A Comparison of Attractants Used for Carnivore Track Surveys

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Abstract: Scent-station surveys have been used to examine trends in felid and canid abundance throughout the Southeast. Scent station methods have been developed on the presumption that canids rely on olfactory stimuli and that bobcats *(Lynx rufus)* rely on sight and auditory stimuli. No studies have quantified the effects of various olfactory, auditory, and visual stimuli on scent-station visitation by bobcats and canids; however, such information could improve the effectiveness and ability of scent-station surveys. We established scent stations and track transects in intensively managed pine forests in east-central Mississippi from August 1989–May 1991 to evaluate the effectiveness of 4 attractants for eliciting response from 3 carnivores. We randomly allocated synthetic fatty acid scent, bobcat urine, an auditory stimulus, a visual stimulus, and a control to stations at monthly intervals. Greatest bobcat visitation rates occurred at stations with audio attractants, whereas greatest coyote *(Canis latrans)* visitation rates occurred at stations with fatty acid scent and bobcat urine. Gray fox *(Urocyon cinereoargenteus)* visitation rates were equally great at stations with fatty acid scent, bobcat urine, or audio attractants. An extremely low number of visits by bobcats in our study suggests that more sensitive techniques may be required to adequately index trends in bobcat relative abundance. Fatty acid scent and bobcat urine appeared to elicit greatest responses from coyotes and gray fox. Additionally, our data indicated that transects may be an alternative method to index bobcat, coyote, and gray fox populations relative to scent stations.

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Estimating abundance of carnivores is important to wildlife managers and biologists; however, the secretive nature of many carnivores often precludes precise estimates of abundance. Therefore, the scent-station technique has been widely used to

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estimate relative abundance and examine carnivore population trends. Specifically, Linhart and Knowlton (1975) suggested that the scent-station technique developed by Cook (1949) and Wood (1959) to monitor gray fox and red fox *(Vulpes vulpes)* was the best way to assess trends in abundance of many predators. Scent stations have been used to monitor populations of bobcats (Hon 1979, Knowlton and Tzilkowsky 1979, Linscombe et al. 1983, Diefenbach et al. 1994), coyotes (Linhart and Knowlton 1975, Morrison et al. 1981, Roughton and Sweeny 1982), and gray foxes (Conner et al. 1983). However, recent studies have suggested that scent stations are best suited for examining broad temporal trends in carnivore populations, rather than precisely estimating abundance (Sargeant et al. 1998). Further, scent stations may be ill-suited for species that are rarely detected and for monitoring wide-ranging carnivores (Sargeant at al. 1998), hence the need for research examining the influence of various attractants on visitation rates of carnivores.

Scent-station surveys have traditionally used olfactory stimuli, based on the rationale that canids most frequently use olfactory cues when hunting. Most studies have used a single olfactory stimulus, often urine or fatty acid scent (FAS), while visual or auditory stimuli have rarely been used. Since bobcats rely extensively on sight and hearing to forage (McCord and Cordoza 1982), the use of olfactory stimuli may not attract bobcats effectively. Sumner and Hill (1980) found that bobcat responses to predator calling stations using a cottontail rabbit *(Sylvilagus floridanus)* distress call were greater than to stations treated with olfactory stimuli. As a result, carnivore population or relative abundance estimates derived using scent-stations with olfactory stimuli may be biased. Information that simultaneously quantifies responses by bobcats, coyotes, and gray fox to auditory, visual, and multiple olfactory stimuli is needed in the southeastern United States to improve scent-station techniques and inferences gained through their use.

Our objectives were to 1) evaluate effectiveness of 4 attractants by comparing bobcat, coyote, and gray fox visitation rates at attractant stations, 2) determine the optimum time of year for eliciting the greatest response (i.e., highest visitation) by bobcats, coyotes, and gray fox, and 3) compare visitation rates of each species between attractant stations and associated track transects in east-central Mississippi.

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Methods

Study Area

This research was conducted on Weyerhauser Company property in east-central Mississippi. The 33,400-ha area was located in the Interior Flatwoods region and was managed primarily for wood fiber production. Silvicultural practices included clear-cutting, mechanical and/or chemical site preparation, pine (*Pinus* spp.) release by herbicides, controlled burning, and commercial thinning. Stand rotation averaged 30 to 35 years. Topography was flat with 0% to 3% slopes and annual precipitation ranged from 127 to 152.4 cm (Mangrum 1994).

Attractant Type and Application

We tested 4 attractants and a control to determine the most effective stimulus to elicit visitation at attractant stations. Attractants included an auditory stimulus, a visual stimulus, 2 olfactory stimuli, and a control. The auditory stimulus was a mechanical predator-calling unit that replicated the distress sounds of a cottontail rabbit *(Sylvilagus floridanus).* A thin, 7.6-cm metallic disk having 1 white side and 1 reflective gold side was the visual stimulus. We used unfiltered bobcat urine and synthetic fatty acid scent (FAS) tablets as scent stimuli. Plaster of Paris disks were located at the center of each station to dispense scent (Roughton and Sweeny 1982). As disks also were potential visual attractants, unscented disks were placed at visual, auditory, and control stations to compensate for potential biases incurred at stations where disks were used to dispense scent. We did not anchor plaster of Paris disks to stations, therefore the potential existed for visitors to remove the disks. However, we encountered few problems with disk removal and recorded many instances of visits by multiple species.

Auditory stimuli were placed directly adjacent to 1 side of the station and covered with vegetation and/or debris. Auditory stimuli were delivered at regular intervals (approximately every 3–5 minutes) during the 24 hours stations were operated. Batteries in all calling units were replaced after each month. Visual stimuli were connected to a supporting pole via a swivel so that the disk could spin freely. The base of the pole was secured to 1 side of the station such that the disk was allowed to suspend freely 1 m over the center of each station. FAS was applied through plaster of Paris disks. Bobcat urine was frozen in small containers, thawed 48 hours prior to each monthly survey, and plaster of Paris disks were soaked in the urine for 4 hours.

Attractant Station Placement and Operation

We established 45 attractant stations and sampled from August 1989 to July 1990. Stations were checked for visitation the morning following establishment each month during this period (i.e., each station checked 1 night/month for 12 months). We located stations $\geq$0.8 km apart along gravel, secondary, or unimproved roadways and placed on alternate sides of the road $<$6 m from the road edge. Sites for station placement were randomly chosen from a sample of all available sites meeting the minimum distance spacing criteria.

Each station was a 1.0-m diameter circle prepared by clearing vegetation and pulverizing the soil to a depth of 3 cm. Fine-textured soil obtained on the study site was sifted into each station to facilitate positive identification of tracks and a plaster of Paris disk was placed in the center of the station with the desired attractant. Each of the 5 treatments was randomly allocated to the 15 attractant stations resulting in 3 replicates of each attractant. Randomization for attractant application was repeated monthly.

Low bobcat visitation to attractant stations during year 1 of this study prompted concern that bobcats were attracted to stations, but were not recorded on the 1-m stations. Thus, we modified stations by adding 100-m long track transects on each side of the attractant station, directly adjacent to the station. Transects consisted of roadside edges and ditches, approximately 1- to 2-m wide. We operated stations and transects during year 2 immediately after rains so that all previous tracks were removed from transects. Visitation to both stations and transects was recorded monthly from June 1990–May 1991. Also, we increased the number of stations from 45 to 50 during year 2, resulting in 50 transects and stations operated monthly. We did not operate stations or transects during August because of logistical problems and severe drought, which hampered tracking medium along transects.

Data Analysis

We defined a visit as a track or tracks of 1 or more individuals at a station or transect. Thus, only 1 visit/species/attractant station or transect was recorded per night. Inoperable stations were those for which tracks could not be distinguished because of wind, rain, or human interference. Stations were regarded as operable even if the attractant was removed because residual odors might exist and the disturbed soil could elicit visits. Visitation rates were converted to abundance indices (Linhart and Knowlton 1975) by dividing the number of visits by the number of operable stations and multiplying this value by 1000. Visitation rates at transects were converted to indices by dividing the number of visits by the total number of transects.

Visitation rates of each species at stations between years were compared using a nonparametric analysis of variance (ANOVA) based on ranks. We considered each station and associated transect as an experimental unit. Visitation rates for attractant stations during both years were combined and comparisons among attractants and seasons made using rank transformed index values and an ANOVA. Likewise, visitation rates at transects were examined among attractants using rank transformed index values and an ANOVA to test the effects of attractant type on visitation across transects. Nonparametric analyses do not allow examination of interactions among treatments; hence, we did not test the effects of interactions between season and attractant on visitation (Zar 1984). Visitation at stations and transects during year 2 were compared by rank transforming index numbers and an ANOVA. Seasons were defined as breeding/gestation (Jan–Apr), parturition/young-rearing (May–Aug) and fall/winter (Sep–Dec).

Results

Bobcat

We detected no year effect ($P=0.86$) in bobcat visitation rates at stations; hence, years were pooled for subsequent analyses. We recorded 12 bobcat visits and detected no differences ($P=0.82$) in visitation responses among the attractants tested. The greatest bobcat visitation rate occurred at stations with audio attractants and the

Table 1. Mean bobcat, coyote, and gray fox visitation rates at attractant stations and associated track transects by season in east-central Mississippi, 1990–1991. Means are the rank-transformed index values for visitation rates.

		Species		
Season	Location	Bobcat	Coyote	Gray Fox
Breeding/gestation[a]	Stations	53.38	39.05	32.03
	Transects	61.73	70.98	51.35
Parturition/young-rearing[b]	Stations	49.00	42.43	33.63
	Transects	52.50	79.33	73.90
Fall/winter[c]	Stations	48.60	36.03	49.68
	Transects	65.43	67.88	91.55

a. 1 Jan–30 Apr.
b. 1 May–31 Aug.
c. 1 Sep–31 Dec.

lowest visitation rate occurred at stations where bobcat urine was used. Bobcat visitation rates at stations did not differ across seasons ($P=0.51$).

We recorded 20 bobcat visits at 550 established transects (i.e., 50 transects monitored during 11 months). Bobcat visitation rates at transects was greater ($P=0.01$) than at corresponding stations during parturition/young-rearing (Table 1). Bobcat visitation rates at transects did not differ ($P>0.05$) among seasons (Fig. 1). We detected no attractant effects ($P=0.41$) across transects, suggesting that the presence/absence of an attractant did not affect visitation rates on transects.

Coyote

Coyote visitation rates did not differ between years ($P=0.42$); hence, data for both years were pooled for subsequent analyses. We recorded 55 coyote visits on stations and visitation differed ($P<0.001$) among attractants, with the FAS and bobcat

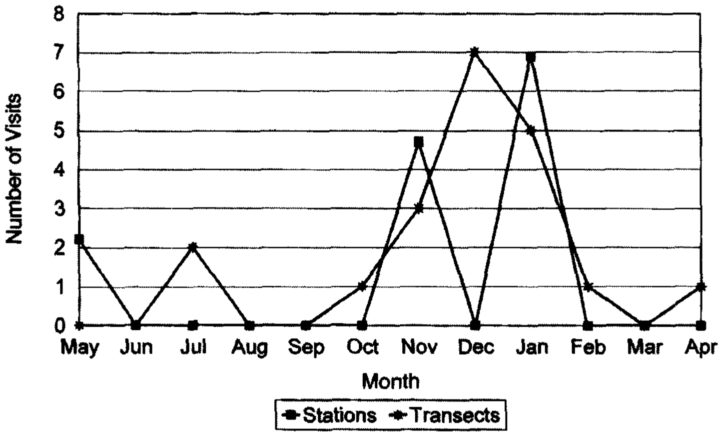

Figure 1. Monthly bobcat visitation at attractant stations and track transects (pooled across attractant types) in east-central Mississippi, 1989–1991.

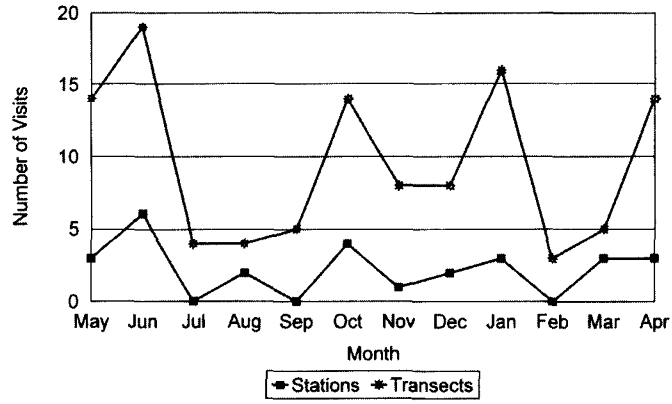

Figure 2. Monthly coyote visitation at attractant stations and track transects (pooled across attractant types) in east-central Mississippi, 1989–1991.

urine eliciting the greatest response from coyotes. Coyote visitation rates appeared similar (P=0.53) across seasons. We recorded 110 coyote visits on transects and visitation was greater (P=0.001) than at corresponding stations in all seasons (Fig. 2, Table 1). Coyote visitation rates on transects did not differ (P>0.05) across seasons and no significant attractant effect (P=0.18) was found across transects, suggesting that the presence/absence of an attractant did not affect visitation rates on transects.

Gray fox

Gray fox visitation rates did not differ between years (P=0.09); hence, years were pooled for subsequent analyses. We recorded 114 gray fox visits on stations and visitation rate differed (P<0.001) among attractants, with the FAS, bobcat urine, and

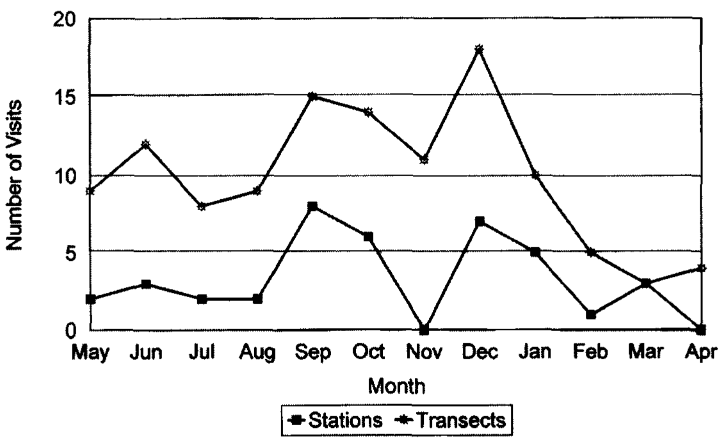

Figure 3. Monthly gray fox visitation at attractant stations and track transects (pooled across attractant types) in east-central Mississippi, 1989–1991.

audio attractant eliciting the greatest responses from gray fox. Gray fox visitation rates at stations differed seasonally (P=0.03), with greatest visitation rates during fall/winter. We recorded 109 gray fox visits on transects and visitation was greater (P<0.01) than at corresponding stations across all seasons (Fig. 3, Table 1). Gray fox visitation rates on transects differed (P=0.03) with highest visitation during fall/winter. We detected no significant attractant effect (P=0.87) among transects, suggesting that the presence/absence of an attractant did not affect visitation rates on transects.

Discussion

Bobcat visitation rates in our study were similar to those reported in Florida (Conner et al. 1983) and Alabama (Sumner and Hill 1980). However, considerably higher visitation rates were reported in Georgia (Hon 1979) and Louisiana (Morrison et al. 1981, Linscombe et al. 1983). Although the relationship between visitation and bobcat density on our study area is unclear, large expanses of midrotation-aged pine plantations and a subsequent lack of habitat diversity may have contributed to lower bobcat densities on our study area than in previous studies. Bobcat urine (Brady 1979, Sumner and Hill, 1980, Morrison et al. 1981, Conner at al. 1983), mixtures of bobcat and fox urine (Hon 1979, Sumner and Hill 1980), and FAS (Sumner and Hill 1980, Linscombe et al. 1983) have been used effectively as olfactory attractants throughout the Southeast. Although statistical differences among attractants were not detected, bobcat visitation in this study appeared to be greater at stations with auditory stimuli. However, extremely low visitation rates prevented our ability to effectively examine response across attractants and seasons.

Coyote visitation rates in our study were lower than those reported in Louisiana (Morrison et al. 1981, Linscombe et al. 1983). We suggest that the lack of olfactory attractants at some stations/transects in this study contributed to lower visitation rates. The use of olfactory cues for hunting has been well documented in coyotes (Lehner 1977). Indeed, olfactory attractants elicited greater response from coyotes than audio or visual attractants. The lack of coyote visitation at stations with visual attractants suggested that coyotes were not attracted by or perhaps avoided these stimuli. Ancillary observations indicated that coyote tracks at visual attractants often shifted to the opposite side of the road and tracks frequently stopped a considerable distance away from the station.

For coyotes, transects appeared to be a more sensitive survey technique than scent stations to index relative abundance. Further, the lack of attractant effects across transects suggested that differences between visitation rates at stations and visitation rates at transects resulted from the increased tracking area of the transects. Peaks in coyote visitation at transects may have been a function of food selection and social behavior. Coyotes often select fruits (*Rubus* spp., *Prunus* spp.) during spring throughout the Southeast (Wooding et al. 1984, Wagner and Hill 1994). Hence, higher coyote visitation along transects in spring may have been in response to increasing abundance of blackberries and dewberries along roadsides. Increased visitation during October could be a function of social behavior. Dispersal of juvenile coyotes often occurs during October (Knowlton 1972), and dispersing juvenile and sub-adult coyotes could have temporarily increased visitation at transects.

Gray fox visitation rates in our study were higher than those reported in Louisiana (Morrison et al. 1981, Linscombe et al. 1983). Our greater gray fox visitation may have resulted from a greater variety of attractants used or simply an increased fox population. Sumner and Hill (1980) reported that predator calling and urine treatments elicited greatest responses from gray fox in Alabama. However, we found that FAS, bobcat urine, and audio attractants elicited similar responses from gray fox. Similar to coyotes, gray fox appeared to show little interest in visual stimulus. However, gray fox, unlike bobcats and coyotes, left considerable sign (tracks, scratching, scat) at all stations and transects, potentially increasing the probability of detecting a gray fox visit when it occurs.

Transects appeared to be a more sensitive survey technique across seasons to index relative abundance of gray fox with approximately twice as many visits recorded. Increased gray fox visitation rates at transects resulted from many individuals being recorded on track transects that did not visit the 1-m^2 area of the station. Our data indicated that for gray fox, the optimal time to establish transects for eliciting greatest response spans from September through December. Increased gray fox visitation during this period was likely a function of juvenile dispersal during early fall (Nicholson et al. 1985). Gray fox visitation peaked during December and coincided with the peak in rabbit visitation on transects. Therefore, increased gray fox activity around transects may have been in response to increased prey activity. Conversely, increased visitation during fall/winter could result from visits by juveniles as populations increase prior to dispersal.

Management Implications

Results of this study suggested that more sensitive techniques, whether auditory or visual, may be required to adequately index bobcat relative abundance, particularly in areas with sparse populations. Our data indicated that olfactory stimuli should be used when attempting to attract coyotes to scent stations. Similarly, although auditory attractants did result in gray fox visits to scent stations, olfactory stimuli combined to elicit the greatest response.

Our results indicated that track transects are a suitable alternative to scent stations for indexing bobcat, coyote, and gray fox relative abundance in the Southeast. In our area, we suggest transects be established during winter, as rainfall improves tracking media, and visitation for all species was highest during winter. Further, because increased visitation at both stations and transects would result from visits by pre-dispersal juveniles, we suggest researchers and biologists consider the influence of demographics during winter on relative abundance estimates. The major disadvantage of the transect method is the reliance on rainfall to produce suitable tracking surfaces. However, the transect method offers advantages including 1) a relatively low man-hour expenditure compared to establishing and maintaining scent stations and 2) no costs to procure attractants and deliver them to field personnel.

Literature Cited

Brady, J. R. 1979. Preliminary results of bobcat scent-station transects in Florida. Proc. Bobcat Resear. Conf., Natl. Wildl. Fed. Sci. Tech. Ser. 6:101–103.

Conner, M. C., R. F. Labisky, and D. R. Progulske, Jr. 1983. Scent station indices as measures of population abundance for bobcats, raccoons, gray foxes and opossums. Wild. Soc. Bull. 11:146–152.

Cook, A. H. 1949. Furbearer investigation. N.Y. State Conserv. Dep. Pittman-Robertson Proj. 10R, Suppl. G, Final Rep. N.Y. State Conserv. Dep. 57pp.

Diefenbach, D. R., M. J. Conroy, R. J. Warren, W. E. James, L. A. Baker, and T. Hon. A test of the scent-station survey technique for bobcats. J. Wildl. Manage. 58:10–17.

Hon, T. 1979. Relative abundance of bobcats in Georgia; survey techniques and preliminary results. Proc. Bobcat Res. Conf., Natl. Wildl. Fed. Sci. Tech. Ser. 6:104–106.

Knowlton, F. F. 1972. Preliminary interpretations of coyote population mechanics with some management implications. J. Wildl. Manage. 36:369–382.

——— and W. M. Tzilkowski. 1979. Trends in bobcat visitations to scent survey lines in western United States. Proc. Bobcat Res. Conf., Natl. Wildl. Fed. Sci. Tech. Ser. 6:8–12.

Lehner, P. N. 1977. Coyote communication. Pages 128–162 *in* Coyotes: biology, behavior, and management. Acad. Press, Inc., N.Y.

Linhart, S. B. and F. F. Knowlton. 1975. Determining the relative abundance of coyotes by scent-station lines. Wildl. Soc. Bull. 3:119–124.

Linscombe, G., N. Kinler, and V. Wright. 1983. An analysis of scent-station responses in Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 27:190–200.

Mangrum, J. W. 1994. Evaluation of four attractants as indices of relative abundance of wildlife with emphasis on bobcats. M.S. Thesis, Miss. State Univ., Miss. State, Miss. 161pp.

McCord, C. M. and J. E. Cordoza. 1982. Bobcat and lynx. Pages 728–766 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America. Johns Hopkins Univ. Press, Baltimore, Md.

Morrison, D. W., R. M. Edmunds, G. Linscombe, and J. W. Goerty. 1981. Evaluation of specific scent station variables in North-central Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 35:281–291.

Nicholson, W. S., E. P. Hill, and D. Briggs. 1985. Denning, pup-rearing, and dispersal in the gray fox in east-central Alabama. J. Wildl. Manage. 49:33–37.

Roughton, R. D. and M. K. Sweeny. 1982. Refinement in scent-station methodology for assessing trends in carnivore populations. J. Wildl. Manage. 46:217–299.

Sargeant, G. A., D. H. Johnson, and W. E. Berg. 1998. Interpreting carnivore scent-station surveys. J. Wildl. Manage. 62:1235–1245.

Sumner, P. W. and E. P. Hill. 1980. Scent-stations as indices of abundance of some furbearers in Alabama. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 34:572–583.

Wagner, G. D. and E. P. Hill. 1994. Evaluation of southeastern coyote diets during the wild turkey reproductive season. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48:173–181.

Wood, J. E. 1959. Relative estimates of fox population levels. J. Wildl. Manage. 23:53–63.

Wooding, J. B., E. P. Hill, and P. W. Sumner. 1984. Coyote food habits in Mississippi and Alabama. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 38:182–188.

Zar, J. H. 1984. Biostatistical analysis. Prentice Hall Inc. Englewood Cliffs, N.J. 718pp.