



2009 Small Mammal Survey Report

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Technical Report Number 10-04
March 2010

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Introduction

The goal of the small mammal survey is to track trends in small mammal (mice, voles, shrews, etc.) populations within the forested and transition zones of northern Minnesota (Figure 1). These trends are important pieces of data that can contribute to the understanding of population fluctuations of a variety of game and nongame wildlife (terrestrial and avian). The small mammal survey was initially created to help explain trends in the pine marten (*Martes americana*) population. It started with some localized small mammal monitoring efforts by Minnesota Department of Natural Resources wildlife staff in Grand Marais and Ely in the mid 1980's. By 1998, nine routes were being completed in northeastern Minnesota by four cooperators. The 1854 Treaty Authority volunteered to coordinate the survey beginning in 2000. A standardized protocol was designed with the help of existing cooperators as well as Bill Berg (retired DNR Wildlife Research Biologist), Gerda Nordquist (DNR Animal Survey Coordinator), and Don Christian (Associate Dean of Biological Sciences at the University of Montana).

Currently, the small mammal survey consists of 43 routes and 17 cooperators (Figure 1). Project collaborators include the Agassiz National Wildlife Refuge, 1854 Treaty Authority, Fond du Lac Community College, Fond du Lac Resource Management Division, Glacial Ridge National Wildlife Refuge, Grand Portage Natural Resource Management Division, Itasca Community College, Leech Lake Department of Natural Resources, Mille Lacs Department of Natural Resources, Minnesota Department of Natural Resources, Red Lake Department of Natural Resources, Red Lake Wildlife Management Area, Roseau River Wildlife Management Area, Rydell National Wildlife Refuge, Superior National Forest, Thief Lake Wildlife Management Area, and Vermilion Community College.

Methods

Materials

In order to standardize the small mammal survey, trapping kits were distributed to each collaborator. Victor M150 mice traps were chosen for the survey, due to the cost factor and ease of replacement for survey participants. Number 15 bonded nylon twine and seven-inch metal spikes were used to secure each trap.

Survey Procedures

Routes were to be completed between September 15 and October 20, if possible. Cooperators were asked to avoid three-day forecasts that predicted heavy precipitation, which would create an increase in tripped traps. Establishment of each route was to be determined by each surveyor. Habitat types were not specified, but were to be representative of each cooperator's work area. Each surveyor was to record percent canopy closure, overhead cover species, diameter at breast height, height, and understory species, as well as chipmunk (*Tamias spp.*) and red squirrel (*Tamiasciurus hudsonicus*) sightings and vocalizations for each transect.

Each route consisted of three transects spaced one or more miles apart. Each transect included 10 stations with two traps per station baited with peanut butter. The first station was placed 100 feet in from the right-of-way and the next four stations were placed at

50-foot intervals. Stations six through 10 were placed in a parallel line 50 feet to either the right or left of stations one through five. Each transect was flagged or recorded using a GPS unit so it could be found in future years. The trapline was checked for two consecutive mornings and then pulled on the last day. Species captured, trapnights, missing traps, and environmental information were recorded each day. Trapnights were recorded as follows: each empty, but triggered or broken trap or otherwise nonfunctional trap or any trap catching a nontarget (frog, bird, etc.) species counted as ½ of a trapnight. Any missing trap counted as a zero trapnight.

Population Index

A population index was developed for each species captured, except for masked shrews (*Sorex cinereus*) and pygmy shrews (*Microsorex spp.*), which were grouped together since they are difficult to distinguish between in the field. Each population index was calculated by taking the catch per unit effort (number of each species captured/total trapnights) X 100.

Habitat Types

Each transect was categorized as forested, grassland, brush or bog habitat, depending on percent canopy closure, overstory/understory species, and description. This was done to gain a more accurate individual species population index according to habitat types. For summary purposes, transects categorized as grassland, brush or bog habitat were combined into the grassland/brush category.

Results

Cooperators ran 25 of the 43 existing small mammal survey routes in 2009 and no additional routes were created (Figures 1 and 2). Routes were run between September 2 and October 20, 2009 (Table 1). One route was run prior to the survey start date of September 15. The 2009 survey period had a mean maximum daily temperature of 51 °F (range 23 to 79 °F) and mean minimum daily temperature of 35 °F (range 17 to 53 °F), with daytime temps greater than 70 °F occurring thru mid September.

As in recent years, routes took an average of 2.3 hours to set-up in 2009. During survey set-up, the mean number of chipmunks seen or heard nearly doubled to 0.32 per route in 2009 (Table 2), but was still below the nine-year average (2001-2009) of 0.45 chipmunks per route per year. The mean number of red squirrels observed during route set-up remained high (2.32) at near 2008 levels (Table 2), well above the long-term average of 1.69 red squirrels per route per year. No other small mammals were recorded as being seen or heard during route set-up in 2009.

Grassland/Brush Habitat

Ten (13%) transects were categorized as grassland/brush habitat in 2009 (Table 1). Five red squirrels and no chipmunks were heard/sighted along these transects during route set-up (Table 2). Overall, 16 total individuals, representing five species, were captured (Table 3). Red-backed voles (*Clethrionomys gapperi*) and meadow voles (*Microtus pennsylvanicus*) dominated the catch, with each species representing 31% of the total captures. Other small mammal species captured included short-tailed shrew (*Blarina brevicauda*, 19%), white-

footed deer mouse (*Peromyscus spp.*, 13%), and masked/pygmy shrew (6%). The total small mammal population index for grassland/brush habitat plunged from 23.51 in 2008 to 4.2 in 2009, the second lowest population index on record since 2002 (2.63). 2009 individual population indices reflected decreasing populations of the five most common small mammal species found in this habitat, with red-backed vole, meadow vole, and white-footed mouse populations plummeting by more than 80% in one year (Table 3, Figure 3).

Forested Habitat

Sixty-five (87%) transects were categorized as forested habitat in 2009 (Table 1), and a total of 53 red squirrels and eight chipmunks were seen or heard along these transects during route set-up (Table 2). Overall, 274 total individuals, representing seven species, were captured (Table 4). Red-backed voles (43%) and white-footed mice (38%) dominated the catch. Other species captured included short-tailed shrew (9%), meadow vole (6%), masked/pygmy shrew (2%), chipmunk spp. (2%) and a northern flying squirrel (*Glaucomys sabrinus*, <1%). While not included in this analysis, there was a report of a possible least shrew (*Cryptotis parva*) captured; however, this could not be substantiated due to a lack of specimen to examine. The total small mammal population index for forested habitat decreased 28% from 2008 to an all time low of 11.32 and was largely due to a 38% decline in the red-backed vole population index (Table 4, Figure 4).

Predator-Prey Relationships

Figure 5 compares the total small mammal population indices for forested transects with the percent of juvenile pine marten harvested during the 2001-2008 state trapping seasons (J. Erb, pers. comm.). 2009 pine marten harvest info was not available at the time this report was written. Red-backed vole population indices were also plotted, since this species is believed to be the primary food source of pine martens. In 2004 and 2007, notable population declines occurred concurrently in pine martens, total small mammals, and red-backed voles in 2007. Since 2007, the total small mammal population index for forested habitat has continued to decrease, mainly due to a reduction in white-footed mice in 2008 and a nearly 40% decline in the red-backed vole population in 2009. Assuming food is an important factor to the production of young pine martens and their survival, and in light of the further decline in the pine marten's small mammal prey base in 2009, particularly red-backed voles, it would be rational to hypothesize that fewer juvenile pine marten were likely available in 2009 to be trapped, due to reduced recruitment in the predator population.

Figure 6 compares the total small mammal population indices for forested transects with the ratio of juvenile to mother pine martens harvested during the 2001-2008 state trapping seasons (J. Erb, pers. comm.). As stated previously, 2009 harvest data was not available at the time this report was written. Like the percent of juvenile pine marten harvested, the ratio of juvenile to mother pine marten trapped (i.e. reproductive success) also dropped sharply (>80%) in 2007, followed by a slight increase in productivity in 2008 (presumably due to a stable supply of red-backed voles in the prey base). With the continued decline in the small mammal prey base, and in particular red-backed vole abundance, it is probable that pine marten reproductive success did not increase in 2009.

Figure 7 compares the total small mammal population indices for forested transects with the mean number of owls detected per route in the Laurentian Forest Province during the 2005-2009 spring surveys (Grosshuesch 2005-2009). Similar to their small mammal prey, northern saw-whet (*Aegolius acadicus*) and long-eared (*Asio otus*) owl numbers peaked in 2006, followed by decreasing population trends in 2007 and 2008. Due to the substantial irruption of great gray owls (*Strix nebulosa*) during winter 2004-2005, great gray detections were higher than expected in 2005 (Grosshuesch 2005). However, similar to the other two owl species, great gray numbers steadily declined in 2007 and 2008. The relationship between these owl species and their small mammal prey base becomes less clear in 2009 when long-eared and great gray owl abundance actually increased despite further declining populations of small mammals. The northern saw-whet owl population, on the other hand, appears to have decreased slightly in 2009, suggesting that this species may be more sensitive to the cyclical availability of its small mammal prey at the local scale than its nomadic cousins (Grosshuesch 2008).

Discussion

Considerable declines were evident in small mammal populations occupying grassland, brush or bog habitats during 2009, particularly red-backed voles, meadow voles, and white-footed mice. In fact, the total small mammal index plunged to the second lowest on record (2002 had lowest), despite hitting a population low just two years earlier in 2007 (5.57). One species, the arctic shrew (*Sorex arcticus*), typically present in small numbers in this habitat was not recorded at all, resulting in a species diversity value (five) slightly below the nine year average of six species detected. After a population low the previous year, 2008 survey results indicated a dramatic recovery of the small mammal population, mostly due to substantial recruitment by meadow voles and, to a lesser extent, red-backed voles in grassland/brush habitat. Based on past survey data and an expected three to five year microtine cycle, we would not have expected the meadow vole population to have fallen for another few years. Rather, the abrupt decline of the small mammal population in 2009 suggests that there are other variables working to depress this population (e.g. reduced food availability, greater predator abundance).

Similarly, declining small mammal populations were also observed in forested habitat during 2009. Since 2006, the total small mammal index for forested transects has been decreasing. This reduction appears to be influenced largely by population declines in the two most dominant species in this small mammal community, red-backed voles and white-footed mice. The red-backed vole population in forest habitat underwent a marked (56%) decline in 2004, but quickly recovered and stabilized through 2006. In 2007, the red-backed vole population decreased again, this time by about 35%, then remained relatively unchanged in 2008. In 2009, the red-backed vole population took another dive (38%), resulting in the second lowest annual population index (4.83) since 2004 (4.73). This combined with the lowest population index for white-footed mice on record (4.34) resulted in the lowest total small mammal index for forested habitat since the survey began in 2001. Based on the reduced density of small mammals living in forested habitat currently, we would expect that small mammal populations, such as the red-backed vole, should begin to increase over the next few years.

Fluctuations in small mammal abundance in forested areas seem to correlate reasonably well with pine marten productivity from 2001 to 2007. For example, total small mammal, red-backed vole, and pine marten indices simultaneously peaked around 2001 and 2006, and then dropped sharply in 2004 and 2007. While differences in the magnitude of these changes may be a function of the harvest data used (e.g. trapping effort, aging techniques), the paralleling trends between predator and prey suggest a positive correlation whereby prey availability affects the success of the predator population to breed and raise young. An interesting anomaly to this pattern occurred in 2008, when pine marten productivity increased slightly, however abundance of its primary prey, the red-backed vole, remained essentially the same as the previous year. 2009 pine marten harvest info was not available at the time this report was written, but based on another year of declining small mammal populations, particularly red-backed voles, it would seem unlikely that the percentage of juvenile pine marten trapped in 2009 would have increased. As the red-backed vole (and the total small mammal) population grows, we might also expect the proportion of juvenile martens harvested to increase, suggesting increased productivity in this predator population.

An organized spring owl monitoring survey began in the Laurentian Forest Province of northern Minnesota in 2005 and has since expanded to other parts of the state (Grosshuesch 2005-2009). This data set provides us with another opportunity to begin to investigate predator-prey relationships between owls and small mammals. From 2006 to 2008, steady declines of northern saw-whet, long-eared, and great gray owls paralleled trends in small mammal abundance, suggesting that these owl species may be heavily influenced by the cyclic dynamics of their small mammal prey. 2009 results, however, did not follow this pattern and highlight the need for longer data sets for both owls and small mammals to determine how sensitive these owl species are to local and regional fluctuations in small mammal abundance.

Recommendations & Future Directions

Since this coordinated effort to survey small mammals began in 2001, an average of 30 routes have been completed each year by project collaborators. Except for a few years, survey participation has gradually declined, and the past few years, survey participation has hovered around 25 survey routes completed (or 58% of the available routes). Renewed effort needs to be put into encouraging past participants to resume small mammal monitoring activities along established routes, while also recruiting new agency staff, individuals, or groups (e.g., students, raptor conservation groups) to create new survey routes, particularly in bog, grassland, and brush habitats where the least effort currently lies. As the small mammal data set expands in future years, more thorough time series analyses can be performed to further elucidate relationships among small mammal species and with their predators, particularly pine marten and owls.

Acknowledgements

I would like to thank the following cooperators and individuals for their assistance with the small mammal survey in 2009: Agassiz National Wildlife Refuge, Fond du Lac Reservation Resource Management Division, Grand Portage Reservation Natural Resource Management Division, Itasca Community College, Marshall County Central High School Ecology Class, Minnesota Department of Natural Resources, Red Lake Reservation Department of Natural Resources, Red Lake Wildlife Management Area, Roseau River Wildlife Management Area, Rydell National Wildlife Refuge, Superior National Forest, and Vermilion Community College, as well as John Erb from the Minnesota Department of Natural Resources for pine marten harvest data and 1854 Treaty Authority staff, particularly Andrew Edwards and Matt Weberg, for their assistance with survey work.

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Table 1: Summary of total trapnights, routes completed, transects, and route dates for 2001-2009.

Year	Total routes completed	Total trapnights	G/B trapnights	Forested trapnights	Total transects	Grassland/Brush/Bog	Forested	Route dates
2001	38	4235	582	3653	114	15	99	9/17/2001-10/24/2001
2002	33	3698.5	721.5	2977	99	19	80	9/16/2002-10/27/2002
2003	31	3412	461	2951	93	12	81	9/16/2003-10/18/2003
2004	30	3176.5	469	2707.5	90	13	77	9/15/2004-10/27/2004
2005	27	3004.5	555.5	2449	81	15	66	9/19/2005-10/19/2005
2006	32	3438.5	425	3013.5	96	13	83	9/19/2006-10/27/2006
2007	28	3104	467.5	2636.5	84	12	72	9/08/2007-10/17/2007
2008	24	2577	327.5	2249.5	72	9	63	9/12/2008-10/31/2008
2009	25	2801	380.5	2420.5	75	10	65	9/2/2009-10/20/2009

Table 2: Total and mean numbers for chipmunks and red squirrels heard or sighted during route set-up, 2001-2009.

Year	Total Chipmunks	Total Red Squirrels	Mean Chipmunks	Mean Red Squirrels
2001	31	41	0.82	1.08
2002	16	57	0.48	1.73
2003	6	50	0.19	1.61
2004	16	29	0.53	0.97
2005	26	44	0.96	1.63
2006	14	62	0.44	1.94
2007	5	44	0.18	1.57
2008	4	56	0.17	2.33
2009	8	58	0.32	2.32

Table 3: Small mammal index and numbers captured (N) in the grassland/brush/bog transects, 2001-2009.

Species Captured	2001 N	2001 Index	2002 N	2002 Index	2003 N	2003 Index	2003 N	2003 Index	2004 N	2004 Index	2005 N	2005 Index	2006 N	2006 Index	2007 N	2007 Index	2008 N	2008 Index	2009 N	2009 Index
Meadow vole (<i>Microtus pennsylvanicus</i>)	23	3.95	5	0.69	18	3.91	36	7.68	51	9.18	24	5.65	5	1.07	23	7.02	5	1.31		
White-footed mice (<i>Peromyscus spp.</i>)	13	2.23	5	0.69	20	4.34	0	0	9	1.52	9	2.12	7	1.5	9	2.75	2	0.53		
Short-tailed shrew (<i>Blarina brevicauda</i>)	3	0.52	1	0.14	5	1.09	1	0.21	7	1.26	7	1.65	2	0.43	4	1.22	3	0.79		
Red-backed vole (<i>Clethrionomys gapperi</i>)	5	0.86	6	0.83	14	3.04	6	1.28	32	5.76	6	1.41	12	2.57	26	7.94	5	1.31		
Masked/Pygmy shrew (<i>Sorex cinereus</i> / <i>Microsorex spp.</i>)	9	1.55	0	0	9	1.95	1	0.21	4	0.72	2	0.47	0	0	3	0.92	1	0.26		
Arctic shrew (<i>Sorex arcticus</i>)	1	0.17	0	0	2	0.43	3	0.64	2	0.36	1	0.24	0	0	12	3.66	0	0		
Meadow jumping mouse (<i>Zapus hudsonius</i>)	0	0	1	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Prairie vole (<i>Microtus ochrogaster</i>)	1	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Water shrew (<i>Sorex palustris</i>)	8	1.37	1	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Total number	63	10.82	19	2.63	68	14.76	47	10.02	105	18.8	49	11.54	26	5.57	77	23.51	16	4.2		
Total number of species	8		6		6		5		6		6		4		6		5			

Table 4: Small mammal index and numbers captured (N) in the forested transects, 2001-2009.

Species Captured	N	Index	N	Index	N	Index	N	Index	N	Index	N	Index	N	Index	N	Index	N	Index	
	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	
Red-backed vole	507	13.88	386	12.97	319	10.81	128	4.73	286	11.67	350	11.61	202	7.66	174	7.74	117	4.83	
(<i>Clethrionomys gapperi</i>)																			
White-footed mice	379	10.38	185	6.21	275	9.31	194	7.17	179	7.31	280	9.29	259	9.82	115	5.11	105	4.34	
(<i>Peromyscus spp.</i>)																			
Meadow vole	10	0.27	13	0.44	10	0.34	4	0.15	13	0.53	28	0.93	2	0.08	20	0.89	17	0.7	
(<i>Microtus pennsylvanicus</i>)																			
Short-tailed shrew	43	1.18	15	0.5	16	0.54	8	0.3	23	0.94	15	0.5	24	0.91	17	0.76	25	1.03	
(<i>Blarina brevicauda</i>)																			
Masked/Pygmy shrew	24	0.66	3	0.1	11	0.37	2	0.07	4	0.16	15	0.5	3	0.11	5	0.22	5	0.21	
(<i>Sorex cinereus/Microsorex spp.</i>)																			
Chipmunk spp.	11	0.3	8	0.27	8	0.27	6	0.22	1	0.04	4	0.13	0	0	0	0	4	0.17	
Northern flying squirrel	0	0	0	0	0	0	0	0	0	0	1	0.03	0	0	0	0	1	0.04	
(<i>Glaucomys sabrinus</i>)																			
House mouse	2	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(<i>Mus musculus</i>)																			
Southern bog lemming	5	0.12	2	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(<i>Synaptomys cooperi</i>)																			
Southern flying squirrel	3	0.08	1	0.03	0	0	1	0.04	0	0	0	0	1	0.04	8	0.36	0	0	
(<i>Glaucomys volans</i>)																			
Arctic shrew	1	0.03	0	0	0	0	0	0	7	0.29	0	0	0	0	12	0.53	0	0	
(<i>Sorex arcticus</i>)																			
Meadow jumping mouse	0	0	2	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(<i>Zapus hudsonius</i>)																			
Water shrew	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.04	0	0	
(<i>Sorex palustris</i>)																			
Total number	985	26.95	615	20.66	639	21.64	343	12.68	513	20.94	693	22.99	491	18.62	352	15.65	274	11.32	
Total number of species	10		9		6		7		7		7		6		8		7		

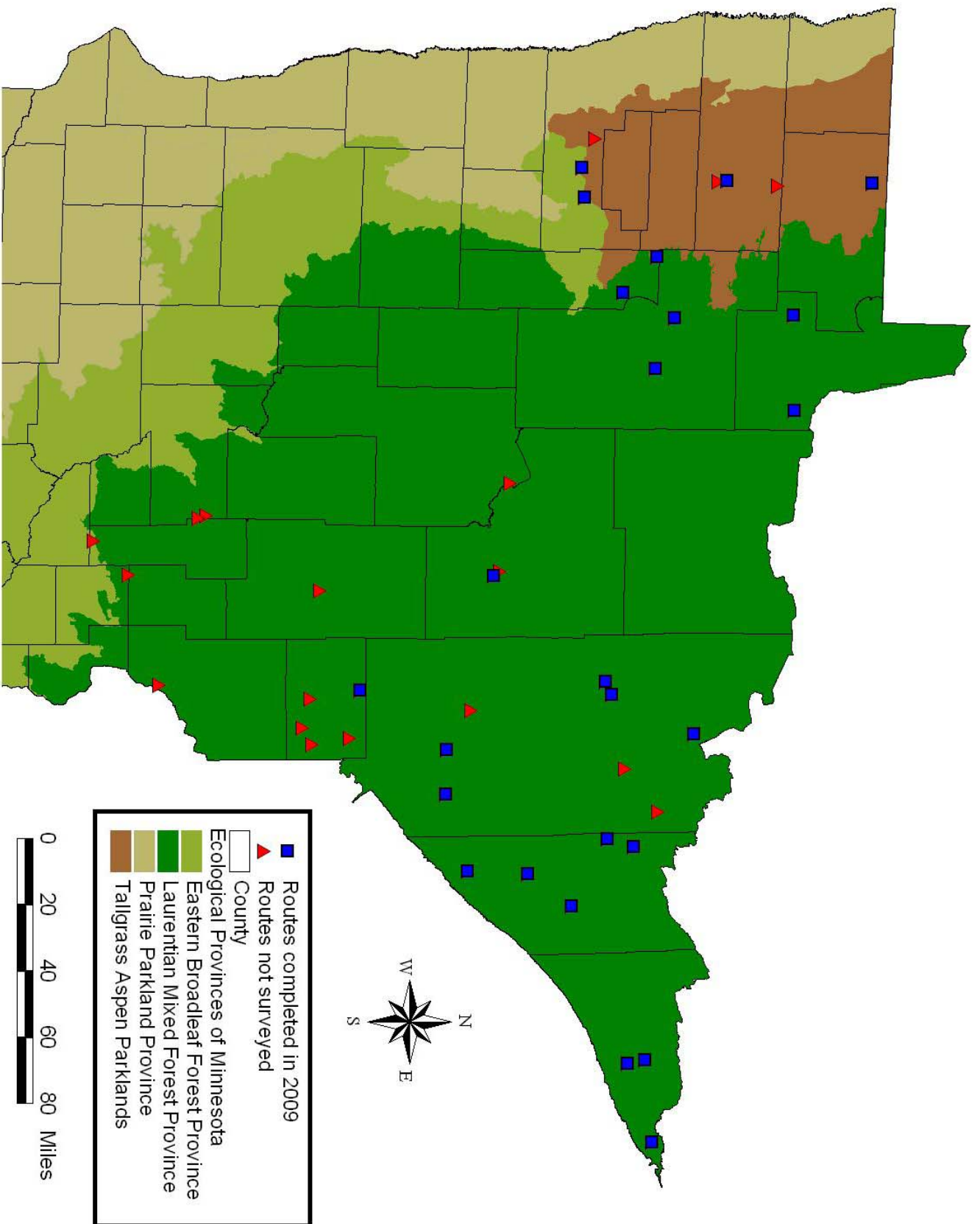


Figure 1. Small mammal survey route locations for 2009.

Completed Routes

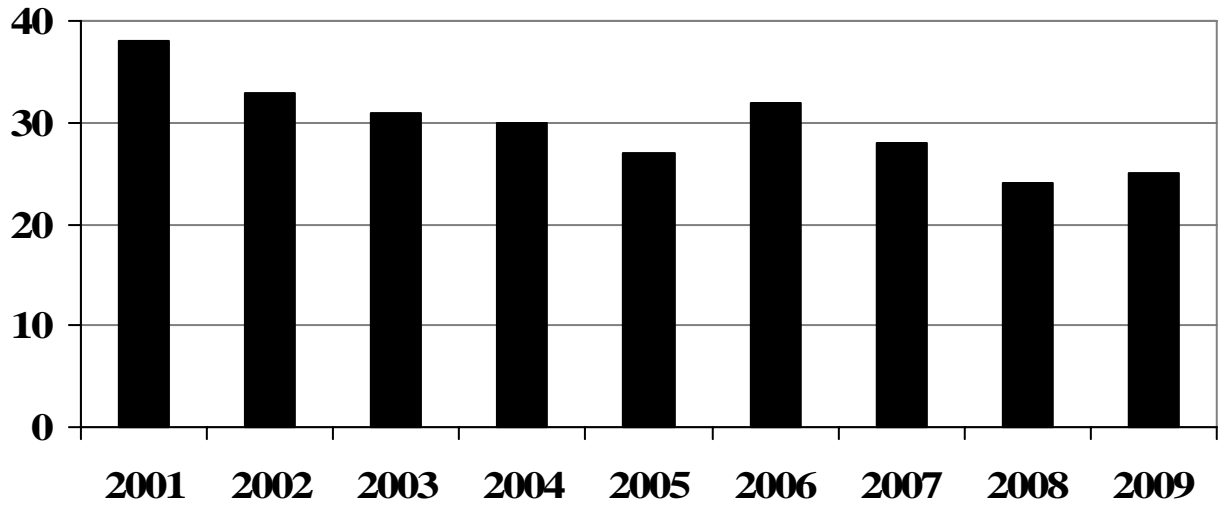


Figure 2. Number of small mammal survey routes completed, 2001-2009.

Figure 3. Small Mammal Indices for Grassland/Brush/Bog Transects, 2001-2009.

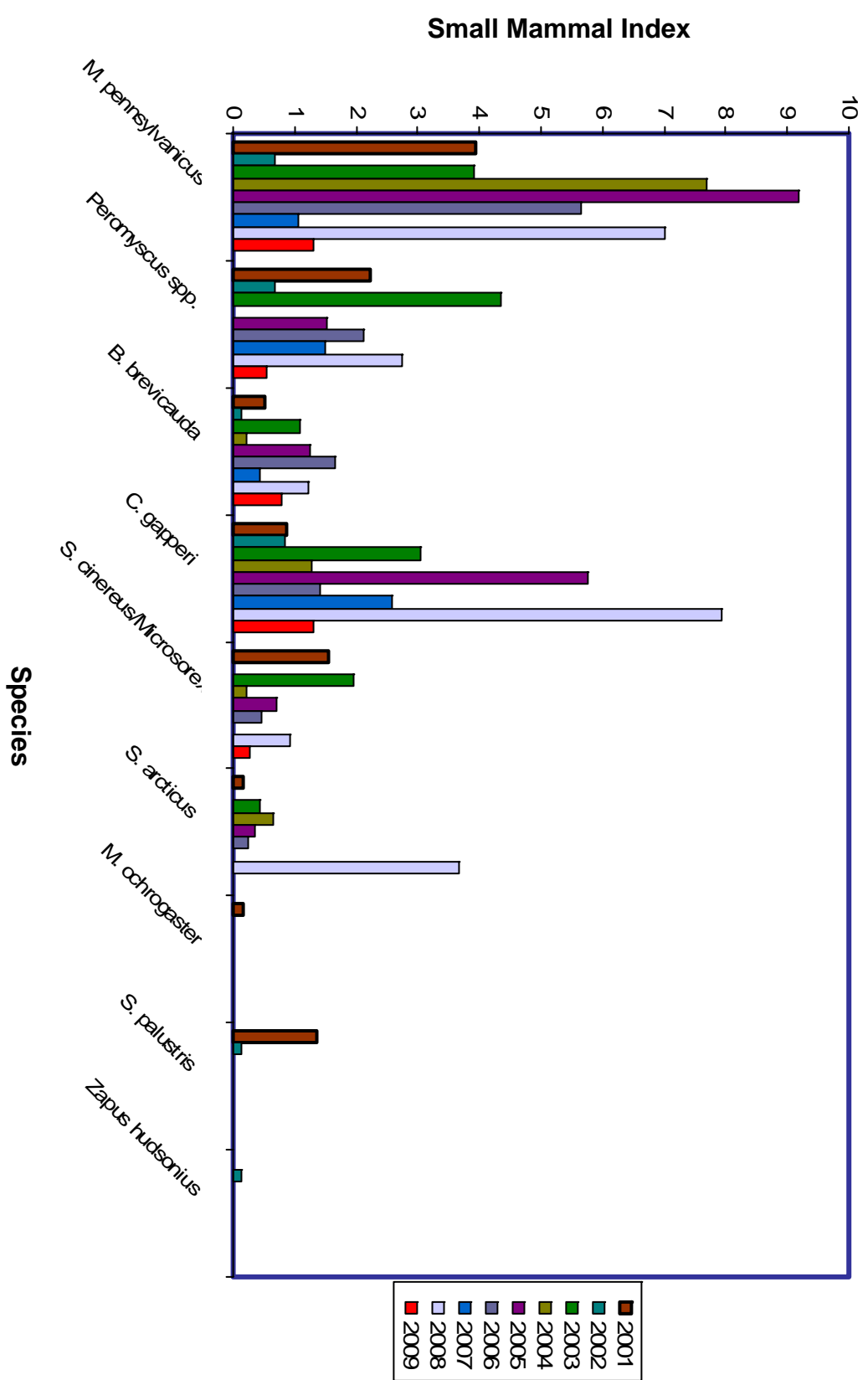


Figure 4. Small Mammal Indices for Forested Transects, 2001-2009.

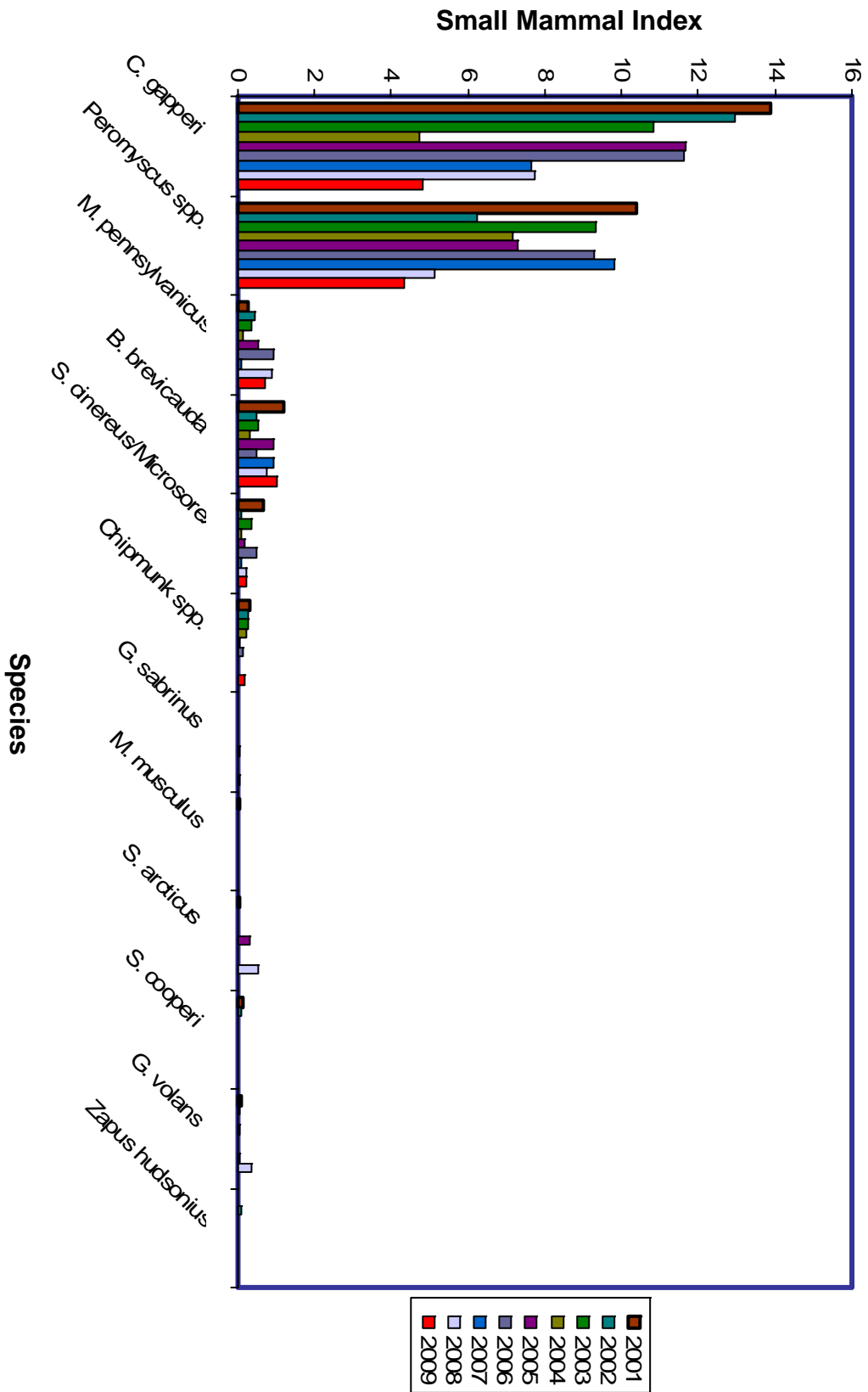
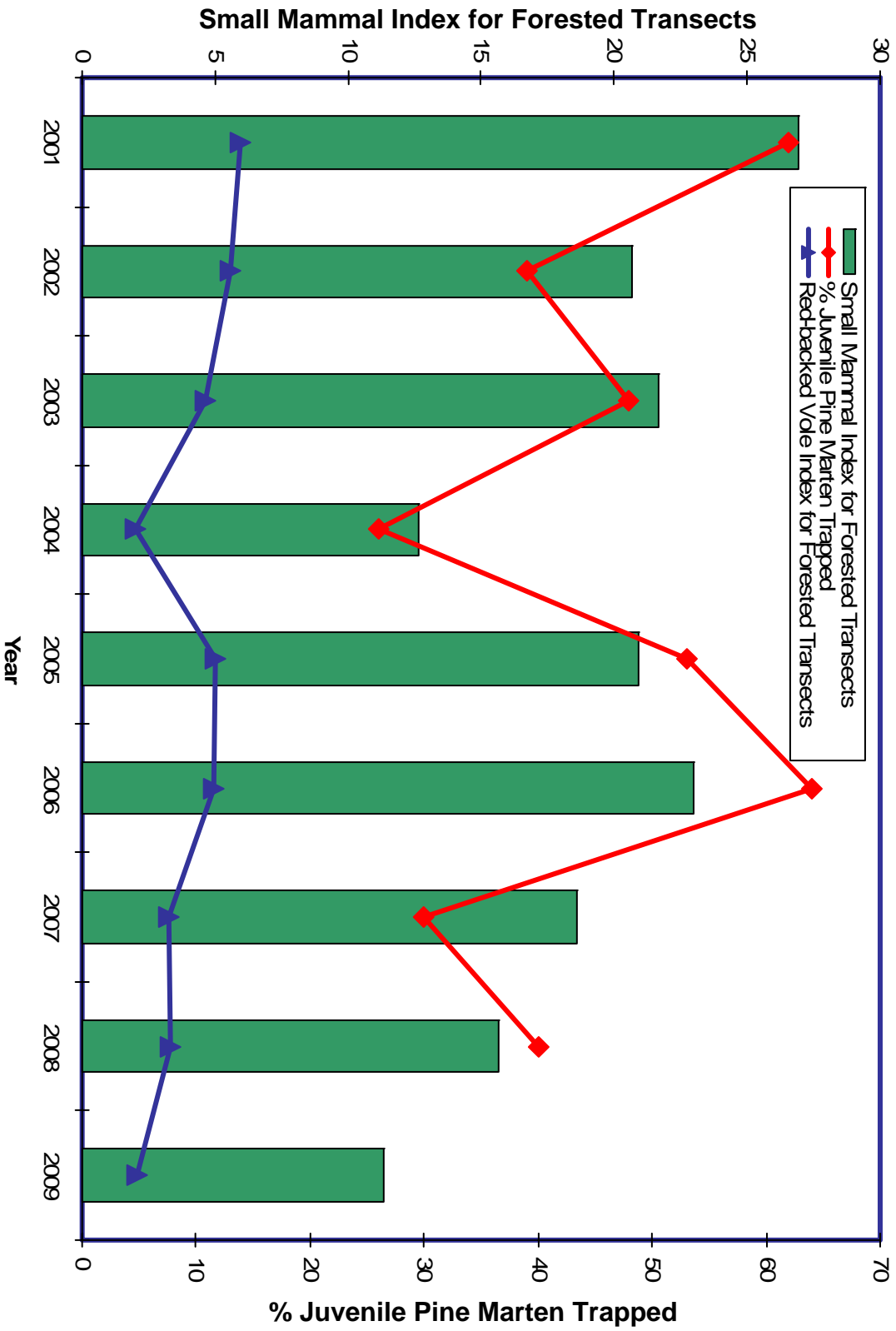


Figure 5. Total Small Mammal Index for Forested Transects and Percent Juvenile Pine Marten Trapped, 2001-2009.



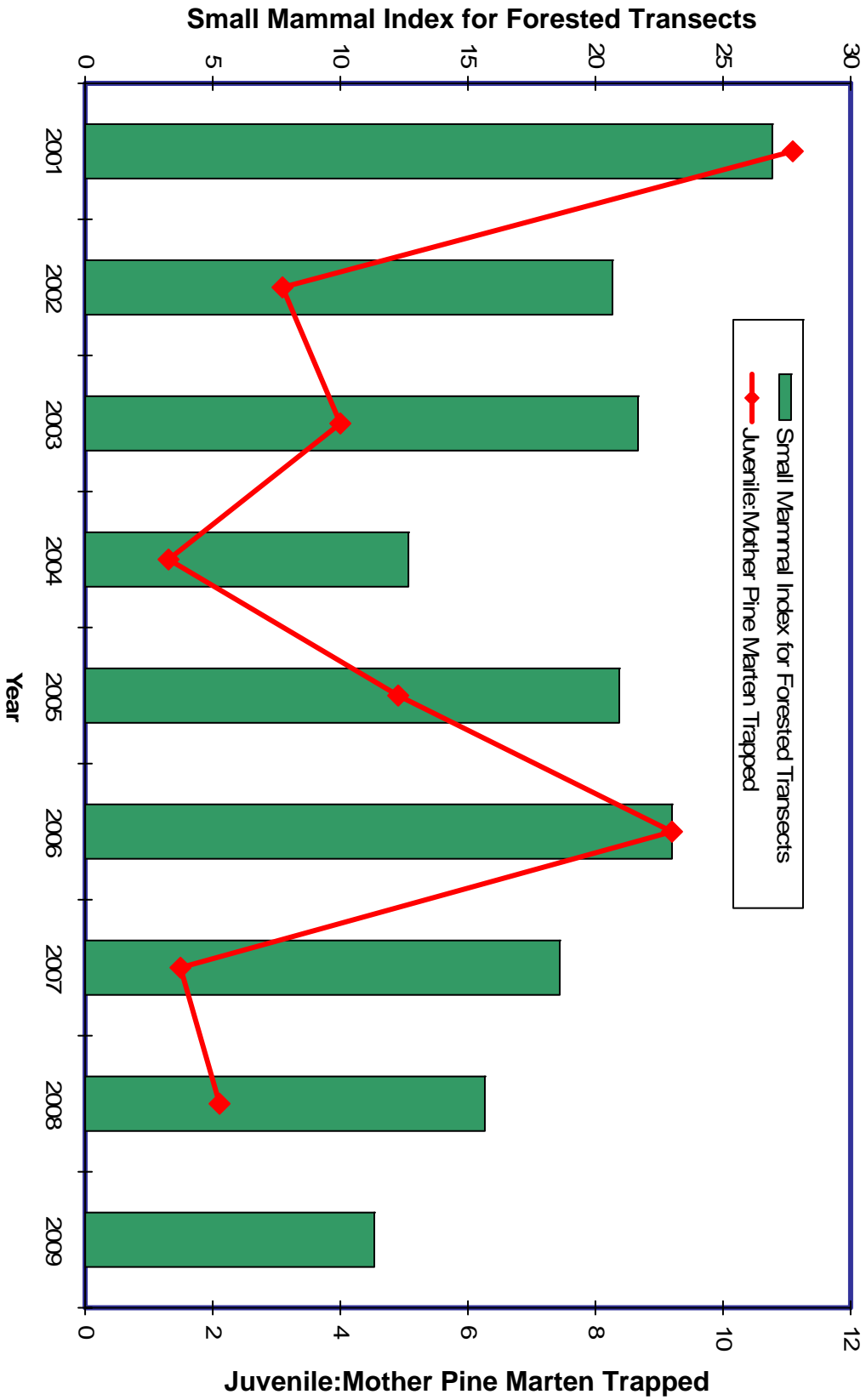


Figure 6. Total Small Mammal Index for Forested Transects and Juvenile to Mother Pine Marten Ratio Trapped, 2001-2009.

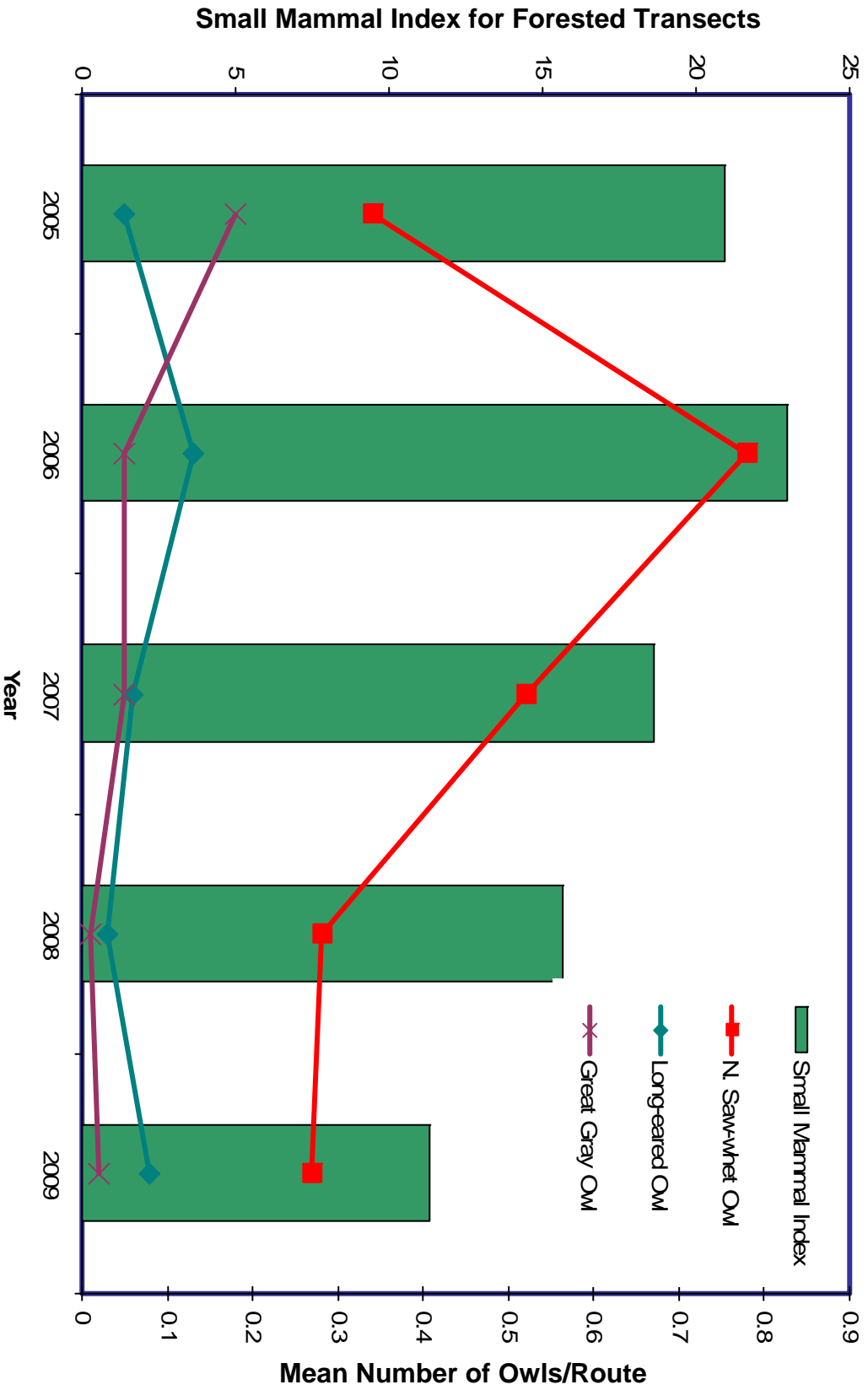


Figure 7. Small Mammal Indices for Forested Transects and Mean Number of Owls/Route for the Laurentian Forest Province, 2005-2009.