Factors Affecting Scent Station Visitation Rates of Raccoons and Bobcats

Timothy M. Gabor,[1] *Department of Biology, Memphis State University, Memphis, TN 38152*

Robert E. Kissell, Jr.,[2] *Department of Biology, Memphis State University, Memphis, TN 38152*

Douglas A. Elrod,[3] *Department of Biology, Memphis State University, Memphis, TN 38152*

Richard E. Lizotte, Jr.,[4] *Department of Biology, Memphis State University, Memphis, TN 38152*

Abstract: Scent stations are assumed to be a simple and economical method to index furbearer populations, but recent literature challenges the reliability of this technique. We examined several variables that could affect visitation rates of 2 commonly indexed species. Raccoon (*Procyon lotor*) and bobcat (*Felis rufus*) visitation rates of scent stations were monitored on the Hatchie National Wildlife Refuge in western Tennessee during summer and fall 1991. Factors tested included placement from water and roads, attractant type, and within-habitat variability of scent-station visitation rates. Placement of scent stations near water (≤10 m) increased visitation rates of raccoons. Attractant type (visual vs. olfactory) did not affect visitation rates of bobcats or raccoons regarding visual attraction to a scent station. Differences existed between sites within a habitat for raccoons. Variability did not increase with increasing visitation rates in raccoons and showed only a slight positive slope in bobcats. Reliability of scent station indices may depend on random locations and optimal placements and will require standardization of techniques for each species.

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[1] Present address: Department of Wildlife and Fisheries Sciences, Texas A&M University College Station, TX 77843.

[2] Present address: Fish and Wildlife Program, Department of Biology, Montana State University, Bozeman, MT 59717.

[3] Present address: Department of Biological Sciences, P.O. Box 5218, University of North Texas, Denton, TX 76203.

[4] Present address: Department of Biology, University of Mississippi, University, MS 38677.

Growing interest in furbearer management has intensified the need to determine population changes (Clark and Andrews 1982, Johnson 1982). Various techniques have been proposed, including spotlight counts (Fountain 1976, Andrews 1979, Rybarczyk et al. 1981), track indices (Becker 1991, Stanley and Bart 1991, Van Sickle and Lindzey 1991), and scent stations. The scent station technique was originally developed for foxes (Richards and Hine 1953, Wood 1959), and was later used to monitor populations of other mammalian predators (Conner et al. 1983). Roughton and Sweeny (1982) described scent stations as a practical means to determine trends in carnivore populations. Use of scent stations has increased recently, but questions concerning reliability and repeatability of this index remain (Conner et al. 1983). Recent research has focused on modifying techniques to standardize this method (Conner et al. 1983).

Ideally, scent station indices should correlate with population densities. Few studies have correlated scent station indices with population densities (Davison 1981, Conner et al. 1983, Diefenbach et al. 1994), and results from these studies have varied. Attempts to standardize techniques had led to the search for higher visitation rates (Morrison et al. 1982, Roughton and Sweeny 1982), assuming a correlation of visitation rates and accuracy of a density estimate exist (Hatcher and Shaw 1981, Roughton and Sweeny 1982). Low visitation generally results from low mammalian predator densities, large home ranges, and/or territoriality (Becker 1991). Variation in visitation rates occur among seasons, habitats, odor attractants, and construction materials (Sumner and Hill 1980, Morrison et al. 1982, Conner et al. 1983, Linscombe et al. 1983, Turkowski et al. 1983, Leberg and Kennedy 1987, Strapper et al. 1989). Preferences for habitat, odor attractant, and construction materials by a species are uniquely influenced by behavior. Because species-related differences occur (Morrison et al. 1982, Conner et al. 1983), standardizing techniques to the behavioral characteristics of each species is essential. Standardizing techniques should reduce within-sample variances and accentuate between-sample variability, thereby allowing for equitable comparisons within a region for a given species.

Previous investigations have focused on attractant and substrate used at the scent station (Morrison et al. 1982). Technique improvements have concentrated primarily on coyotes (*Canis latrans*). Because coyotes use unimproved roads as travel lanes (Hodges 1975, Morrison et al. 1982, Roughton and Sweeny 1982), and cost-effectiveness is increased by setting scent stations along roads, most research has centered on increasing visitation rates for all furbearer species at road sites, while minimizing multiple visits by an individual animal (Roughton and Sweeny 1982, Linscombe et al. 1983, Diefenbach et al. 1994).

Sumner and Hill (1980) and Leberg and Kennedy (1987) described placing scent stations for raccoons near water to increase precision, but there were no data to corroborate this assumption. Because many carnivores do not use roads as corridors, placement of scent stations may differentially affect visitation rates among these species.

Our objectives were to investigate the effect of odor attractant and placement of scent stations on visitation rates within bottomland hardwoods, a preferred habitat of bobcats and raccoons (Conner et al. 1983, Linscombe et al. 1983, Leberg and Kennedy 1987).

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Methods

We conducted the study during summer and fall 1991 on the Hatchie National Wildlife Refuge (HNWR) in Haywood County, Tennessee, approximately 5 km east of Brownsville, Tennessee. Habitat consisted mainly of bottomland hardwood forests, prone to flooding by the Hatchie River during winter and spring. Less than 10% of habitats consisted of uplands composed of agricultural fields with scattered hardwood forests and pine (*Pinus* spp.) stands. A limited hunting season (6 nights) was held annually for raccoons. Bobcat hunting followed the statewide season and regulations (Tenn. Wildl. Res. Agency 1992).

We did not estimate population densities of the target species because the primary objective was to assess variability of scent station visitation rates with respect to placement of the scent station and attractant type. Two study sites (eastern and western) were selected based on accessibility to the Hatchie River. Each consisted of a river site paired with an adjacent road site. Roads were unimproved gravel, closed to the public at night, and paralleled the river at a distance of 50 to 400 m within the same habitat.

Scent stations consisted of a sifted circle of soil 1 m in diameter with a scent stick placed in the center. Scent sticks were tongue depressors with cotton balls inserted into a slot in the wood. Cotton balls were saturated (approx. 2–3 ml) with an attractant, including deer (*Odocoileus* sp.) urine (non-predator), bobcat urine (predator), and water (control; visual attractant only). Local soils were used because substrate affects visitation rates (Morrison et al. 1982). Stations were checked for tracks and scent sticks were removed the following morning. A visit consisted of ≥1 track on the scent station. A scent station was considered non-operational and was not used in analyses if it was disturbed by humans or unreadable, e.g., rained out. Unidentifiable tracks were not used in analyses.

Attractant, placement (1, 5, and 10 m from water and at roadside), and site (eastern and western) were tested using an incomplete factorial design. Five scent stations of each attractant X placement combination were constructed at each site per sampling period. We sampled the western site 4 times (12 Aug, 14 Sep, 14 Oct, and 4 Nov 1991) and the eastern site 3 times (14 Sep, 14 Oct, and 4 Nov 1991). Sampling periods were separated by ≥3 weeks to insure independence. This period was deemed long enough to prevent "learning" (Diefenbach et al. 1994). Scent stations were placed on alternate sides of the road at 320-m intervals, and riverside scent stations were separated by >200 m on alternative river banks to reduce probability of an animal visiting >1 station. Riverside stations were placed on slopes <15% and were randomized for attractant and placement; roadside stations were randomized for attractant.

Statistical analyses consisted of 2 3-factor Analysis of Variances (ANOVA), 1 for raccoons and 1 for bobcats. Data were analyzed using SAS (Proc GLM: SAS Inst. 1990). Bonferroni adjustment (Rice 1989) were used to adjust significance levels because visitation of 1 species may have affected visitation of another species, i.e., ANOVAs were not independent. Percentage of stations visited per sampling period for each attractant X placement X site combination were arcsine square-root transformed (Kirk 1982). Bonferroni multiple range tests were used to determine differences among levels of a factor because of differing within-cell sample sizes (SAS Inst. 1990). Contrasts were used to determine differences from controls (water vs. scented attractants and roadside sets vs. riverside sets). Means of each attractant X placement X site were regressed against their coefficient of variation (CV) and standard deviation to test correlation between variability of visitation rates and mean visitation rate.

Results and Discussion

Raccoon visitation rates were different for site and placement ($F = 24.29$, 1,54 df, $P < 0.001$ and $F = 11.17$, 3,54 df, $P < 0.001$, respectively; Table 1). All other factors and interactions were not different ($P > 0.05$). The eastern site had higher raccoon visitation rates than the western site. Differences found between sites may be related to differing densities or adjacent habitats. The eastern site had more agricultural fields closer to the river, which may account for the

Table 1. Mean visitation rates (percentages of scent stations visited) of raccoons at scent stations using 4 placements at 2 sites on the Hatchie National Wildlife Refuge, Tennessee, during summer and fall 1991.

	Site[a]		
Placement	Western	Eastern	Total
1 m[b]	42.9 (57)[c]	69.1 (42)	54.4A[d] (99)
5 m[b]	29.2 (58)	64.4 (43)	44.3A (101)
10 m[b]	29.2 (56)	70.0 (44)	46.7A (100)
Roadside	10.0 (38)	16.7 (30)	12.7B (68)
Total	29.0 (209)	58.6 (159)	41.4 (368)

[a]Sites were significantly different ($F = 24.29$, 1,54 df, $P < 0.0001$).
[b]Distance of leading edge of scent-station from water.
[c]Number of operational scent stations in parentheses.
[d]Means having the same letter are not different. (Bonferroni multiple range test; $P < 0.05$)

larger raccoon population. Agricultural crops, such as corn, were common in the area and are a major seasonal food of raccoons (Stewer 1943, Tester 1953, Dorney 1954). Furthermore, these data suggested that significant variation within a habitat type was probable; supporting that raccoons congregate around abundant food sources (Sonenshine and Winslow 1972).

Scent stations placed near water (1, 5, and 10 m from the river) had higher visitation rates by raccoons than those placed near the road ($F = 32.18$, 1,54 df, $P < 0.001$; Table 1). No differences were detected among placements near water ($P > 0.25$). Raccoon habitat use has been associated with water and may be a result of their foraging behavior and physiological adaptations (Kaufmann 1982, Sanderson 1987).

Our study also indicated that scent stations placed within 10 m of a major water source would receive greater raccoon visitation than road-side stations. Visitation rates did not vary within the 10-m strip ($P > 0.25$). Higher visitation rates have been suggested as a way to detect more subtle population changes (Roughton and Sweeny 1982). Our raccoon visitation rates for sets near water (44%–54%) were within the optimal range (40%–60%) for detecting these changes (Roughton and Sweeny 1982).

Scented attractants (deer and bobcat urine) were not visited more frequently than controls (water) by raccoons ($F = 3.39$, 1,54 df, $P = 0.071$). Bare soil and scent sticks provided adequate visual stimuli to elicit a response by a raccoon. Nottingham et al. (1989) reported similar results, and attributed this as an attraction to a visual anomaly. Variation in visitation rate from attractant type occurs with other furbearers (Sumner and Hill 1980, Morrison et al. 1982), but we found no differences in visitation rates among attractant types for raccoons.

CV of mean visitation rate of raccoons declined with increasing visitation rates (slope = -161.3, $R^2 = 0.67$, $t = -6.75$, $P < 0.001$) and standard deviation of mean visitation rate did not vary with visitation rate ($R^2 = 0.091$, $t = 1.48$, $P = 0.152$). Therefore, as mean visitation rate increased, variability around the mean remained constant but decreased when scaled by the mean (Byrkit 1987). Theoretically, variance should increase with an increasing proportional mean (Diefenbach et al. 1994), but this does not hold true. In our case, biological outcome differed from statistical theory.

Bobcat visitation rates were not different for placement, site, and attractant ($P > 0.05$). An interaction between placement and site was significant for bobcats ($F = 3.47$, 3,54 df, $P = 0.022$; Table 1). All other interactions were not significant ($P > 0.05$). The contrast of water placements against roadside placement showed no differences in bobcat visitation rates ($F = 0.54$, 1,54 df, $P = 0.466$). Interaction between placement and site was highly variable in bobcat visitation and occurred between sites at the 1-m placement. Visitation rates at other placements followed a similar trend (Table 2), indicating that variation between sites at the 1-m placement was probably due to an extraneous factor not tested in this study.

Table 2. Mean visitation rates of bobcats at scent stations using 4 placements at 2 sites on the Hatchie National Wildlife Refuge, Tennessee, during summer and fall 1991. Placements were 1, 5, and 10 m from the Hatchie river edge and along a gravel road that paralleled the river.

	Site	
Placement	Western	Eastern
1 m[a]	14.6 (57)[b]	2.2 (42)
5 m[a]	1.7 (58)	6.7 (43)
10 m[a]	7.5 (56)	11.1 (44)
Roadside	2.8 (38)	6.7 (30)

[a]Distance of leading edge of scent-station from water.

[b]Number of operational scent stations in parentheses.

Low visitation rates have been suggested as a reason for the inability to detect differences (Roughton and Sweeny 1982). Low visitation rates by bobcats are common because of low population densities (Sumner and Hill 1980, Linscombe et al. 1983), but significant differences could be detected with large sample sizes (Linscombe et al. 1983). However, increasing sample sizes reduces cost-effectiveness of the scent-station technique and questions the biological significance of the differences.

Differences between visitation rates of scented attractants and the control (water) were not detected for bobcats ($F = 1.18$, 1,54 df, $P = 0.282$). Differences in bobcat visitation rates have been attributed to attractant type in previous studies. Sumner and Hill (1980) found that bobcat and fox urine elicited greater visitation rates than synthetic fatty acid scents or mixed urines. Conversely, Morrison et al. (1982) found no differences in visitation rates for odored attractant type, but did find that using agricultural lime (a visual attractant) as a tracking surface increased bobcat visitation rates. We suggest that odor attractant was not as important as the visual stimulus of the scent-station.

Standard deviation of bobcat visitation rates increased slightly with increasing visitation rates (slope = 0.723, $R^2 = 0.36$, $t = 3.49$, $P = 0.002$), but regression of the CV on visitation rate showed a negative slope (slope = -833.6, $R^2 = 0.65$, $t = -4.715$, $P < 0.001$). Although variance did increase with increasing visitation rates, this increase was not proportional to the visitation rate.

Management Implications

Raccoons and bobcats relied similarly on visual and olfactory cues. Also, higher visitation rates in this study did not increase variability of indices. We believe this may not apply to other habitats. Thick understory or bare sandy soil may negate visual stimuli of scent stations, thereby increasing the relative effect of olfactory attractants.

We suggest that placement of scent stations is a critical factor in obtaining reliable indices of a population. Road-side scent stations are cost-effective, but indices obtained for some species of furbearers, such as raccoons, may not reflect actual population densities because of within-population variability. Road-side sets may be sampling a microhabitat used at a different rate than most of a specie's habitat. Locating scent stations within a habitat type instead of along roads should provide a more precise population index.

Bobcat visitation rates were not different among placements, but this does not suggest that road-side sets will accurately record population changes. Placement, attractant type, and other variable techniques of scent stations should be based on the biology of the target species. Scent station techniques used to index 1 species may not be reliable for another species.

Although this study suggests that placement and visual attraction of scent stations are important factors in determining visitation rates, research is needed to determine optimal placements and visual attractants for each furbearer species. Research is still needed to define the relationship between this index and population densities. Also, standardization of techniques for each species is needed so that data may be compared, at least regionally.

Scent stations are a valuable asset to wildlife management because of their low cost and simplicity, but this should not preclude use of other more accurate and reliable estimates of furbearer populations.

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