

## INTRODUCTION

There have been nine bat species recorded in Wisconsin representing 12% of the state's mammal diversity. Four bats (Hoary bat, Eastern red bat, Silver-haired bat, and Northern long-eared myotis) were identified as Species of Greatest Conservation Need (SGCN) in the recent Wildlife Action Plan (WAP) (<http://www.dnr.state.wi.us/org/land/er/WWAP>), while the remaining four bats were identified as species having additional information needs (eastern pipistrelle, little brown bat, big brown bat, and Indiana bat). The WAP chapter on monitoring identifies additional needs for bats: *"Inventory and monitoring efforts for bats are not adequate to address any topic area, including population trends, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. Inventory and monitoring efforts should be increased to address these deficits."*



Since the WAP was written in WI in 2005, four bat species (little brown bat, big brown bat, eastern pipistrelle [aka tri-colored bat] and northern long-eared bat) have been listed as state threatened due to overall declines in the populations at the national level and the immediate threat of this deadly fungal disease called white-nose syndrome (WNS) in WI. WNS is an emerging issue that did not exist when the state wildlife action plan was written. Because of the impact of WNS, United States Fish and Wildlife Service (USFWS) listed the northern long-eared bat as federally threatened in spring 2015. In addition, two other cave-dwelling species, the eastern pipistrelle (*Perimyotis subflavus*) and the little brown bat (*Myotis lucifugus*) are also adversely impacted by WNS and are currently under review for federal listing.

## ACOUSTIC MONITORING

*"Monitoring WNS-affected bat populations is necessary to determine which species may be at risk of local extirpations and extinction due to WNS, and WHERE conservation and management activities would be most effective."* A National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats, USFWS 2011.

Bats are a difficult group of mammals to study because they 1) are nocturnal, 2) fly relatively fast, 3) produce sound above the range of human hearing, 4) roost in cavities, cracks, and crevices that are difficult to find and/or 5) their coloration allows them to blend in with the tree foliage or bark on which they rest during the day. It was not until the late 1930's that scientists discovered that some bats produce ultrasonic signals (sound above the range of human hearing) to locate and intercept insect prey in flight. Bats emit these high-frequency calls and listen for returning echoes to determine distance and direction of various objects in their path. Echo-location, as the finding was termed, allows bats to fly in complete darkness while searching for tiny insects and to avoid obstacles like overhanging tree branches. One important outcome of this discovery was that it opened up a whole new way of studying bats in the wild by using electronic tools for ultrasound detection. Observers can listen for bats just as bird watchers have listened for birds for many years past.

Acoustic technology passively records bat activity by detecting ultrasonic echolocation calls emitted as bats forage and navigate across the landscape. The use of ultrasonic detectors provides detailed species-specific ecological data which is a non-invasive and cost-effective method for monitoring multiple bat species simultaneously at large spatial scales. This method is especially valuable for identifying species that are difficult to capture. Acoustical surveys have often been used to document activity levels and species diversity in different habitat types or in specific locations. A species-specific index of activity will be developed to monitor spatial and temporal fluctuations in species composition, activity and population. Identification of quality habitat or areas of higher activity levels, including both public and private lands, for bat populations before and after exposure to WNS is necessary for the development of effective conservation strategies.

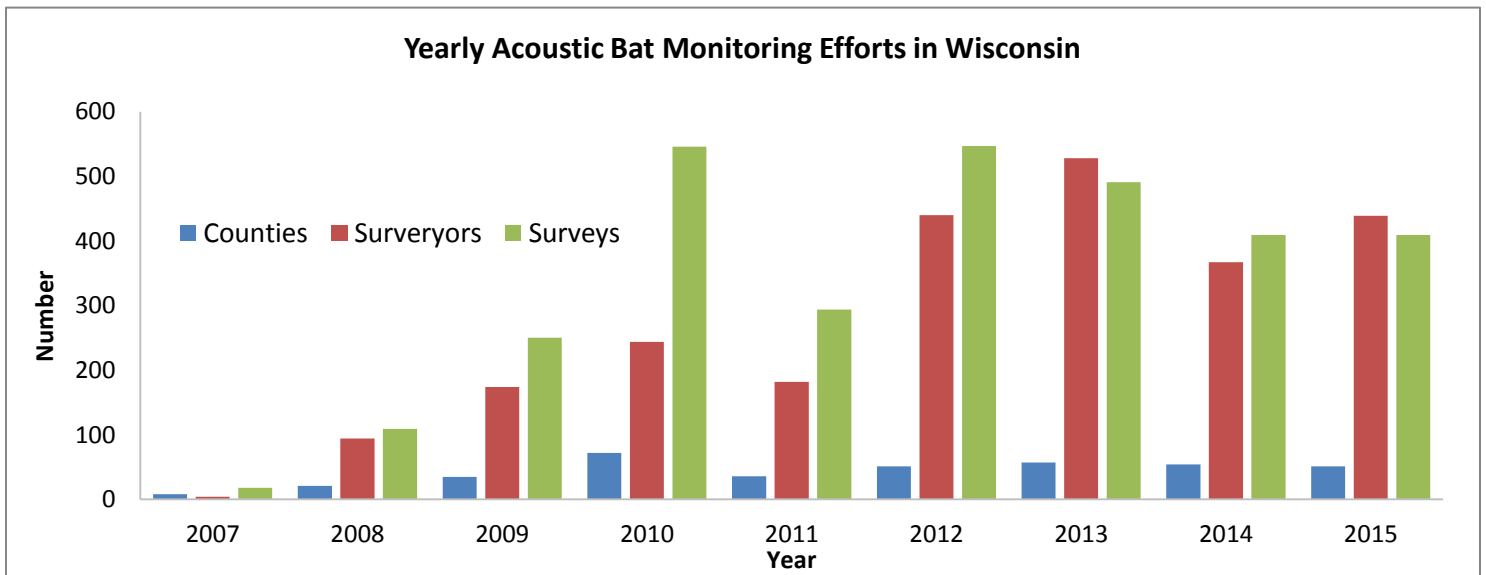


Figure 1 Yearly acoustic bat monitoring efforts in Wisconsin (2007-2015). Depicted in the figure are the number of surveys completed, surveyors who participated and counties where surveys took place.

### BAT MONITORING IN WISCONSIN

In general, bat populations are susceptible to decline because of low reproductive rates and many species congregate at a limited number of locations during critical stages of their natural history cycle (i.e., hibernacula and maternity colonies). Lack of information on basic ecology and trends is one of the greatest limitations to conservation of bat species. With growing monitoring demands, the Wisconsin Department of Natural Resources (WDNR) has turned to the WI Citizen-based Monitoring Network for assistance with monitoring bats. In the United Kingdom using trained citizens to collect long-term bat data has proven an effective solution with successful results for gathering large-scale inventory and monitoring data. The Wisconsin DNR is employing a similar approach by using Citizen-based Monitoring Network volunteers to collect acoustic bat data. In fact, this project would not be possible without the dedicated help of citizens collecting bat data.

In Wisconsin, acoustic bat monitoring began as a pilot project in 2007 and 2008. The goals of the pilot project were to identify partners to serve as regional coordinators, understand the challenges associated with using bat detection systems with citizen scientists and to develop protocols and sampling methods that address the statewide monitoring needs of the Wisconsin Bat Program (WBP).

Once partners were identified, training sessions were held to familiarize both the volunteers and regional coordinators with the equipment and protocols necessary to conduct a bat survey. Regional coordinators were responsible for data management, scheduling and training new recruits. After a survey was completed, survey information and acoustic data were uploaded to the WBP website. From there, WBP staff would retrieve the centralized data, analyze and map the findings. These findings, which included a visual representation of the route traveled along with the bat species or species group observed, were presented to volunteers usually within 2-4 weeks after completion of a survey.

### **THE IMPORTANCE OF ACOUSTIC MONITORING**

Coordinated bat population monitoring is critical for: 1) understanding the continental scale impacts of WNS and other bat population stressors including mortality due to wind energy development (Arnett et al. 2008), habitat loss, and climate change (Jones et al, 2009); 2) determining levels of activity in different habitat types to identify key habitat types, migration corridors, and foraging areas (Gannon and Sherwin, 2004); and, 3) determining the efficacy of management actions taken to conserve bat populations. Collecting and analyzing data in a standardized way will allow for the development of a national picture of bat populations and will allow species abundance comparisons between WNS affected and susceptible areas. Compared to wintering bat population information (trends, species composition, critical habitat) there is a void of information about how these bats are using the summer landscape. Knowing the activities and important habitats of bats throughout the year is critical for effective conservation of SGCN bat species.

Monitoring of SGCN bat species using acoustic detection techniques generates critically needed data about bat population trends for all resident bat species and habitat use during the summer. These data on SGCN and other bat species will inform Wildlife Actions Plans and assist local and regional priority planning and management decisions. Without information about summer bat populations, habitat use, and activity, states will be unable to prioritize SGCN work targeting conservation of these species during the summer, the bat's active period. Allocations of time and funding will not be made to protect vulnerable SGCN species or habitats if there is no documentation of the important habitats and population trends in a state.

### **GOALS OF ACOUSTIC BAT MONITORING IN WISCONSIN**

- Identify distribution and relative abundance of bat species throughout Wisconsin;
- Improve upon methods of acoustic monitoring for bats;
- Monitor status & trends;
- Provide information to land managers, industry, and the public.

## **FOCAL AREA**

Statewide; all 72 Wisconsin counties.

## **METHODS**

Acoustic surveys for all species of bats in Wisconsin are performed to determine presence/absence throughout the state. As bats fly through an area they can be surveyed with an acoustic recording system capable of detecting a bat's echolocation call. The bat detection system detects and records these acoustic signals as the bats fly past and records the date, time, and location of each encounter. The WDNR's currently uses broadband frequency division ultrasound detection equipment that can record in two methods: 1) using a Personal Data Assistant (PDA, Hewlett-Packard Company iPAQ models) and a Global Positioning System/GPS (Global Sat, BC-337) or 2) using a compact flash card with the SD1/2 AnaBat for data storage while using a mouse GPS powered through USB port with a lithium rechargeable battery pack.

Active mobile acoustic surveys are performed by trained individuals walking on a predetermined route. On all survey nights bat activity was monitored acoustically with an AnaBat SD1/2 bat detector (Titley Electronics, [www.titley.com.au](http://www.titley.com.au)). The detector's sensitivity was set at 7, data division ratio was set at 8, and audio division set to 16. Surveys were to begin no earlier than ½ after sunset to maximize likelihood of survey overlapping with the period of greatest bat activity.

## **SURVEY TYPES**

Bat surveys may be conducted by 1) Using a boat, canoe, and/or a kayak over navigable waterways, 2) Walking transect routes over land, or 3) Driving transects using a vehicle. Typical survey should last between 1 and 3 hours (1 hour minimum).

The WBP has over 400 predetermined water, walking and driving transects, which are promoted to all volunteers interested in acoustic bat monitoring. In addition to the predetermined transects, volunteers are encouraged to conduct exploratory surveys where they determine the scale and frequency by which the area is surveyed.

## **ANALYSIS**

Acoustic survey data was analyzed manually using AnalookW software ([http://users.lmi.net/corben/WinAnalook.htm#AnaLookW\\_Contents](http://users.lmi.net/corben/WinAnalook.htm#AnaLookW_Contents)). Recorded bat passes were compared to recordings from known species collected by the WDNR to aid in classification. Bat passes were placed into the following groups based on call characteristics because certain species could not be reliably distinguished from one another: *Myotis* spp., including both *Myotis lucifugus* (MYLU) and *Myotis septentrionalis* (MYSE), *Lasiurus borealis/ Perimyotis subflavus* (LABO/PESU), *Eptesicus fuscus* / *Lasiurus noctivagans* (EPFU/LANO), *Lasiurus cinereus* (LACI), and a category of unknown bats. Calls that were classified as "unknown" had characteristics of more than one species group and, or contained incomplete calls: high frequency group >35 kHz (HFG) and low frequency group <35 kHz (LFG).

## RESULTS

Since 2009, nearly 3,000 acoustic bat surveys have been completed by over 1,000 volunteers (Figure 1). The yearly average for acoustic bat surveys completed is 420.9 (range: 250-547), with an average annual participation by volunteers at 339.1 (range: 174-528).

The bat monitoring season in Wisconsin officially begins April 1<sup>st</sup> and ends September 30<sup>th</sup>, although if there are suitable weather conditions a few surveys are completed outside of the usual sampling period. Wisconsin experienced a colder than average spring which suppressed bat monitoring efforts, with the majority of surveys taking place in the summer residency period of June and July (Figure 2). In 2015, 399 acoustic bat surveys were uploaded to the WBP website. Of the 409 surveys, 376 returned complete acoustic results (92% success rate). There were 33 acoustic surveys that produced incomplete results which resulted from issues ranging from inclement weather to technical problems related to the monitoring equipment.

Acoustic bat surveys were completed in 51 (71%) of the possible 72 Wisconsin counties, with Dane (n=52) and Vilas (n=51) counties contributing the most surveys this season (Figure 3). As previously mentioned, depending on volunteer preference, bat surveys can be conducted by 1) a water vessel (i.e. boat, canoe, and/or a kayak) over navigable waterways, 2) walking transect routes over land, or 3) driving transects using a vehicle. Walking surveys consisted of nearly half of the acoustic surveys in 2015 with 179 (48%) successfully completed, followed by water surveys at 112 (30%) and driving surveys at 85 (22%) (Table 1). As expected, driving surveys monitored more miles than any other survey method with a mean of 29.0 miles (range 6-45.5) for a total of 2467.9 miles driven in 2015 (Figure 4).

Survey effort varied by method, but with all methods combined amassed over 69,000 minutes conducting acoustic bat surveys in 2015 (Table 2). The average number of surveyors per survey was 2.2 with a range of 1 to 42 volunteers, with the upper range of volunteer per survey consisting of training sessions.

The number of surveys increased dramatically from the spring movement period to the summer residency period. The mean number of bat encounters of all successful acoustic bat surveys followed the general trend of bat activity where bats are less conspicuous on the landscape in early spring as they migrate to Wisconsin or travel from winter hibernacula to summering grounds; where they then become more prevalent from May through August (Figure 5, Table 3).

Regardless of monitoring method (driving, walking and paddling), little brown bats were the most encountered bat species in Wisconsin 2015, followed by big brown and silver-haired bats (Figure 6). The highest bat detection per hour values for all bat species were found on paddling surveys, with the exception of the eastern red bat, which was most commonly encountered on driving routes (Table 4).

## Acoustic Bat Surveys by Month (2015)

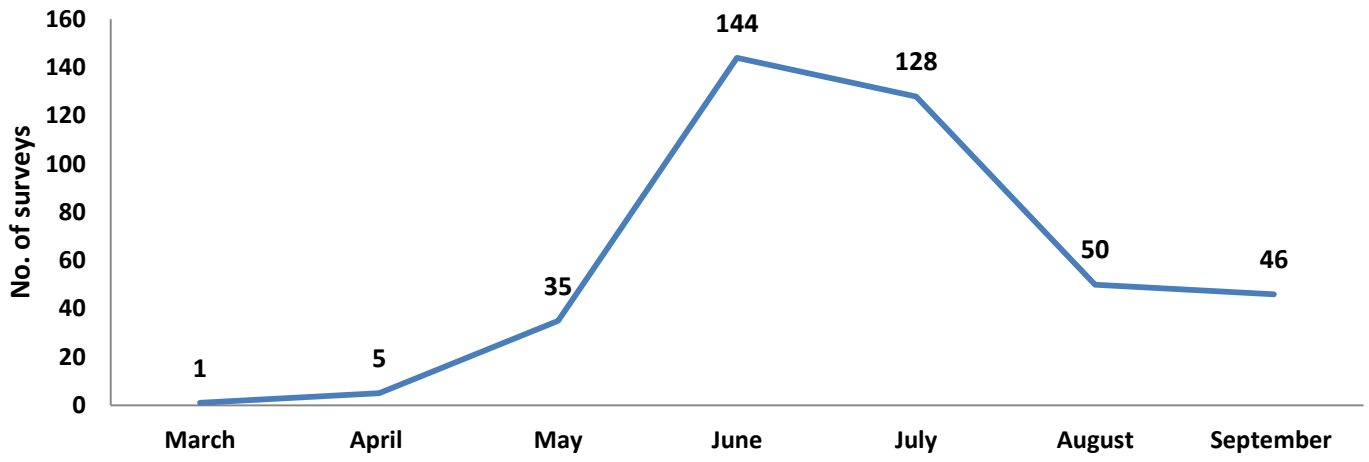


Figure 2 Number of acoustic bat surveys by month. Includes both failed (n=33) and successful (n=376) survey attempts.

## Wisconsin Counties with Five or More Acoustic Bat Surveys in 2015

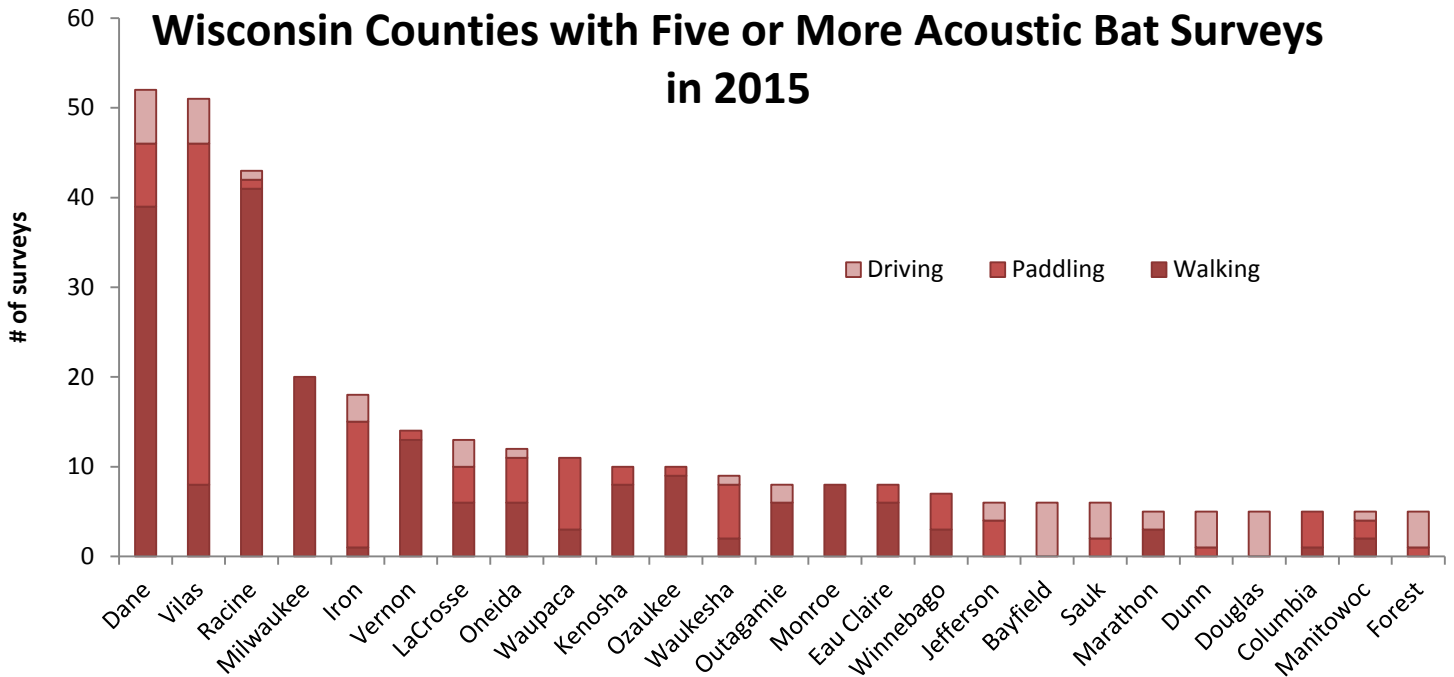


Figure 3 Wisconsin counties with five or more acoustic bat surveys separated by survey method (driving, paddling and walking). Includes both failed (n=33) and successful (n=376) survey attempts.

## Acoustic Bat Surveys Total Miles Surveyed in 2015

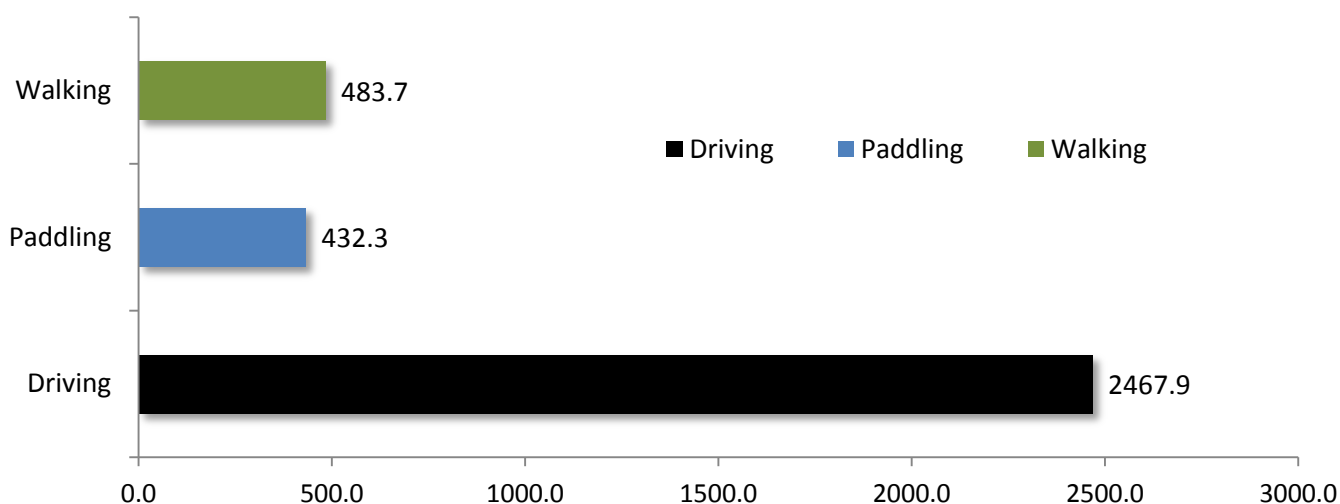


Figure 4 Illustrates total miles surveyed by survey method. Includes both failed (n=33) and successful (n=376) survey attempts.

Table 1 Number of acoustic bat surveys by survey method, including total distance traveled (kilometers and miles). Only includes successful (n=376) survey attempts.

Survey Method	No. of Surveys	Total Kilometers	Total Miles
Driving	85	3,971.7	2,467.9
Paddling	112	695.7	432.3
Walking	179	778.4	483.7
<b>Total</b>	<b>376</b>	<b>5,445.8</b>	<b>3,383.8</b>

Table 2 Mean number of acoustic bat surveyors per survey. Also depicted is survey length (mins/hrs) and survey effort. Survey effort is defined as the number of survey participants multiplied by time spent surveying. Only includes successful (n=376) survey attempts.

	<u>Mean (Range) S.E.</u>	<u>Total</u>
<b>No. of surveyors per survey</b>	2.2 (1.0-42.0) 0.1	439 surveyors
<b>Survey Length (mins)</b>	80.6 (10.0-152.0) 1.6	32,902 minutes
<b>Survey Length (hrs)</b>	1.3 (0.2-2.5) 0.0	548.4 hours
<b>Surveyor Effort (mins)</b>	170.2 (10.0-2,100.0) 10.4	69,461 minutes
<b>Surveyor Effort (hrs)</b>	4.8 (0.2-104.0) 0.7	1,969.9 hours

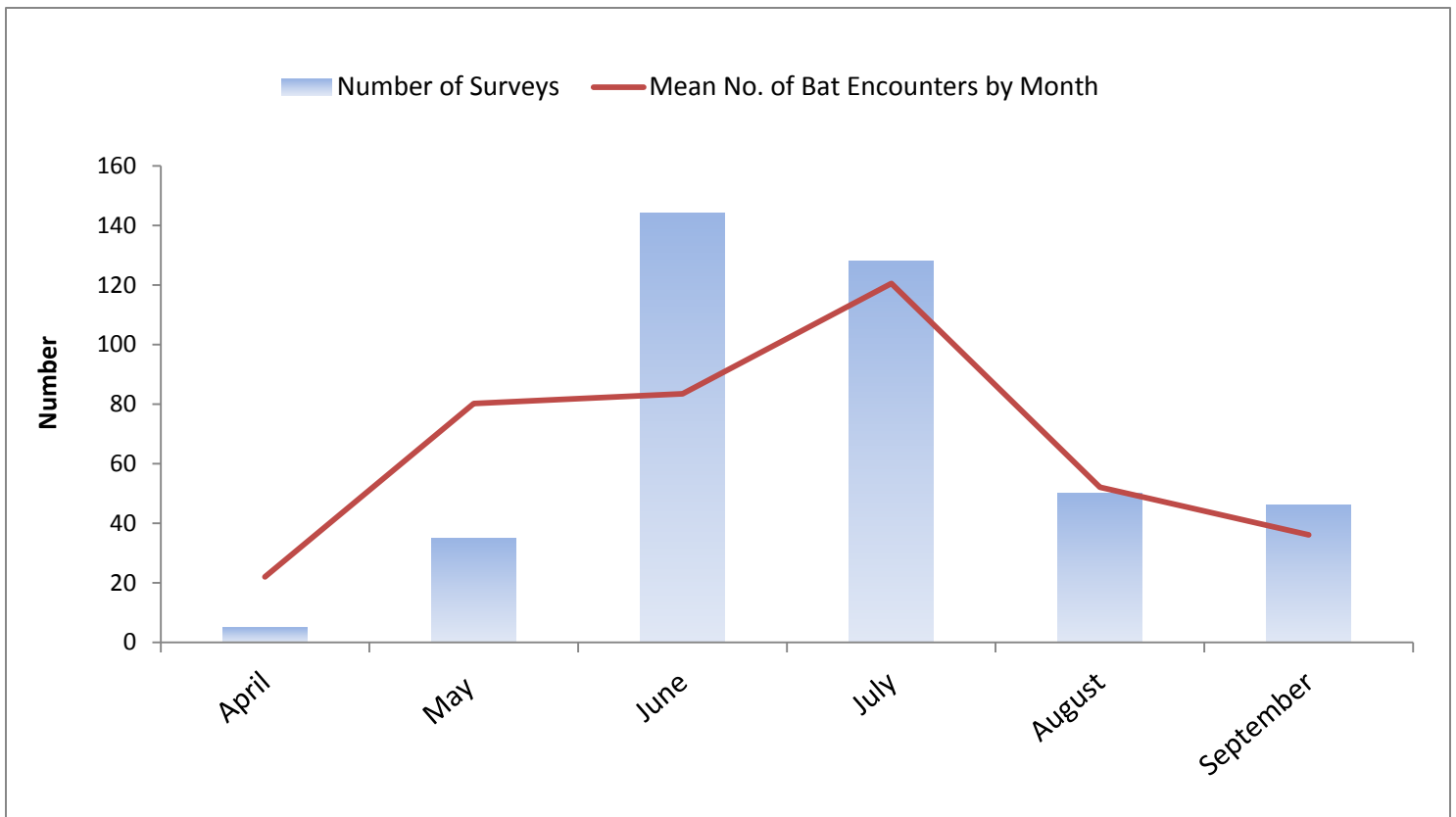


Figure 5 Illustrates the number of acoustic bat surveys by month along with the mean number of bat encounters of all surveys within a given month. Only includes successful (n=376) survey attempts.

Table 3 Mean bat passes per detector hour by month and bat species. Only includes successful (n=376) survey attempts.

Species	April	May	June	July	August	September
<i>Myotis lucifugus</i> (Little Brown Bat)	1.8	28.3	25.4	37.3	21.7	13.7
<i>Myotis septentrionalis</i> (Northern Long-eared Bat)	0.0	0.2	0.2	0.5	0.0	0.0
<i>Lasiurus borealis</i> (Eastern Red Bat)	0.0	0.7	2.8	3.0	2.3	2.5
<i>Perimyotis subflavus</i> (Eastern Pipistrelle)	0.0	0.0	0.5	1.2	0.1	0.2
<i>Lasionycteris noctivagans</i> (Silver-haired Bat)	0.0	0.9	0.7	0.7	0.2	0.0
<i>Eptesicus fuscus</i> (Big Brown Bat)	5.6	10.9	11.2	16.5	2.4	1.9
<i>Lasiurus cinereus</i> (Hoary Bat)	0.0	1.1	5.1	7.5	1.7	3.1



Table 4 Bat passes per detector hour by bat species and survey method. Only includes successful (n=376) survey attempts.

	<i>Driving; Mean (range) S.E.</i>	<i>Walking; Mean (range) S.E.</i>	<i>Paddling; Mean (range) S.E.</i>
Little Brown/detector hour	6.1 (0-29.7) S.E. 0.7	7.7 (0-84.0) S.E. 1.4	48.8 (0-284.6) S.E. 5.6
Northern Long-eared/detector hour	0 (0-0) S.E. 0	0.2 (0-8.9) S.E. 0.0	0.7 (0-45.6) S.E. 0.6
Eastern Red/detector hour	3.2 (0-28.0) S.E. 0.5	2.2 (0-38.6) S.E. 0.7	1.4 (0-34.8) S.E. 0.6
Eastern Pipistrelle/detector hour	0.1 (0-1.8) S.E. 0.0	0.2 (0-5.5) S.E. 0.0	1.0 (0-24.3) S.E. 0.4
Silver-haired/detector hour	0.6 (0-10.3) S.E. 0.2	0.1 (0-6.0) S.E. 0.1	0.8 (0-21.7) S.E. 0.4
Big Brown/detector hour	4.9 (0-26.6) S.E. 0.6	6.8 (0-72.0) S.E. 1.0	11.7 (0-123.4) S.E. 2.9
Hoary/detector hour	3.2 (0-21.0) S.E. 0.4	0.6 (0-13.0) S.E. 0.2	7.1 (0-77.7) S.E. 1.5
<b>Total Bat Passes/Detector Hour</b>	<b>37.2 (0.9-120.0) S.E. 2.8</b>	<b>38.4 (0-216.0) S.E. 3.9</b>	<b>118.7 (0-657.7) S.E. 13.1</b>

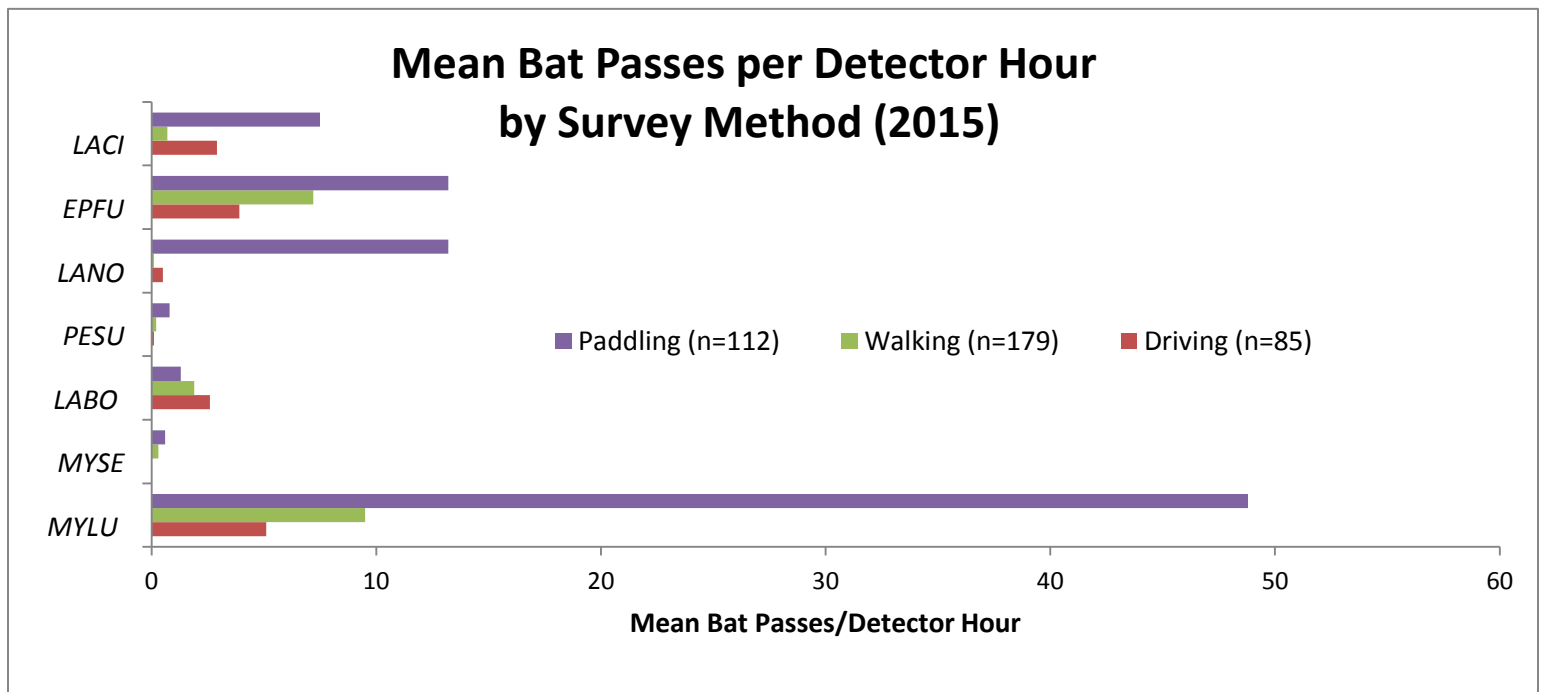


Figure 6 Displays the mean bat passes per detector hour by bat species and survey method. *Myotis lucifugus* (MYLU) and *Myotis septentrionalis* (MYSE), *Lasiurus borealis* (LABO), *Perimyotis subflavus* (PESU), *Eptesicus fuscus* (EPFU), *Lasiurus noctivagans* (LANO) and *Lasiurus cinereus* (LACI). Only includes successful (n=376) survey attempts.

## DISCUSSION

Despite the invasive fungus that causes WNS spreading from one county in 2014 to seven additional counties in 2015 (as of May), little brown bats continue to make up the majority of bat encounters on acoustic surveys. That said, Wisconsin is still early in the infection process, so the state should expect considerable losses of cave bat species (little brown, big brown, eastern pipistrelle and northern long-eared bats) in the upcoming years which reemphasizes the prominence of acoustic bat surveys now and into the future. Acoustic bat surveys can specify areas of concentration by affected bat species in addition to identifying landscape level changes of bat communities.

All survey methods remain relevant with each technique providing a different level of scale as well as habitat monitored. Walking transects conducted by volunteers provide small scale (5mi<) snapshots of bat activity in habitats that can be hard to access (private lands or limited trail/road access). Driving transects cover large geographical distances, although the call quality of recorded bat encounters are often compromised because in part, the speed at which the survey takes place (20mph>). But driving transects had the highest bat species diversity in 2015 compared to the other methods (Figure 7) and the transects have been a central tool of the national bat monitoring efforts; so employing such strategies that allow comparisons across state lines can prove valuable. Nationally speaking, the WBP is unique in its efforts to use mobile acoustic surveys on waterbodies to monitor bat activity. Despite the many challenges connected to monitoring waterways during the evening, these surveys consistently produce the highest bat detections per hour when compared to the two other survey methods (Figure 6). Likewise there are some species, like the eastern pipistrelle, that remain mostly undetected until the implementation of water surveys (Appendix D, E). For these reasons, water surveys will remain an essential component in the WBP's survey methods.

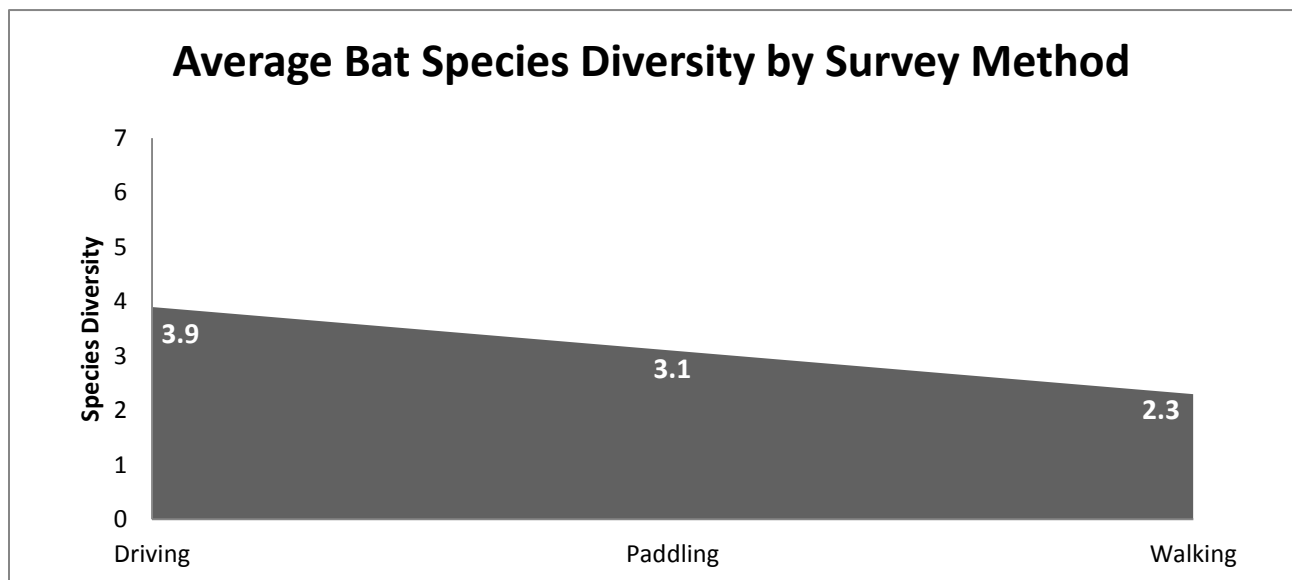


Figure 7 Average bat species diversity among survey methods (7 bat species in WI). Only includes successful (n=376) survey attempts.

# Wisconsin Dept. of Natural Resources

## 1947 - 2014 Records (June - July)

### Eastern Pipistrelle (*Perimyotis subflavus*)

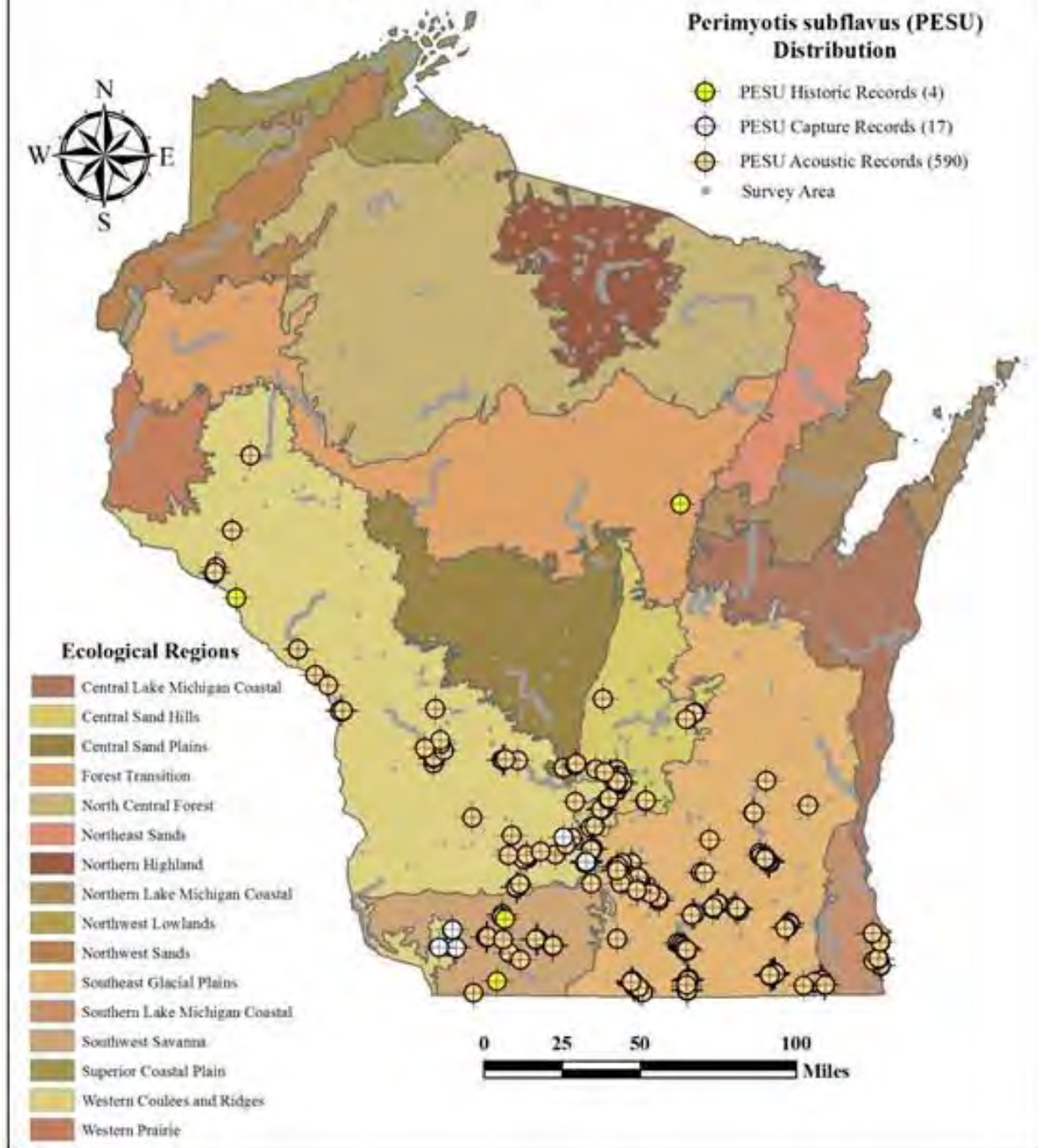


Figure 8 Displays eastern pipistrelle occurrence records (historic, capture and acoustic) from 1974-2014.

With over 30 acoustic bat detection systems positioned in various locations in Wisconsin, the WBP has greatly benefitted from the remarkable effort that volunteers and regional coordinators have put forth since the projects' inception in 2007. Statewide maps that define species range such as in Figure 8 would remain largely incomplete if it not for the information collected by the WBP's citizen scientists. Seasonal trends that highlight bat phenology, like defined in Figure 5 (mean bat passes per detector hour), would go unnoticed if state biologists were the only collectors of information. The significance of citizen-based monitoring efforts cannot be understated, but not only for data collection, but perhaps just as importantly, for education and awareness of issues that surround bat conservation. While the numbers indicate there have been over a 1,000 volunteers participating on acoustic bat surveys since the project began, the data doesn't accurately account for the outreach that has stemmed from those participants. From training sessions to school projects through word of mouth, bat conservation issues in Wisconsin have been brought out of the darkness and into the light more so than any time before; for that, we have citizen scientists to thank.

## **FUTURE EFFORTS**

The Wisconsin Bat Program's future efforts will be targeted at summarizing and comparing the baseline acoustic data from 2007-2014 as 2015 marks the first year that an in-depth analysis had been completed.

## **LITERATURE CITED**

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**APPENDIX A Acoustic bat survey completed by vehicle**

**Acoustic Bat Encounters**

**Survey Route**

**SPECIES/GROUP**

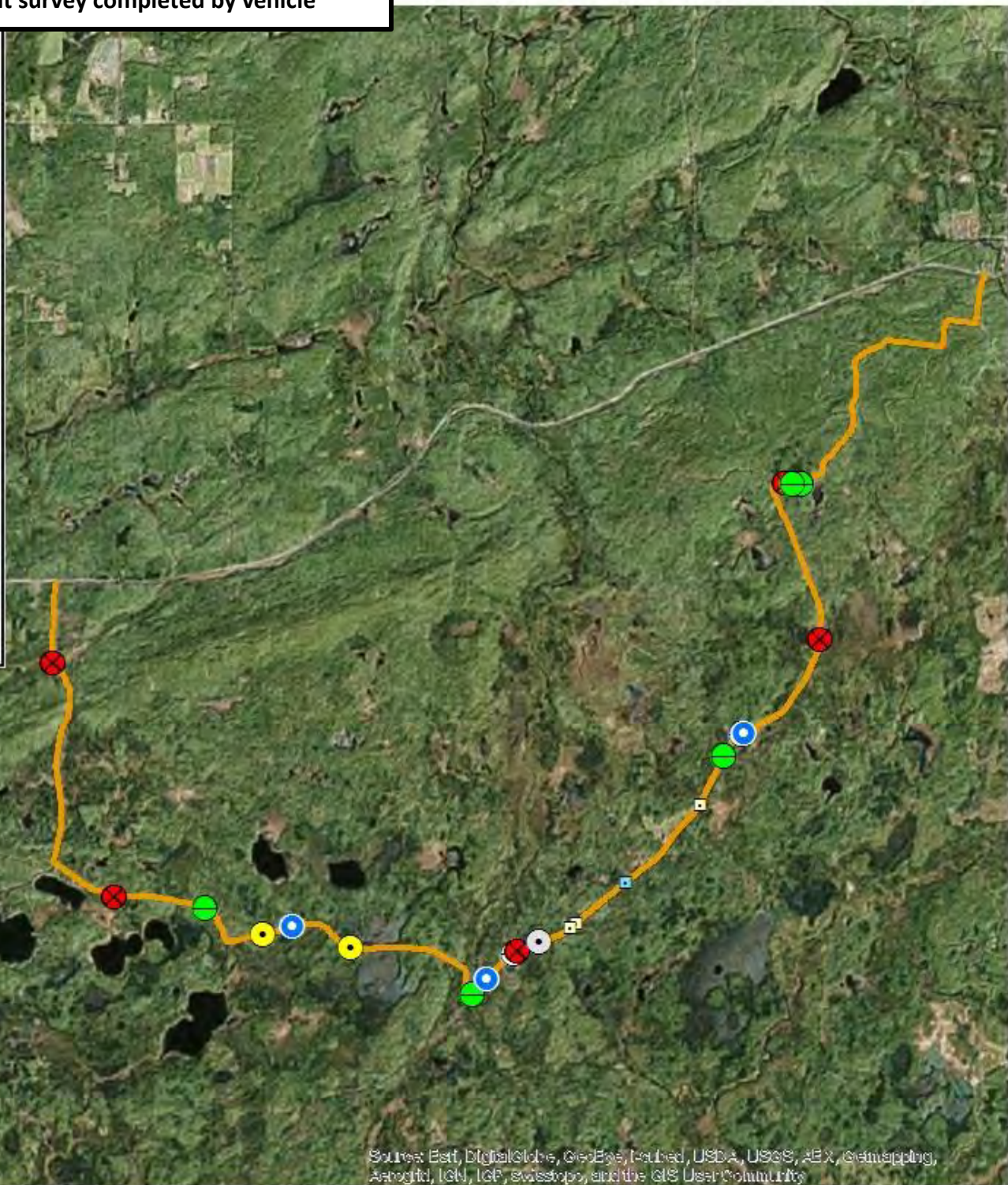
**High Frequency  $\geq 35$  kHz**

- Little Brown/  
Northern Long-eared
- Little Brown
- Northern Long-eared
- ⊗ Eastern Red/ Pipistrelle
- Eastern Red
- Eastern Pipistrelle

**Low Frequency  $\leq 35$  kHz**

- Hoary
- Big Brown/ Silver-haired
- Big Brown
- Silver-haired





**SURVEY RESULTS**

Ashland/Iron County  
 Penokees  
 25 June 2015  
 RT 3257

Surveyors: L Radke & BRNRD  
 Route Length: 25.71 km  
 4 Species Encountered

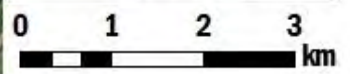
**Time & Weather**

Time (PM)	
9:32	10:50
Temperature (F)	
61.0	54.0
Relative Humidity (%)	
97.0	95.0
Wind (m/s)	
0.0	0.0

Notes:



Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AeroGRID, IGN, IGP, Swirestop, and the GIS User Community





APPENDIX B Acoustic bat survey completed by boat

**Survey Route**

**SPECIES/GROUP**

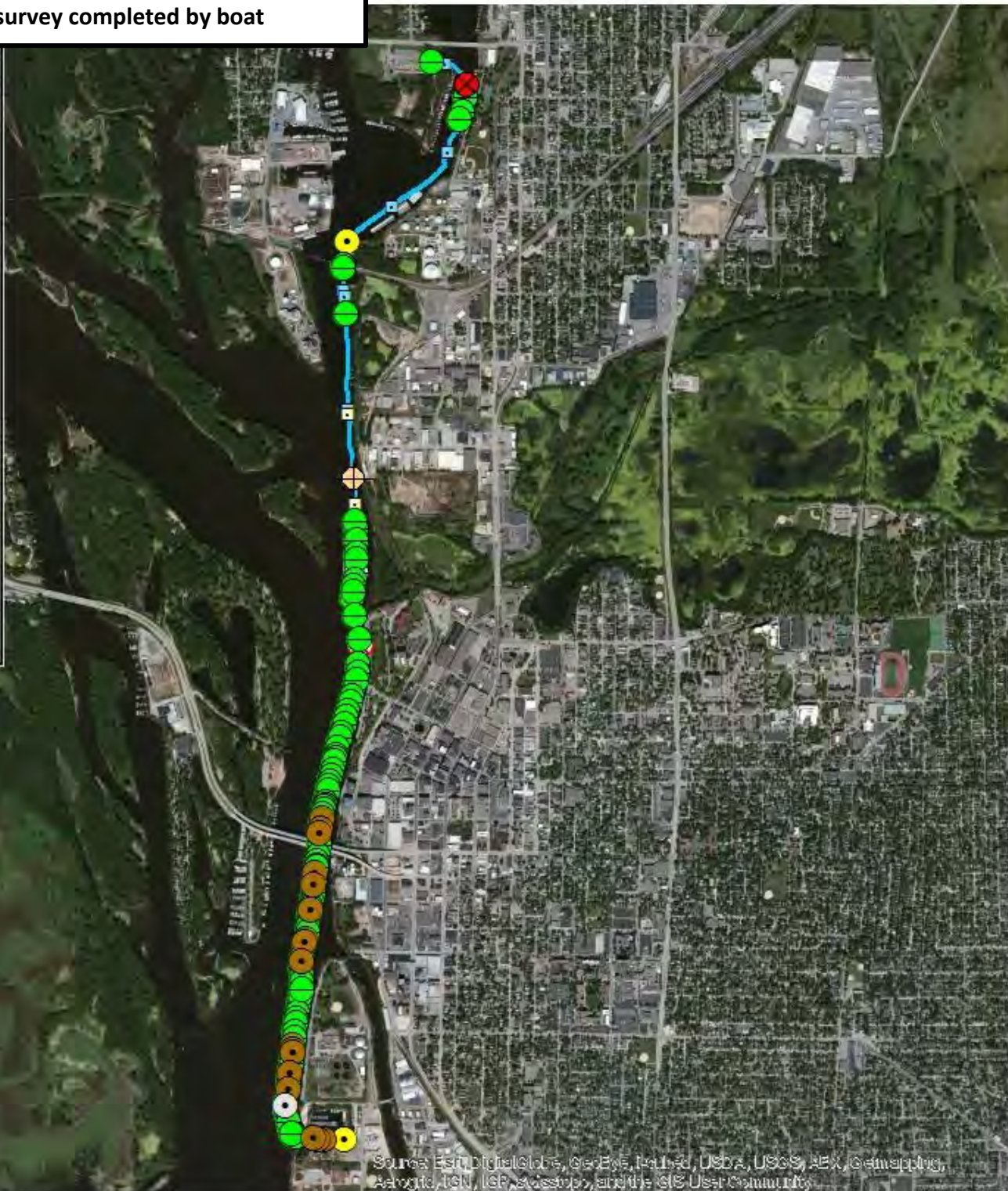
**High Frequency  $\geq 35$  kHz**

- Little Brown/ Northern Long-eared
- Little Brown
- Northern Long-eared
- Eastern Red/ Pipistrelle
- Eastern Red
- Eastern Pipistrelle

**Low Frequency  $\leq 35$  kHz**

- Hoary
- Big Brown/ Silver-haired
- Big Brown
- Silver-haired





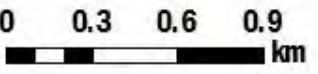
**SURVEY RESULTS**

La Crosse County  
 Mississippi River 2  
 29 July 2015  
 RT 3427  
 Surveyors: W Drye & B Johnston  
 Route Length: 5.50 km  
 5 Species Encountered

**Time & Weather**

Time (PM)	
9:19	10:11
Temperature (F)	
75.0	74.0
Relative Humidity (%)	
50.0	52.0
Wind (m/s)	
3.1	4.5

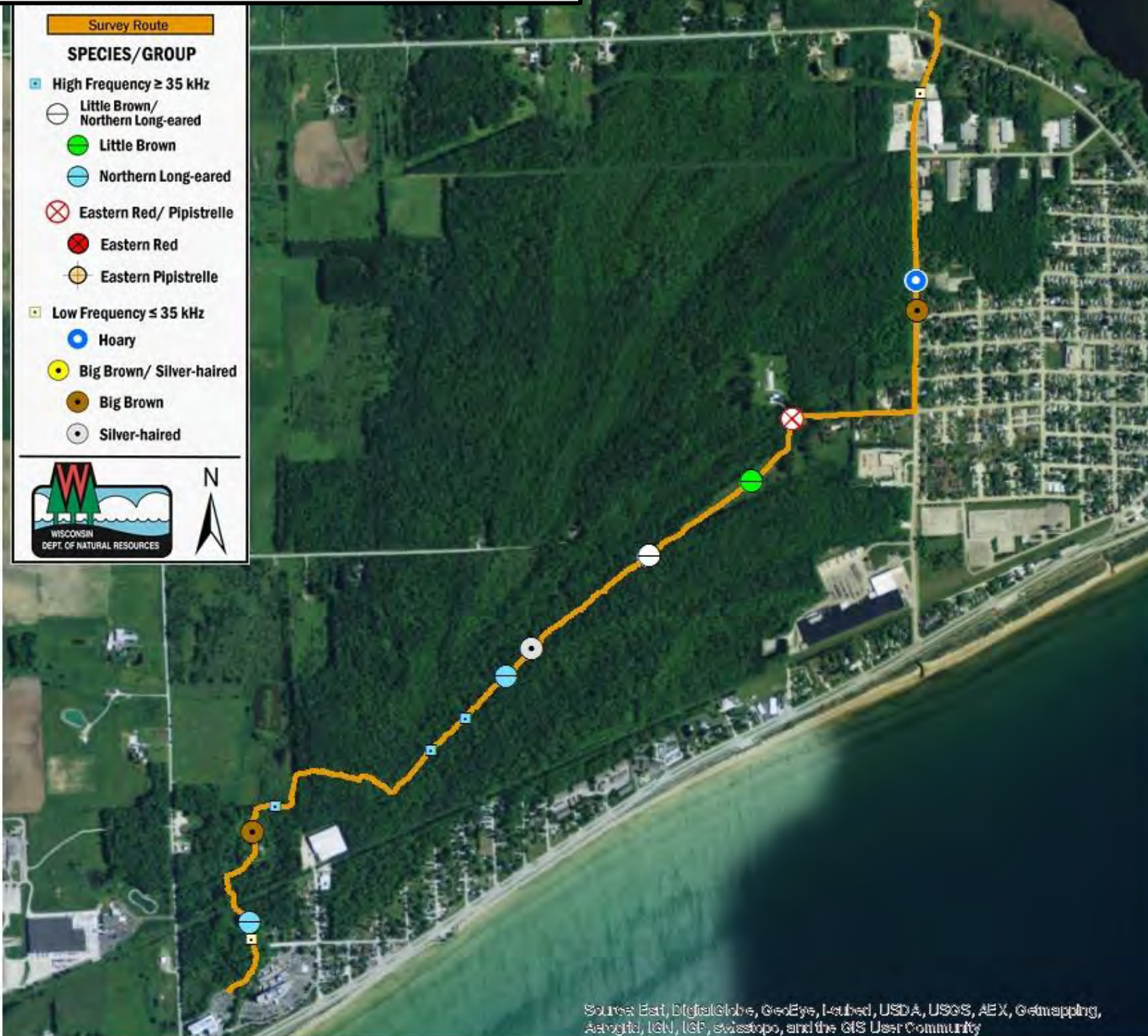
Notes: BATLAS Rt  
 Survey completed N to S



Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AeroGRID, IGN, IGP, Swirebird, and the GIS User Community



**APPENDIX C Acoustic bat survey completed by walking**



Survey Route

**SPECIES/GROUP**

- High Frequency  $\geq 35$  kHz
- Little Brown/  
Northern Long-eared
- Little Brown
- Northern Long-eared
- ⊗ Eastern Red/ Pipistrelle
- Eastern Red
- Eastern Pipistrelle
- Low Frequency  $\leq 35$  kHz
- Hoary
- Big Brown/ Silver-haired
- Big Brown
- Silver-haired



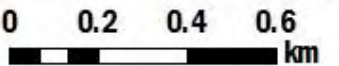
**SURVEY RESULTS**

Manitowoc County  
Ice Age Trail  
15 June 2015  
RT 3223  
Surveyors: J Johnsrud,  
D McNulty, & B Gosh  
Route Length: 5.07 km  
5 Species Encountered

**Time & Weather**

Time (PM)	
9:20	10:33
Temperature (F)	
65.5	66.0
Relative Humidity (%)	
96.0	95.0
Wind (m/s)	
3.62	3.62

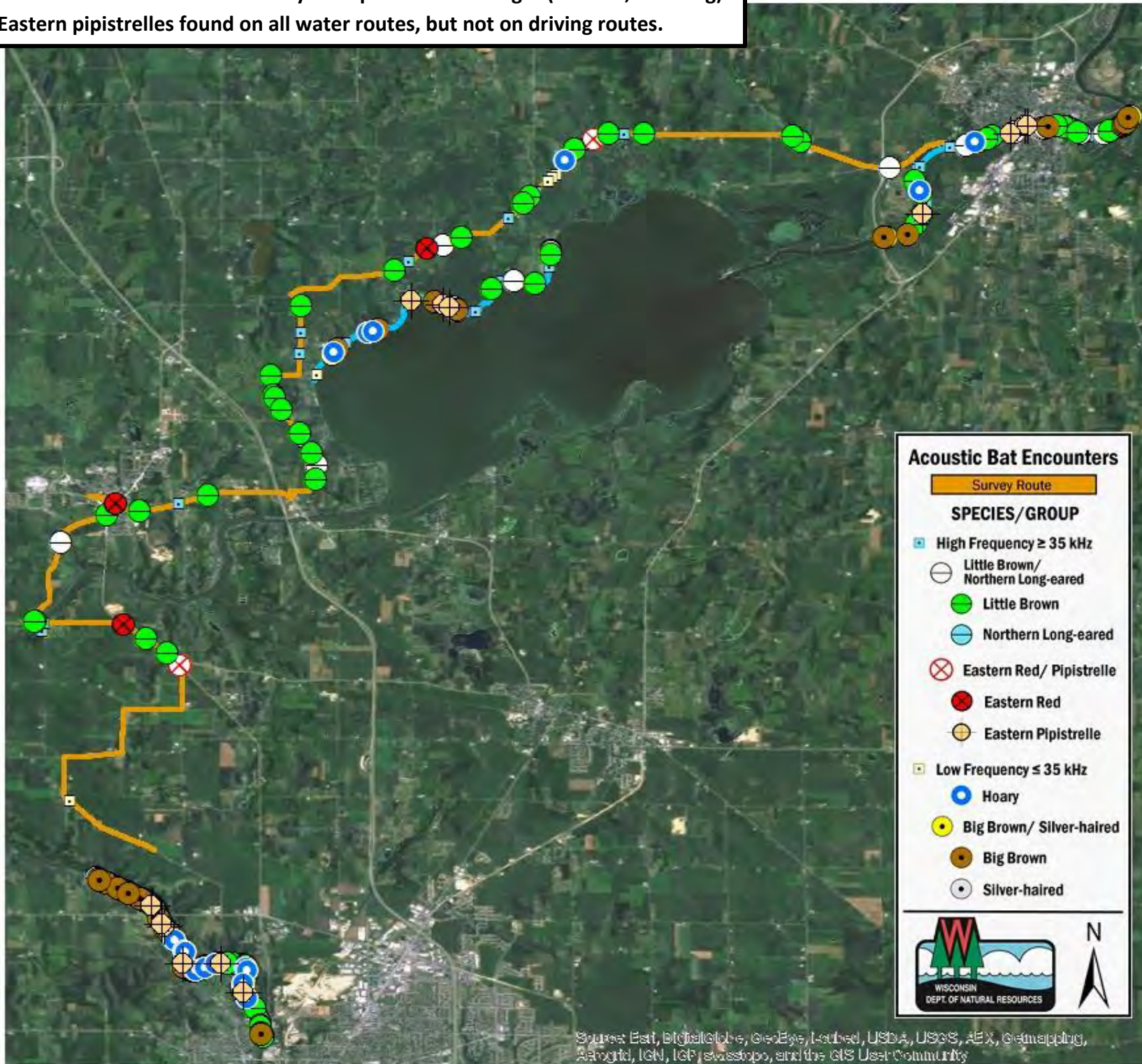
Notes: Woodland Dunes Segment



Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AEX, Geomatics, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community



**APPENDIX D Four acoustic surveys completed on one night (3 water, 1 driving). Eastern pipistrelles found on all water routes, but not on driving routes.**



**SURVEY RESULTS**

Dane/ Jefferson/ Rock County

Janesville BatBlitz

13 June 2013

Surveyors: White, Redell, Kaarakka, & Badje

5 Species Encountered

**Time & Weather**

Time (PM)

9:10      11:14

Temperature (F)

66.2      57.2

Relative Humidity (%)

78.0      86.0

Wind (m/s)

1.6      2.05



Notes: BATLAS Routes - Rock River 6 & 8, Lake Koshkonong, Driving Route - SGP 1

**Acoustic Bat Encounters**

**Survey Route**

**SPECIES/GROUP**

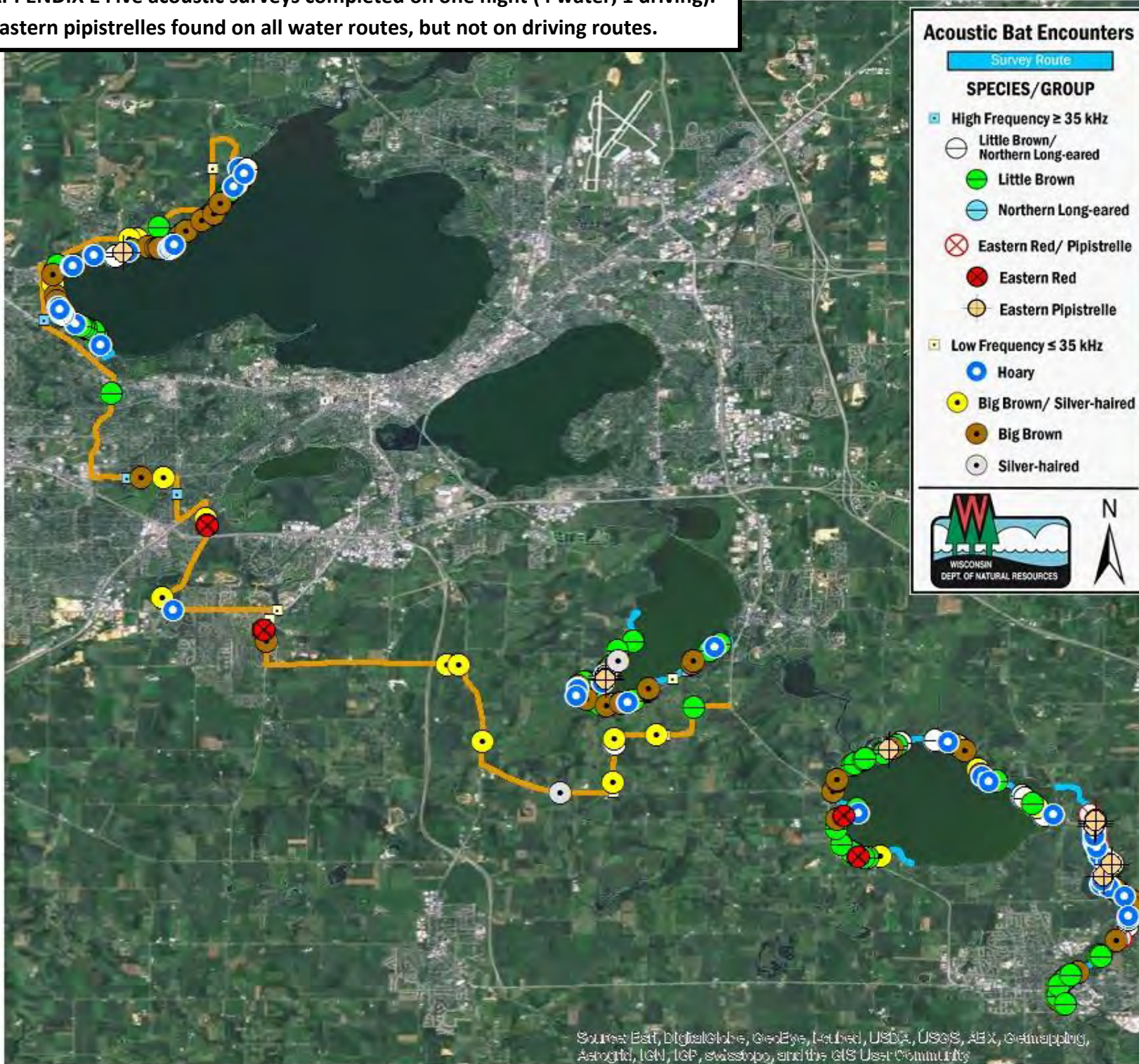
- High Frequency  $\geq 35$  kHz
- Little Brown/ Northern Long-eared
- Little Brown
- Northern Long-eared
- ⊗ Eastern Red/ Pipistrelle
- Eastern Red
- ⊗ Eastern Pipistrelle
- Low Frequency  $\leq 35$  kHz
- Hoary
- Big Brown/ Silver-haired
- Big Brown
- Silver-haired


Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community



**APPENDIX E** Five acoustic surveys completed on one night (4 water, 1 driving).  
 Eastern pipistrelles found on all water routes, but not on driving routes.



**Acoustic Bat Encounters**

Survey Route

**SPECIES/GROUP**

- High Frequency  $\geq 35$  kHz
  - Little Brown/Northern Long-eared
  - Little Brown
  - Northern Long-eared
  - ⊗ Eastern Red/ Pipistrelle
  - Eastern Red
  - Eastern Pipistrelle
- Low Frequency  $\leq 35$  kHz
  - Hoary
  - Big Brown/ Silver-haired
  - Big Brown
  - Silver-haired



**SURVEY RESULTS**  
 Dane County  
 Madison Area BatBlitz  
 10 June 2013

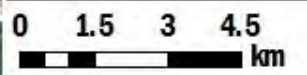
Surveyors: G Emerson, J Redell,  
 N Hyleert, P White, H Kaarakka,  
 & A Badje

Total Survey Distance: 76.17 km  
 6 Species Encountered

**Time & Weather**

Time (PM)	
9:04	11:18
Temperature (F)	
72.0	68.0
Relative Humidity (%)	
71.0	81.0
Wind (m/s)	
2.1	1.6

Notes: 4 BATLAS Routes  
 & 1 Driving Route



Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, Aero, GeoMapping, AstroGEO, IGN, IGP, swisstopo, and the GIS User Community

## APPENDIX F Volunteers who participated on an acoustic bat survey in 2015. Information retrieved from survey data form.

B. Johnston, A. Badje, S. Chojnacki, J. Warner, A. Blattner, M. Warner, B. Paulan, B. Heil, K. Nolan, S. Mason, J. Clements, P. Moses, R. Duley, A. Reis, P. Peterson, J. Miller, K. Firebaugh, M. Peters, S. Firebaugh, T. Ludwig, A. DeVoe, W. Mueller, B. Konsela, D. Boyle, H. Kaarakka, J. Durbin, J. Lund, K. Schluter, L. Johnson, M. Firebaugh, N. Gremban, S. Schumacher, Anne Small, Christopher Suehs, Chuck Hayes, Danny Suehs, G. Emerson, Gloria Suehs, Jeanne Hanisko, Jill Wilm, Jim Meyers, Kathy Hayes, Kevin Liesner, Kris Liesner, Lisa Ludwig, Matt Schumaker, Mike Nigl, Nathan Suehs, Ray Firebaugh, Sarah Besadny, Susan Cushing, Andy Ledin, Bob Ruch, Brian Heeringa, BRNRD, C. Anderson, C. Catalano, Chris Floyd, Dale Reilley, Ed Taylor, Ellen Ripp, Emma Neuman, George Liu, Gunilla Skonie, Hedda Patzke, Jan Schumacher, Jennifer Mitchell, Jesse Hill, Jessica Johnsrud, Joe Scott, John Jorgensen, Judy Ruch, Kaela Firebaugh, Kelsey Crank, Lissa Radke, Luanne Frey, Mark Lukow, Mary Schroeder, Matthew Berg, Melinda Pearce, Nancy Russell, Nathan Kilger, Nicholas Nolan, Karl Overn, P. White, Peter Altenbach, R. Wife, Ray Jay, Robert Bultman, Sarah Horn, Scott Schuppe, Stephen Russell, Terri Jay, Tom Skonie, Tracy Arnold, Al Sommer, Amanda Walsh, Andrea Auel, Betsy Kocourek, Breanna Gosh, Brenda Schuppe, Bryan Lenz, C. Bowen, Carl Brust, Carlton Kind, Chris Schorse, Christine Senski, Chuz Wilson, D. Curtis, Darcy Kind, Dave Warren, Donna Mandt, DuWayne Schumacher, Elise Myers, Emily Lind, G. Ziskin, Howard Aprill, Isaish Janke, Jan Carter, Jane Reilley, Janel Scharhag, Janice Udovich, Jason O'Brein, Jennifer Summers, Jennine Pufahl, Jim Weinmann, John Mistele, Kath Wilson, Katie Luukonen, Lauren Snell, Lili Kelly, Lin Ahlstedt, Lori Bogstad, M. Lamonda, Meg Werren, Michael Nolan, Mike Schlotfeldt, N. Bentley, Nick Bouley, Nicole Shutt, Noah Laubach, Norm Gunder, Pat Brust, R. Cornell, Robert Eady, Ryan Summers, M. Pfeiffer, S. Drexler, Stacy Zacher, Steve Laubach, Tom Kocourek, Wes Drye, William Zacher, Yolanda Mistele, A. Hollywood, Adam, AJ Leiden, Al Harper, Ali Ban-Herr, Ali Dickson, Allison Heil, Alona, Amy Hung, Andrea Gargas, Andrea Poehling, Andrea Taylor, Angie Ziobro, Ann Dassow, B. Binkart, B. Hansen, B. Poulter, Barb Newmann, Barbara Olson, Beth Mittermaier, Beverly Harper, Bob Holzrichter, Bob Momper, Bob Schmidt, Bob Wannemaker, Brenda DeBruyn, Bryn Sriver, C Seabul, Carl Jensen, Carrie Nelson, Caryn Treiber, Casey Garcia, Cathy Chybowski, Chuck Kilpatrick, Colin Meyer, Cooper, Coretta, Courtney Wright, Criss Sriver, D. Buckler, D. Hansen, Dan Barron, Dave Blink, Dave Leifeit, David Herrewig, Deb Moran, Deb Nichols, Dennis, Diane Dempsey, Dolly McNulty, Don DeBruyn, Don Pearce, DonDeBruyn, Doug Goetzinger, E. Breffle, E. Kenny, E. Marshall, Elise Myers, Emily Brown, Emma Pelton, Erica Groelle, Ethan Scott, Fritz Wotruba, G Schneider, Gabe Ziskin, Gina Auel, Grace Johns, Gwen Baker, Hazel Schmidt, HKO, Holly Hanson, HS, Isaiah Ripp, Izzy, J Westwater, J. Besharse, J. Catalano, J. Earl, J. Hess, J. Nickels, J. Thompson, J. Tutkowski, Jackie Davis, Jackie Schroeder, Jan Axleson, Janet Battista, Janet Carter, Jarron Biebl, JDO, Jeanette Kelly, Jen Bruening, Jeni Powell, Jill Dickson, Jim, Jim Knickelbine, JO, Joey Biebl, John Alt, John Blum, John Chancellor, John Elanpt, John Moran, Jon Motquin, Jordan Just, Josh Soine, K. Corey, K. Frye, Karn Hermansen, K. Lorbiecki, Karen Kipatrick, Karla Wotruba, Katrina Skong, Ken Damro, Kennedy Gilchrist, Kristi Lund, Kyriaki Chatzikyirakibou, L. Hansen, L. Russel, Lauren Snell, Leah Keefe, Leanna, Levi Wood, Lindsay Browne, Lindsay Meyer, M. Erie, M. Nickels, M. Wayner, Maria Benz, Mark Hess, Mary Elanpt, McGrath, Meg La Pointe, Meg O'Brien, Melissa Evatt, Meri DeGarmo, Mike Austin, Mitch Erie, Mitchel Berg, Mitchell LEDwith, Mollie Schmidt, Mom Chojnacki, Moriah Tobin, N. Leigh, Naomi Benz, Nick Bossenbroek, Nick Nichols, Nilssen Lund, Noah Meyer, Stanga, Oliver Garcia, PA, Pam Russell, Paul Kaarakka, Paul Lundspen, R. Newbauer, Rebecca Berg, Reed Urban, Robin Cornell, Rori Paloski, Rosa Blum, Russ Biebl, S. Minstuck, S. Nickels, Sam Clary, Scott Dibble, Scott Small, Sergio, Sherlene Schmidt, Slone, Sue Eiler, Sue Holloway, Sue Weinauer, Susan Casey, T. Earl, Tammy Ruggaber, Terry Konsela, Tim Leigh, Thomas Moore, Tom Gratz, Tom Olson, Wayne Russell, 20 volunteers, 3 Giles-Pufahl Family, 5 boy scouts (w/Kevin Nolan), 41 program participants, 5 Conserve School Students, 5 Coulee Region Audubon Society, 5 et al (Lorbiecki), 5 Homeschool Group, 5 program participants, 5 Students and 5 et al.