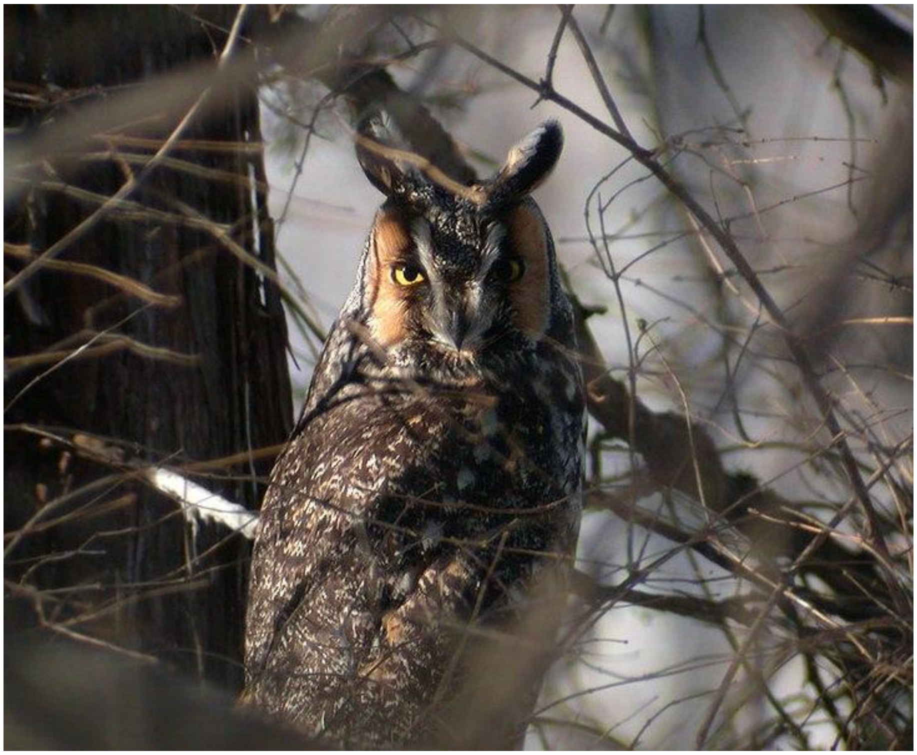
WESTERN GREAT LAKES REGION

OWL SURVEY

2012 Report



David A. Grosshuesch — Hawk Ridge Bird Observatory

Ryan S. Brady — Wisconsin Bird Conservation Initiative

Prepared for

Minnesota Dept. of Natural Resources – Nongame Region 2
Wisconsin Dept. of Natural Resources – Wildlife Management

February 2013

HRBO: P.O. Box 3006, Duluth, MN 55803, www.HawkRidge.org *WBCI: www.wisconsinbirds.org*

TABLE OF CONTENTS

Cover photo: Long-eared Owl
Photo credit: Mike McDowell, *www.birddigiscoper.com*

LIST OF TABLES

LIST OF FIGURES

2012 WESTERN GREAT LAKES REGION OWL SURVEY

EXECUTIVE SUMMARY

As top predators of the food chain, owls are considered good indicators of environmental health, making them important to monitor. However, there is a paucity of abundance and population status data available for most species of owls in the western Great Lakes region. Currently, few species of owls are adequately monitored using traditional avian survey methods, such as the Breeding Bird Survey (BBS) and Christmas Bird Counts (CBC). For these reasons, the Western Great Lakes Region Owl Survey was initiated in 2005. The objectives of this survey are to: 1) understand the distribution and abundance of owl species in the region, 2) determine trends in the relative abundance of owls in the region, 3) determine if trends are comparable in surrounding areas and analyze whether these trends could be scaled up or down on the landscape, and 4) determine if there are habitat associations of owl species in the region.

This was the eighth year of a collaborative effort between personnel from the Hawk Ridge Bird Observatory (HRBO), Natural Resources Research Institute (NRRI), MN-Dept. of Nat. Res. (MN-DNR), Wisconsin Bird Conservation Initiative (WBCI), and the WI-Dept. of Nat. Res. (WI-DNR) to monitor owl populations in the western Great Lakes region. Existing survey routes were used to conduct roadside surveys in Minnesota and Wisconsin. In 2012, surveys were conducted between April 1 and April 15. All survey routes were randomly chosen and consisted of 10 survey points spaced ~1.6 km (1 mile) apart. There was a 5 minute passive listening period at each designated survey point along the route.

The number of routes assigned in 2012 was 173, with 85 in Minnesota and 88 in Wisconsin. Of the assigned routes, 63 and 77 routes were surveyed in Minnesota and Wisconsin, respectively. The number of participants that signed up to conduct an owl survey was 146, with 118 volunteers (81%) returning completed survey sheets.

In total, 314 owls of seven species were recorded on 100 routes, with no owls recorded on 40 routes. The top three owl species combined for Minnesota and Wisconsin were Barred Owl, Great Horned Owl, and Northern Saw-whet Owl, respectively. In Minnesota, a total of 156 individual owls comprising six species were recorded. The mean number of owls/route was 2.48 compared to 2.13 in 2011. In Wisconsin, a total of 158 individual owls comprising six species were recorded. The mean number of owls/route was 2.05 compared to 2.21 in 2011.

Recommendations and future perspectives for the Western Great Lakes Region Owl Survey include: 1) centralize storage of all data collected to date into the newly-created Midwest Avian Data Center, 2) develop an on-line data entry system, 3) conduct analysis of owl habitat associations, detectability, climatic variables influencing owl calling activity, and power of the current survey to detect population trends, and 4) evaluate current survey methods and objectives to determine if modifications are needed to better inform resource managers, enhance volunteer experiences, and monitor owl populations.

INTRODUCTION

There is increasing concern about the distribution, population status, and habitat loss for both diurnal and nocturnal raptors (Newton 1979, Gutierrez *et al*. 1984, Wellicome 1997, Takats *et al*. 2001). Birds of prey occupy the top of the food chain and may be susceptible to environmental toxins and contaminants, making them important to monitor as indicators of environmental health (Johnson 1987, James *et al*. 1995, Duncan and Kearns 1997, Francis and Bradstreet 1997). Further understanding of the distribution, relative abundance, and density of wildlife populations would be valuable to make sound management decisions (Mosher and Fuller 1996).

Currently, there is a paucity of abundance and population status information available for most owl species in the western Great Lakes region. Due to their nocturnal behavior and time of breeding, owls often go undetected using traditional avian population monitoring methods (e.g. Breeding Bird Survey routes, Breeding Bird Atlases, Christmas Bird Counts, and migration monitoring). Breeding Bird Surveys and Breeding Bird Atlases are conducted in the morning, when few owls are vocal, and occur after the breeding season for most owl species in North America. Christmas Bird Counts are also done outside of the breeding season and may not detect resident owl species. Migration monitoring can be a viable alternative method to monitor owl populations, but it may not be suitable to detect all owl species or determine reliable trends. Therefore, a large scale, long-term owl survey in the Western Great Lakes region would be beneficial to monitor owl populations.

In 2012, the HRBO and WBCI, in collaboration with the NRRI, MN-DNR, and WI-DNR, coordinated the eighth year of a volunteer-based roadside owl survey to monitor owl populations in the western Great Lakes region. Standardized methods developed by existing surveys in the United States and Canada were implemented to increase the statistical power to monitor owl population trends in North America (Takats *et al.* 2001, Hodgman and Gallo 2004, Monfils and Pearman 2004, Paulios 2005). The objectives of this survey are to: 1) understand the distribution and abundance of owl species in the region, 2) determine trends in the relative abundance of owls in the region, 3) determine if trends are comparable in surrounding areas and analyze whether these trends could be scaled up or down on the landscape, and 4) determine if there are habitat associations of owl species in the region.

This report summarizes the results of the 2012 Western Great Lakes Region Owl Survey conducted in Minnesota and Wisconsin, and briefly discusses a few recommendations and future perspectives.

METHODS

A standardized protocol, developed in 2005 from currently existing owl survey protocols, was used in 2012 to conduct a volunteer-based roadside survey in Minnesota and Wisconsin. The use of standardized methods to monitor owl populations will provide comparable data throughout North America (Morrell et al. 1991, Takats et al. 2001).

CURRENT PROTOCOL

In both Minnesota and Wisconsin, each survey route consisted of 10 survey stations spaced ~1.6 km (1 mile) apart. A 5 minute "passive" listening period was done at each station, with data for each owl recorded at one-minute intervals, which will be used to test detection probabilities. Playbacks were not used given the logistical and standardization concerns with broadcast equipment.

At the start and finish of an owl survey route, the temperature, cloud cover, precipitation level and type, and snow cover and depth was recorded. At each survey station, the time, wind speed, and noise level was recorded. Volunteers were asked to record each owl detected on the data sheet, including direction (Azimuth bearing) and estimated distance [Categories = 1) ≤ 100 m, 2) > 100 m to 500 m, 3) >500 m to 1000 m, 4) >1000 to 1500 m, and 5) >1500 m]. Additionally, volunteers were asked to record the time interval when each owl detected was heard (e.g. in first minute, second minute, third minute, etc.). Volunteers were asked to conduct surveys on days with minimal wind (≤ 25 km/hr) and little or no precipitation.

SURVEY TIMING

Minnesota and Wisconsin. The owl survey period went from April 1 to April 15. Surveys started at least one half-hour after sunset and finished when the volunteer completed the route(s), typically taking 1.5 to 2 hours to complete. Likely due to convenience, most but not all observers conducted surveys in the first half of the night between 8pm and midnight.

ROUTE SELECTION

Minnesota. Owl surveys were conducted along currently existing randomized routes. The MN-DNR Frog/Toad survey routes were used as the base to conduct owl surveys. There are ~138 Frog/Toad survey routes randomly located in a variety of habitat types throughout Minnesota. The start point for the owl survey route corresponded with the start point of the Frog/Toad route.

Additionally, the 31 routes first identified in the Laurentian Forest Province of Minnesota in 2006 were again used in 2012. These routes were randomly selected implementing the same protocol used to identify the initial Frog/Toad survey routes. There are currently 82 survey routes in the Laurentian Forest Province of Minnesota and 87 routes throughout the remainder of southern and western Minnesota.

Wisconsin. Owl surveys were conducted along randomized Breeding Bird Survey (BBS) routes. There are 92 active BBS routes located in a variety of habitat types throughout the state. The start point for the owl survey route corresponded with the start points of the BBS route.

DATA COLLECTION/ANALYSIS AND DATABASE STRUCTURE

Data collection/analysis. Volunteers were asked to record all owls detected, seen or heard, at each designated station along the route, keeping track of the direction and estimated distance for each owl**.** Additionally, participants were asked to document the time interval for each owl detected during the 5 minute listening period (e.g. first minute, second minute, third minute, etc.). The number of owls for each route was determined by eliminating any birds a participant detected from a previous station. Volunteers were requested to record other nocturnal species, such as American Woodcock, Wilson's Snipe, and Ruffed Grouse, detected on survey routes.

Database structure. Data collected by volunteers were computerized into a Microsoft Excel database. The data were separated into three database files which included: 1) general survey data (including overall weather data), 2) station survey data (including station weather and additional species data), and 3) owl data.

RESULTS

VOLUNTEER PARTICIPATION

In 2012, 146 volunteers signed up to conduct owl surveys in Minnesota and Wisconsin, with 118 participants (81%) surveying at least one route. In total, 173 survey routes were assigned to volunteers, with 85 in Minnesota and 88 in Wisconsin. In Minnesota, 55 volunteer teams returned data sheets for 63 routes. Forty-seven volunteer teams surveyed 1 route and 8 volunteer teams surveyed 2 routes. In Wisconsin, 63 volunteer teams returned data sheets for 77 routes. Fifty-four volunteer teams surveyed 1 route, six volunteer teams surveyed 2 routes, one volunteer team surveyed 3 routes, and two volunteer teams surveyed 4 routes.

SURVEY TIMING AND WEATHER

Minnesota. The date most surveys were completed in 2012 was 11 April (Table 1). The mean start and end temperatures for all routes was 43.4 °F and 39.1 °F, respectively. The mode average wind speed code, based on the Beaufort scale, for all routes was 0 (<1 mph). The mode average sky code for all routes was 0 (0 – 25% cloud cover).

Wisconsin. The date most surveys were completed in 2012 was 11 April (Table 1). The mean start and end temperatures for all routes was 42.6 °F and 38.6 °F, respectively. The mode average wind speed code, based on the Beaufort scale, for all routes was 0 (<1 mph). The mode average sky code for all routes was 0 (0 – 25% cloud cover).

Table 1. ***The mean or mode survey dates from 2005 – 2012 for Minnesota and Wisconsin. The number of survey periods was reduced from three to one period in 2008.***

	Minnesota			Wisconsin		
Year	**1**	**2**	**3**	**1**	**2**	**3**
2005	17 March	4 April	19 April	—	4 April	20 April
2006	16 March	1 April	18 April	17 March	31 March	18 April
2007	14 March	1 April	17 April	14 March	30 March	18 April
2008		10 April			11 April	
2009		10 April			9 April	
2010		8 April			9 April	
2011		8 April[1]			6 April[1]	
2012		11 April[1]			11 April[1]	

[1] = Mode average survey date.

OWL ABUNDANCE AND DISTRIBUTION

In total, 314 owls of seven species were recorded on 100 routes, with no owls being detected on 40 routes (Table 2). The top five owl species combined between Minnesota and Wisconsin were Barred Owl, Great Horned Owl, Northern Saw-whet Owl, Eastern Screech Owl, and Long-eared Owl, respectively. The overall mean number of individual owls detected per route was 2.24 compared to 2.17 in 2011. The overall mean number of Barred Owls detected per route increased by 15% compared to 2011 (0.91 to 1.05 owls/route). The overall mean number of Great Horned Owls detected per route remained the same compared to 2011 (0.51 owls/route). The overall mean number of Northern Saw-whet Owls detected per route decreased by 20% compared to 2011 (0.50 to 0.41 owls/route). The overall mean number of Eastern Screech Owls detected per route remained the same compared to 2011 (0.11 owls/route). Finally, the overall mean number of Long-eared Owls decreased by 14% compared to 2011 (0.07 to 0.06 owls/route).

Table 2. ***Total number of individual owls and the number of routes each species was detected in Minnesota and Wisconsin, 2012.***

	Minnesota		Wisconsin	
Owl Species	**Individuals**	**Routes**	**Individuals**	**Routes**
Barred Owl	65	21	82	38
Great Horned Owl	35	21	36	18
Northern Saw-whet Owl	40	20	17	15
Eastern Screech Owl	1	1	15	12
Long-eared Owl	5	5	3	2
Short-eared Owl	0	0	2	2
Great Gray Owl	2	2	0	0
Unknown Owl	6	3	3	3
Total	156	43[1]	158	57[2]

[1] = total number of routes with at least one owl detected in Minnesota.
[2] = total number of routes with at least one owl detected in Wisconsin.

Minnesota. A total of 156 individual owls comprising six species were recorded during all surveys (Table 3). The top three species detected in Minnesota were Barred Owl, N. Saw-whet Owl, and Great Horned Owl, respectively. The mean for Barred Owls was 1.03 owls/route, which was a 37% increase compared to the 2011 total (Figure 4). The mean for N. Saw-whet Owls was 0.63 owls/route, which was a 12% decrease compared to 2011 total (Figure 6). The mean for Great Horned Owls was 0.56 owls/route and represents a 30% increase compared to 2011 (Figure 5). The number of individual owls detected during a survey ranged between 1 and 12, comprising between 1 and 4 species. The mean number of owls/route went up 16% compared to 2011 (2.13 to 2.48 owls/route). The 2012 overall mean of 2.48 owls/route was a new high compared to the eight seasons of data collected thus far, representing a 14% increase compared to the previous high in 2006 (2.17 owls/route; Figure 9).

Barred Owls were detected in 13 counties (Figure 1), Northern Saw-whet Owls in 9 counties (Figure 3), and Great Horned Owls in 16 counties (Figure 2). Long-eared Owls were detected in four counties including: Aitkin, Houston, Roseau, and St. Louis. Great Gray Owls were detected in two counties including: Lake and St. Louis. Eastern Screech Owl was detected only in Goodhue County.

Wisconsin. A total of 158 individual owls comprising six species were recorded during all surveys (Table 2). As in most years, the top three species detected in Wisconsin were Barred Owl, Great Horned Owl, and Northern Saw-whet Owl, respectively. The mean for Barred Owls was 1.06 owls/route (Table 3), which was a 5% decrease compared to 2011 (Figure 1). The overall mean for Great Horned Owls was 0.47 owls/route (Table 3), representing a 22% decrease compared to 2011 (Figure 2). The overall mean for N. Saw-whet Owls was 0.22 owls/route (Table 3), which was a 12% decrease compared to 2011 (Figure 3). The number of individual owls/route detected ranged from 1 to 10, comprising between 1 and 5 species. The overall mean number of owls/route decreased by 7% compared to 2011 (2.21 to 2.05 owls/route) (Figure 6).

Barred Owls were detected in 30 counties (Figure 1), Great Horned Owls in 14 counties (Figure 2), and Northern Saw-whet Owls in 13 counties (Figure 3). Eastern Screech Owls were detected in ten counties including: Crawford, Dodge, Door, Dunn, Fond du Lac, Jackson, Kenosha, Lafayette, Monroe, and Sauk. Long-eared Owls were detected in two counties including: Jackson and Lafayette. Short-eared Owls were detected in two counties including: Grant and Taylor.

Table 3. ***The number of owls observed and mean number of owls/route for Minnesota and Wisconsin, 2012.***

			Barred Owl		Great Horned Owl		N. Saw-whet Owl		E. Screech Owl		Long-eared Owl	
Region	**Date**	**# Routes[a]**	**# Obs.[b]**	**Mean[c]**	**# Obs.**	**Mean**	**# Obs.**	**Mean**	**# Obs.**	**Mean**	**# Obs.[d]**	**Mean**
Minnesota	April 1 – 15	63	65	1.03	35	0.56	40	0.63	1	0.02	5	0.08
Wisconsin	April 1 – 15	77	82	1.06	36	0.47	17	0.22	15	0.19	3	0.04
Overall	April 1 – 15	140	147	1.05	71	0.51	57	0.41	16	0.11	8	0.06

[a] Number of routes surveyed between survey date.
[b] Number of owls detected.
[c] Average number of owls detected per route surveyed.

Table 3 (continued). ***The number of owls observed and mean number of owls/route for Minnesota and Wisconsin, 2012.***

			Short-eared Owl		Great Gray Owl		Total	
		# Routes[a]	# Obs.[b]	Mean[c]	# Obs.	Mean	# Obs.[d]	Mean
Minnesota	April 1 – 15	63	0	0.0	2	0.03	156	2.48
Wisconsin	April 1 – 15	77	2	0.03	0	0.0	158	2.05
Overall	April 1 – 15	140	2	0.01	2	0.01	314	2.24

[d]Total # observed includes 8 and 3 unknown owl species in MN and WI, respectively.

ADDITIONAL SPECIES

Volunteers recorded a variety of additional non-target birds and wildlife while conducting owl surveys. In both Minnesota and Wisconsin, the most abundant among these were American Woodcock, Ruffed Grouse, and Wilson's Snipe (Table 4).

Table 4. ***Top three additional species detected during owl surveys in Minnesota and Wisconsin, 2012.***

Minnesota		Wisconsin	
Species	**Total**	**Species**	**Total**
American Woodcock	146	American Woodcock	145
Wilson's Snipe	139	Ruffed Grouse	70
Ruffed Grouse	58	Wilson's Snipe	56

DISCUSSION

The 2012 Western Great Lakes Region Owl Survey was another good one. The overall mean number of owls per route for both states (2.24) marked a record high, barely besting the 2011 mark of 2.17. Minnesota saw a 14% increase in detections versus a 7% decline across the border in Wisconsin. The former's increase largely resulted from 37% and 30% increases in Barred and Great Horned Owls, respectively. Meanwhile, Wisconsin saw 5% and 22% decreases in these same species, possibly related to phenological difference in survey routes between the two states. Great Horned Owls are early breeders and may have become relatively quiet in southern Wisconsin by the April survey period. In both states, N. Saw-whet Owls continued modest decreases toward their cyclical lows following a peak in 2010. Eastern Screech Owl made an excellent showing in Wisconsin with a record-high 15 individuals detected, supporting an apparent increase in this species over the survey's 8-year history (Figure 7).

Explaining causes for such annual patterns requires caution as a variety of factors can influence the number of owl detections in a given year. For example, it's possible the owl population truly increased or decreased in number, which may be related to a decrease in available habitat, more abundant prey populations, or other variables. However, another possibility is not a change in numbers but a change in detectability, i.e. the likelihood that an owl calls and we are able to hear it. Calling activity may be affected by time of year, time of night, various weather conditions, and a host of other factors, many of which remain poorly understood. Hearing owls may be affected by observer ability, wind, and other external noise sources, such as frogs, traffic, etc.

The Western Great Lakes Region Owl Survey is designed to account for changes in detectability by controlling for some of these variables (e.g. time of year) and quantifying others for use as covariates in analyses. For example, one can calculate probabilities of detections using data from the five 1-minute listening intervals. These detection probabilities are then incorporated into population indices to provide more accurate assessments of relative abundance and population trends (Pollock et al. 2002). Ultimately, the goal of the survey is to detect long-term changes in population trends, which is best achieved with 10+ years of survey data. Fortunately, with hundreds of volunteers annually, there is a solid base of citizen scientists interested in collecting survey data, and after another few years of data we should be able to start assessing population trends while accounting for these detectability issues.

Partners in the Western Great Lakes Region Owl Survey also received a grant to conduct detailed analyses of all years' data prior to the 2014 field season. This analysis is ongoing and will include calculations of detection probabilities, assessment of variables affecting detectability (e.g. time of year, count duration, number of survey replicates, etc.), a power analysis to determine the level of survey effort required to detect trends, and a revised evaluation of population indices and trends. In addition, we hope to pursue habitat analyses to investigate habitat associations of owls and help to address management questions for some species. Results of all analyses will be used to adjust survey design to adequately meet survey objectives and engage land managers in hopes of providing them the information they need to better manage and conserve owls.

In addition, data gathered to date shows the statistical power using current survey methods remains low for uncommon or hard-to-detect species such as Eastern Screech Owl, Long-eared Owl, Short-eared Owl, Great Gray Owl, and Boreal Owl. We plan to assess this in at least two ways:

1. We are planning to pilot the use of playback/broadcast for these species. The current survey protocol would remain unchanged, but the addition of playback after completing a survey or along designated survey routes should increase detections of these species and provide more accurate information about their distribution and abundance. For example, the Monitoring of Owls and Nightjars in Illinois (http://www.inhs.illinois.edu/research/MOON/) has significantly increased detections of E. Screech-Owls through the use of conspecific playback.

2. Populations of these species may be monitored on a regional level (Western Great Lakes) if other states joined MN and WI in conducting standardized owl surveys. Fortunately, this effort is gaining momentum as Illinois recently completed a fifth year of nocturnal bird surveys and Michigan began surveys in 2011. With standardized methods in place, these data can be synthesized for efficient large-scale analyses, including these less common, hard-to-detect species. All of this work is united through an active Midwest Nocturnal Bird Monitoring Working Group, spearheaded by USFWS biologist Katie Koch, who is coordinator of the Midwest Coordinated Bird Monitoring Partnership (http://midwestbirdmonitoring.ning.com/).

Finally, the development of a nightjar (Common Nighthawk, Whip-poor-wills) survey in Wisconsin, where surveys are conducted from late May to early July, allows surveyors to also record owls. This data may be used to supplement results and interpretation of the spring owl survey, which will provide increased confidence in our conclusions.

RECOMMENDATIONS AND FUTURE GOALS

1. We will complete analyses of detection probability, power, climatic influences on calling activity, and possibly habitat associations prior to the 2014 field season. Results may lead to adjusted protocols in order to best meet the survey's monitoring goals. These goals are also being revised as needed by the Midwest Nocturnal Bird Monitoring Group based on discussions initiated at an August 2012 regional coordinated bird monitoring conference in Milwaukee.

2. In 2013, we plan to upload all data into the newly-formly Midwest Avian Data Center, which will centralize and permanently archive all data in the Avian Knowledge Network.

3. Wisconsin plans to pilot a web-based data entry system in 2013. Volunteers will enter their own data via the same website in which they sign up for routes, view protocols, print datasheets, etc.
4. We would like to increase the number of participants conducting surveys in southern and western Minnesota. To achieve this we will contact and recruit volunteers well in advance of the looming survey period.

5. As future data continues to be collected, a trend analysis will be done to determine changes in owl populations.

6. Pilot the use of playback for species of interest.

7. Lastly, it would be valuable to collect data on small mammal populations. Currently, limited small mammal data is available, but it may prove valuable to include such information when interpreting trend abundance and distribution data. In the future, it may be possible to work collaboratively with other resource organizations collecting such data.

ACKNOWLEDGMENTS

Thanks to the Minnesota Dept. of Natural Resources for funding this project, and the Wisconsin Bird Conservation Initiative for taking over volunteer coordination in Wisconsin and providing on-line training/certification. Thanks to Jerry Niemi, of NRRI, for providing logistical support. Thanks to Ron Regal, of the Univ. of MN-Duluth, for helping with database formatting and statistical analysis. Thanks to Rich Baker, of the MN-DNR, for providing information and maps for MFTCS routes throughout Minnesota. Thanks to Debbie Waters, of HRBO, for helping with website logistics in MN, and Jill Rosenberg (WI-DNR) for website development in Wisconsin. Finally, special thanks to Julie O'Connor, of HRBO, for helping with logistics and volunteer recruitment and coordination in Minnesota.

Most importantly, we would like to thank the volunteers that made this project possible! Participants deserve special thanks for generously donating their time and money driving many miles to conduct owl surveys. The amount of energy and enthusiasm volunteers expressed is greatly appreciated, and it will surely help with the continuation of this survey! Thanks again for your dedication in providing valuable information about owls in the western Great Lakes region.

LITERATURE CITED

Duncan, J.R. and A. E. Kearns. 1997. Habitat association with barred owl (*Strix varia*) locations in southeastern Manitoba: a review of a habitat model. In: Biology and Conservation of Owls of the Northern Hemisphere by J.R. Duncan, D.H. Johnson, and T.H. Nicholls (eds.). USDA Forest Service General Technical Report NC-190. Pp. 138-147.

Francis, C.M. and M.S.W. Bradstreet. 1997. Monitoring Boreal Forest Owls in Ontario using Tape Playback Surveys with Volunteers. In: Biology and Conservation of Owls of the Northern Hemisphere by J.R. Duncan, D.H. Johnson, and T.H. Nicholls (eds.). USDA Forest Service General Technical Report NC-190. Pp. 175-184.

Gutierrez, R.J., D.M. Solis, and C. Sisco. 1984. Habitat ecology of the spotted owl in northwestern California: implications of management. Proceedings of the Society of American Foresters 1983. Pp. 368-373.

Hodgman, T.P. and S.M. Gallo. 2004. Conservation Status and Volunteer Monitoring of Maine Owl Populations. Annual report, Maine Outdoor Heritage Fund. Pp. 16.

James, P.C., K.M. Mazur, and S.D. Frith. 1995. The barred owl as an indicator of old forest and its role in long-term forestry planning. Annual report, Saskatchewan Environment and Resource Management. 27pp.

Johnson, D.H. 1987. Barred owls and nest boxes: results of a five-year study in Minnesota. In: Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 129-134.

Monfils, M.J. and P.B. Pearman. 2004. Woodland Owl Surveys in Support of the Michigan Breeding Bird Atlas II: Distribution, Abundance, and Survey Effectiveness. Annual report, Michigan Dept. of Nat. Resources-Wildlife Division, Natural Heritage Program. 40 Pp.

Morrell, T.M. R.H. Yahner, and W.L. Harkness. 1991. Factors affecting detection of Great Horned Owls by using broadcast vocalizations. Wildlife Society Bulletin 19(4): 481-488.

Mosher, J.A. and M.R. Fuller. 1996. Surveying woodland hawks with broadcasts of Great Horned Owl vocalizations. Wildlife Society Bulletin 24(3): 531-536.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD. Pp. 13-17.

Paulios, A. 2005. Habitat Selection and Distribution of Owls in the Nicolet National Forest, WI, USA. M.S. Thesis. University of Wisconsin, Green Bay.

Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey, J.R. Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13: 105-119.

Takats, D.S., D.L., C.M. Francis, G.L. Holroyd, J.R. Duncan, K.M. Mazur, R.J. Cannings, W. Harris, D. Holt. 2001. Guidelines for Nocturnal Owl Monitoring in North America. Beaverhill Bird Observatory and Bird Studies Canada, Edmonton, Alberta. 32 pp.

Wellicome, T. 1997. Status of the burrowing owl (*Speotyto cunucularia hypugaea*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 11. 21 pp.

Figure 1: Distribution and abundance of Barred Owls for MN and WI in 2012.

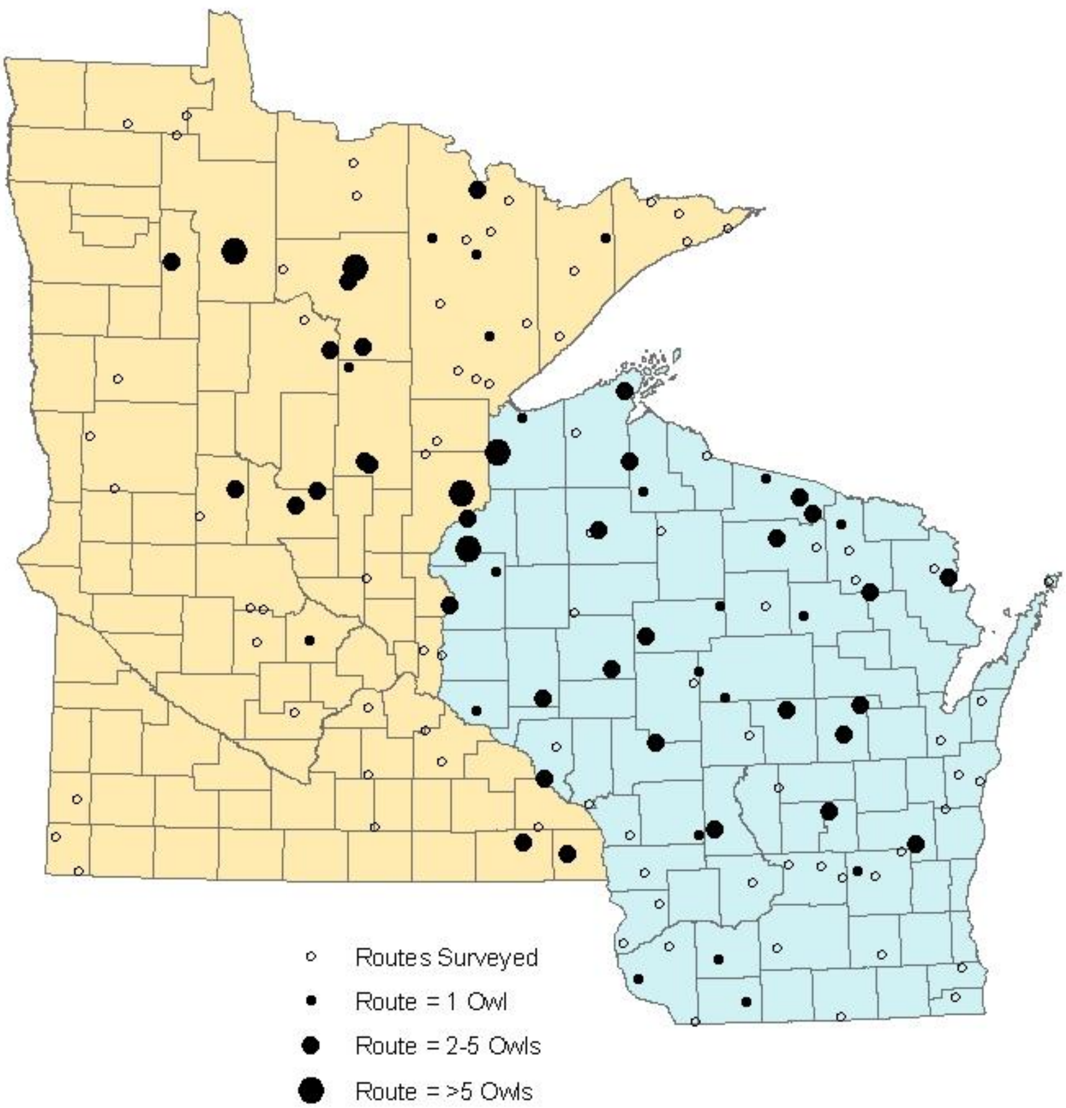


Figure 2: Distribution and abundance of Great Horned Owls for MN and WI in 2012.

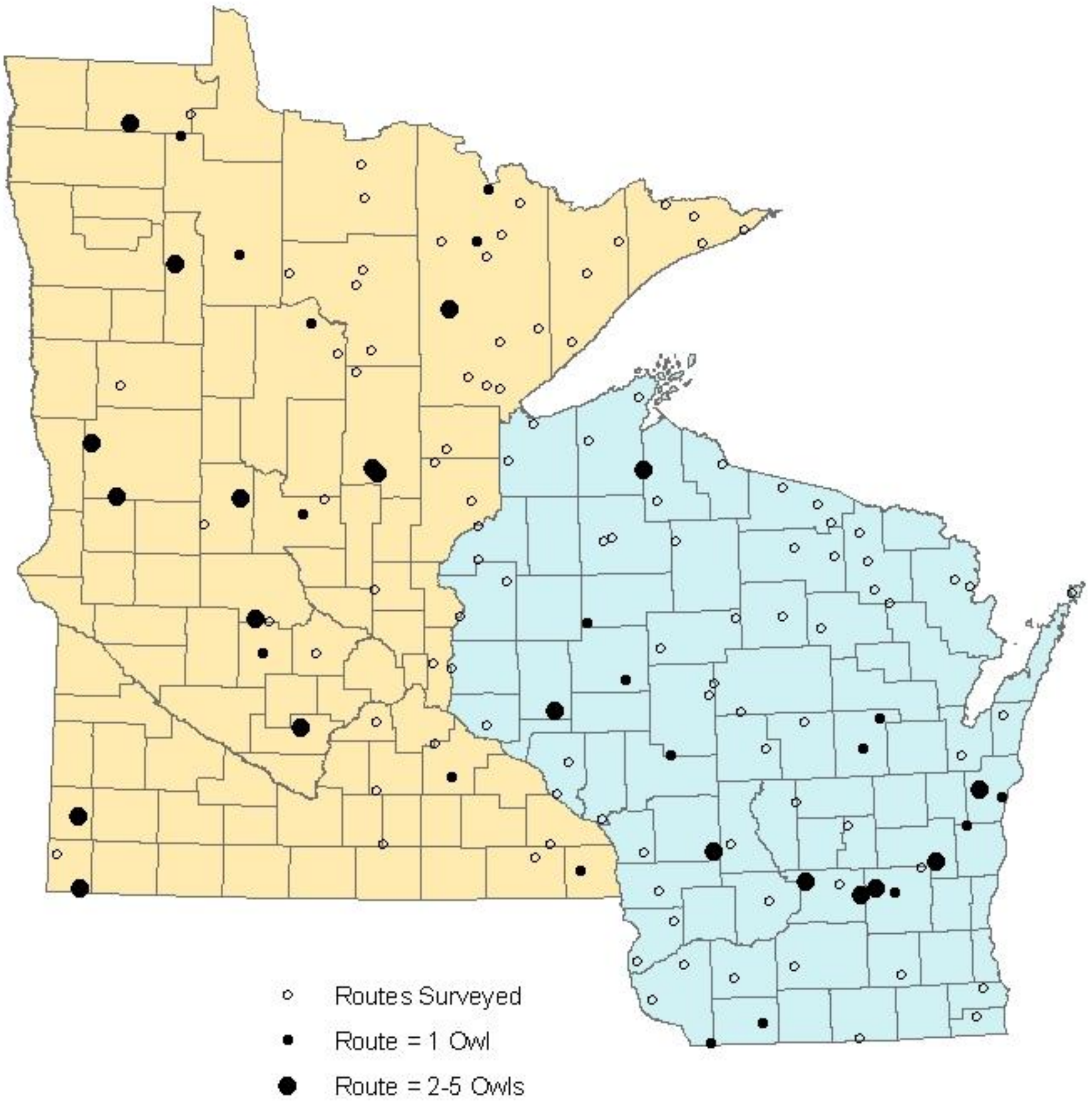


Figure 3: Distribution and abundance of N. Saw-whet Owls for MN and WI in 2012.

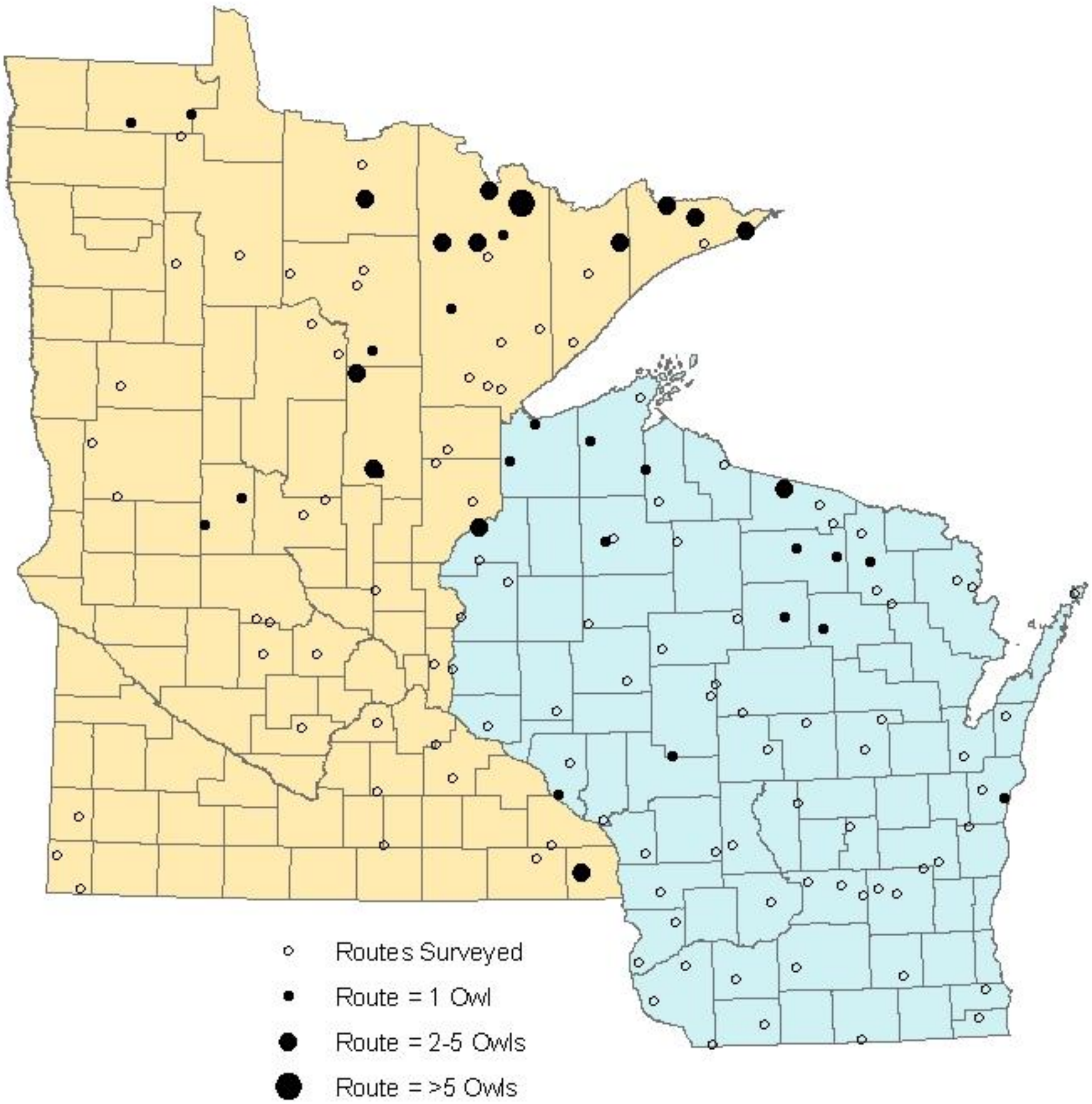


Figure 4: Mean # Barred owls/route for Minnesota and Wisconsin, 2005 - 2012.

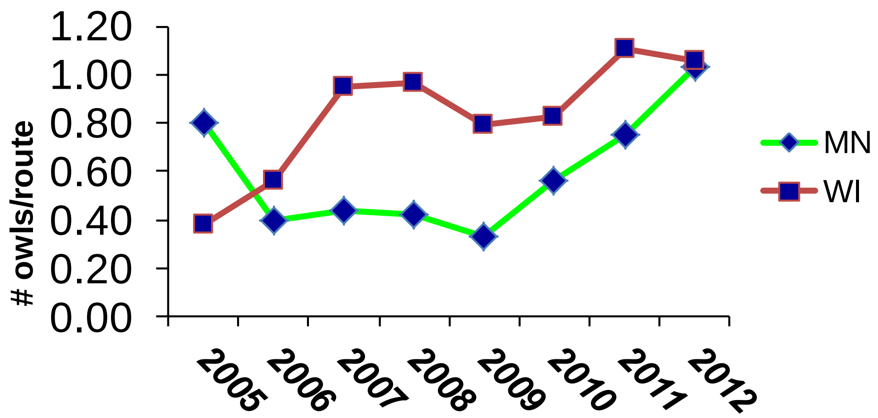


Figure 5: Mean # Great Horned owls/route for Minnesota and Wisconsin, 2005 - 2012.

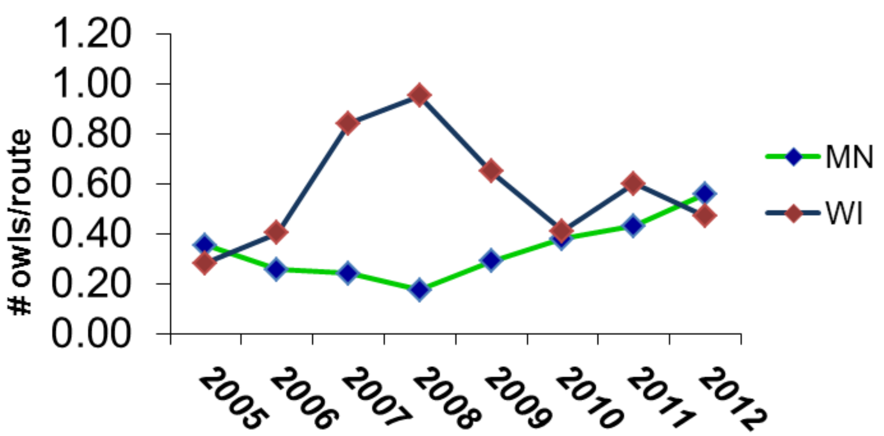


Figure 6: Mean # N. Saw-whet owls/route for Minnesota and Wisconsin, 2005 - 2012.

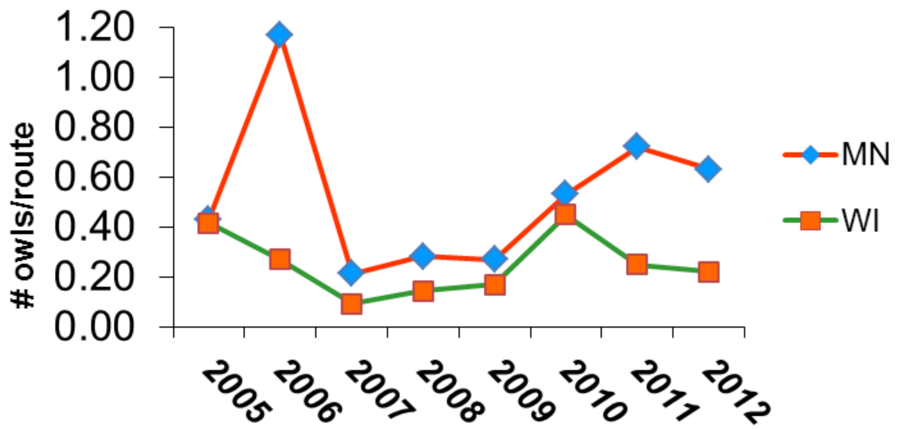


Figure 7: Mean # E. Screech owls/route for Minnesota and Wisconsin, 2005 - 2012.

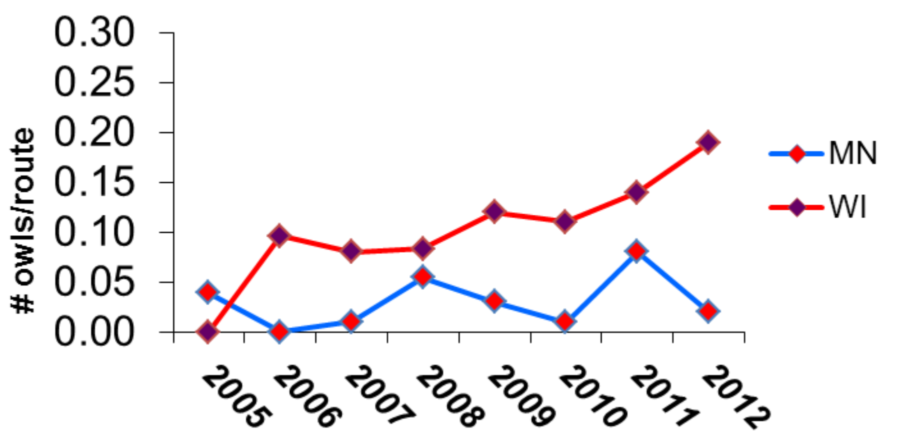


Figure 8: Mean # Long-eared owls/route for Minnesota and Wisconsin, 2005 - 2012.

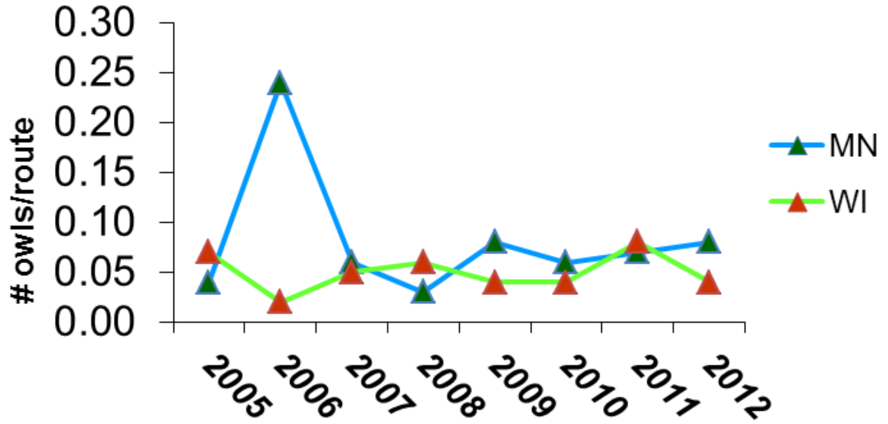


Figure 9: Overall mean # owls/route for Minnesota and Wisconsin, 2005 - 2012.