# An Analysis of Scent Station Response in Louisiana[1]

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*Abstract:* An annual scent station survey was conducted in Louisiana from 1978 through 1982 to determine relative abundance of bobcats (*Felis rufus*) and relate indices to geographical regions and habitat types. A total of 29 lines each with 50 stations per line was proportionally divided into 5 regions. The use of fatty acid scent resulted in an average visitation rate of 4.6% for bobcats, 9.7% for coyotes (*Canis latrans*), 7.3% for fox (*Vulpes vulpes* and *Urocyon cinereoargenteus*), 7.2% for raccoon (*Procyon lotor*), 11:8% for opossum (*Didelphis virginiana*) and 7.1% for skunk (*Mephitis mephitis*). Significant differences were detected among years, regions and habitats for bobcat ($P < 0.01$). Regional visitation rates varied for coyotes with current harvest data supporting survey results ($P < 0.01$). Significant differences occurred among years and regions for fox ($P < 0.01$). For raccoon, significant differences were detected among regions, among years within 4 regions, and among habitat types in 4 regions ($P < 0.01$). Visitation rates for opossum varied among years, regions, years within 4 regions, and by habitat within 4 regions. Significant differences were detected for skunks between years, regions, years within 2 regions, and between habitats within 3 regions.

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The Louisiana Department of Wildlife and Fisheries recorded an increase in the harvest of all furbearers during the mid-1970s. During the same period controversies arose between state agencies and protectionist organiza-

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tions concerning furbearer management. In 1976, the bobcat (*Felis rufus*) was placed on Appendix II of the Convention on International Trade in Endangered Species without biological justification. The federal interpretation of this Appendix II listing resulted in states being required to provide data on bobcat status to the U.S. Department of the Interior Fish and Wildlife Service in order to obtain export approval.

From the 1965–1966 season through the 1974–1975 season, Louisiana annually produced an average of 260 bobcat pelts. During the 1975–1976 season, the bobcat harvest in Louisiana was 1,269 pelts valued at an average of $25 each. The next season's catch was 2,997 pelts averaging $50 each. This resource had been essentially unutilized from the 1945–1946 season through the early 1970's because of the low average price per pelt ($1.16).

After reviewing a number of methods to evaluate bobcat population trends, it was decided to use an annual scent station survey. Wolfe (1973), working in the Southeast United States, reported this type of survey to be 1 of the most effective means of determining population indices. Relative to other methods, scent stations are cost efficient and offer uniformity and repeatability (Linhart and Knowlton 1975, Brady 1979). It is applicable to extensive land areas, yields data that can be analyzed statistically, can be uniformly repeated, and can be compared from year to year (Brady 1979). Primary limitations of scent station surveys are weather conditions and relatively low visitation rates. With low visitation rates, misidentification of tracks could bias index values with the result being an inaccurate population trend estimate (Andrews 1979). This problem can be reduced by careful observation of tracks by competent observers. The U.S. Fish and Wildlife Service has used scent station surveys primarily for coyotes (*Canis latrans*) in the western states since 1979. In recent years, several southeastern states initiated scent station surveys to index bobcat and fox populations. Conner et al. (1983) reported that scent station indices accurately reflected trends in the abundance of bobcats, raccoons (*Procyon lotor*), and gray foxes (*Urocyon cinereoargenteus*), but not of opossums (*Didelphis virginiana*).

The objectives of this 5-year study were to determine the relative annual abundance of bobcats and to relate these indices to geographical regions and habitat types. Although the survey was designed with bobcat as the primary species, data on coyote, raccoon, opossum, fox (*Vulpes vulpes* and *Urocyon cinereoargenteus*), and skunk (*Mephitis mephitis*) were also collected.

This project would not have been possible without the interest, cooperation, and efforts of Larry Soileau, research leader of the Louisiana Department of Wildlife and Fisheries, and the many biologists and technicians of the game division who actually conducted the survey. W. Warren suggested the log likelihood ratio as a method of analysis. Yvette Delcambre assisted with manuscript preparation.

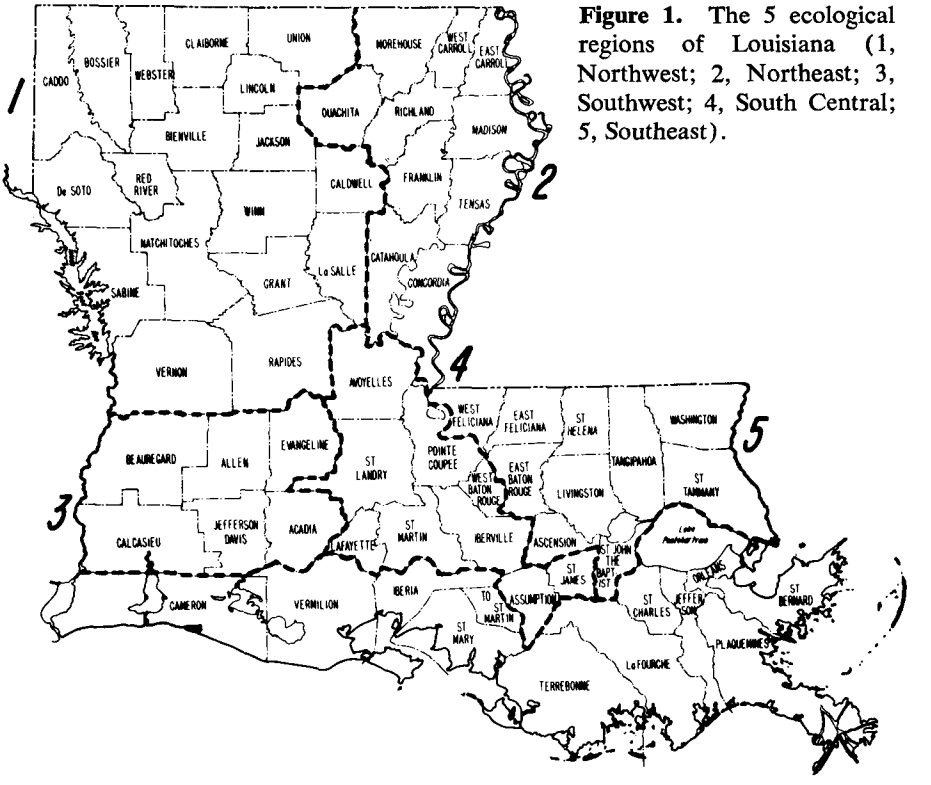


**Figure 1.** The 5 ecological regions of Louisiana (1, Northwest; 2, Northeast; 3, Southwest; 4, South Central; 5, Southeast).

## Methods

The design of the survey was a modification of the U.S. Fish and Wildlife Service survey (Roughton 1979). Twenty-nine biologists or technicians were allocated for the annual survey. The state was divided into 5 geographical regions for the purpose of the survey (Fig. 1). The Northwest Region is an area of mixed pine-hardwood transected by Red River bottoms. It made up 40.9% of the study area and contained 12 survey lines. The Northeast Region is characterized by Mississippi River delta which is primarily agriculture interspersed with remaining areas of bottomland hardwood. Five lines were assigned to this region which contained 16.9% of the study area. The Southwest Region had 13.6% of the area, 4 lines, and is characterized by pine in the north and agriculturally altered prairie in the south part of the region. The South Central Region consists primarily of bottomland hardwood and contained 13.2% of the area and 4 lines. The Southeast Region contains a diversity of habitats but is dominated by mixed pine-hardwood. It made up 15.6% of the study area and had 4 survey lines. The coastal area of the state was

excluded because the technique is not applicable. The primary habitat types in the coastal region are flooded swamp or marsh with relatively little high ground. Survey lines could not be set up with a random starting point and a line run in any distance without entering flooded areas. Also, this habitat type is of minimal importance to bobcat, fox, and coyote. According to Louisiana harvest data, less than 3% of bobcats are trapped in this coastal region, less than 2% of fox, and less than 2% of coyote (Louisiana Department of Wildlife and Fisheries, unpubl. data 1983).

The starting point of each line was the nearest secondary road to a randomly-selected point. Once all starting points in a region were selected, a general direction for travel was assigned to each line in order to get the best possible coverage of the region. The spacing of the stations and the length of the lines were modified from the standard U.S. Fish and Wildlife Service lines. Instead of 0.48 km spacing, we selected 1.6 km spacing in an attempt to reduce the possibility of an animal traveling down a road and visiting 2 or more stations and thus eliminating station independence. Also, this spacing allowed a habitat designation at each station. Each survey line consisted of 50 scent stations at 1.6 km intervals. Twenty-nine lines were used each year for a total of 2,333.5 km of survey line.

Observers were instructed to construct stations in the right-of-way along secondary roads. The stations began at the randomly selected starting point, and proceeded in the assigned direction at 1.6 km intervals for 80.5 km.

The station consisted of a 0.91 m diameter circle which was cleared of all vegetation. The soil was raked smooth to create a good tracking medium. During the initial survey in 1978, a variety of tracking surfaces were used. Since the quality of the tracking medium varied greatly, agricultural lime (light gray color) was used to improve track identification and standardize the tracking medium. During the 1979 survey, agricultural lime was used for all stations on 27 lines. On the remaining 2 lines, lime and natural soil were alternated to provide comparative data for the 1978 survey. Morrison et al. (1981) showed that the use of agricultural lime when compared to natural soil increased bobcat visits significantly ($P < 0.001$). Lime apparently provides a sight attractant for bobcat. Visitations by other mamals were not adversely affected by the use of lime. Therefore, lime became the standard tracking medium and was used on all lines in 1980, and 1981, and 1982.

Synthetic fatty acid scent (FAS) developed by the U.S. Fish and Wildlife Service (Roughton 1979) was the attractant used. White, plastic, perforated tissue capsules ($10 \times 33$ mm), containing a small piece of sponge saturated with approximately 1 ml of the scent solution, were secured with a nail in the center of station and slightly elevated above ground level to allow air circulation.

The survey was conducted on 2 consecutive nights in October during all 5 years. October was selected because it is generally the driest month of the year and is before work assignments increase with the opening of many hunt-

ing seasons in November. Morrison et al. (1981) found summer visitation rates were lower than those during the fall. Conner et al. (1983) found no differences in monthly visitation rates of bobcat in Florida ($P > 0.05$). However he found the highest visitation rate for gray fox (*Urocyon cinereoargenteus*) occurred in November. Johnson et al. (1981) reported 8 of 9 southeastern states conducted scent post surveys in October or November.

Habitats for this study were divided into 6 types: bottomland hardwood, mixed pine-hardwood, pure pine, recent clear cut, agriculture, and pasture. A habitat classification was assigned to each station as determined by the dominant habitat in the vicinity of the station. Due to small sample size, some habitat types were grouped. Each observer was given a track identification guide. Questionable tracks were recorded as unknown. Efforts were made to have the same observer run the same lines each year. A map was prepared for each line so that a new observer could duplicate the same line each year.

If a specific station was visited on 2 consecutive nights, it was considered a single visit for analytical purposes. Log-likelihood ratios of the proportion of stations visited were used to test for homogeneity of proportions across years, regions and habitats within regions (Bishop et al. 1975). This analysis essentially calculated a statistic ($G^2$) which asymptotically approaches a chi-square with t-1 degrees of freedom. The calculation is:

$$G^2 = \left\{ \sum_{i=1}^{t} V_i \, ln \, \frac{V_i}{S_i} + (S_i - V_i) \, ln \left( \frac{S_i - V_i}{S_i} \right) \right\} - \Sigma V_i \, ln \frac{\Sigma V_i}{\Sigma S_i} + (\Sigma S_i - \Sigma V_i) \, ln \left( \frac{\Sigma S_i - \Sigma V_i}{\Sigma S_i} \right)$$

Where $V_i$ = the number of visits during the ith year
$S_i$ = the number of operable stations during the ith year
*ln* is the natural logarithm and the summation symbol extended from i = 1 to t for all summation signs
t = number of years

If we allow i to represent regions or habitats within regions we can perform the same calculation with these data.

## Results and Discussion

Approximately 96% of the 1,450 stations prepared annually were readable. The other 4% were disturbed by weather, domestic animals, or people. The random selection of starting points and long survey lines located stations in a variety of habitat types. Some stations fell in good bobcat habitat and some in fair or poor habitat. We believed that this type of sampling would be important if animal densities did not fluctuate in synchrony in good, fair, and

poor habitats. Telemetry data on bobcats in bottomland hardwoods of southern Louisiana indicated activity closely associated with pipeline rights-of-way and roads (Hall 1973). These data provided more justification for greater spacing in order to achieve station independence. Similar surveys in many states located lines in optimum bobcat habitat. Since our lines were established randomly, we itersected many habitat types which varied in quality. Our results and discussion relate to habitat, yet many states do not record this variable. Other techniques which varied among states conducting scent station surveys were spacing of stations, scent type and method of presentation, and tracking medium. We conducted the survey on 2 consecutive nights while many states check stations only 1 night. These differences in surveys must be recognized when attempting to compare results.

## Bobcat

For all years combined 4.6% of all stations were visited by bobcats. Brady (1979) reported 18.6% in Florida, Hon (1979) 9.3% in Georgia, Hill and Sumner (1980) 0.04% in Alabama. The spacing of stations and the selection of optimum habitat in Georgia and Florida may partially account for higher visitation rates. It is also possible that these states have higher bobcat densities. Annual bobcat visitation rates during the 5 years were significantly different ($P < 0.01$). Percent visitation was higher in 1978 and 1979 than in 1980 through 1982 (Table 1).

Visitation rates by region with all years combined showed a significant difference with the highest visitation rate (9.4%) in the South Central Region ($P < 0.01$). The northern end of this region is predominantly bottomland hardwoods. Lowery (1974) stated that the bobcat occurred in appreciable numbers through the vast hardwood bottomlands of the Mississippi flood plain. Hall (1973), working in the South Central region reported higher densities than for other areas of the south. The next highest visitation rate

**Table 1.** Annual scent station visitation rates (%) for 6 mammals in Louisiana.

| Year | Visitation rates (%) | | | | | | *N* of readable stations |
|---|---|---|---|---|---|---|---|
| | Bobcat | Coyote | Fox | Raccoon | Opossum | Skunk | |
| 1978 | 6.2 | 9.6 | 10.0 | 8.4 | 9.7 | 5.5 | 1,373 |
| 1979 | 6.7 | 9.8 | 7.2 | 6.7 | 15.4 | 7.8 | 1,393 |
| 1980 | 3.2 | 8.8 | 6.8 | 5.9 | 11.3 | 6.7 | 1,419 |
| 1981 | 3.3 | 10.8 | 6.0 | 6.5 | 11.2 | 6.8 | 1,376 |
| 1982 | 3.7 | 9.8 | 6.4 | 8.4 | 11.6 | 8.8 | 1,396 |
| All years combined | 4.6 | 9.7 | 7.3 | 7.2 | 11.8 | 7.1 | 6,957 |
| $\chi^2_{4df}$ | 35.40[a] | 3.04 | 19.07[a] | 11.43 | 22.85[a] | 13.30[a] | |

[a] Difference among years ($P \leq 0.01$).

was in the Southeast followed by the Northwest, the Southwest and the Northeast Regions (Table 2). The extensive agricultural area of the Northeast Region with small, isolated stands of remaining bottomland hardwoods would be expected to have the lowest bobcat densities.

No significant difference in visits by years within region was shown ($P > 0.01$) except in the Southeast ($P < 0.01$). The visitation rate in this region dropped dramatically from 11.9% in 1978 to 10.5% in 1979, then to 3.0% in 1980, 2.1% in 1981 and 2.6% in 1982. These data indicate a decrease in the bobcat population in the Southeast Region. However, harvest data from this region did not indicate a change in the population. The percentage of the total bobcat harvest taken in this region remained relatively stable (Louisiana Department of Wildlife and Fisheries, unpubl. data 1983). A substantial portion of the decrease in bobcat visitation statewide from the 1978–1979 to 1980–1982 seasons can be accounted for by the decrease in the Southeast Region.

Visits in different habitats within regions showed significant differences in the Northwest, the South Central, and the Southeast ($P < 0.01$). These data support the basic assumption of the survey that visitation rates reflect population size. Visitation rates were highest in the habitat type that Hall (1973) and Lowery (1974) implied was the best for bobcat. In the Northwest, bottomland hardwoods had 10.6% visitation. Next highest was recent clearcuts with 6.1% and mixed pine-hardwood with 4.5%. The remaining habitats (pure pine, agriculture, and pasture) averaged 1.7%. In the South Central Region, bottomland hardwood had the highest rate with 12.1%, pasture and recent clearcuts combined had 10.6%, and agriculture, 5.9%. The visitation rates in pasture, clearcuts, and agriculture were probably a function of the interspersion of this habitat type with large areas of bottomland hardwood. In the Southeast, bottomland hardwood combined with mixed pine-

**Table 2.** Five-year mean scent station visitation rates (%) for 5 regions and 6 mammals in Louisiana (1978 through 1982).

| Region | Visitation rates (%) | | | | | | *N* of readable stations |
|---|---|---|---|---|---|---|---|
| | Bobcat | Coyote | Fox | Raccoon | Opossum | Skunk | |
| Northwest | 4.0 | 14.3 | 9.6 | 5.0 | 7.4 | 4.9 | 2,896 |
| Northeast | 1.9 | 9.1 | 4.4 | 6.6 | 16.5 | 11.1 | 1,201 |
| Southwest | 3.7 | 10.3 | 5.7 | 7.7 | 5.7 | 8.9 | 949 |
| South Central | 9.4 | 4.4 | 3.2 | 16.7 | 28.0 | 11.7 | 957 |
| Southeast | 6.0 | 1.7 | 9.5 | 4.7 | 9.2 | 2.5 | 954 |
| All regions combined | 4.6 | 9.7 | 7.3 | 7.2 | 11.8 | 7.1 | 6,957 |
| $\chi^2_{4df}$ | 71.88[a] | 203.40[a] | 76.61[a] | 132.02[a] | 314.44[a] | 119.21[a] | |

[a] Difference among regions ($P \leq 0.01$).

hardwood had a 10.0% visitation rate, followed by recent clearcuts with 4.2%, pure pine with 3.4%, and pasture with 3.2%. In the Southeast, there was a significant drop in visitation by year within the combined habitat of bottomland hardwood and mixed pine-hardwood ($\chi^2 = 17.83$, $P < 0.01$). The visitation rate in 1978 and 1979 averaged 16.7% as compared to 4.4% in 1980 and through 1982. The other regions showed similar but not significant differences ($P > 0.01$).

### Coyotes

For all years, combined coyote visitation rates averaged 9.7% (Table 1). No significant difference was detected among years ($P \geq 0.01$). However, with all years combined, visitation rates were significantly different among regions ($P < 0.01$, Table 2) and decreased from the Northwest to the Southeast Region. These data appear to document the invasion and spread of the coyote from the Northwest Region to the south and east, as described by Hall (1979), with a fairly recent move across the Atchafalaya River and subsequently the Mississippi River. Recent harvest data support this pattern. The coyote harvest was 16.7/40,470 ha in the Northwest and decreased to 0.2/40,470 ha in the Southeast Region (Louisiana Department of Wildlife and Fisheries, unpubl. data 1983). Further analysis of visits by year within regions showed no significant difference ($P > 0.01$) except for the South Central Region ($P < 0.01$). These data indicated that the coyote population is increasing rapidly in this region. Visitation rates show an upward trend: 1978, 1.0%; 1979, 3.7%; 1980, 2.1%; 1981, 8.4%; 1982, 6.7%. With all years combined, the data indicated no preference among these habitats for coyotes.

### Fox

We did not attempt to separate gray and red fox tracks. The over-all fox visitation rate was 7.3% and visits differed significantly among years ($P < 0.01$, Table 1). The highest visitation rate was in 1978, with lower but relatively stable rates from 1979 through 1982. With all years combined, a significant difference was detected among regions ($P < 0.01$, Table 2). The Northwest Region and the Southeast Region had the highest rates. The only region that showed a significant change by year was the Northeast which fluctuated with no apparent pattern ($P < 0.01$).

Visitation by habitat within a region was significantly different only in the Southwest Region ($P < 0.01$). The combination of agriculture and pasture had a much higher rate (11.1%), than either mixed pine hardwood and pure pine (3.1%) or recent clearcuts (2.3%).

### Raccoon

With all years combined, the raccoon visitation rate was 7.2%. No difference was detected among years ($P > 0.01$, Table 1). However a significant

**Table 3.** Annual scent station visitation rate (%) and sample size ($N$) for raccoons in 5 regions in Louisiana.

| | Visitation rate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Northwest | | Northeast | | Southwest | | South Central | | Southeast | |
| Year | % | $N$ | % | $N$ | % | $N$ | % | $N$ | % | $N$ |
| 1978 | 4.6 | 582 | 3.8 | 238 | 6.8 | 177 | 28.1 | 192 | 7.6 | 184 |
| 1979 | 2.7 | 585 | 11.8 | 238 | 8.0 | 188 | 11.5 | 191 | 6.8 | 191 |
| 1980 | 6.8 | 590 | 4.9 | 247 | 7.2 | 194 | 8.4 | 190 | 1.0 | 198 |
| 1981 | 4.4 | 567 | 3.4 | 236 | 7.2 | 194 | 18.4 | 190 | 3.7 | 189 |
| 1982 | 6.3 | 572 | 9.1 | 242 | 9.2 | 196 | 17.0 | 194 | 4.7 | 192 |
| $\chi^2_{4df}$ | 13.52[a] | | 20.34[a] | | 0.94 | | 31.10[a] | | 13.81[a] | |

[a] Difference among years ($P < 0.01$).

difference was present among regions with the visitation rate in the South Central (16.7%), more than twice that of any other region ($P < 0.01$, Table 2). These data were supported by harvest information which indicated that the South Central Region produced the most raccoons/unit area (93/4,470 ha). The next highest harvest was in the Southeast with 78.3/4,470 ha and the lowest was in the Northwest with 42.9/4,470 ha (Louisiana Department of Wildlife and Fisheries, unpubl. data 1983).

Significant differences ($P < 0.01$) were found among years for all regions except the Southwest Region ($P = 0.9$, Table 3). This was somewhat unexpected since we did not find a significant difference at the 0.01 level for the statewide total among years. These variations in visitation rates may have resulted from either population fluctuations, or movements related to precipitation. Precipitation may have influenced raccoon movements more than movements of other species.

Visitation rates by habitat type showed a significant difference ($P < 0.01$) with all regions except the Southeast ($P = 0.7$). Bottomland hardwoods had the highest or 1 of the highest rates in these regions where it occurred.

### Opossum

The average opossum visitation rate for the 5-year study was 11.8% and rates among the 5 years were significantly different ($P < 0.01$). Percent visitation was the lowest in 1978, highest in 1979, then dropped and stabilized in 1980 through 1982 (Table 1).

Visitation rates by region with all years combined showed a significant difference ($P < 0.01$) with the South Central the highest (28.0%) and the Northeast next (16.5%, Table 2).

Visitation rates by habitat within regions differed significantly in the Northwest, the Northeast, Southwest, and the South Central regions ($P < 0.01$). Bottomland hardwood habitat had the highest visitation rate in the Northwest

(13.0%), the Northeast (29.2%), and the South Central (33.4%) regions. This habitat type did not occur in the Southwest, however in this region the highest rates occurred in the combination of pasture and agriculture (10.2%).

Rates by year in bottomland hardwood in the South Central Region showed significant differences ($P < 0.01$). In 1978, the rate was 29.0%, then in 1979 the rate climbed to 50.0%; in 1980, dropped to 35.6%; in 1981, to 31.8%; and in 1982, fell to 21.8%.

### Skunk

The average skunk visitation rate for the 5 years was 7.1%. A significant difference ($P < 0.01$) was detected among years with the lowest rate in 1978 and the highest in 1982 (Table 1).

Visitation rates by region were also significant ($P < 0.01$) with the same patterns as opossum. The South Central Region was highest and the Northeast was next (Table 2).

Visitation rates by habitat type within a region were quite different from the opossums. The Northwest ($\chi^2 = 19.3$), Southwest ($\chi^2 = 87.81$) and the South Central ($\chi^2 = 12.4$) regions showed significant difference in visitation rates among habitats ($P < 0.01$). In the Northwest, pasture had the highest rates (10.3%) while in the Southwest it was the combination of agriculture and pasture (20.9%). However, in the South Central Region, bottomland hardwoods was the highest (15.0%).

## Conclusions

The overall results of this 5-year survey indicated that scent station response provided a valuable index to population size of several species of furbearers.

The visitation rates by region and habitat were reasonable and in some cases agreed with harvest data. The data suggest that a change occurred in bobcat populations from 1978–1979 to 1980–1982. The differences in visitation rates among years for fox, opossum, and skunk reflect year-to-year changes with no apparent trend. Visitation rates of coyote and raccoon remained relatively stable.

This survey should become an annual project for monitoring population trends of bobcat, fox, and coyotes. The usefulness of the results for management decisions, legislation and public relations provide ample justification for the expenditure of money and manpower.

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