Use of Bait Stations to Monitor Black Bear Populations in the Mississippi Alluvial Valley

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Abstract: Black bear populations of the Mississippi Alluvial Valley (MAV) are threatened by continuing habitat destruction, necessitating development of techniques to monitor population trends. Bait station surveys have proven successful for monitoring other southeastern bear populations. We conducted experimental bait station surveys during May–August 1992 and 1993 to evaluate effect of bait type (fish, sardines, meat), sampling duration (4 and 8 days), and sampling month on bait station visitation rates by black bears. In 1992 and 1993, visitation rates by black bears were 11.4% and 27.2%, respectively. Highest visitation rates occurred using fish bait in August with an 8-night sampling period. We recommend conducting MAV bait station surveys in August using fish bait. Bait stations should be conducted annually where visitation rates allow monitoring of population trends and every 3–5 years in low bear density areas to provide baseline distributional information.

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The Louisiana black bear (*Ursus americanus luteolus*) is a federally threatened species (U.S. Dep. Int. 1991) and it, as well as the American black bear (*U. a. americanus*), are endangered in Mississippi (Miss. Mus. Nat. Sci. 1990). Habitat destruction and alteration (Smith 1985, Weaver et al. 1990, Spencer 1981) threaten remaining bear populations in the Mississippi Alluvial Valley (MAV), which includes Arkansas. To preserve MAV black bear populations, it is essential to understand black bear distribution and monitor population trends (Miller 1993). Consequently, reliable indices are needed to monitor long term population trends.

Bait station indices have been correlated with population estimates in the

Great Smoky Mountains (Johnson 1980, Carlock et al. 1983). Bait stations also were a valuable technique to determine relative abundance and distribution of black bears in north Georgia (Carlock 1986). In Wisconsin, bait stations were an economical and reliable index to bear abundance (Kohn 1982). Current management applications indicate that bait station surveys are a valid, feasible, and comprehensive method to objectively monitor relative density and distribution of black bears in the Southern Appalachian Region (Johnson 1982, Carlock et al. 1983, Carlock 1986, Johnson 1993). However, bait station techniques have been developed in areas other than forested wetland habitats typical of the MAV. Techniques to maximize visitation rates within the MAV would improve the utility of this population index for MAV bear populations. Our objective was to determine effects of bait type, sample period duration, and sampling month on black bear visitations to bait stations in the MAV.

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Methods

Study Areas

We established and monitored bear bait stations on 2 Mississippi River Islands. Study areas were chosen because of known bear presence. Montgomery Island and Big Island are located 3 km west of Rosedale, Mississippi, in Desha County, Arkansas, and comprise 2,429 ha and 12,955 ha, respectively. Montgomery Island is bordered on the east, north, and south by the Mississippi River and on the west by the Old White River Chute. Big Island is separated from Montgomery Island by the Old White River Chute on its eastern edge, by the Arkansas River on the south and west, and the White River to the north. Bears readily traverse many of these waterways (T. H. White, Miss. State Univ., Dep. Wildl. and Fish. pers. commun.). Therefore, the study areas were considered to be one unit.

Dominant overstory species on Montgomery Island were green ash (*Fraxinus americanus*), American elm (*Ulmus americanus*), and sugarberry (*Celtis occidentalis*). Dominant overstory species on Big Island were pecan (*Carya illinoensis*), cypress (*Taxodium distichum*), oak (*Quercus* spp.), green ash, and sugarberry. Common understory species included persimmon (*Diospyrus virginiana*), dogwood (*Cornus spp.*), sassafras (*Sassafras albidum*), and swamp privet

(*Ligustrum sinense*). The primary use of Montgomery Island is hunting with little human activity during summer. Big Island, owned by the Anderson-Tully Company, is used for timber production and is leased to hunting clubs. Summer use is primarily restricted to limited logging activity.

Bait Station Techniques

Meat scraps (Johnson and Pelton 1980, Kohn 1982), fish (Ball 1976, Smith 1985), and sardines (Beeman 1975, Johnson and Pelton 1980, Carlock 1986, Johnson 1993, Abler 1988) were used for bait. Pork and beef with fat were obtained from the Sunbelt Meat Company, Macon, Mississippi. Fish baits consisting of common carp (*Cyprinus carpio*), freshwater drum (*Aplodontus grunniens*), gar (*Lepisosteus* spp.), and/or river redhorse (*Moxostoma carinatum*) were obtained from commercial fishermen.

Both meat and fish bait stations consisted of 0.9 kg of bait enclosed in a 0.45- × 0.45-m white cotton muslin cloth. The bait "bag" was tied closed with 81.7-kg (180 lb) test nylon string. Bait bags were stored frozen and thawed 4–24 hours before use. Sardines packed in soybean oil (Port Clyde Foods, Inc., Rockland, Maine) were stored unrefrigerated. At each sardine bait station, 3 cans were partially opened and oil was poured on a tree and the ground (Carlock 1986). Bait bags and sardine cans were suspended from overhanging tree limbs with 81.7-kg test nylon string at least 1 m from any vertical structure. In 1992, baits were suspended 1.5–2 m above ground (Kohn 1982). In 1993, baits were suspended 2–2.5 m above ground (Johnson and Pelton 1980, Carlock 1986) to reduce disturbance by non-target species.

Bait station surveys were conducted once each month during May (Abler 1988), June (Kohn 1982), July (Carlock 1986, Abler 1988, Johnson 1993) and August in 1992 and 1993 for an 8-night sampling period (Abler 1988). Stations were checked 4 nights after establishment, rebaited with fresh bait, and checked again after 4 more nights when baits were removed. Baits were replaced regardless of whether the station was visited after 4 days. Fish, meat, or sardine baits were randomly assigned to each station each month. Bait stations were established systematically (Carlock et al. 1983, Roughton and Sweeney 1982, Hatcher and Shaw 1981) along existing roads and all-terrain vehicle (ATV) trails at 0.8-km linear intervals (Kohn 1982, Carlock 1986, Johnson 1993). Bait sites were placed at the first appropriate tree (i.e., overhanging limb at least 1.5 m above ground and ≥1 m from other vertical structures) found near roads or ATV trails. In May 1993, bait stations on Big Island were established by boat because high water made roads inaccessible.

Statistical Analysis

We used log linear models (Fienberg 1977) to test the null hypotheses of no significant differences ($P \geq 0.05$) between years (1992, 1993), bait types (meat, fish, or sardine), months (May–August), sample period durations (4 or 8 nights), and visitation rate.

Table 1. Black bear visitation rates by bait type on Big Island and Montgomery Island, Arkansas, May–August 1992 and 1993.

Year/bait type	*N* baits	*N* Bait sites visited	Visitation rate
1992			
Meat	61	3	4.9
Fish	40	12	30.0
Sardines	83	6	7.2
Subtotal	184	21	Average 11.4
1993			
Meat	41	11	26.8
Fish	52	27	51.9
Sardines	54	2	3.7
Subtotal	147	40	27.2
Total	331	61	Average 18.4

Results

In 1992, 21 of 184 (11.4%) bait stations were visited by black bears and, in 1993, 40 of 147 (27.2%) bait stations were visited (Table 1). Black bear visits were detected by presence of tracks ($N = 2$), presence of scat ($N = 1$), observation of a bear eating bait ($N = 1$), and a combination of broken limbs and strings from which bait was suspended coupled with vegetation being trampled and/or bait missing ($N = 57$). Missing baits with no evidence of bear presence were considered as unknown visits. No instances of bear sign without bait disturbance was recorded.

Log-linear analysis of independence indicated years interacted significantly with months (partial $\chi^2 = 9.26$ $P = 0.026$, df = 3), bait type (partial $\chi^2 = 6.08$ $P = 0.048$, df = 2), and sampling duration (partial $\chi^2 = 283.01$ $P = <0.001$, df = 1). This indicated that months, bait type, and sampling duration were significantly dependent with year, thereby preventing data pooling between years. However, visitation rate was not involved in any between-year interactions indicating that differences in visitation rates between years could be examined. Visitation rates to bait stations did not significantly differ between years (partial $\chi^2 = 3.24$ $P = 0.072$, df = 1). Log-linear analyses were conducted within each year because of interactions that existed between years.

In 1992, a significant interaction (partial $\chi^2 = 14.413$, $P = 0.025$, df = 1) existed among bait, month, and visitation rate. Interaction terms involving sampling duration were not significant, indicating that effect of sampling duration on visitation rate was independent of other variables making inferences concerning sampling duration possible. There was a significant difference (partial $\chi^2 = 510.16$ $P = \leq 0.001$ df = 1) between sample period duration with the 8-night sampling period producing a higher visitation rate (43% for 4 nights and 57% for 8 nights). An upward trend in visitation rates occurred from May through August with fish bait being causal in the upward trend (Fig. 1).

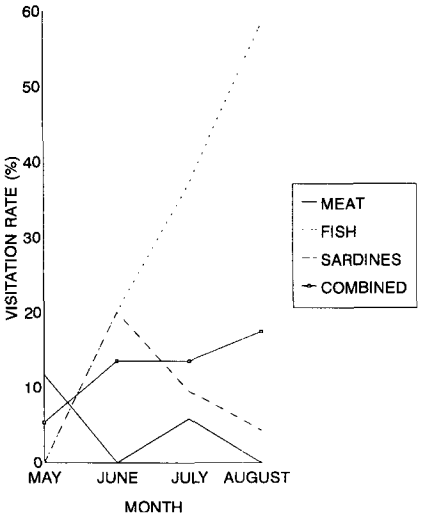

Figure 1. Bait station visitation rate trends, Mississippi Alluvial Valley, May to August 1992.

In 1993, there was a significant interaction (partial $\chi^2 = 8.56$ $P = 0.036$, df = 2) between months and visitation rate and between bait type and visitation rate (partial $\chi^2 = 27.67$ $P = <0.001$, df = 2). Sampling duration was not involved in any significant interactions meaning inferences concerning sampling duration could be made. There was no significant difference (partial $\chi^2 = 0.00$ $P = 1.00$, df = 1) in bait visitation between sampling period duration (47.5% for 4 nights, 52.5% for 8 nights) in 1993.

As in 1992, an upward trend in percentage visitation occurred from May to August, 1993 with most variation attributable to fish bait (Fig. 2). Although trends were similar, year interactions were significant because dissimilar interactions occurred. In 1992, month by bait by visit was significant but, in 1993, 2 interactions (month by visit and bait by visit), were significant.

In 1992, 40 non-target species visitation occurred (21.7%) with 44 occurring in 1993 (29.9%). Raccoon visitations comprised most known non-target species disturbance in 1992 (85%, $n = 34$) and in 1993 (54.5%, $n = 24$). Most raccoon visits were at sardine bait stations, possibly reflecting a preference for sardines or that sardines were more easily obtainable than fish or meat baits.

Discussion

This study was experimental in nature; results cannot be construed to represent actual bait station surveys. The experiment was designed to employ techniques used in bait station surveys to determine optimal parameters for maximizing black bear visits in the MAV. Results indicated techniques that will positively influence visitation rates in future bait station surveys.

The marked increase in bait station visitation rates between 1992 and 1993

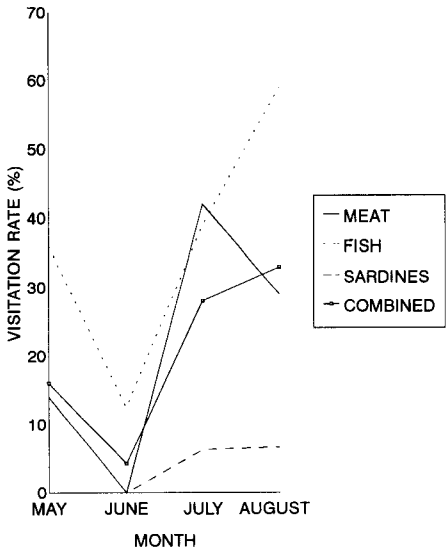

Figure 2. Bait station variation rate trends, Mississippi Alluvial Valley, May to August 1993. (Note: no visits occurred to sardine baits in May or June).

may have resulted from changing environmental conditions. In 1992, the Mississippi River mean river stage at Rosedale, MS (U.S. Army Corps Eng., Vicksburg, Miss.) for May–August was 4.45 m. In 1993, the mean river stage for May–August was 9.35 m. Assuming the black bear population did not significantly increase between 1992 and 1993, higher river stages may have forced a similar number of bears onto less area. This may have increased black bear density on Big Island and Montgomery Island, thereby artificially inflating visitation rates. However, it is important to note that even a three-fold increase in visitation rate did not produce a significant difference in visits between years. This may be from low sample size decreasing index sensitivity and, because variance of a binomial variable is related to the mean, as visitation rate increases, so does the variance (Diefenbach et al. 1994). These factors reduce power of the test so that statistical differences are difficult to detect.

Highest visitation rates occurred with fish bait in August. This result may be related to diet. Smith (1988), on the White River National Wildlife Refuge, which bordered our study area to the north, reported fish to increase in black bear scats throughout the summer, peaking in August and September. August is a period of low water and fish trapped in sloughs and backwaters provide an easily obtainable food source. Bears may be keying in on this ephemeral food source, thus increasing their likelihood of visiting a fish bait station.

Visitation rate differed significantly by sampling period duration in 1992, but not in 1993. When indexing low density populations within the MAV, we recommend conducting bait stations for 8 nights and replacing baits after 4 nights. In the MAV, baits must be replaced every 4 days due to rapid rates of decomposition. The 8-night sampling period increases probability of a bear en-

countering a bait station, thus producing higher visitation rates. In low density populations, it is imperative to produce the highest visitation rates possible to validate bait station indices and to ensure detection of bear presence.

In June 1993, only 4 bait stations were established on Big Island. This resulted from problems associated with extreme water level fluctuations of the Mississippi River. To ensure consistency in yearly surveys in the MAV, bait stations should be conducted when river stages are least variable. Variation in river stage was smallest from 1980–1992 in August ($\bar{x}$ = 7.17, *sd* = 6.52) (Army Corps Eng., Vicksburg, Miss., from Rosedale, Miss. river stage data) further supporting August as the appropriate sampling month.

Bait station distances from roads varied between 11 m to 1219 m ($\bar{x}$ = 60 m). Bait station distance from roads and trails affected visitation rates in North Carolina (Teunissen Van Manen 1990). Distance from roads on our study areas did not affect black bear visitation rates (Miller et al. 1994). This is probably because roads on our study areas had extremely low traffic volume during sampling periods.

Johnson (1993) recommended a density of 1 bait station/2.6 km^2. Sampling intensities in our study were difficult to determine. We could not sample all of Big Island because of inaccessible roads. However, we sampled all of Montgomery Island with sampling intensities of 1 bait station/1.40 km^2 in 1992 and 1 bait station/1.31 km^2 in 1993. Although this sampling intensity is higher than that recommended by Johnson (1993), bait stations, even nonconsecutive stations, were never located closer than 0.8 km from one another, thus maintaining integrity of the experimental design. Higher densities may have resulted from a road network that made most of our study area accessible for placing bait stations.

Methods need to be developed to minimize non-target species visits, especially in areas of low bear densities. Minimizing such visits increases opportunity for black bears to visit a bait station. One possible solution to minimize raccoon visits would be to secure baits to a ground structure using monofilament fishing line. This would prevent raccoons from pulling baits up over tree limbs. A second solution would be to place fish in wire mesh nailed to bait trees. Non-target species would be unable to remove baits, but black bears would be able to take bait or leave claw marks. Also, using only fish bait may reduce incidence of non-target species visits.

Several caveats are warranted. Results of bait station surveys developed in the MAV will be only comparable to other MAV surveys. Differences in appropriate techniques, bear response to bait, and habitat conditions prevent comparisons with other physiographic regions. Additionally, affects of flooding on bear movements is undocumented. High water during June 1993 may have decreased probability of a bear visiting a bait station. Finally, by replacing baits after 4 nights, a black bear may be more likely to visit the same station after 8 nights. If MAV bait station surveys are to be correlated with population trends, separate analyses for 4 night sampling periods and 8 night sampling periods should be conducted to determine if replacing baits has a significant influence.

Management Implications

Roughton and Sweeney (1982) suggested that scent station visitation rates of 40%–60% were optimal for statistical detection of population changes. In the Great Smoky Mountains National Park, visitation rates ranged 34–70.2% over a 10 year period (Johnson 1990). This visitation rate may be obtainable, using our technique, for black bear populations in areas of the MAV with relatively dense bear populations. However, low population levels in many areas of the MAV may preclude effectiveness of bait station indices to detect population changes. Hellgren (1993) and Rossell (1990) both observed that low visitation rates yield little distributional information, causing bait station indices not to be cost effective; however, in areas of low density, such surveys represent a baseline for future surveys (Hellgren 1993) and may provide black bear presence/absence data.

Wildlife professionals need to conduct preliminary bait station surveys to determine where sufficiently dense bear populations exist for indexing purposes. In these areas, surveys should be conducted annually. Additional areas determined to have low bear densities may have bait station surveys conducted every 3–5 years. These surveys will provide baseline data on bear distribution and establish routes for future annual surveys if populations increase to levels that can be successfully indexed. It may also be necessary to conduct a pilot study to estimate required sample size to detect a given population change. Our sample size was inadequate to address population trends. Diefenbach et al. (1994) discuss methodologies for estimating sample sizes for scent station surveys and appropriate analyses for survey data.

Standardization of techniques (Connor et al. 1983) and consistently locating indexing lines to systematically and representatively sample the area of interest (Carlock et al. 1983) every year are important to compare survey results among years. To further enhance technique standardization, personnel responsible for conducting bait station surveys need to be trained in proper bait station methodology (Miller 1993). Survey routes also should be periodically updated to incorporate new information obtained from bear sightings.

Literature Cited

Abler, W. A. 1988. Evaluation of sardine bait-stations for indexing black bears in southeast Georgia. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:396–403.

Ball, R. E. 1976. The use of time-lapse cameras in distribution and population studies of grizzly bears (*Ursus arctos*) in the Shoshone National Forest, Park County, Wyoming. M.S. Thesis, Univ. of Wyoming. Laramie. 33pp.

Beeman, L. E. 1975. Populations characteristics, movements, and activities of the black bear (*Ursus americanus*) in the Great Smoky Mountains National Park. Ph.D. Diss., Univ. Tenn., Knoxville. 218pp.

Carlock, D. M. 1986. Distribution and density of black bears in north Georgia. Final Report, P-R Project W-47-R, Study XIX. Ga. Dep. Nat. Resour., Gainesville. 19pp.

———, R. H. Conley, J. M. Collins, P. E. Hale, K. G. Johnson, A. S. Johnson, and M. R. Pelton. 1983. The tri-state black bear study. Pope and Young Club. 286pp.

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

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

Fienberg, S. E. 1977. The analysis of cross-classified data. MIT Press, Cambridge, Mass. 151pp.

Hatcher, R. T. and J. H. Shaw. 1981. A comparison of three indices to furbearer populations. Wildl. Soc. Bull. 9:153–156.

Hellgren, E. C. 1993. Status, distribution, and summer food habits of black bears in Big Bend National Park. Southwest. Nat. 38:77–80.

Johnson, K. G. 1980. Developing population indices for black bears in the Great Smoky Mountains. Proc. Annu. Sci. Res. Meeting, the Uplands Area of the Southeast Region, Natl. Park Serv. 6:33 (abstract).

———. 1982. Preliminary results of bait-station surveys to monitor relative abundance, distribution, and activities of black bears in Southern Appalachian Region. Proc. Annu. Sci. Res. Meeting, the Uplands Area of the Southeast Region, Natl. Park Serv. 8:27 (abstract).

———. 1990. Bait station surveys to monitor relative density, distribution, and activities of black bears in the southern Appalachian region—annual progress report. Univ. Tenn., Knoxville. 59pp.

———. 1993. Bait station surveys to monitor relative density, distribution, and activities of black bears in the southern Appalachian region—annual progress report. Univ. Tenn., Knoxville. 138pp.

——— and M. R. Pelton. 1980. Prebaiting and snaring techniques for black bears. Wildl. Soc. Bull. 8:46–54.

Kohn, B. E. 1982. Status and management of black bears in Wisconsin. Tech. Bul. 129. Dep. Nat. Resour., Madison, Wisc. 31pp.

Miller, D. A. 1993. Preliminary investigation into bait station use to monitor black bear populations in Mississippi. M.S. Thesis, Miss. State Univ. Miss. State, Miss. 69pp.

———, Jacobson, H. A., and B. D. Leopold. 1994. Effects of vegetation composition and land-use variables on bait station visitations by black bears. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 47:252–260.

Mississippi Museum of Natural Science. 1990. Newsletter. 7(1):1–3.

Rossell, C. R., Jr. 1990. The influence of human demographic factors on black bear harvests in New Hampshire. M.S. Thesis, Univ. N.H., Durham. 60pp.

Roughton, R. D. and M. W. Sweeney. 1982. Refinements in scent-station methodology for assessing trends in carnivore populations. J. Wildl. Manage. 46:217–229.

Smith, T. R. 1985. Ecology of black bears in a bottomland hardwood forest of Arkansas. Ph.D. Diss., Univ. Tenn., Knoxville. 209pp.

Spencer, J. 1981. Soybean boom, hardwood bust. Am. For. 87:23–25, 49–52.

Teunissen Van Manen, F. 1990. Black bear bait-station surveys on the Pisgah National

Forest, North Carolina. 14th Annu. Sci. Resour. Meeting, the Uplands Area of the Southeast Region. Natl. Park Serv. Knoxville, Tenn. p. 22.

U.S. Department of the Interior. 1991. Louisiana black bear listed as threatened species. Release No. 120–91. U.S. Fish and Wildl. Serv., Washington, D.C. 1p.

Weaver, K. M., D. R. Tabberer, L. U. Moore, Jr., G. A. Chandler, and J. C. Posey. 1990. Bottomland hardwood forest management for black bears in Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 44:342–350.