Transactions of the Kansas Academy of Science
Vol. 109, no. 1/2
p. 3-10 (2006)

The effect of scent-station precipitation covers on visitations by mammalian carnivores and eastern cottontails.

Roger A. Baldwin[1,2], Philip S. Gipson[1], Gerald L. Zuercher[1,3], and Troy R. Livingston[1]

1. *Kansas Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, Division of Biology, 205 Leasure Hall, Kansas State University, Manhattan, Kansas 66506*
2. *Present address: Department of Fishery and Wildlife Sciences, P.O. Box 30003 MSC 4901, New Mexico State University, Las Cruces, New Mexico 88003 rbaldwin@nmsu.edu*
3. *Present address: Department of Natural and Applied Sciences, University of Dubuque, 2000 University Avenue, Dubuque, Iowa 52001-5099*

The distribution and abundance of mammalian predators are difficult to monitor because of their elusive nature. One tool used to monitor predators is strategically placed tracking stations. Precipitation often renders tracking stations unreadable by obscuring tracks and other sign. In our study we sought to evaluate the feasibility of placing covers over stations to protect tracking surfaces from precipitation. Survival of the cover structures was negatively correlated with wind speed and positively correlated with woodlands. This suggested that covers might be best used in areas with low wind speeds and/or in forests or other sites that provide shelter from wind. Covers appeared to negatively affect visitations by coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and eastern cottontails (*Sylvilagus floridanus*), but not raccoons (*Procyon lotor*) or Virginia opossums (*Didelphis virginiana*). Track quality was not substantially different for covered stations during light rain or snow.

Keywords: covers, monitoring, scent-stations, wildlife.

Introduction

Many techniques have been used to monitor mammalian predator populations including aerial counts (Knowlton 1984; Sargeant, Johnson and Berg 1998), scat deposition rates (Clark 1972), rural mail-carrier sightings (Allen and Sargeant 1975), tracking stations in sifted soil with scent attractants (Linhart and Knowlton 1975; Roughton and Sweeny 1982; Sargeant, Johnson and Berg 1998), and smoked metal plates to record tracks (Zielinski and Kucera 1995). Of these techniques, perhaps the most widely used and critically evaluated is the use of scent-stations in sifted soil (Sargeant, Johnson and Berg 1998). Scent-stations have been used to document the occurrence of particular predators in an area. Attempts have also been made to correlate size of predator populations with the number of visits to scent-stations (Conner, Labisky and Progulske 1983; Leberg and Kennedy 1987; Diefenbach et al. 1994). Results from scent-stations are often disputed when used to estimate abundance (Sargeant, Johnson and Berg 1998). Some research has shown a positive relationship between predator populations and visits to scent-stations (Conner, Labisky and Progulske 1983; Leberg and Kennedy 1987; Diefenbach et al. 1994), while others have not (Nottingham, Johnson and Pelton 1989). Nonetheless, scent-stations may be useful in determining long-term trends in predator populations (Sargeant, Johnson and Berg 1998) if this positive relationship exists.

Scent-station surveys continue to be used in predator studies because they are easily standardized, repeatable, relatively inexpensive to use (Linscombe, Kinler and Wright 1983; Nottingham, Johnson and Pelton 1989; Diefenbach et al. 1994), and there is a lack of other credible census techniques. Also, there is evidence that non-predatory mammals, such as eastern cottontails (*Sylvilagus floridanus*), might be attracted to scent-stations in sifted soil (Drew, Fagre and Martin 1988). Therefore, scent-stations were monitored on forest and prairie sites as part of a long-term study of predator and habitat associations on Fort Riley Military Reservation, Kansas (Page 1997).

One problem with using scent-stations to assess such associations is that tracks are often obscured by precipitation. A study conducted in Nicaragua showed that shelters could be placed over scent-stations to keep rain from obscuring tracks (Nachman 1993) with no noticeable effect on visitation rates of target species. We evaluated the effectiveness of covers placed over scent-stations on Fort Riley Military Reservation in northeastern Kansas. Four questions were addressed: 1) What was the survival rate of precipitation covers in different vegetation types and under different wind conditions? 2) Were visitation rates impacted when covers were placed over stations? 3) If covers impacted visitation to covered stations, was 20 m an adequate distance between covered and uncovered stations to avoid biasing visitation rates to uncovered stations? 4) Did covers maintain track imprint quality during precipitation events?

Methods

Study site

This study was conducted on Fort Riley Military Reservation, a 40,273 ha U.S. Army installation in the Flint Hills of northeastern Kansas. The Flint Hills region contains the largest contiguous remnant of tallgrass prairie in North America (Zimmerman 1985; Lauver 1994). The most common grasses present are big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) (U.S. Army 1994; Michaels and Cully 1998). Trees generally occur in the narrow valley bottoms and along moist rocky outcrops. The most abundant trees are bur oak (*Quercus macrocarpa*), chinkapin oak (*Quercus muhlenbergii*), American elm (*Ulmus americana*), red mulberry (*Morus rubra*), bitternut hickory (*Carya cordiformis*), black walnut (*Juglans nigra*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), cottonwood (*Populus deltoides*), and honey locust (*Gleditsia triacanthos*) (U.S. Army 1994; Michaels and Cully 1998).

Cover Design

Covers were constructed from polyvinyl chloride (PVC) pipe and clear plastic sheeting (3.5 mm; Fig. 1). A U-shaped frame of PVC pipe, 2 m in height, 2 m in length, and 2 m in width at the base was centered over a scent-station and plastic sheeting was stretched over the frame extending 1.5 m along both sides of the frame. Nylon lines were attached to the plastic sheet and to stakes driven into the ground and were adjusted to keep the sides of the plastic cover at least 1 m above the ground to minimize frightening animals.

Study Design

Thirty scent station sites were randomly selected from 64 stations established in an

Figure 1 - Precipitation cover over a scent station.

earlier study (Johnson, Gipson and Pontius 1997). Thirteen sites were in prairie, 9 were in woodland, and 8 were in prairie and woodland edge. At each site, 2 circular 1 m^2 scent-stations were established 20 m apart with tracking surfaces of fine mason sand mixed with soil from the site in approximately a 50:50 ratio. A standard fatty acid scent tablet was placed in the center of the station to serve as an attractant (Roughton and Sweeny 1982). A cover was placed over 1 scent station, while the second station was not covered. Covered stations were constructed on alternating left and right sides of selected sites. The stations were placed 20 m apart to minimize the possibility of the cover impacting animal visits to the uncovered site. Scent stations were monitored for one 24 hour period each season from July 1998 through May 1999. Seasons were defined as standard calendar seasons. Costs of establishing and operating covered and uncovered scent stations for each season were calculated.

Snow was used as the tracking-station surface for 14 sites in winter when several cm of snow covered the ground and a high likelihood of freezing sand existed. This change in tracking surface introduced a possible bias and these sites were not considered for statistical analysis. Differences in visitations to covered and uncovered sites were evaluated using Chi-square goodness of fit analysis.

Although pairs of scent-stations were separated by 20 m, the covered station and its uncovered match might have been too close to consider them independent of each other. Precipitation covers could possibly have biased visitations to the uncovered station, as well as to the covered match. To evaluate the potential bias of placing uncovered stations near covered ones, we compared visitation rates to the uncovered sites to standard scent-stations operated concurrently on the fort $\geq$ 2 km away from these sites using McNemar's Test (PROC FREQ; SAS Institute 1997). The protocols for operating the standard scent-stations were the same as for the covered stations. Analysis was performed for stations in the 3 vegetation types and for all vegetation types combined.

The tracking surface of each station was assigned a numerical ranking to help evaluate the effect of covers on the readability of the scent-stations. Rankings for scent-stations are: 3 = all tracks identifiable; 2 = 50 to 99% of tracks identifiable; 1 = less than 50% of tracks identifiable; 0 = no tracks identifiable.

As the study progressed, several cover structures were destroyed by wind. If a cover was destroyed, that station and its uncovered match were removed from analysis. Spearman's Ranked Correlation Analysis was used to determine relationships between wind speed and survival of covers, as well as relationships between habitat type and cover survival (PROC CORR; SAS Institute 1997).

Results

The percentages of stations that remained operable throughout the 24-hour test period varied from summer 1998 through spring 1999, and were 100%, 70%, 50%, and 45%, respectively. Mean maximum wind speeds for 24-hour periods when stations were operated were 16 km/h, 37 km/h, 53 km/h, and 43 km/h for each season, respectively. Cover survivorship for all seasons in prairie habitats was 54%, 67% in edge habitats, and 83% in woodland habitats. Wind speed and cover survival were negatively correlated (r_s = –0.507, $P < 0.001$), while cover survival and vegetation type were positively correlated (r_s = 0.249, $P = 0.006$) with greatest survival in woodlands and lowest in prairie. The effect of wind speed on covers for each vegetation type is shown in Fig. 2.

The number of visits to covered and uncovered stations was similar for coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and Virginia opossums (*Didelphis virginiana*;

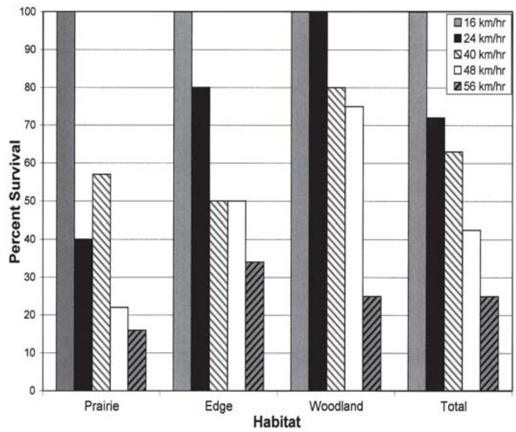

Figure 2 - Percent of precipitation covers that survived in each habitat type during 24 hour periods with different wind speeds.

Table 1). Coyotes were the most common visitors to standard scent-stations, but they tended to avoid stations at the cover sites. No bobcats (*Lynx rufus*) visited the covered or uncovered sites, while their tracks were often identified at standard scent-stations. Eastern cottontails commonly visited uncovered stations but visited no covered stations, while striped skunks more frequently visited covered stations than uncovered (Table 1).

Results from McNemar's Test showed that coyotes visited standard scent-stations more frequently in prairie and in all vegetation types combined, while bobcats visited standard stations more frequently in woodlands and in all vegetation types combined (Table 2). No detectable difference was found in visitation rates by raccoons to either set of scent-stations when each vegetation type was considered, but more visits by raccoons to covered scent-stations were noted when all vegetation types were combined.

Precipitation covers slightly improved tracking condition of stations during light rain (n = 12 for both covered and uncovered; mean = 1.8 for covered, mean = 1.5 for

Visitors	Uncovered stations (n = 78)	Covered Stations (n = 78)	Standard stations (n = 116)
Coyote	2	1	22
Bobcat	0	0	8
Raccoon	12	11	8
Skunk	1	6	6
Opossum	2	3	7
Cottontail	8	0	8

Table 1. Number of visits by each species to uncovered, covered, and standard scent-stations from summer 1998 to spring 1999.

uncovered) but had no effect on the tracking condition of sites during light snowfall (n = 4 for both covered and uncovered; mean = 2 for both covered and uncovered). Costs of materials and labor to establish and check scent-stations with precipitation covers averaged $12.05. The average cost to establish and check scent-stations without covers was $3.42

Discussion

Wind was the greatest source of damage to covers and it affected cover survival differently depending on vegetation structure around covers. Covers were more likely to survive in woodlands where they were sheltered by trees than on edge and prairie sites.

For station covers to be efficient, the likelihood of precipitation had to be greater than the chance that the structures would be blown down. Since precipitation occurred, in some form, approximately 25% of the time during our study, we calculated that a minimum of 80% survival would be required for covers to be effective. We considered survival rates ≥ 80% necessary to justify operating covered stations because of greater cost, which was approximately 3.5 times more than uncovered stations, and the need to have most stations operable to obtain representative data. Even with ≥ 80% survival of stations on average in all habitats, there could be a survival bias toward woodlands and, therefore, more records of visits in woodlands because of greater protection from wind provided by trees. We concluded that use of station covers were justified for open prairie sites when wind speeds were < 16 km/h, for edge sites when wind speeds were < 24 km/h, and for woodland sites when wind speeds were < 40 km/h (Fig. 2). Survival of our station covers was markedly reduced by wind speeds of 24 km/h (Fig. 2) in all vegetation types except woodlands.

Three precautions might increase the longevity of covers. First, they can be used when forecasted wind speeds are < 16 km/h. Second, covers can be placed in woodland sites sheltered from wind. Nachman (1993) reported no problems with cover survival in a dense tropical rain forest in Nicaragua, where the average maximum wind gusts rarely exceed 17 km/h (National Climate Data Center; http://www.ncdc.noaa.gov). Finally, more robust covers could be fabricated to withstand high winds. The covers in our study were designed with a steep roof that extended down the sides to shed precipitation and prevent it from blowing on the tracking station (Fig. 1). However, in contrast to Nachman's (1993) simple four-legged covers with flat roofs, the relatively large roof of our stations caught wind. Flat roofs would reduce the impact of wind on covers, but could collapse from the weight of rain, hail, or snow and allow more precipitation to blow in from the sides.

Our results suggest that precipitation covers could likely be used in studies of raccoons and Virginia opossums without biasing visitation rates. The greatest differences in visitation rates were those of eastern cottontails, coyotes, bobcats, and striped skunks (*Mephitis mephitis*). Since precipitation covers probably biased visitation rates by these species, such

Vegatation	Coyotes	Bobcats	Raccoons	Skunks	Opossums	Cottontails
All vegetation	$P < 0.001$*	$P = 0.020$*	$P = 0.039$*	$P = 0.079$	$P = 0.275$	$P = 0.657$
Prairie	$P = 0.002$*	$P = 0.228$	$P = 0.075$	$P = 0.201$	$P = 0.138$	$P = 0.580$
Edge	$P = 0.111$	$P = 0.338$	$P = 0.585$	------------	$P = 0.289$	$P = 0.557$
Woodland	$P = 0.790$	$P = 0.043$*	$P = 0.416$	$P = 0.251$	$P = 0.228$	$P = 0.135$

Table 2. McNemar's Test results comparing visits to standard scent-stations versus visits to uncovered scent-stations 20 m from stations with rain covers for three different vegetation types. (* indicates a significant difference at $\propto = 0.05$)

covers might not be appropriate for studies of them.

We found differences in visitation rates by predators to standard scent stations when compared to visits to the matched covered and uncovered stations. Coyotes and bobcats avoided sites with covered and uncovered stations, particularly in their preferred habitats (Fig. 2). On Fort Riley, prairie sites are generally preferred by coyotes (Kamler and Gipson 2000b), while woodland sites are preferred by bobcats, especially during fall and winter (Kamler and Gipson 2000a). Both species avoided sites with covered stations, even though they readily visited our standard stations. This suggests that 20 m was not an adequate separation of covered and uncovered stations.

Striped skunks were the only carnivores that appeared to be attracted to covered stations when they visited sites with both covered and uncovered stations (Table 1). Interestingly, the six visits by skunks to covered scent stations were identical to the number of visits by skunks to traditional scent stations.

Drew, Fagre and Martin (1988) found that eastern cottontails regularly visited scent stations in Texas, and they were common visitors to our uncovered scent stations on Fort Riley (Table 1). Eastern cottontails might have avoided the covered stations because they were unable to observe avian predators while under the structures. Even though our covers were constructed from clear plastic sheeting, it was not completely transparent and likely obstructed overhead views. Many raptors prey on cottontails (Chapman, Hockman and Ojeda 1980). Therefore, cottontails might be cautious about entering structures that obstruct overhead views. McNemar's Test showed no detectable difference in the use of traditional scent stations by eastern cottontails and the uncovered match of covered stations.

We had only limited opportunities to test the ability of the covers to increase the readability of tracking surfaces during precipitation. The average tracking conditions were similar for the covered stations and uncovered stations after light rain fell overnight in fall 1998. Snow flurries occurred during 1 night in the winter and only 4 covers remained operational. No difference was detected in tracking surfaces of these 4 stations. Covers did not appear to be effective in protecting tracking surfaces from snow that is much lighter than rain and more readily carried by wind. When snow falls under windy conditions, it is likely to be blown under the covers, thus reducing their effectiveness. In the absence of wind, tracking stations could be protected from rain and snow. A larger sample size is required to adequately test the effectiveness of covers during precipitation.

Acknowledgements

Funding was provided by the Conservation Division, Department of Defense, Fort Riley, Kansas, and by the Kansas Cooperative Fish and Wildlife Research Unit. We thank Dr. Jeffrey S. Pontius and Brian D. Carver for reviewing an early draft and suggesting changes to improve the manuscript.

Literature cited

Allen, S.H. and Sargeant, A.B. 1975. A rural mail-carrier index of North Dakota red foxes. Wildlife Society Bulletin 3, p. 74-77.

Chapman, J.A., Hockman, J.G. and Ojeda C., M.M. 1980. *Sylvilagus floridanus.* Mammalian Species 136, p. 1-8.

Clark, F.W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management 36, p. 343-356.

Conner, M.C., Labisky, R.F. and Progulske, Jr., D.R. 1983. Scent-station indices as measures of population abundance for bobcats, raccoons, gray foxes, and opossums. Wildlife Society Bulletin 11, p. 146-152.

Diefenbach, D.R., Conroy, M.J., Warren, R.J., James, W.E., Baker, L.A. and Hon, T. 1994. A test of the scent-station survey technique for bobcats. Journal of Wildlife Management 58, p. 10-17.

Drew, G.S., Fagre, D.G. and Martin, D.J. 1988. Scent-station surveys for cottontail rabbit populations. Wildlife Society Bulletin 16, p. 396-398.

Johnson, J.S., Gipson, P.S. and Pontius, J.S. 1997. Habitat preferences of mammalian predators in the Flint Hills of Kansas. Research Report, Kansas Cooperative Fish and Wildlife Research Unit, Kansas State University, Manhattan, 12 p.

Kamler, J. and Gipson, P.S. 2000a. Home range, habitat selection, and survival of bobcats, *Lynx rufus*, in a prairie ecosystem in Kansas. Canadian Field-Naturalist 114, p. 388-394.

Kamler, J. and Gipson, P.S. 2000b. Space and habitat use by resident and transient coyotes. Canadian Journal of Zoology 78, p. 2106-2111.

Knowlton, F.R. 1984. Feasibility of assessing coyote abundance on small areas. Annual Report of Predator Ecology and Behavior Project, Denver Wildlife Research Center, 14 p.

Lauver, C.L. 1994. Natural community analysis of Fort Riley Military Reservation. Kansas Biological Survey, Report No. 59, Lawrence, 31 p.

Leberg, P.L. and Kennedy, M.L. 1987. Use of scent-station methodology to assess raccoon abundance. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 41, p. 394-403.

Linhart, S.B. and Knowlton, F.R. 1975. Determining the relative abundance of coyotes by scent station lines. Wildlife Society Bulletin 33, p. 119-124.

Linscombe, G., Kinler, N. and Wright, V. 1983. An analysis of scent station response in Louisiana. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 37, p. 190-200.

Michaels, H.L. and Cully, Jr., J.F. 1998. Landscape and fine scale habitat associations of the Loggerhead shrike. Wilson Bulletin 110, p. 474-482.

Nachman, J.E. 1993. Preliminary comparison of four neotropical survey techniques for terrestrial mammals. M.S. Thesis, University of Wisconsin Stevens Point, 54 p.

Nottingham, Jr., B.G., Johnson, K.G. and Pelton, M.R. 1989. Evaluation of scent-station surveys to monitor raccoon density. Wildlife Society Bulletin 17, p. 29-35.

Page, K. 1997. Determining the abundance of selected species of mammalian predators on Fort Riley Army Installation, Kansas. Special Report, Natural Resources Division, Fort Riley, Kansas, 29 p.

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

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

SAS Institute. 1997. SAS/STAT user's guide. Version 6.11, 4th ed., vol. 1-2. SAS Institute Inc., Cary, North Carolina.

U. S. Army. 1994. Integrated natural resource management plan for Fort Riley, Kansas. Louis Berger and Associated, Inc., Washington, D.C, 178p.

Zielinski, W. J., and Kucera, T.E. 1995. American marten, lynx, and wolverine: survey methods for their detection. General Technical Report PSW-GTR-157. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, 163 p.

Zimmerman, J.L. 1985. The birds of Konza Prairie Research Natural Area, Kansas. Prairie Naturalist 17, p. 185-192.