United States
Department
of Agriculture

Forest Service

**Rocky Mountain
Research Station**

Research Paper
RMRS-RP-39

March 2003

Detecting Swift Fox: Smoked-Plate Scent Stations Versus Spotlighting

Daniel W. Uresk
Kieth E. Severson
Jody Javersak

Abstract

Uresk, Daniel W.; Severson, Kieth E.; Javersak, Jody. 2003. **Detecting swift fox: smoked-plate scent stations versus spotlighting**. Res. Pap. RMRS-RP-39. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 5 p.

We compared two methods of detecting presence of swift fox: smoked-plate scent stations and spotlight counts. Tracks were counted on ten 1-mile (1.6-km) transects with bait/tracking plate stations every 0.1 mile (0.16 km). Vehicle spotlight counts were conducted on the same transects. Methods were compared with Spearman's rank order correlation. Repeated measures analysis of variance was used to test the null hypothesis that there were no differences between months or between days that track and spotlight counts were conducted. We also evaluated optimum spacing of tracking plates by comparing estimates of the proportion of plates with swift fox tracks based on all plates against estimates based on a subset of plates with the latter mimicking a lower sampling intensity. Analyses of spotlight counts were limited by the preponderance of zero data points. Further, there was no defined relationship between track counts and spotlight counts. We determined that track stations could be used successfully to detect swift fox. More tracks were found in September than in July or August. We suggest a system of 1-mile (1.6-km)-long transects with four stations placed at 0.3-mile (0.5-km) intervals during late August and September. We also recommend counting tracks for 2 to 3 consecutive nights to ensure an adequate sample.

Keywords: swift fox, *Vulpes velox*, monitoring techniques, track counts, spotlight counts, smoked plates, South Dakota

Authors

Dr. Daniel W. Uresk is Project Leader and Research Biologist with the Rocky Mountain Research Station's Center for Great Plains Ecosystem Research in Rapid City, SD.

Dr. Kieth E. Severson (retired) was a Research Wildlife Biologist at the Rocky Mountain Research Station in Rapid City, SD, and Tempe, AZ. His current address is Isle, MN 56342.

Jody Javersak is a Biological Science Technician at the RMRS Center for Great Plains Ecosystem Research, Rapid City, SD.

Acknowledgments

This study was done in cooperation with South Dakota State University, Department of Wildlife and Fisheries (cooperative agreement 28-C1-586). Partial funding was provided by the Nebraska National Forest. Thanks are extended to Steve Denison and Darin Hirschkorn for data collection and to Lynn Hetlet and Bob Hodorff for technical expertise and assistance. As always, Rudy King, Station Biometrician, provided invaluable assistance and advice. We would also like to thank Robert Childress, Greg Schenbeck, Fred Lindzey, and two anonymous reviewers for comments on an earlier version of this manuscript.

You may order additional copies of this publication by sending your mailing information in label form through one of the following media. Please specify the publication title and number.

Telephone	(970) 498-1392
FAX	(970) 498-1396
E-mail	rschneider@fs.fed.us
Web site	http://www.fs.fed.us/rm
Mailing Address	Publications Distribution Rocky Mountain Research Station 240 West Prospect Road Fort Collins, CO 80526

Detecting Swift Fox: Smoked-Plate Scent Stations Versus Spotlighting

Daniel W. Uresk
Kieth E. Severson
Jody Javersak

Introduction

The swift fox (*Vulpes velox*), once abundant throughout the Great Plains, was distributed from southeastern Alberta southward into the Texas Panhandle and from the Rocky Mountains eastward to the western edge of the True or Tallgrass Prairie (Scott-Brown and others 1987). These small foxes were nearly extirpated from the Plains by 1900; none were reported from North Dakota between 1915 and 1970, from South Dakota between 1914 and 1966, or from Nebraska between 1901 and 1953 (Hillman and Sharps 1978). The decline was attributed to predator and rodent control programs involving the use of poisons, trapping, and hunting, and to the destruction of native prairie habitat (Bailey 1926; Robinson 1953). Since 1966, however, occasional sightings have been reported from these three States. A continued increase in the number of sightings has suggested that a small population is establishing in western South Dakota (Hillman and Sharps 1978). The swift fox is currently listed as a threatened species in South Dakota.

Management agencies are expected to monitor threatened, endangered, and sensitive species. However, it is difficult to determine the occurrence, population trend, or local distribution of rare species, especially those that are primarily nocturnal, such as the swift fox. Direct observations of individuals from spotlight counts and indirect methods, such as track counts on scent stations, have been successfully used for other species, for example, coyote (*Canis latrans*) (Linhart and Knowlton 1975; Woelfl and Woelfl 1997), gray fox (*Urocyon cinereoargenteus*) (Conner and others 1983), red fox (*Vulpes vulpes*) (Wood 1959), and kit fox (*V. macrotis*) in Utah (Thacker 1995) and California (Ralls and Eberhardt 1997). None have been shown to be effective for swift fox, however. The objective of this study was to compare the effectiveness of spotlight and smoked-plate scent station track counts as a tool to determine presence of swift fox in prairie habitats.

Study Area and Methods

This study was conducted in Fall River County, southwestern South Dakota, on private land and on lands administered by the USDA Forest Service, Buffalo Gap National Grassland. The area, located 5 miles east of Ardmore, South Dakota, included 16 sections (4,144 ha) of mixed prairie habitat dominated by western wheatgrass (*Pascopyrum smithii*) and blue grama (*Bouteloua gracilis*). Topography was gently rolling upland straddling the divide between Mule Creek and Horsehead Creek. Small, first-order drainages flowed northwest toward Mule Creek or southeast to Horsehead Creek. Several cattle allotments were grazed in either season-long or rotation grazing systems. During the time of this study, a population of approximately 60 swift fox was being monitored in the area as part of another study.

Ten 1-mile (1.6-km)-long permanent transects were established along existing roadways (pasture roads and trails). Track plates, 24 x 24 inches (61 x 61 cm), constructed of thin galvanized steel on top of 1/2-inch (1.3-cm) outdoor particle board, were placed approximately 15 m off the road at 0.1-mile (0.16-km) intervals along each transect for a total of 10 plates per transect. Plates were smoked with a torch using pure acetylene (no oxygen) and a plumber's torch tip. Smoke was applied by using a gentle back-and-forth movement with low pressure, just enough to smoke the plate without heating it. A stake hole, 1 x 1¾ inches (2.5 x 4.4 cm), was cut in the center to hold the plate in place. A small amount (about 60 g) of canned mackerel packed in oil (fig. 1) was placed near the center of each plate. Plates were placed on transects on one day and revisited every day for 3 days. Bait was freshened every day by adding either more mackerel or just oil.

Selection of the plate/bait combination described above was based on tests conducted on the study area. Combinations of track detectors, including sand, grease, grease and smoke, grease and lime powder, and just smoke, were tested with canned mackerel, canned tuna, bacon, and fatty acid scent tabs, and placed around known den sites.

Spotlight counts were conducted from a 4-wheel-drive vehicle equipped with a bank of three forward-directed spotlights, constructed from airport landing lights, attached to the top of the cab. The two observers were also equipped

Figure 1—Smoked track plate with bait.

Table 1—Mean number of plates ± standard deviation per transect (n = 10) with swift fox tracks on the first, second, and third day of sampling during July, August, and September 1993.

	Day			
Month	1	2	3	Mean/day[a]
July	2.1 ± 2.1	1.4 ± 1.4	1.4 ± 0.7	1.6 ± 1.5a
August	1.2 ± 1.9	1.9 ± 1.9	3.1 ± 2.9	2.2 ± 2.4a
September	3.1 ± 3.3	4.8 ± 4.0	6.1 ± 3.9	4.7 ± 3.8b
Mean/month	2.1 ± 2.6	2.7 ± 3.1	3.5 ± 3.4	

[a]Averages within this column followed by the same letter are not significantly different according to Dunnett's T3 procedure (P = 0.10).

with similar, but hand-held, spotlights to illuminate areas off the side of the road. When an animal was located, the vehicle was stopped and identification made. Spotlight counts were conducted during the same nights track counts were being obtained for 3 consecutive nights during each of July, August, and September.

The number of plates with swift fox tracks per transect was analyzed for variation among months, and among days within months, using a variance-weighted analysis of variance to account for heterogeneous variance (Wilcox 1997). Dunnett's T3 heterogeneous variance multiple comparison procedure was used to separate means of significant factors (Dunnett 1980). The number of foxes seen by spotlight counts were too few for analysis of variance, but were compared to track counts with Spearman's rank correlation. All statistical inferences were made at a probability level of 0.10.

We evaluated optimum spacing of tracking plates by comparing estimates of the proportion of plates with swift fox tracks based on all plates against estimates based on subsets of plates, with the latter mimicking a lower sampling intensity. Subsets were:

- Two samples of 50 plates (every other plate per transect, mimicking plates placed every 0.2 mile [0.3 km]).
- Three samples of 33 plates (every third plate per transect, mimicking plates placed every 0.3 mile [0.5 km]).
- Four samples of 25 plates (every fourth plate per transect, mimicking every 0.4 mile [0.6 km]).
- Five samples of 20 plates per transect (every fifth plate per transect, mimicking every 0.5 mile [0.8 km]).

With n = 100 plates, a P = 0.90 confidence interval on the overall proportion estimate is approximately ± 0.08 (figs. 2–5), which provides a perspective for evaluating how closely individual sample estimates correspond to the overall estimate.

We estimated the number of stations required to reliably detect the presence of swift fox using the binomial distribution

$$f_x(x) = \Pr(X = x) = \binom{n}{x} p^x (1-p)^{n-x},$$

where p is the probability that a station will have a track, n is the number of stations, and $x \le n$ is the number of stations with tracks.

$$\Pr(\text{detect at least one track}) = 1 - \Pr(\text{detect no tracks}) = 1 - \Pr(X = 0) = 1 - (1-p)^n.$$

Results

Analysis of spotlight counts was not computed because of the preponderance of zero data points. Swift foxes were observed on only 14 of the 90 transects (10 transects x 3 replications x 3 months) counted; 12 observations were of single animals and 2 were of two foxes.

Analyses of scent-station data indicated significant differences among months (p = 0.007), but no differences were detected among days within each month (July, p = 0.770; August, p = 0.727; September, p = 0.878). Track counts in September were significantly higher than in July or August (table 1).

There was no defined relationship between track counts and spotlight counts (Spearman's rank correlation: r = 0.095, n = 90, p = 0.375). This analysis, however, may be somewhat clouded by the preponderance of zero data among spotlight transects.

Analysis of plate spacing revealed that sample estimates of every 0.2 mile (0.3 km) (fig. 2) and 0.3 mile (0.5 km) (fig. 3) usually fell within ±0.08, while sample estimates of 0.4 mile (0.6 km) (fig. 4) and 0.50 mile (0.8 km) (fig. 5) frequently did not. This provides an approximate indication that 0.3 mile (0.5 km) is the longest spacing between plates that should be used.

An alternative framework for estimating number of stations is to ask how many stations are needed to detect any presence of swift fox. If swift fox is rare or for other reasons is unlikely to track very many plates (for example, 1 out of 20 plates in the bottom curve of fig. 6), then a sample of 20 plates would provide only a 60-percent chance of seeing even one track. Alternatively, if swift fox were more common or otherwise more likely to track a plate (for example, 5 out of 20 plates in the top curve in fig. 6), then a sample of 20 plates would very likely detect the presence of swift fox.

Discussion and Management Implications

The smoked plate/canned mackerel combination attracted the most swift fox activity and yielded the most definitive tracks. Tracks in sand or those with grease were often difficult to identify. All meat-based baits attracted foxes, but mackerel was superior to either bacon or tuna. Swift fox

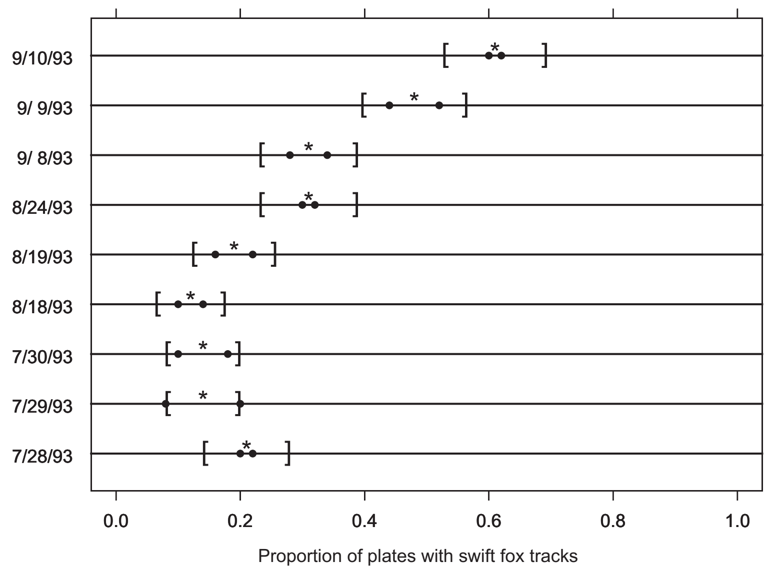

Figure 2—Estimates for two samples of 50 plates spaced at 0.2 miles, with • = mean of each subset, ⋆ = mean of all plates, and [ ] = associated P = 0.9 confidence limits based on all plates, by sampling date.

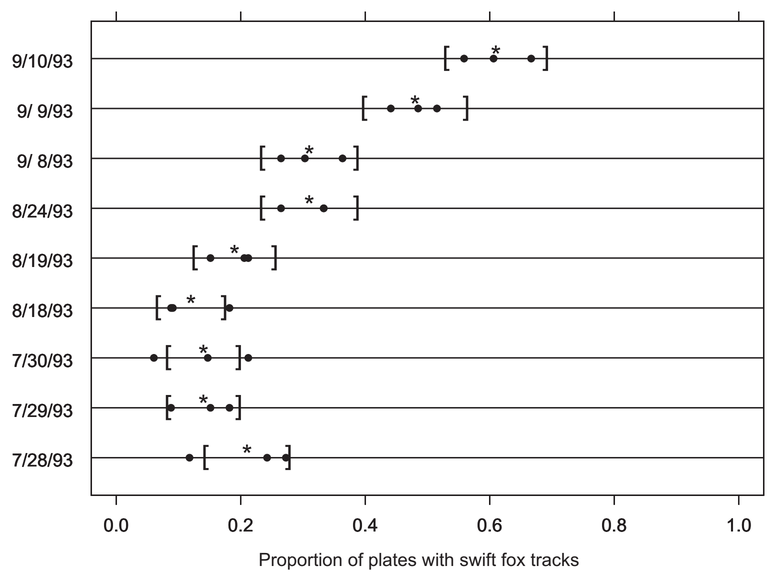

Figure 3— Estimates for three samples of 33 plates spaced at 0.3 miles, with • = mean of each subset, ⋆ = mean of all plates, and [ ] = associated P = 0.9 confidence limits based on all plates, by sampling date.

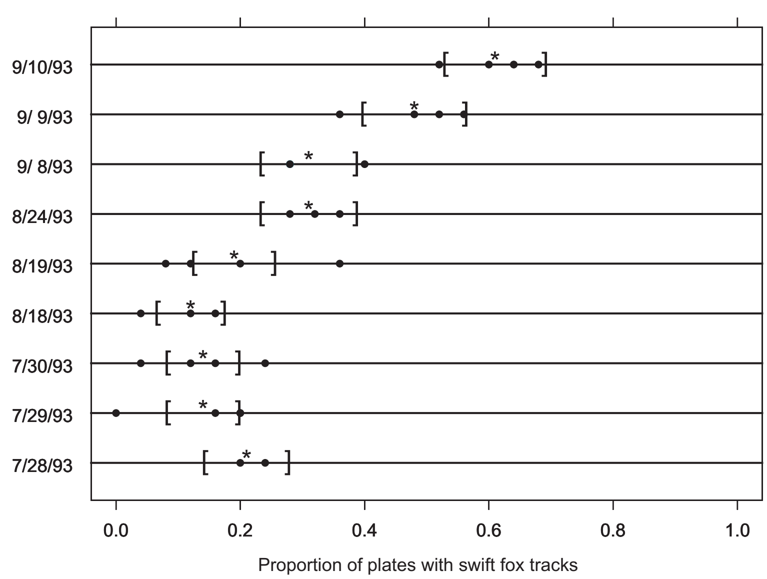

Figure 4—Estimates for four samples of 25 plates spaced at 0.4 miles, with • = mean of each subset, ⋆ = mean of all plates, and [ ] = associated P = 0.9 confidence limits based on all plates, by sampling date.

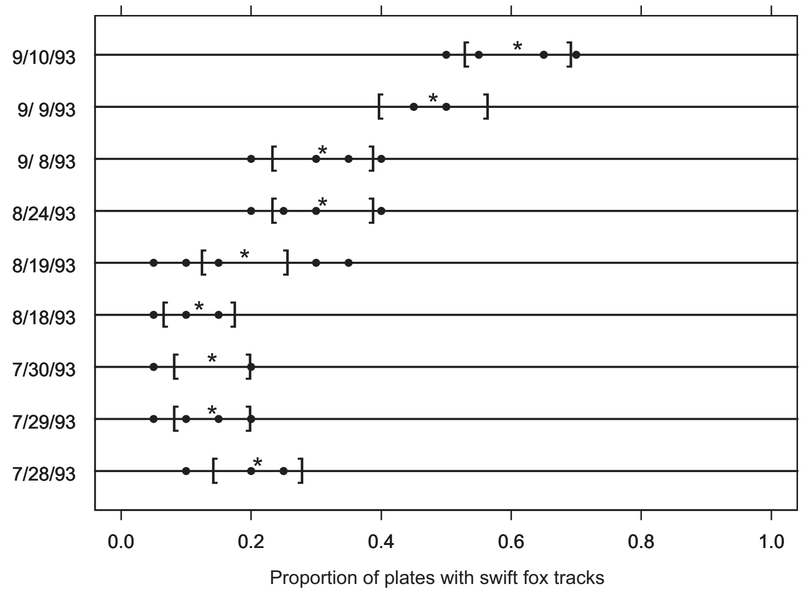

Figure 5—Estimates for five samples of 20 plates spaced at 0.5 miles, with • = mean of each subset, ⁎ = mean of all plates, and [ ] = associated P = 0.9 confidence limits based on all plates, by sampling date.

were not attracted by fatty acid scent tabs. Smoked plates were effective in obtaining clear tracks except when rain or heavy dew obliterated tracks, a problem common to other tracking media as well (Linhart and Knowlton 1975). Smoking with acetylene is difficult and presents safety hazards. Our efforts with powdered lime were not successful; tracks were difficult to identify on this medium but we used it with a grease base, which may have contributed to the lack of definition. A recently developed method using carpenter's chalk in an isopropyl alcohol dispersant (Orloff and others 1993) may offer an alternative. These authors concluded that tracks thusly obtained were almost as detailed as those from smoke soot, that the medium was easier to apply than smoke, and did not present a fire hazard.

Most track count studies have estimated population trends without verifying or comparing results with another independent method of population estimation (Linhart and Knowlton 1975; Wood 1959). This is a valid approach for monitoring trends if the target species can be properly and adequately detected by the method. Conner and others (1983), for example, when comparing scent-station indices to mark/recapture, radioisotope tagging, and radio telemetry, found that bobcat (*Felis rufus*), raccoon (*Procyon lotor*), and gray fox (*Urocyon cinereoargenteus*) populations could be reliably indexed by scent-station transects, but that opossums (*Didelphis virginiana*) could not be reliably indexed. Both bobcats and opossums had relatively low visitation rates to scent-stations, but bobcats were regular visitors whereas opossum use varied so much that analyses were meaningless. Similarly, we could not detect a meaningful relationship between the two methods (track counts and spotlighting) because swift foxes could not be reliably located by the spotlighting technique. This resulted in a preponderance of missing spotlight data, which rendered subsequent analyses irrelevant. Use of smoked-plate scent stations, however, provided consistent and reliable patterns of swift fox presence.

We believe that a properly designed system of smoked-plate bait station transects can be used to detect the presence of swift fox. Our design of 10 transects over an area of 16 miles^2 with 10 stations per 1-mile transect resulted in good transect-level detection. However, this sampling effort may prove too costly. If the probability that a swift fox tracks a station is $p = 0.1$, or about the smallest rate in our observed data, then 20 stations provide >80 percent probability that swift fox will be detected. At minimum, we suggest using 1-mile (1.6-km)-long transects with bait-station tracking plates placed every 0.3 mile (0.5 km), for a total of four stations per transect. No information is currently available on the number of transects required per unit area (Conner and others 1983), but, based on our 16-mile^2 (41.4-km^2) study area, we

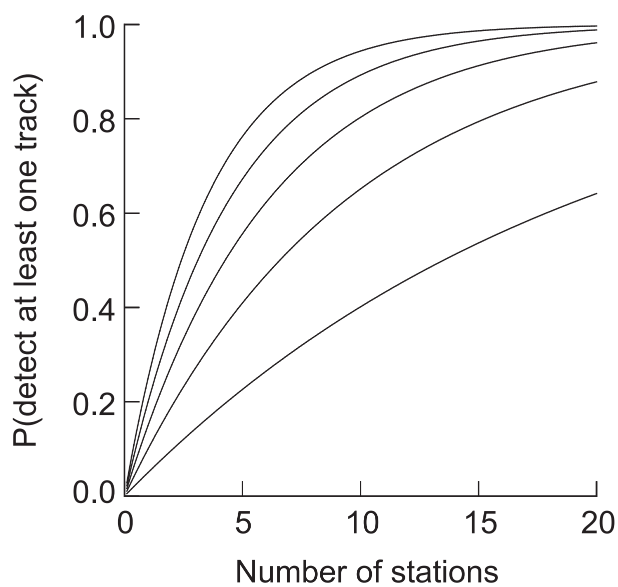

Figure 6—Probability of detecting at least one track as a function of number of stations for p = 0.05 (bottom curve), 0.1, 0.15, 0.2, and 0.25 (top curve).

suggest a minimum of five transects with four stations per transect over 15 to 18 miles^2 (38.8 to 46.6 km^2). This sampling design would cover about two to three times the area of an average swift fox home range size of 6.0 miles^2 (15.5 km^2) reported for swift fox in Nebraska (Hines 1980). Although still intensive, redundancy of effort is preferable to failing to detect rare animals (Zielinski and others 1995). Transects should be placed in areas characteristic of swift fox denning sites (fig. 7) within locally available potential swift fox habitat: short- to midgrass rolling prairie, sloping plains, or agricultural fields (Cutter 1958; Kilgore 1969; Uresk and Sharps 1986; Uresk and others 2003).

Techniques must be standardized (Conner and others 1983). Transect locations, plate locations, tracking medium, attractant, and time of sampling must remain the same among sampling intervals. Roughton and Sweeny (1983) recommend that surveys for carnivore populations be conducted when juveniles are dispersing. Our results indicated that the number of plates with tracks increased from July through September, presumably due to increased mobility and dispersal of young foxes. Hence, track counts for detection should be conducted no earlier than mid-August and continue into September when a maximum number of foxes are moving.

Although track counts tended to increase from the first through the third day of August and September (table 1) no statistical differences were noted. This indicates that counting tracks for only 1 night might provide an adequate sample for detecting swift fox. However, lack of significance among days is likely the result of high variability in our data as indicated by the large standard deviations (table 1). The variable nature of these data and the tendency for increasing means from the first through the third day suggest that sampling for 2 or 3 nights would be prudent. We therefore concur with recommendations by Conner and others (1983) that multiple-night sampling be considered for rare or uncommon species.

Figure 7—Swift fox pup at den site.

While spotlight counts alone are not adequate for detecting swift fox, the method would be useful in locating den sites and for estimating the number of young produced per den per year once swift fox are detected in the area. Den sites could be located by noting locations of plates with tracks and then searching habitats in those areas (Scott-Brown and others 1987). If denning sites could be located early, approximately April to mid-May in South Dakota, spotlight counts would yield number of adults and number of young at each known den site.

References

Bailey, V. 1926. A biological survey of North Dakota. North American Fauna No. 49. Washington, DC: U.S. Department of Agriculture.

Conner, M. C.; Labinsky, R. F.; Progulske, D. R. 1983. Scent-station indices as measures of population abundance for bobcats, raccoons, gray foxes, and opossums. Wildlife Society Bulletin. 11(2): 146–151.

Cutter, W. L. 1958. Denning of the swift fox in northern Texas. Journal of Mammalogy. 39(1): 70–74.

Dunnett, C. W. 1980. Pairwise multiple comparisons in the unequal variance case. Journal of the American Statistical Association. 75: 796–800.

Hillman, C. N.; Sharps, J. C. 1978. Return of swift fox to Northern Great Plains. South Dakota Academy of Science. 57: 154–162.

Hines, T. 1980. An ecological study of *Vulpes velox* in Nebraska. Lincoln: University of Nebraska. Thesis

Kilgore, D. L., Jr. 1969. An ecological study of the swift fox (*Vulpes velox*) in the Oklahoma Panhandle. American Midland Naturalist. 81: 512–534.

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

Orloff, S. G.; Flannery, A. W.; Belt, K. C. 1993. Identification of San Joaquin kit fox (*Vulpes macrotis mutica*) tracks on aluminum tracking plates. California Fish and Game. 79: 45–53.

Ralls, K.; Eberhardt, L. L. 1997. Assessment of abundance of San Joaquin kit foxes by spotlight surveys. Journal of Mammalogy. 78: 65–73.

Robinson, W. B. 1953. Population trends of predators and fur animals in 1080 station areas. Journal of Mammalogy. 34(2): 220–227.

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

Scott-Brown, J. M.; Herrero, S.; Reynolds, J. 1987. Swift fox. In: Novak, M.; Baker, J.; Ubbard, M.; Mallock, B., eds. Wild furbearer management and conservation in North America. Ontario, Canada: Ministry of Natural Resources: 433–440.

Thacker, R. K. 1995. Comparison and use of four techniques for censusing three sub-species of kit fox. Provo, UT: Brigham Young University. Thesis.

Uresk, D. W.; Severson, K. E.; Javersak, J. 2003. Vegetative characteristics of swift fox (*Vulpes velox)* denning and foraging sites in southwestern South Dakota. Res. Pap. RMRS-RP-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 4 p.

Uresk, D. W.; Sharps, J. C. 1986. Denning habitat and diet of the swift fox in western South Dakota. Great Basin Naturalist. 46(2): 249–253.

Wilcox, R. R. 1997. Introduction to robust estimation and hypothesis testing. San Diego, CA: Academic Press. 296 p.

Woelfl, S.; Woelfl, M. 1997. Coyote, *Canis latrans*, visitations to scent stations in southeastern Alberta. Canadian Field Naturalist. 111: 200–203.

Wood, J. E. 1959. Relative estimates of fox population levels. Journal of Wildlife Management. 23(1): 53–63.

Zielinski, W. J.; Kucera, T. E; Halfpenny, J. C. 1995. Chapter 2: Definition and distribution of sample units. In: Zielinski, W. J.; Kucera, T. E., tech. eds. American marten, fisher, lynx, and wolverine: survey methods for their detection. Gen. Tech. Rep. PSW-157. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 17–24.

RMRS
ROCKY MOUNTAIN RESEARCH STATION

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications may be found worldwide.

Research Locations

Flagstaff, Arizona
Fort Collins, Colorado*
Boise, Idaho
Moscow, Idaho
Bozeman, Montana
Missoula, Montana
Lincoln, Nebraska
Reno, Nevada
Albuquerque, New Mexico
Rapid City, South Dakota
Logan, Utah
Ogden, Utah
Provo, Utah
Laramie, Wyoming

*Station Headquarters, Natural Resources Research Center,
2150 Centre Avenue, Building A, Fort Collins, CO 80526