23.7 (13)	26.4 (9)	26.5 (15)	4.1 (1.4)
NCF	51.0 (8)	49.8 (12)	51.2 (12)	51.0 (11)	42.1 (12)	41.4 (8)	37.8 (11)	39.3 (8)	53.2 (11)	8.0 (3.0)
NES	33.0 (1)	N/A	N/A	29.1 (1)	42.1 (1)	18.8 (3)	23.1 (3)	37.7 (2)	33.8 (3)	6.7 (2.2)
NH	59.5 (1)	43.7 (2)	16.6 (3)	19.6 (3)	8.9 (3)	16.3 (3)	11.3 (2)	27.6 (2)	18.8 (3)	16.5 (5.5)
NLMC	20.7 (4)	31.6 (4)	29.4 (3)	N/A	20.5 (4)	17.6 (5)	16.3 (6)	22.1 (2)	19.7 (4)	5.6 (2.0)
NWL	36.3 (4)	17.5 (3)	35.4 (3)	27.5 (3)	23.6 (3)	N/A	15.4 (6)	N/A	25.9 (6)	8.0 (2.8)
NWS	32.8 (5)	17.4 (1)	12.6 (3)	13.5 (3)	35.6 (4)	14.4 (3)	16.6 (6)	25.7 (3)	20.1 (6)	8.7 (3.1)
SCP	27.2 (4)	59.1 (4)	32.1 (5)	34.6 (3)	25.4 (4)	50.3 (6)	32.2 (8)	22.1 (3)	25.7 (10)	12.4 (4.1)
SGP	29.7 (15)	22.6 (9)	45.7 (8)	31.6 (11)	22.9 (16)	24.3 (14)	24.2 (15)	28.9 (13)	24.9 (15)	10.1 (3.4)
SLMC	12.8 (3)	10.4 (3)	14.1 (1)	N/A	N/A	14.8 (3)	10.2 (3)	10.8 (2)	6.8 (3)	5.6 (2.1)
SWS	14.8 (3)	17.8 (3)	23.0 (2)	11.9 (2)	15.8 (3)	29.1 (3)	14.0 (3)	13.2 (2)	9.9 (3)	3.8 (1.3)
WCR	42.5 (19)	26.3 (16)	36.6 (15)	30.4 (14)	28.3 (16)	33.6 (19)	22.9 (16)	33.3 (13)	32.3 (18)	5.8 (1.9)
WP	46.7 (3)	46.9 (2)	42.9 (1)	73.1 (1)	47.2 (3)	44.5 (3)	35.8 (3)	38.6 (1)	19.0 (3)	14.5 (4.8)
Mean (Total #)	***36.9 (92)***	***34.5 (78)***	***38.5 (77)***	***34.3 (71)***	***30.6 (92)***	***31.7 (96)***	**24.3 (107)**	**32.5 (73)**	**29.3 (113)**	8.5 (3.1)

Worth noting, for the first time in these acoustic driving reports, an evening bat map (Figure 17) was created. Within the past 15 years, records for the evening bat in the Great Lakes region are becoming increasingly common (Kaarakka et al., 2018, Kurta et al., 2005, and Münzer 2008). As these acoustic records expand from regions with confirmed evening bat presence through bat captures, further investigation by way of mist-netting will be warranted to verify the acoustic findings. As such, these evening bat acoustic records should be treated as suspect only until confirmed.

For its part, acoustic bat driving transects can survey large areas while including many different ecologically unique landscapes and property boundaries. To date, this survey method has been used as an important part of the North American Bat Monitoring Program (NABat) and the Wisconsin Bat Program (WDNR 2020). Besides driving surveys, there have not been viable mobile alternatives to collecting bat data, especially over large areas. For example, the use of unmanned aerial vehicles (UAV) or drones, have been attempted to detect bats using an ultrasound detector affixed to the drone. While the concept of surveying within the same airspace is appealing and the ability to navigate above the canopy and without the need for roads is interesting, noise interference compromised detectability in this study and didn't offer a functional survey alternative to driving at this point (Ednie et al. 2021).

It's been well-documented that long-term studies using standardized monitoring methods are effective in documenting declines and provided critical data in animals populations such as birds (Roth and Johnson 1993; Le Gouar et al., 2011), amphibians (Blaustein et al., 1994), and mammals (Durant et al. 2007), including bats (Frick et al., 2010). It is the intention of Wisconsin Bat Program to continue to use these standardized and straightforward surveys to estimate and evaluate species trends over time, which Evans et al. (2021) points out are the keys to a successful monitoring program. This year marked the nineth year of these organized driving surveys which illustrates the WBP's long-term commitment to monitoring bat populations, but also highlights the remarkable work of WBP partners to complete surveys on an annual basis.

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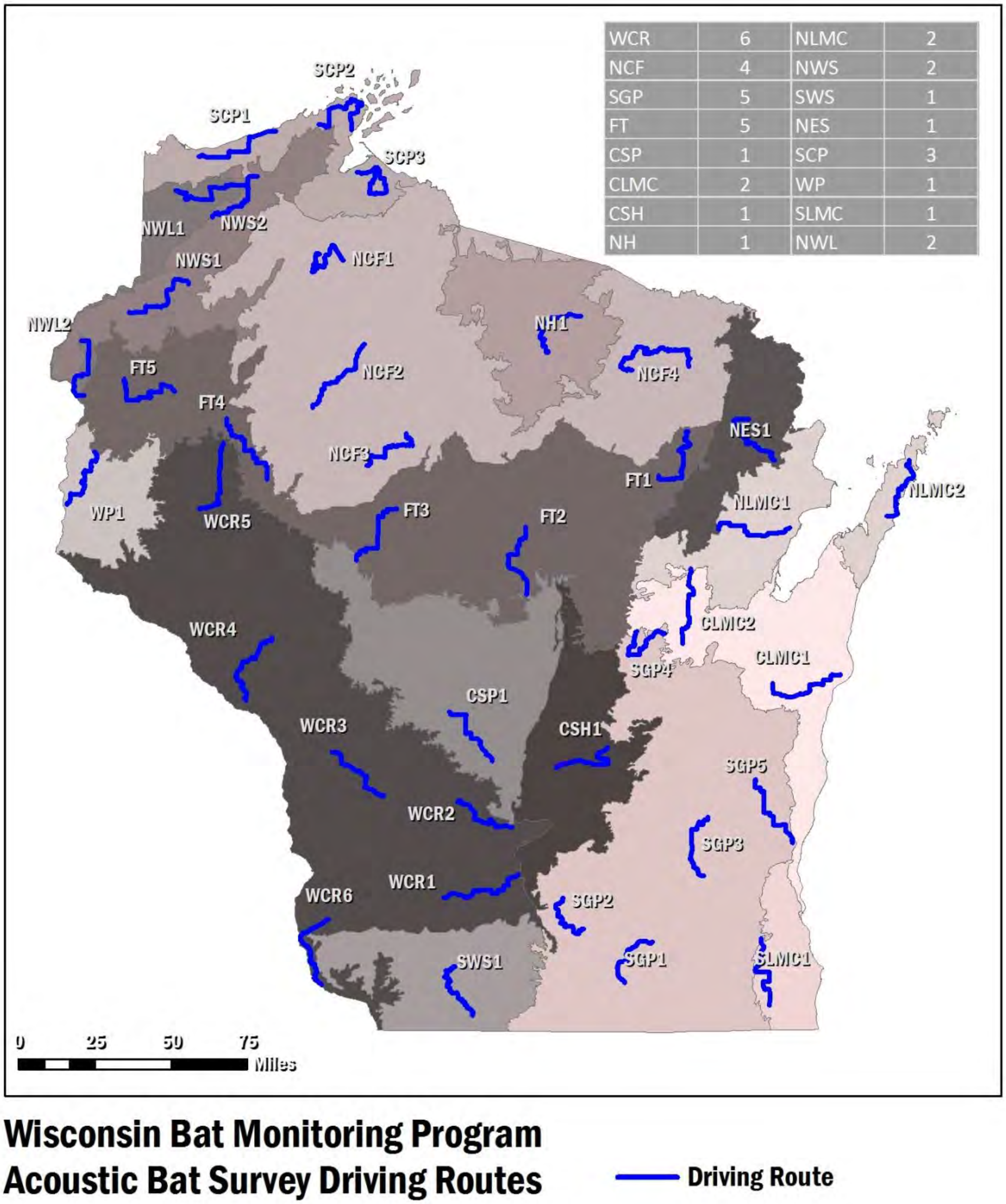
Appendix 1 Acoustic Bat Driving Transects by Ecological Landscape



WCR	6	NLMC	2
NCF	4	NWS	2
SGP	5	SWS	1
FT	5	NES	1
CSP	1	SCP	3
CLMC	2	WP	1
CSH	1	SLMC	1
NH	1	NWL	2

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 northern long-eared bat because this species was not detected in 2021.

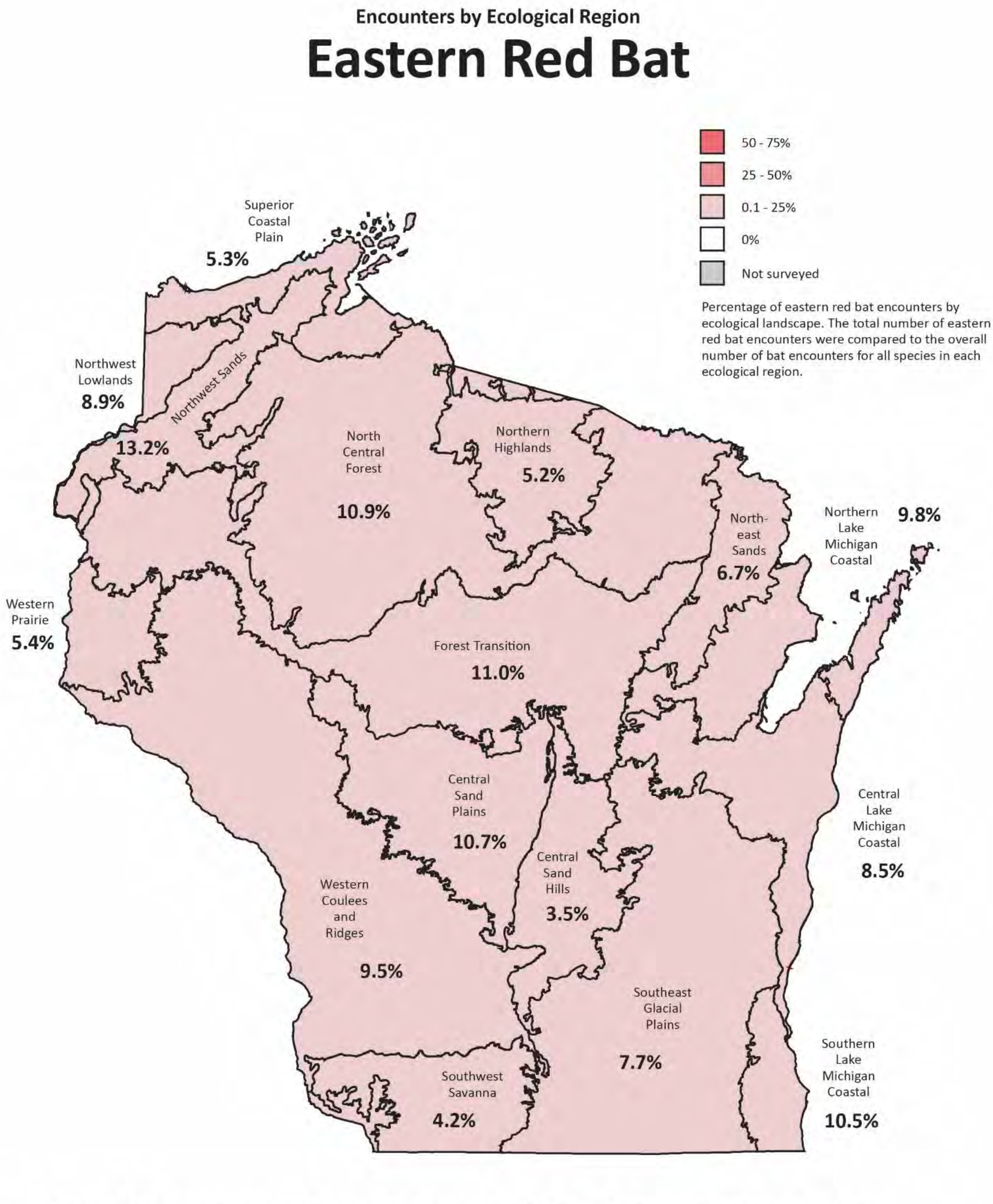


Figure 11. The eastern red bat encounters accounted for 8.8% of all recorded bat passes during driving surveys in 2021.

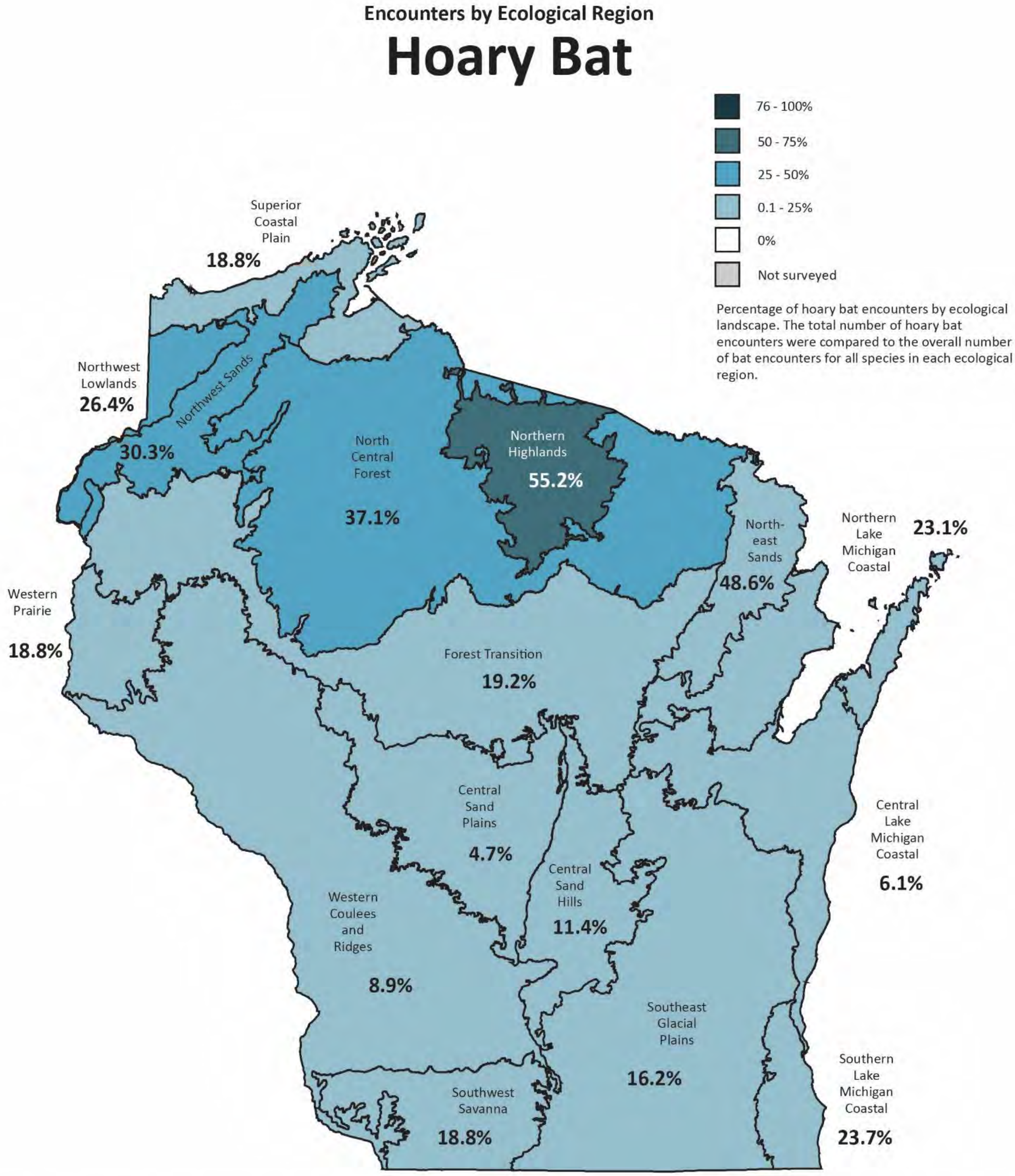


Figure 12. The hoary bat had the highest encounter percentage (55.2%) in Northern Highlands region and comprised 21.8% of all bat encounters during driving surveys in 2021.

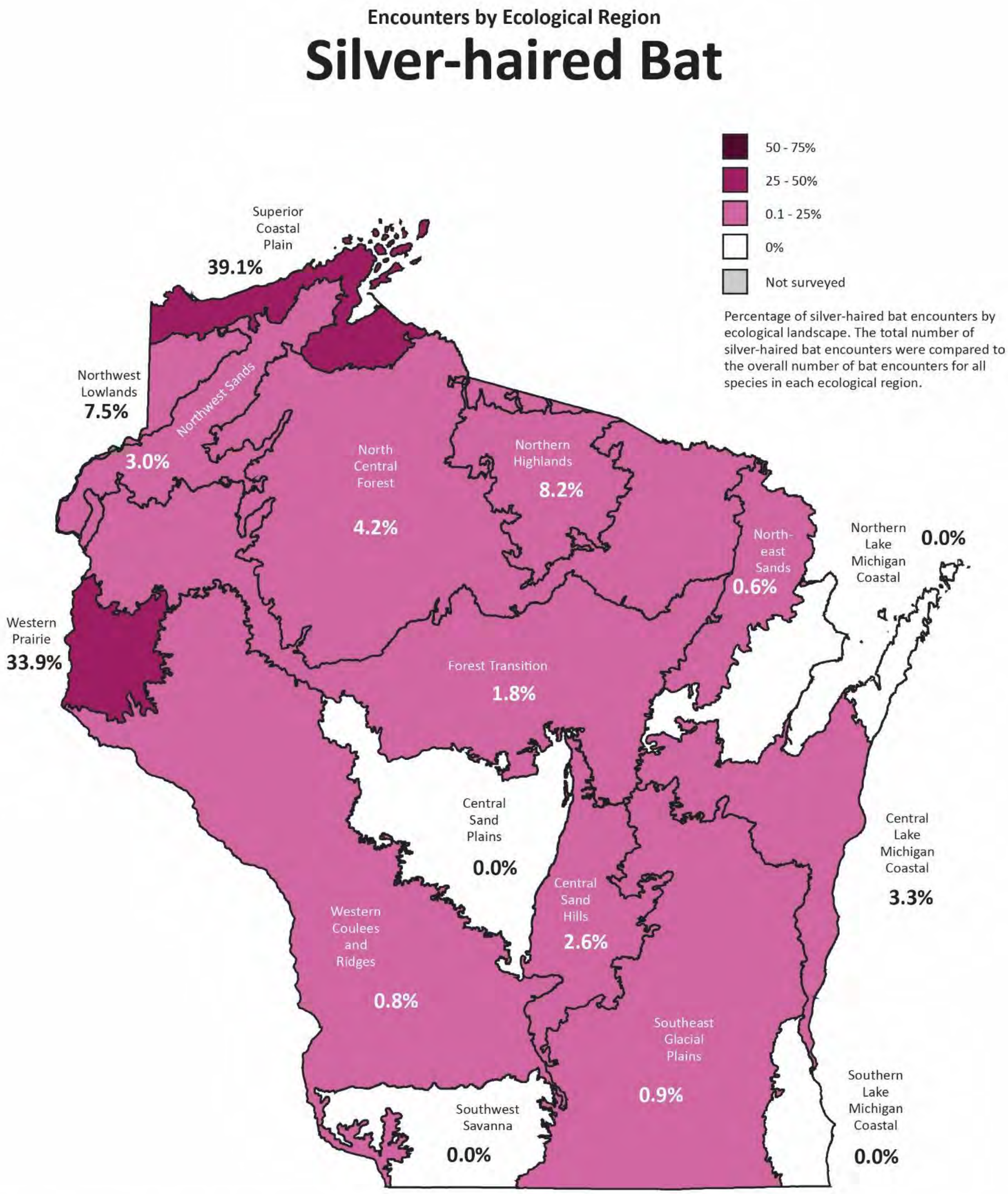


Figure 13. Silver-haired bat encounters accounted for 5.6% of all encounters recorded during driving surveys in 2021.

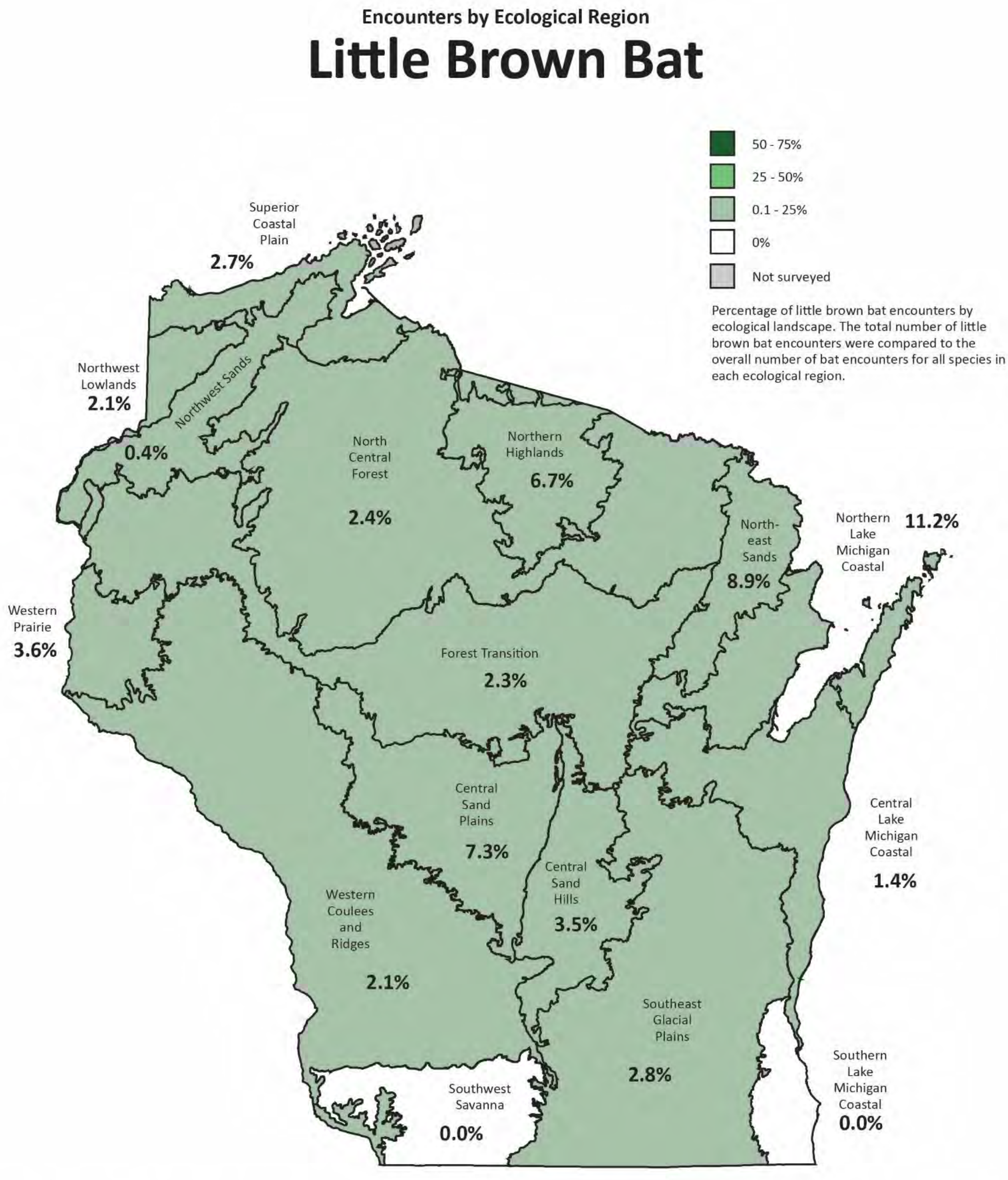


Figure 14. The little brown bat encounters accounted for 3.0% of all bat encounters recorded during driving surveys in 2021. Of note, little brown bat comprised 34.3% of all encounters in 2013 driving surveys.

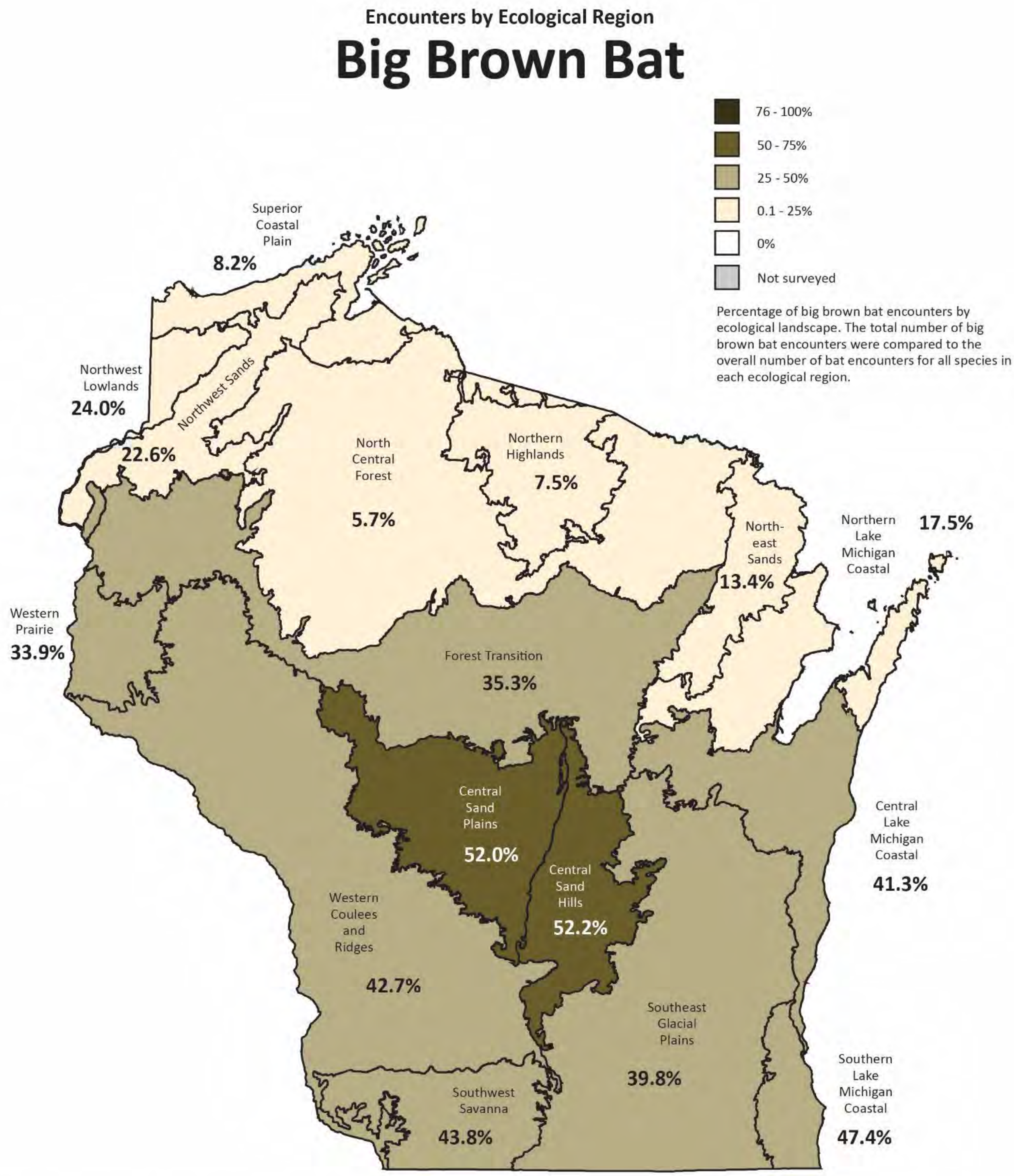


Figure 15. The big brown bat had the highest encounter percentage (52.2%) in Central Sand Hills region, and comprised 28.2% of all bat encounters during driving surveys in 2021.

Encounters by Ecological Region

Eastern Pipistrelle/Tricolored Bat

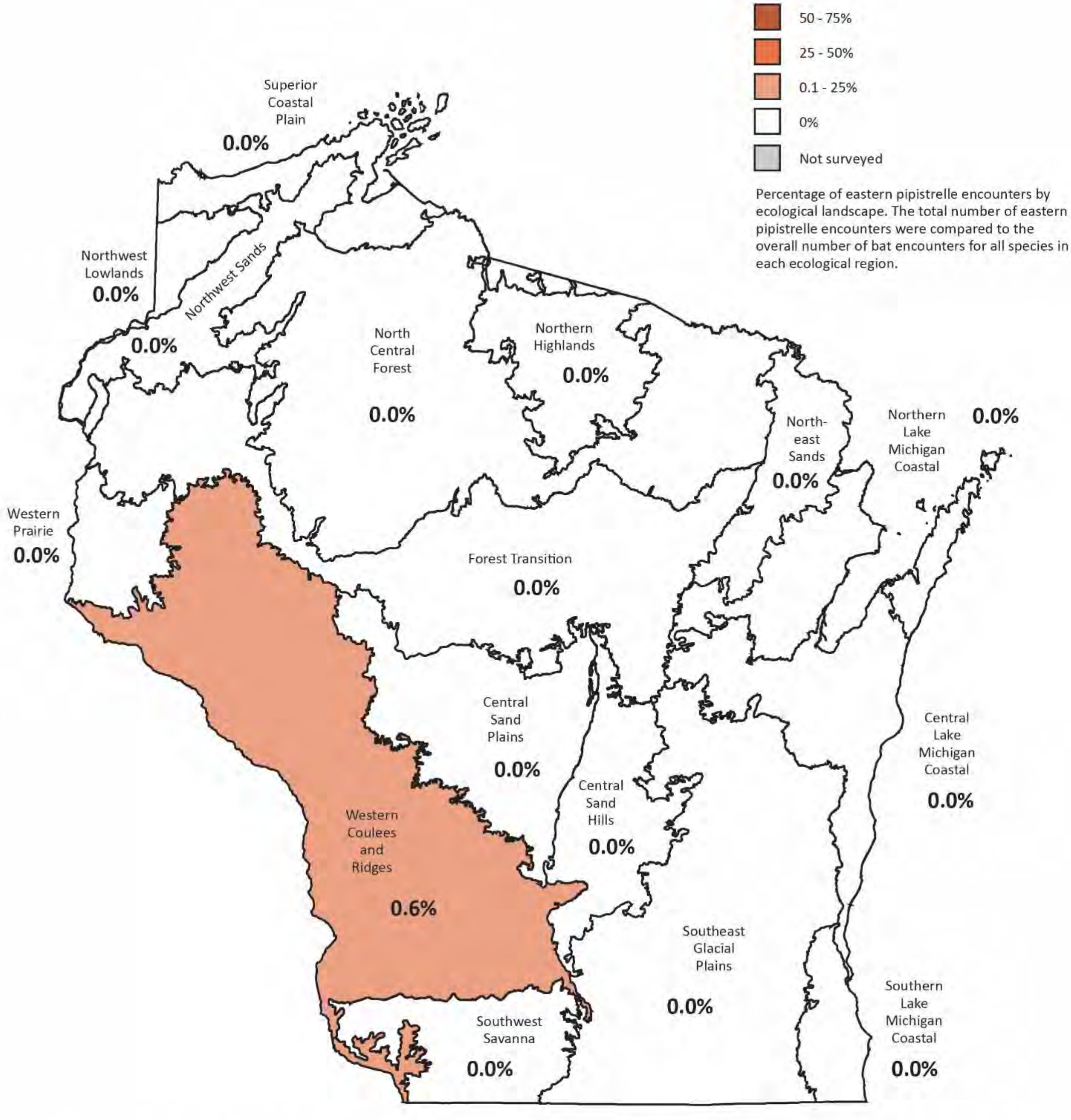


Figure 16. The eastern pipistrelle/tricolored was one detected once and it was on a survey in Western Coulee and Ridges region in 2021.

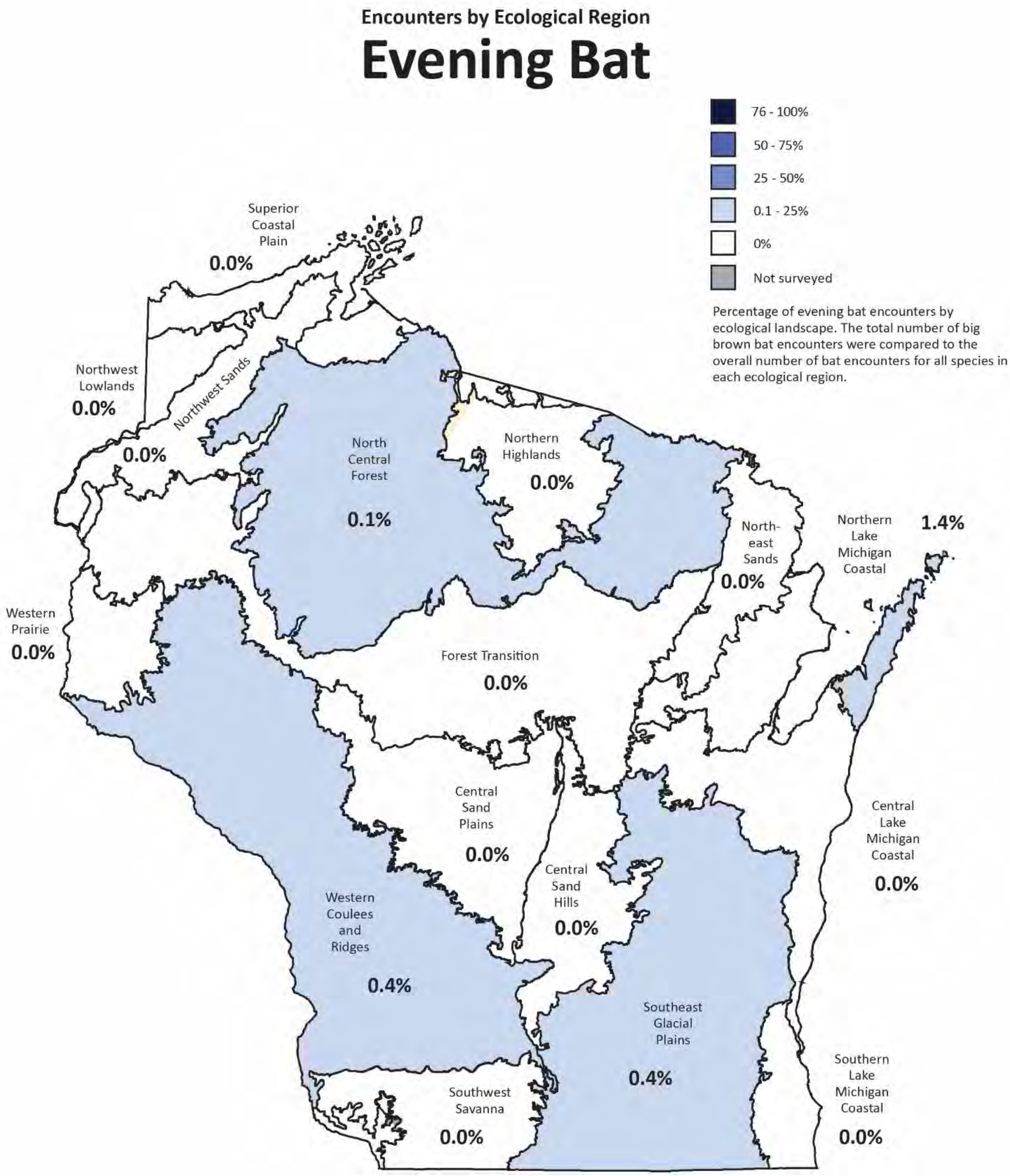


Figure 17. The evening bat comprised 0.2% of all bat encounters during driving surveys in 2021.

Appendix 3 Table 4. Total area surveyed in June-July 2021

Ecological Landscape	No. Surveys	Total Kilometers	Total Miles	Acres surveyed	Hectares surveyed
CLMC 1	3	151.6	94.2	570.9	231.0
CLMC 2	2	104.2	64.7	392.4	158.8
CSH 1	5	238.9	148.4	899.7	364.1
CSP 1	3	133.9	83.2	504.3	204.1
FT 1	3	149.7	93.0	563.8	228.1
FT 2	3	153.7	95.5	578.8	234.2
FT 3	3	145.4	90.3	547.6	221.6
NCF 1	3	139.0	86.4	523.5	211.8
NCF 2	2	122.4	76.1	460.9	186.5
NCF 3	3	218.5	135.8	822.8	333.0
NCF 4	2	100.2	62.3	377.3	152.7
NES 1	2	95.7	59.5	360.4	145.8
NH 1	2	101.5	63.1	382.2	154.7
NLMC 1	3	133.8	83.1	503.9	203.9
NLMC 2	3	177.4	110.2	668.1	270.4
NWS 2	3	124.7	77.5	469.6	190.0
SCP 2	3	117.9	73.3	444.0	179.7
SGP 1	3	141.0	87.6	531.0	214.9
SGP 2	2	90.7	56.4	341.6	138.2
SGP 3	2	103.2	64.1	388.6	157.3
SGP 4	2	102.9	63.9	387.5	156.8
SGP 5	2	91.7	57.0	345.3	139.8
SLMC 1	3	161.8	100.5	609.3	246.6
SWS 1	2	106.3	66.1	400.3	162.0
WCR 1	2	95.7	59.5	360.4	145.8
WCR 2	4	190.3	118.2	716.6	290.0
WCR 4	2	140.3	87.2	528.4	213.8
WCR 5	1	51.5	32.0	193.9	78.5
WCR 6	3	151.6	94.2	570.9	231.0
WP 1	2	104.2	64.7	392.4	158.8
Total	**73**	**3,684**	**2,289**	**13,873.1**	**5,614.3**
Mean	**2.6**	**131.6**	**81.8**	**495.5**	**200.5**

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 (18-20) depict Wisconsin's migratory tree bat species (excluding Evening bat). Figure 18. Silver-haired bat passes per kilometer hour by year (Figure 18). 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.

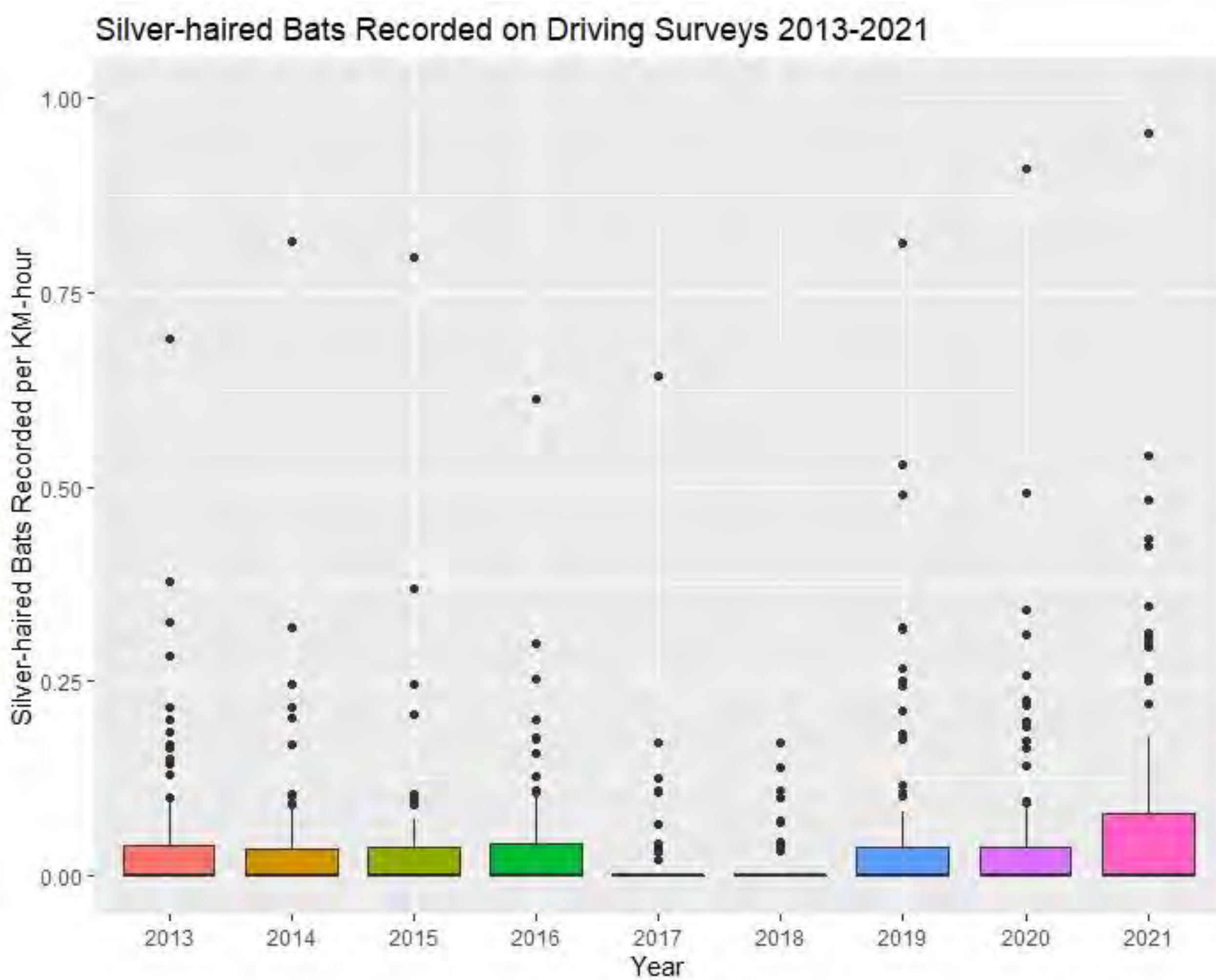


Figure 19. Eastern red bat passes per kilometer hour by year. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range.

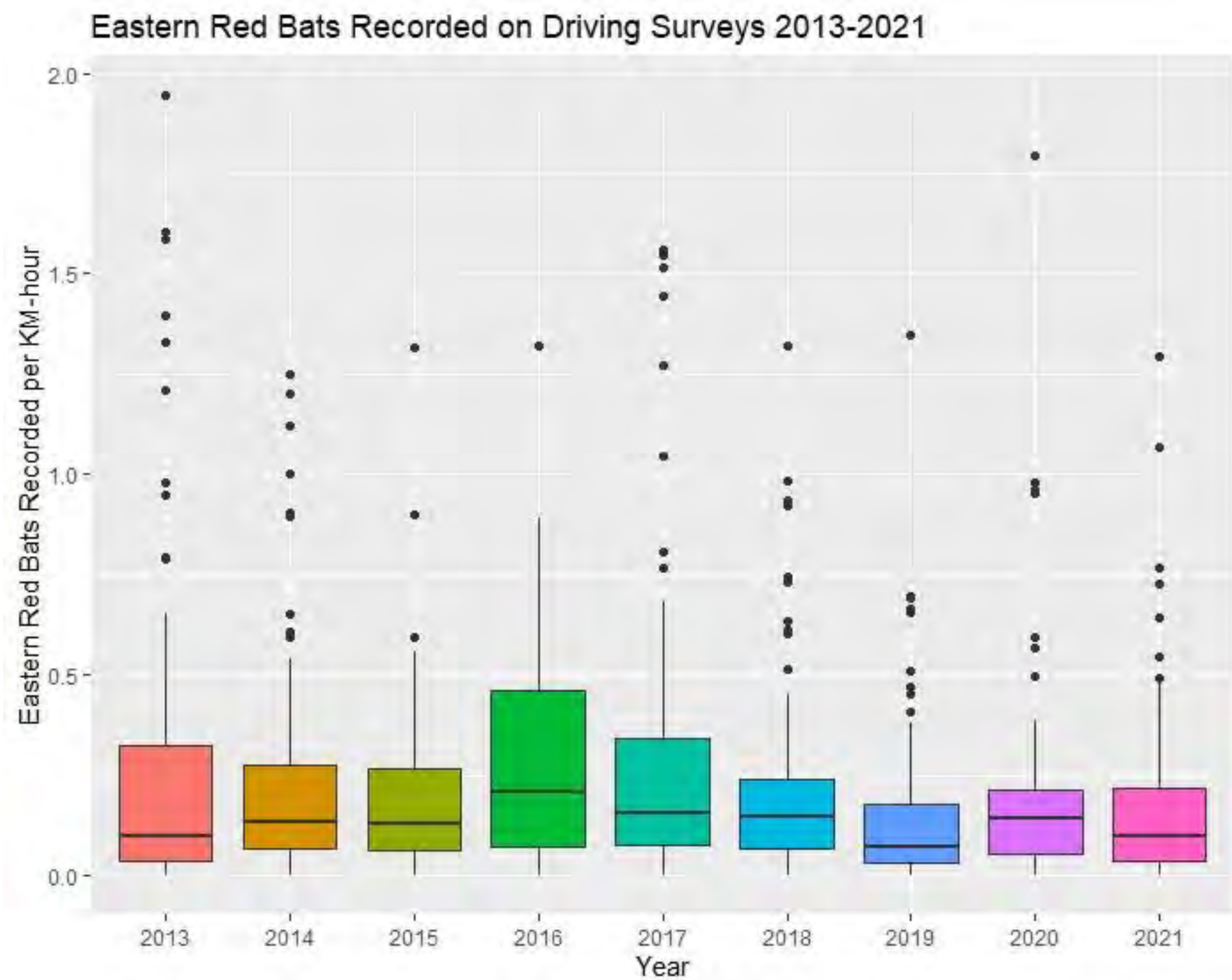


Figure 20. Hoary bat passes per kilometer hour by year. The bar is median, the outside edges of the boxes are 1st and 3rd quartiles, and the whiskers are, upper whisker = Q_3 + 1.5 * IQR, lower whisker = min. IQR is interquartile range. Hoary bat passes per km/hr were significantly higher in 2020 than previous years, but not statistically significantly different from 2021 which is also significantly higher than 2013-2019.