CARNIVORE SCENT STATION SURVEY

AND

WINTER TRACK INDICES

NOTE: This survey is organized and coordinated by the Forest Wildlife Populations and Research Group, 1201 E. Hwy 2, Grand Rapids, MN 55744. Results are presented at this location in the book because of the statewide nature of the data.

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CARNIVORE SCENT STATION SURVEY SUMMARY, 2017

John Erb, Minnesota Department of Natural Resources, Forest Wildlife Research Group

INTRODUCTION

Monitoring the distribution and abundance of carnivores can be important for understanding the effects of harvest, habitat change, and environmental variability on these populations. However, many carnivores are highly secretive, difficult to repeatedly capture, and naturally occur at low to moderate densities, making it difficult to annually estimate abundance over large areas using traditional methods (e.g., mark-recapture, distance sampling, etc.). Hence, indices of relative abundance are often used to monitor such populations over time (Sargeant et al. 1998, 2003, Hochachka et al. 2000, Wilson and Delahay 2001, Conn et al. 2004, Levi and Wilmers 2012).

In the early 1970's, the U.S. Fish and Wildlife Service initiated a carnivore survey designed primarily to monitor trends in coyote populations in the western U.S. (Linhart and Knowlton 1975). In 1975, the Minnesota DNR began to utilize similar survey methodology to monitor population trends for numerous terrestrial carnivores within the state. This year marks the 42nd year of the carnivore scent station survey.

METHODS

Scent station survey routes are composed of tracking stations (0.9 m diameter circle) of sifted soil with a fatty-acid scent tablet placed in the middle. Scent stations are spaced at 0.5 km intervals on alternating sides of a road or trail. During the initial years (1975-82), survey routes were 23.7 km long, with 50 stations per route. Stations were checked for presence/absence of tracks on 4 consecutive nights (old tracks removed each night), and the mean number of station visits per night was the basis for subsequent analysis. Starting in 1983, following suggestions by Roughton and Sweeny (1982), design changes were made whereby routes were shortened to 4.3 km, 10 stations/route (still with 0.5 km spacing between stations), and routes were surveyed only once on the day following route placement. The shorter routes and fewer checks allowed for an increase in the number and geographic distribution of survey routes. In either case, the design can be considered two-stage cluster sampling.

Survey routes were selected non-randomly, but with the intent of maintaining a minimum 5 km separation between routes, and encompassing the variety of habitat conditions within the work area of each survey participant. Most survey routes are placed on secondary (unpaved) roads/trails, and are completed from September through October. Survey results are currently stratified based on 3 habitat zones within the state (forest (FO), transition (TR), and farmland (FA); Figure 1).

Track presence/absence is recorded at each station and track indices are computed as the percentage of scent stations visited by each species. Confidence intervals (95%) are computed using bootstrap methods (percentile method; Thompson et al. 1998). For each of 1000 replicates, survey routes are randomly re-sampled according to observed zone-specific route sample sizes, and station visitation rates are computed for each replicate sample of routes.

Replicates are ranked according to the magnitude of the calculated index, and the 25th and 975th values constitute the lower and upper bounds of the confidence interval.

RESULTS AND DISCUSSION

A total of 203 routes and 1,879 stations were surveyed this year, the fewest since the survey became fully operational in the early 1980's. Route density varied from 1 route per 761 km^2 in the Forest Zone to 1 route per 1,891 km^2 in the Farmland Zone (Figure 1). The decline in survey effort was likely a result of staffing shortages and competing workload demands.

Statewide, route visitation rates (% of routes with detection), in order of increasing magnitude, were opossum (5%), wolves (12%), bobcats (13%), domestic dogs (15%), domestic cats (26%), coyotes (28%), skunks (32%), raccoons (33%), and red foxes (35%). Regionally, route visitation rates were as follows: red fox – TR 17%, FA 31%; FO 47%; coyote – FO 13%, TR 36%, FA 58%; skunk – FO 25%, TR 28%, FA 58%; raccoon – FO 16%, TR 34%, FA 86%; domestic cat – FO 11%, TR 33%, FA 58%; domestic dog – FO 6%, FA 25%, TR 26%; opossum - FO 0%, TR 10%, FA 14%; wolf - FA 0%, TR 2%, FO 21%; and bobcat - FA 0%, TR 9%, FO 19%.

Figures 2-5 show station visitation indices (% of stations visited) from the survey's inception through the current year. Although the survey is largely intended to document long-term trends in populations, confidence intervals improve interpretation of the significance of annual changes. Based strictly on the degree of confidence interval overlap, significant changes this year include 1) increases in red fox, skunk, and raccoon indices in the Farmland Zone (Figure 2), 2) declines in red fox, skunk, and domestic cat indices in the Transition Zone (Figure 3), 3) decreases in coyote, skunk, and raccoon indices in the Forest Zone (Figure 4), and 4) increases in wolf and bobcat indices in the Forest Zone (Figure 5).

In the Farmland Zone (Figure 2), the red fox index increased significantly from last year, but the index remains below the long-term average and has fluctuated around a stable trend since the mid-2000s. Although the farmland coyote index was the highest on record, it was not significantly different from last year. It is however, suggestive of a continuing increase in coyotes that began in the late 1990's. Raccoon and skunk indices both exhibited significant increases from last year, and both were the highest since the survey began. However, neither has exhibited any consistent trend over the last decade, with recent indices for both generally remaining above the long-term average.

In contrast to the Farmland Zone where numerous indices increased, red fox, skunk, domestic cat, and wolf indices all declined in the Transition Zone (Figure 3). However, over the last decade there has been no consistent trend for these species, with most fluctuating at or below long-term averages. There was no significant change in the Transition Zone coyote index from last year; coyote indices here have generally declined over the past 4 years but remain well above the long-term average. Raccoon indices in the Transition Zone remain near their long-term average.

In the Forest Zone (Figures 4 and 5), significant declines were observed in coyote, skunk and raccoon indices. However, there has been no consistent trend for these species over the past decade, all fluctuating at or below their long-term average. Conversely, wolf and bobcat indices significantly increased from last year and are well above their long-term averages. Although these surveys cannot ascertain cause and effect, published research would suggest an increase in wolves would negatively affect coyotes, which in turn could positively affect bobcats; observed changes in the Forest Zone indices from last year are consistent with this scenario.

ACKNOWLEDGMENTS

I wish to thank all of the cooperators who participated in the 2017 survey: DNR Division of Wildlife staff; Superior National Forest Aurora District; Agassiz, Rice Lake, Rydell, Sherburne and Tamarac National Wildlife Refuges; 1854 Treaty Authority, White Earth, Red Lake, and Leech Lake Tribal Natural Resource Departments; Lori Schmidt and Vermillion Community College; Peter Jacobson and Faribault High School; Josh Tharaldson and Central High School (Marshall County); and Steven Hogg and the Three Rivers Park District. This project was funded in part by the Wildlife Restoration Program (Pittman-Robertson).

LITERATURE CITED

Conn, P. B., L. L. Bailey, and J. R. Sauer. 2004. Indexes as surrogates to abundance for low-abundance species. Pages 59-76 *in* W. L. Thompson, editor. Sampling rare or elusive species: Concepts, designs, and techniques for estimating population parameters. Island Press, Washington, D.C., USA.

Hochachka, W. M., K. Martin, F. Doyle, and C. J. Krebs. 2000. Monitoring vertebrate populations using observational data. Canadian Journal of Zoology 78:521-529.

Levi, T., and C. C. Wilmers. 2012. Wolves-coyotes-foxes: a cascade among carnivores. Ecology 93: 921-929.

Linhart, S. B., and F. F. Knowlton. 1975. Determining the relative abundance of coyotes by scent station lines. Wildlife Society Bulletin 3: 119-124.

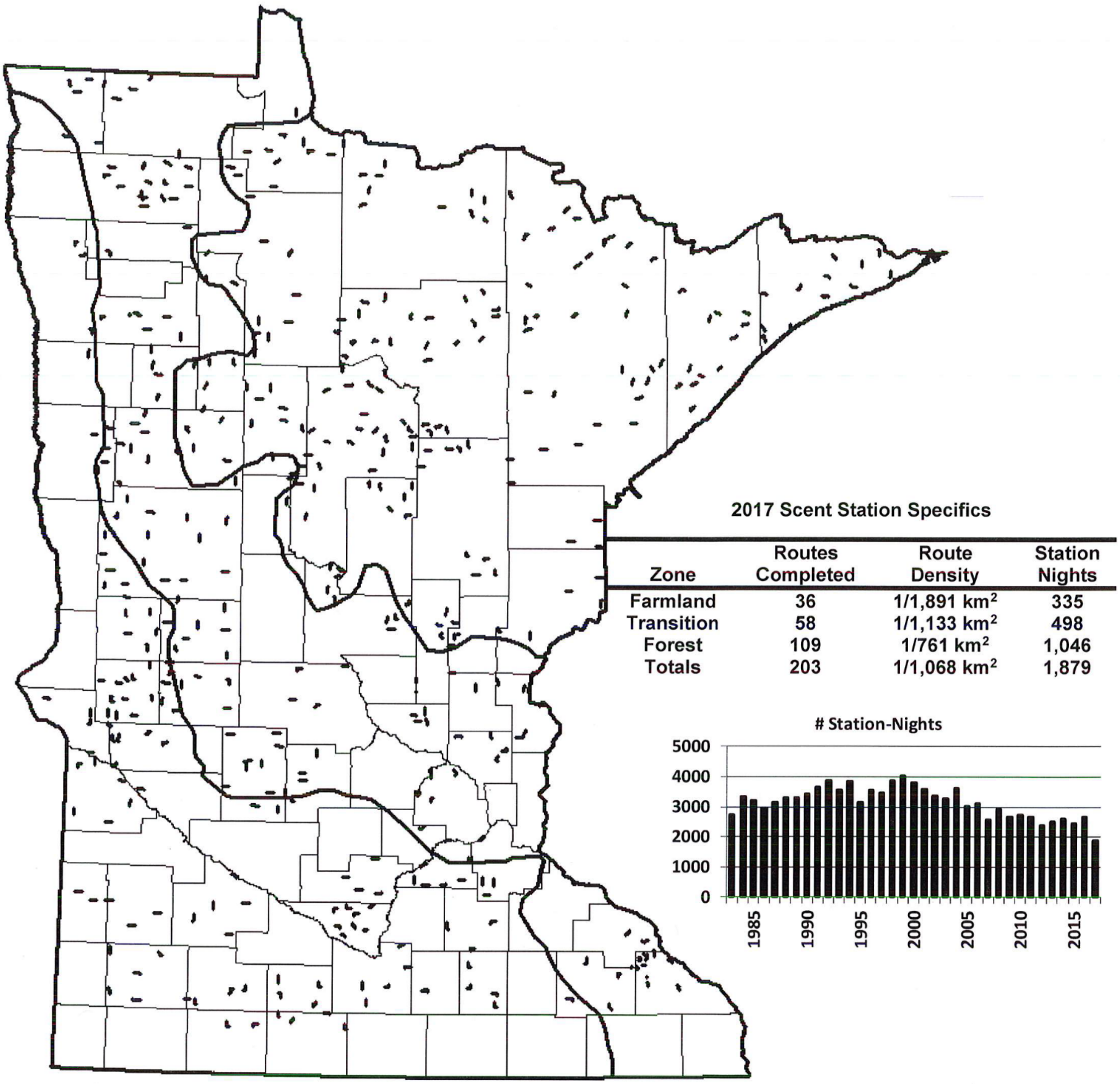
Roughton, R. D., and M. D. Sweeny. 1982. Refinements in scent-station methodology for assessing trends in carnivore populations. Journal of Wildlife Management 46: 217-229.

Sargeant, G. A., D. H. Johnson, and W. E. Berg. 1998. Interpreting carnivore scent station surveys. Journal of Wildlife Management 62: 1235-1245.

Sargeant, G. A., D. H. Johnson, and W. E. Berg. 2003. Sampling designs for carnivore scent-station surveys. Journal of Wildlife Management 67: 289-298.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, San Diego, California.

Wilson, G. J., and R. J. Delehay. 2001. A review of methods to estimate the abundance of terrestrial carnivores using field signs and observation. Wildlife Research 28:151-164.



2017 Scent Station Specifics

Zone	Routes Completed	Route Density	Station Nights
Farmland	36	1/1,891 km^2	335
Transition	58	1/1,133 km^2	498
Forest	109	1/761 km^2	1,046
Totals	203	1/1,068 km^2	1,879

Figure 1. Locations of existing scent station routes (not all completed every year). Insets show 2017 route specifics and the number of station-nights per year since 1983.

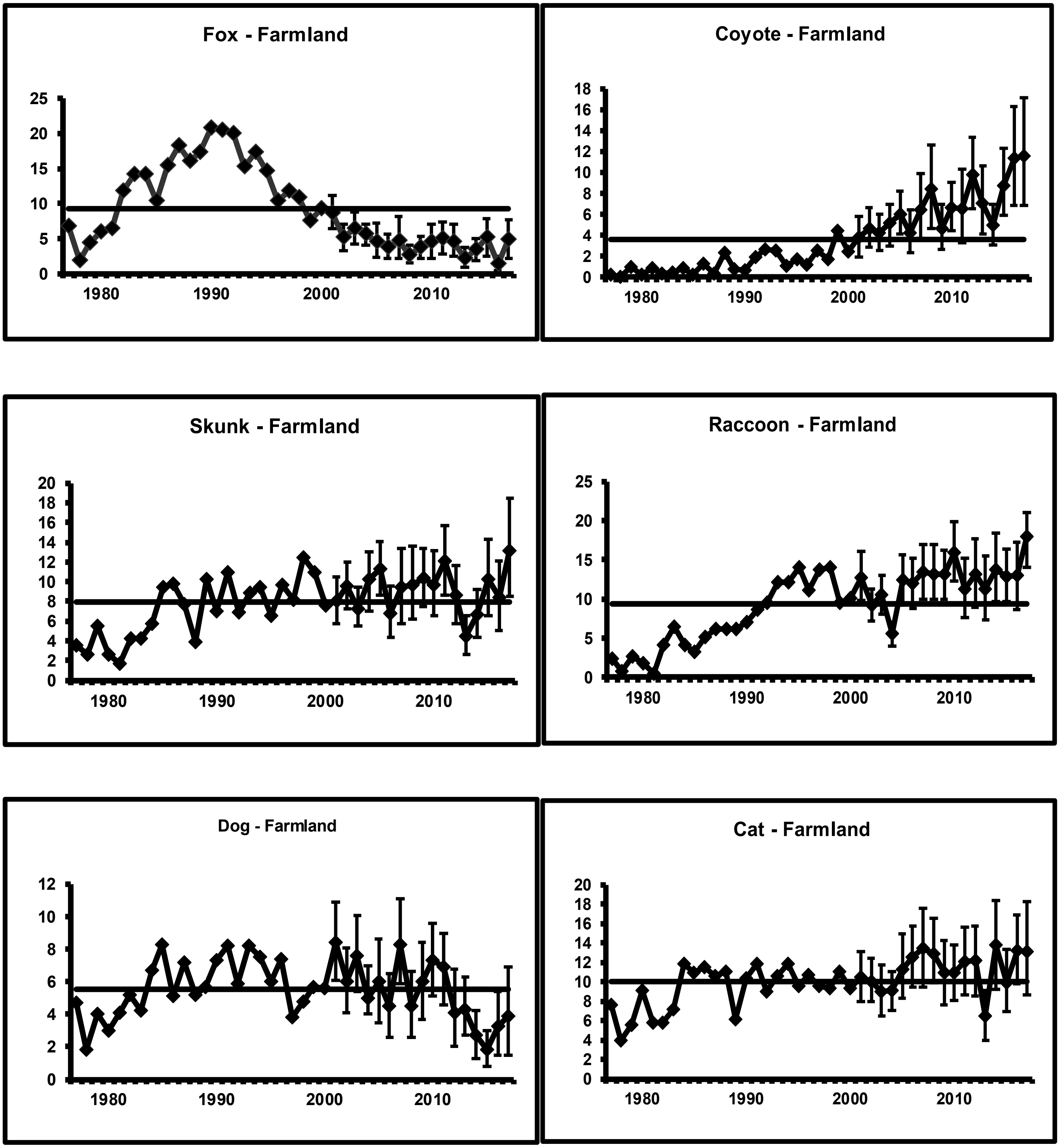


Figure 2. Percentage of scent stations visited by selected species in the Farmland Zone of Minnesota, 1977-2017. Horizontal line represents long-term mean.

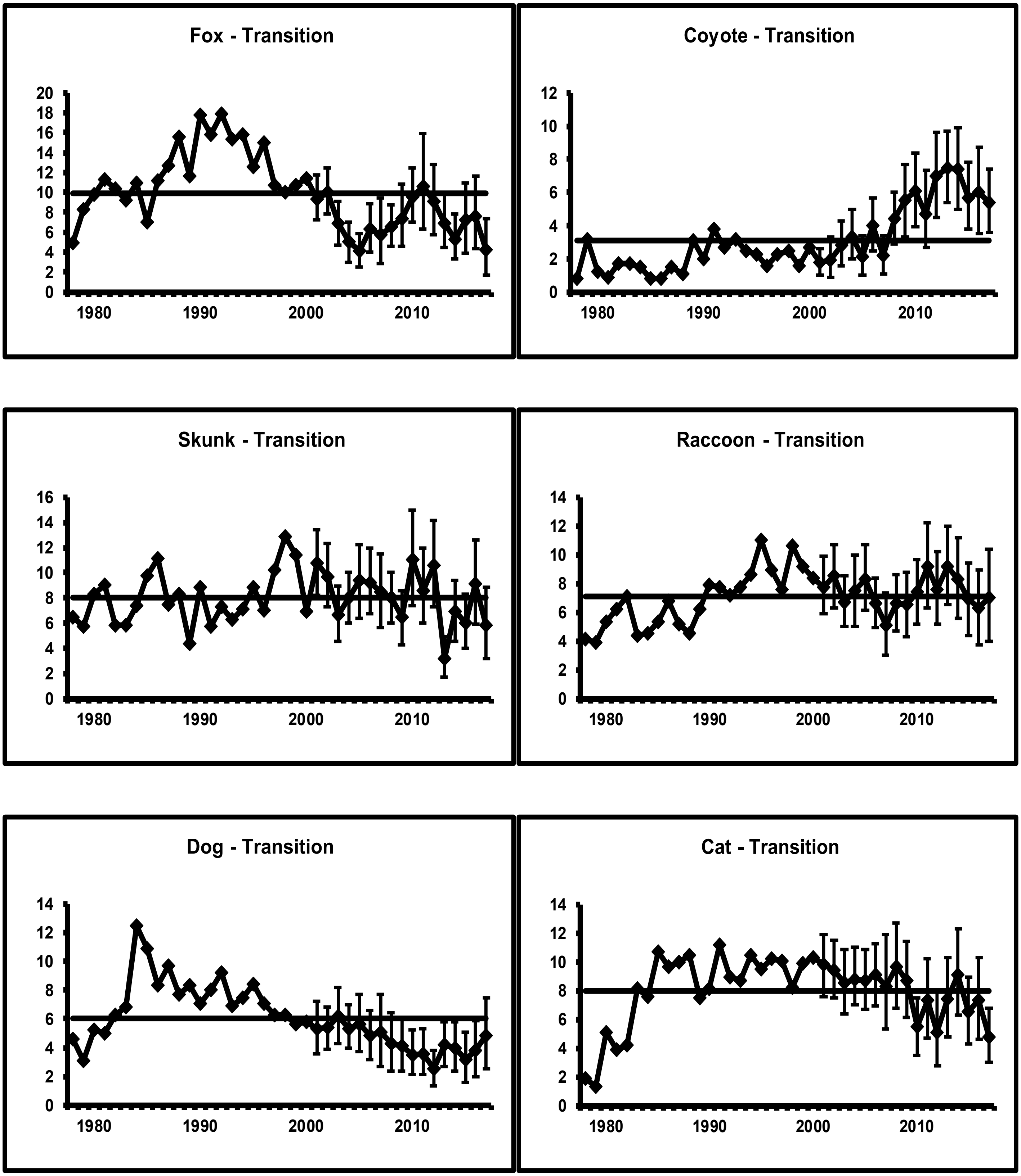


Figure 3. Percentage of scent stations visited by selected species in the Transition Zone of Minnesota, 1978-2017. Horizontal line represents long-term mean.

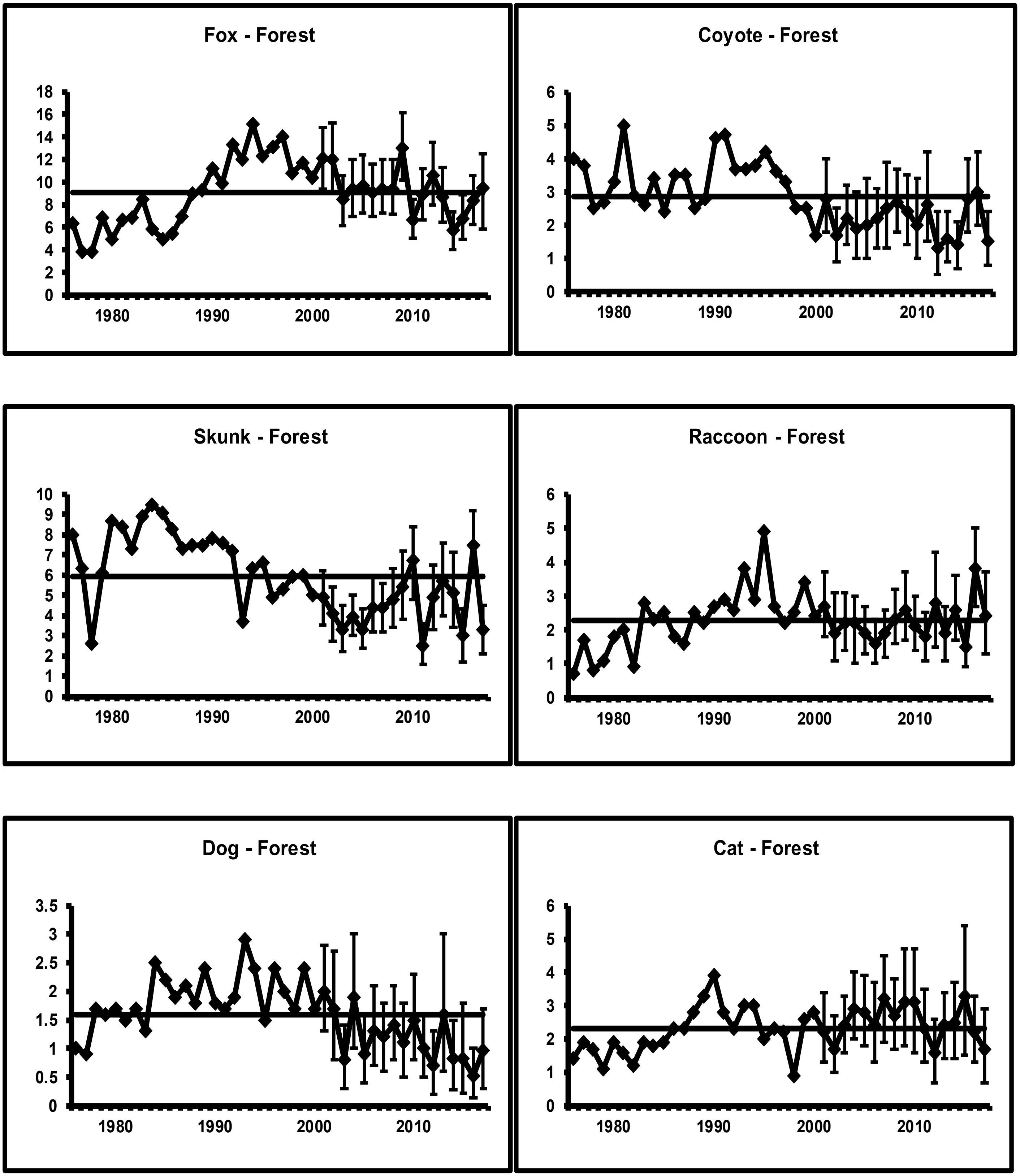


Figure 4. Percentage of scent stations visited by selected species in the Forest Zone of Minnesota, 1976-2017. Horizontal line represents long-term mean.

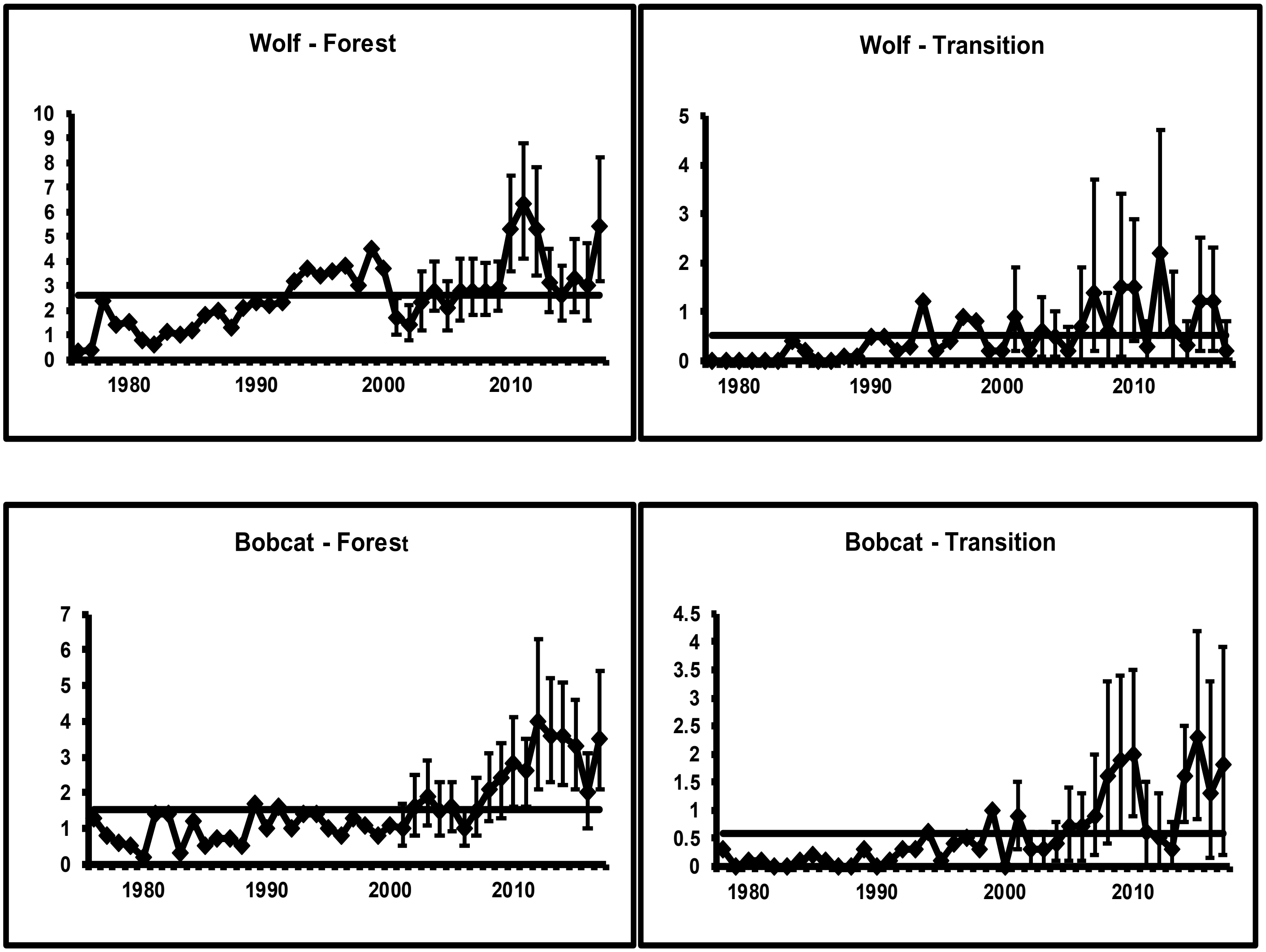


Figure 5. Percentage of scent stations visited by wolves and bobcat in the Forest and Transition Zones of Minnesota, 1976-2017. Horizontal lines represents long-term mean.

FURBEARER WINTER TRACK SURVEY SUMMARY, 2017

John Erb, Minnesota Department of Natural Resources, Forest Wildlife Research Group

INTRODUCTION

Monitoring the distribution and abundance of carnivores can be important for documenting the effects of harvest, habitat change, and environmental variability on these populations. However, many carnivores are highly secretive, difficult to repeatedly capture, and naturally occur at low to moderate densities, making it difficult to estimate abundance over large areas using traditional methods (e.g., mark-recapture, distance sampling, etc.). Hence, indices presumed to reflect relative abundance are often used to monitor such populations over time (Hochachka et al. 2000, Wilson and Delahay 2001, Conn et al. 2004).

In winter, tracks of carnivores are readily observable following snowfall. Starting in 1991, Minnesota initiated a carnivore snow-track survey in the northern portion of the State. The survey's primary objective is to use a harvest-independent method to monitor distribution and population trends of fisher (*Martes pennanti*) and marten (*Martes americana*), two species for which no other survey data is available. Because sign of other carnivores is readily detectable in snow, participants also record tracks for other selected species. After three years of evaluating survey logistics, the survey became operational in 1994. Formal recording of gray fox detections did not commence until 2008.

METHODS

Presently, 57 track survey routes are operational across the northern portion of the state (Figure 1). Each route is a total of 10 miles long and follows secondary roads or trails. A majority of routes are continuous 10-mile stretches of road/trail but a few are composed of multiple discontinuous segments. Route locations were subjectively determined based on availability of suitable roads/trails but were chosen where possible to represent the varying forest habitat conditions in northern Minnesota. For data recording, each 10-mile route is divided into 20 0.5-mile segments.

Each route is surveyed once following a fresh snow typically from December through mid-February, and track counts are recorded for each 0.5-mile segment. When it is obvious the same animal crossed the road multiple times *within* a 0.5-mile segment, the animal is only recorded once. If it is obvious that an animal ran along the road and entered multiple 0.5 mile segments, which often occurs with canids, its tracks are recorded in all segments but circled to denote it was the same animal. Though duplicate tracks are not included in calculation of track indices (see below), recording data in this manner allows for future analysis of animal activity in relation to survey 'plot' size and habitat. Snowshoe hares (*Lepus americanus*) are recorded only as present or absent in the first 0.1 miles of each 0.5-mile segment. Although most routes are surveyed one day after the conclusion of a snowfall (ending by ~ 6:00 pm), thereby allowing one night for tracks to be left, a few routes are usually completed two nights following snowfall. In such cases, track counts on those routes are divided by the number of days post-snowfall.

Because most targeted species occur throughout the area where survey routes are located, calculated indices for all species prior to 2015 utilize data from all surveyed routes. Starting with the 2015 report, all past marten indices were re-calculated using only those routes that fall within a liberal delineation of marten range. However, in general there were minimal differences in temporal patterns observed in this subset versus the full sample of routes.

Currently, three summary statistics are presented for each species. First, I compute the percentage of 0.5-mile segments with species presence after removing any duplicates (e.g., if the same fox clearly traverses two adjacent 0.5-mile segments along the road, and it was the only 'new' red fox (*Vulpes vulpes*) in the second segment, only one of the two segments is considered independently occupied). In addition to this metric, but on the same graph, the average number of tracks per 10-mile route is presented after removing any obvious duplicate tracks across segments. For wolves (*Canis lupus*) traveling through adjacent segments, the maximum number of pack members recorded in any one of those segments is used as the track total for that particular group, though this is likely an underestimate of true pack size. Because individuals from many of the species surveyed tend to be solitary, these two indices (% segments occupied and # tracks per route) will often yield mathematically equivalent results; on average, one tends to differ from the other by a constant factor. In the case of wolf packs, and to a lesser extent red fox and coyotes (*Canis latrans*) which may still associate with previous offspring or start traveling as breeding pairs in winter, the approximate equivalence of these two indices will still be true if average (detected) group sizes are similar across years. However, the solitary tendencies in some species are not absolute, potential abundance (in relation to survey plot size) varies across species, and for wolves, pack size may vary annually. For these reasons, as well as to provide an intuitive count metric, both indices are currently presented. Because snowshoe hares are tallied only as present/absent, the 2 indices are by definition equivalent. Dating back to 1974, hare survey data has also been obtained via counts of hares observed on ruffed grouse drumming count surveys conducted in spring. Post-1993 data for both the spring and winter hare indices are presented for comparison in this report.

In the second graph for each species, I illustrate the percentage of *routes* where each species was detected (hereafter, the 'distribution index'). This measure is computed to help assess whether any notable changes in the above-described track indices are a result of larger-scale changes in distribution (more/less routes with presence) or finer-scale changes in density along routes.

Using bootstrap methods, I compute confidence intervals (90%) for the percent of segments with species presence and the percent of routes with species presence. For each of 1000 replicates, survey routes are randomly re-sampled with replacement according to the observed route sample size. Replicates are ranked according to the magnitude of the calculated index, and the 50th and 950th values constitute the lower and upper bounds of the confidence interval.

RESULTS

This winter, 44 of the 57 routes were completed, the third most since the survey began (Figure 2). Survey routes took an average of 1.9 hours to complete. Total snow depths averaged 10.5" along completed routes, similar to the long-term average (Figure 3). Mean overnight low temperature the night preceding the surveys was -1°F, below the long-term average (Figure 3). Survey routes were completed between December 12th and February 28th, with a mean survey date of January 9th (Figure 3).

Based on degree of confidence interval overlap, significant changes from last winter include an increase in wolves and a decrease in coyotes (Figure 4). Red fox and bobcat indices also increased, though less significantly (Figure 4). These changes mirror similar results on the fall scent station survey, and are consistent with expectations based on known inter-specific interactions among these species.

Fishers were detected on approximately 4% of the route segments and along 50% of the routes (Figure 4). Numerous sources of information indicate that over the past decade fishers have expanded in distribution and abundance along the southern and western edge of their Minnesota range, an area currently with few or no track survey routes. Hence, fisher indices in this report are presumed indicative of population trends only in the previous 'core' of fisher range. In the core area, data indicates a longer-term decline, with low but stable numbers since 2012; at their peak (2003/2004), fishers were detected on 14% of the segments and 78% of the survey routes.

Within the 'marten zone', martens were detected on approximately 6% of the route segments and 56% of the survey routes (Figure 4), similar to last year. Similar to results for fishers, marten indices remain below their long-term average and have not exhibited any unidirectional trends over the last 11 years. However, recent marten fluctuations show indications of 3-5 year cycles consistent in timing with cyclic fluctuations of some of their rodent prey species in Minnesota (e.g., Oestricher 2018, Berg et al. 2017).

Bobcat indices had increased for approximately 15 years through 2014, and then declined to their long-term average the past two years. Data from this winter suggests a moderate increase, now slightly above the long-term average. Bobcats were detected on 3.4% of the segments and 45% of the routes.

Wolf indices increased significantly to their second-highest level since the survey began. Wolves were detected on approximately 10% of the route segments and 82% of the survey routes (Figure 4). The average number of wolves detected per route was 3.5. Coyotes were detected on 2.3% of the route segments and 27% of the routes. As with martens and weasels (see below), coyote indices appear to exhibit 4 to 5 year cycles consistent in timing with data for some rodent species in MN. Although red fox indices have been comparatively stable in recent years, indices have remained below the long-term average since 2006. Red foxes were detected on approximately 12% of the segments and 80% of the routes (Figure 4), both slight increases from the previous winter. Gray fox detections have only been formally recorded since 2008. Although it may be premature to characterize longer patterns in gray fox detections, data from the past 9 years suggests a possible 4-5 year cyclic fluctuation. However, gray fox fluctuations appear inversely correlated with those in rodent and coyote indices, suggesting, as found in various studies, a potential negative influence of coyotes on gray foxes. There was a marginally significant increase in gray fox indices from last winter, with gray foxes being detected on 2% of the segments and 18% of the routes.

Weasel (*Mustela erminea* and *Mustela frenata*) indices did not change significantly from last year and their long-term fluctuations have been characterized by 4 to 5 year cycles or 'irruptions' superimposed on a declining trend (Figure 4). No significant change was observed in winter snowshoe hare indices from last winter. Since the winter track survey began in 1994, hare indices had steadily increased, leveled off some around 2010, and declined in recent years (Figure 4). Both the spring and winter indices were near (slightly above in spring, slightly below in winter) their long-term averages (Figure 4). Historic data (pre-1994; not presented here) for the spring index of snowshoe hares clearly exhibited 10-year cycles. Since then, only subtle 'hints' of a cycle are apparent in both surveys during the first few years of each decade.

DISCUSSION

Reliable interpretation of changes in these track survey results is dependent on the assumption that the probability of detecting animals remains relatively constant across years (Gibbs 2000, MacKenzie et al. 2004). Because this remains an untested assumption, caution is warranted when interpreting changes, particularly annual changes of low to moderate magnitude or short-term trends. The only significant changes detected this winter were an increase in wolves and a decrease in coyotes, potentially explained by increasing deer numbers facilitating a wolf increase, which in turn may have a negative impact on coyotes. Overall, the timing and average ambient conditions during this winter's survey suggest conditions slightly more 'extreme' than their long-term averages (later in winter, with slightly more snow and colder temperatures than average). While this could negatively bias indices for some species as a result of reduced animal activity, average conditions during route completion were not 'severe' and other unknown factors can influence animal movement and detection rates. Hence, there is no clear indication that results were biased in either direction, and as always, inferences should largely be restricted to multi-year trends.

ACKNOWLEDGMENTS

I wish to thank all those who participated in this year's survey, including staff with the Minnesota DNR, Superior National Forest (Cook, Ely, and Grand Marais offices), Leech Lake, Fond-du-Lac, Grand Portage, and Red Lake Bands of Ojibwe, and the 1854 Treaty Authority. This project was funded in part by the Wildlife Restoration Program (Pittman-Robertson).

LITERATURE CITED

Berg, S. S., J. D. Erb, J. R. Fieberg, and J. D. Forester. 2017. Comparing the utility of varying amounts of radio-telemetry data for improving statistical population reconstruction of American Marten in Northern Minnesota. Journal of Wildlife Management 81:535-544.

Conn, P. B., L. L. Bailey, and J. R. Sauer. 2004. Indexes as surrogates to abundance for low-abundance species. Pages 59-76 *in* W. L. Thompson, editor. Sampling rare or elusive species: Concepts, designs, and techniques for estimating population parameters. Island Press, Washington, D.C., USA.

Gibbs, J. P. 2000. Monitoring populations. Pages 213-252 *in* L. Boitani and T. K. Fuller, editors. Research Techniques in Animal Ecology. Columbia University Press, New York, USA.

Hochachka, W. M., K. Martin, F. Doyle, and C. J. Krebs. 2000. Monitoring vertebrate populations using observational data. Canadian Journal of Zoology 78:521-529.

Mackenzie, D. I., J. A. Royle, J. A. Brown, and J. D. Nichols. 2004. Occupancy estimation and modeling for rare and elusive populations. Pages 149-172 *in* W. L. Thompson, editor. Sampling rare or elusive species: Concepts, designs, and techniques for estimating population parameters. Island Press, Washington, D.C., USA.

Oestreicher, S. 2018. 2017 Small Mammal Survey Report. Technical Report Number # 18-01. 1854 Treaty Authority. Duluth, MN.

Wilson, G. J., and R. J. Delahay. 2001. A review of methods to estimate the abundance of terrestrial carnivores using field signs and observation. Wildlife Research 28:151-164.

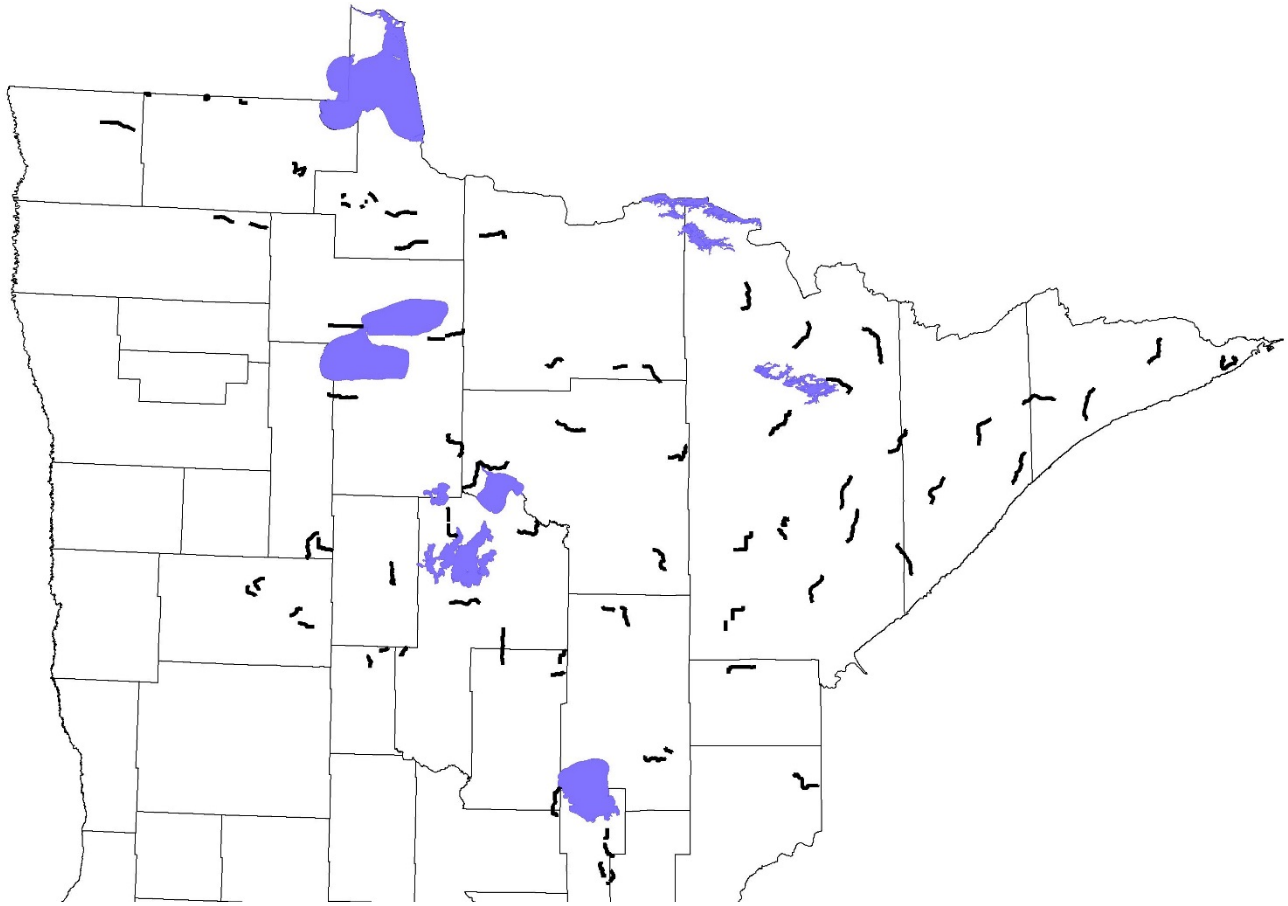


Figure 1. Locations of furbearer winter track survey routes in northern Minnesota.

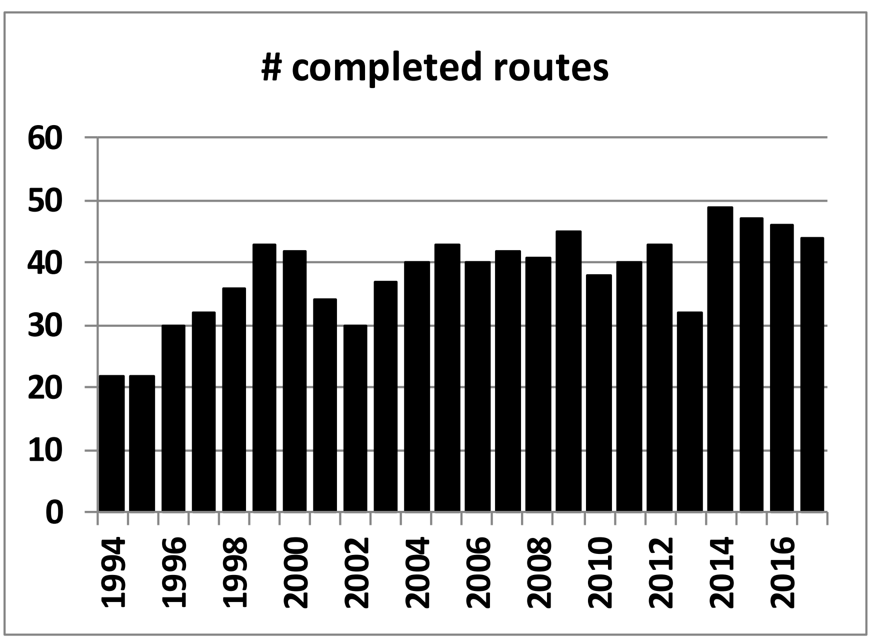


Figure 2. Number of snow track routes surveyed in Minnesota, 1994-2017.

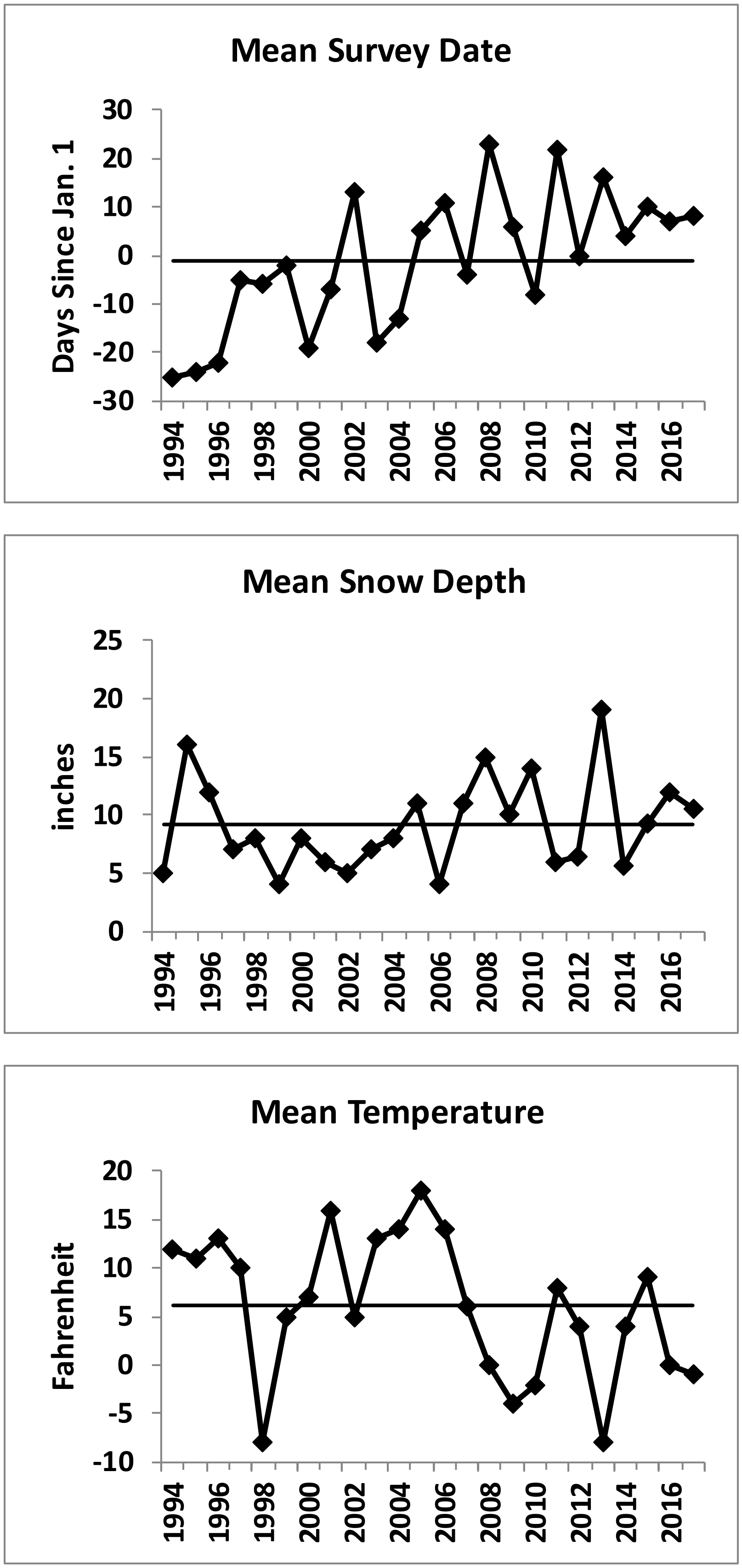


Figure 3. Average survey date, snow depth, and temperature for snow track routes completed in Minnesota, 1994-2017. Horizontal line represents long-term mean.

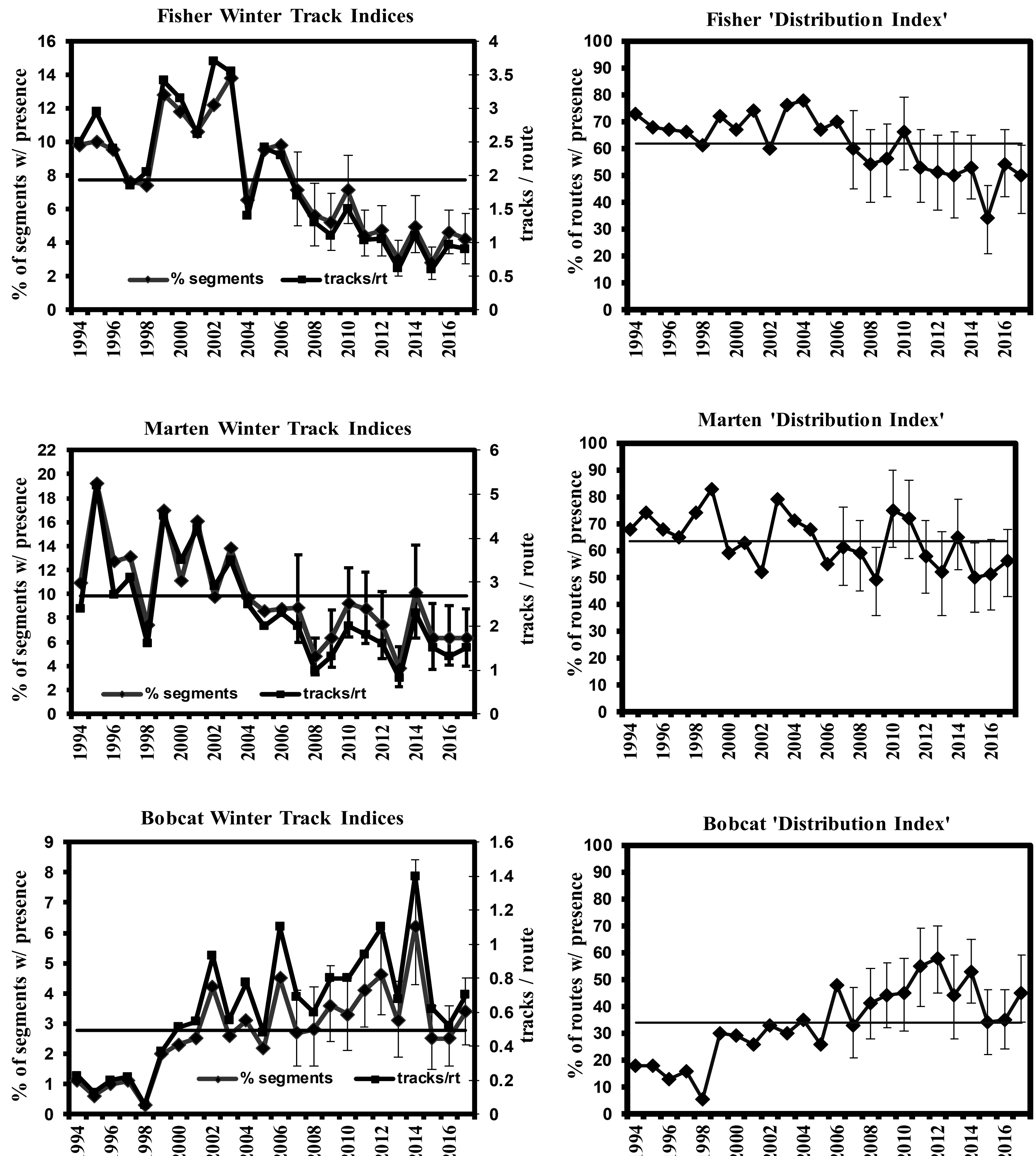


Figure 4. Winter track indices for selected species in Minnesota, 1994-2017. Confidence intervals are presented only for % segments and % routes with track presence; horizontal lines represent their long-term averages.

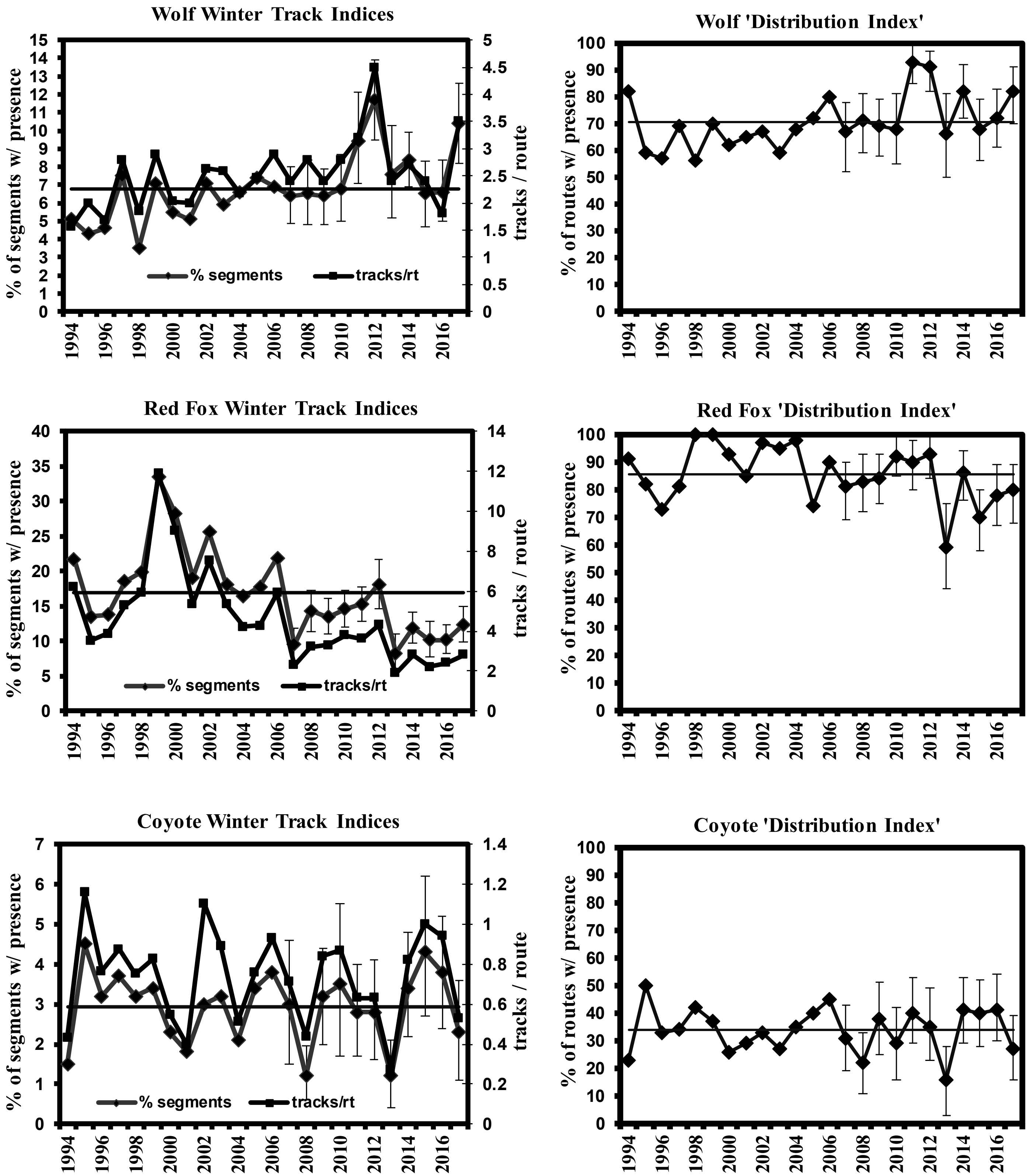


Figure 4 (continued). Winter track indices for selected species in Minnesota, 1994-2017.

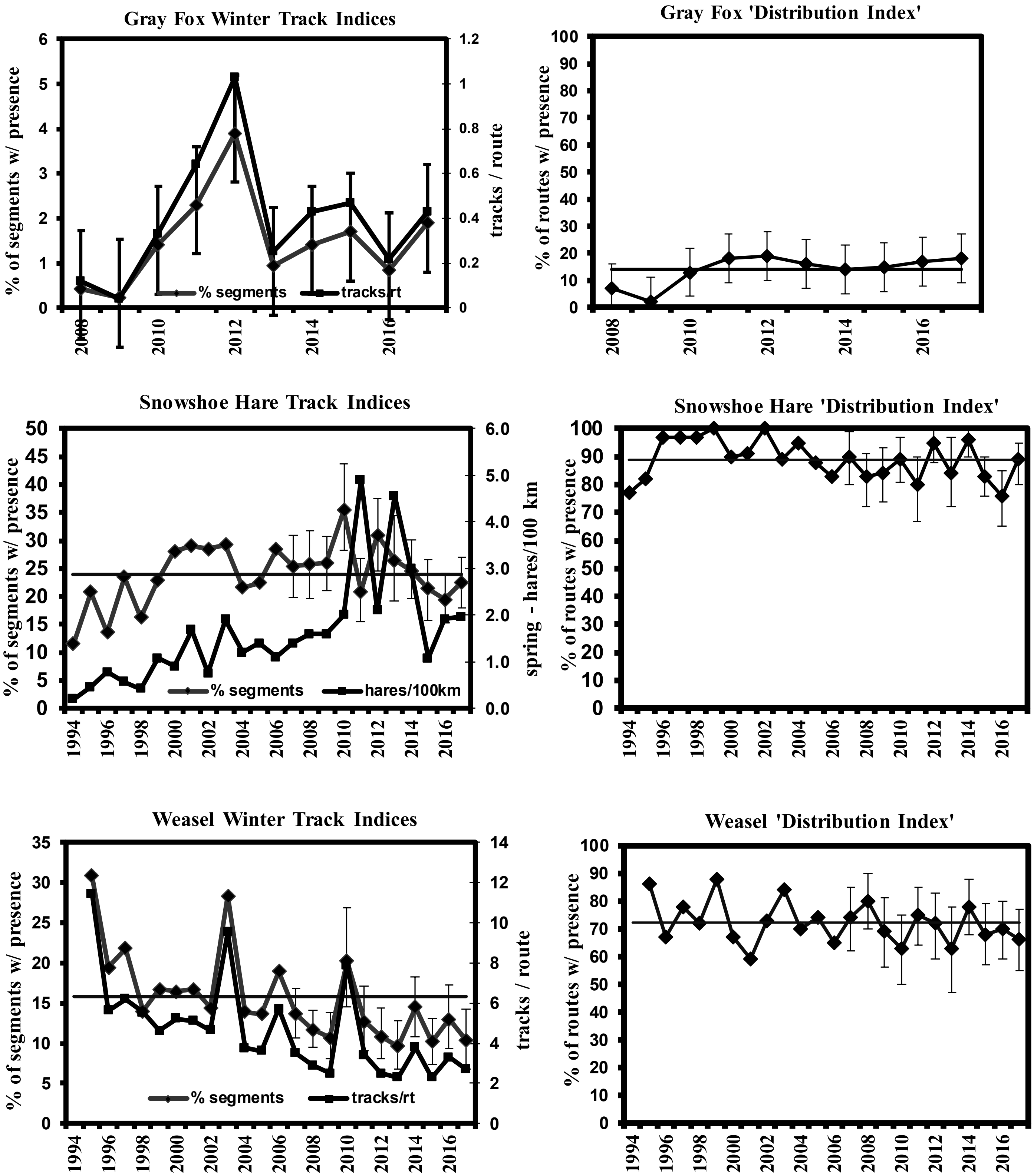


Figure 4 (continued). Winter track indices for selected species in Minnesota, 1994-2017.