TRANSMITTER DROPS AS A TECHNIQUE FOR DETECTING BLACK BEAR HABITAT USE

JEFF BERINGER,[1] Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN 37901
STEVEN G. SEIBERT,[2] Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN 37901
MICHAEL R. PELTON, Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN 37901

Abstract: We developed a transmitter drop technique that improved interpretation of habitat-use data by black bears (*Ursus americanus*). The study was conducted in Harmon Den Bear Sanctuary, Pisgah National Forest, North Carolina, during 1985-87. To assess the accuracy and value of transmitter drops, habitat-use data obtained with this technique was compared to those collected using conventional aerial and ground tracking. We used 1,697 ground locations, 204 aerial locations, and 111 transmitter drops to determine the habitat types used by 14 radio-tagged female black bears. Habitat use, as determined by the 3 tracking methods, varied among methods. Ground tracking suggested bears used white oak (*Quercus alba*)-red oak (*Q. rubra*)-hickory (*Carya* spp.) cover types more than expected and yellow poplar (*Liriodendron tulipfera*) cover types less than expected in 1986-87. During 1985 ground tracking suggested bears used all cover types in proportion to availability. Aerial telemetry suggested bears avoided yellow poplar stands over all years. Data from transmitter drops detected differences in habitat use for all years. Yellow poplar-white oak-northern red oak and chestnut oak (*Q. prinus*) cover types were used more than expected and nonforest, pine (*Pinus* spp.), mixed hardwood, and yellow poplar stands were used less than expected.

Int. Conf. Bear Res. and Manage. 9(1):303-307

Accurate radio locations and associated cover types of animals within their home ranges are necessary for successful evaluation of habitat use. The accuracy of telemetry locations can be influenced by such variables as topography, vegetation, weather conditions, the time interval between successive readings, and the ability of the receiver to interpret transmitted signals (Springer 1979, Hupp and Ratti 1983). The accuracy of ground tracking in mountainous terrain is generally poor. Steep ridges and patchy vegetation patterns often lead to errors in evaluating habitat use by animals. Error polygons (Springer 1979) compensate for some telemetric error but often are large and may include several cover types. Telemetry accuracy is also a major factor influencing the power of the Chi-square tests used to determine habitat selection, with power decreasing by increasing habitat complexity and decreased precision of triangulation (White and Garrott 1986, Nams 1989). In our study, we often had large error polygons that enclosed several cover types. This problem was exacerbated by the patchy habitats found in our study area.

Aerial locations eliminate much of the error associated with ground telemetry. However, the accuracy of identifying the cover type associated with an aerial location is limited by the accuracy and detail of cover type maps. Cover maps that are inaccurate or lack the detail required for habitat studies are not useful when studying the use of complex habitats by large, mobile, secretive animals. Maps used in studies on national forest lands often place cover types into specific forest stand types. However, within the stands, small habitats are not designated on conventional maps. In addition, many stands are large (>50 ha) and contain small pockets of different stand types created by varying slope, aspect, gap-phase replacement, or past logging history. Such habitats often can be detected only by ground evaluation.

To improve the accuracy of radio telemetry in our habitat study, we developed a transmitter drop technique that enabled more accurate interpretation of habitat-use data and activities by black bears on Harmon Den, Pisgah National Forest, North Carolina. The technique enables a researcher to visually interpret bear activity and habitat use. This paper expands upon the work of Beringer and Pelton (1986). To assess the accuracy and value of transmitter drops, habitat-use data obtained with this method was compared to data collected using conventional aerial and ground tracking.

This research was funded by the U.S. Department of Agriculture Forest Service (USFS), the Department of Forestry, Wildlife and Fisheries, and the Agricultural Experimental Station of The University of Tennessee, Knoxville. We thank the North Carolina Wildlife Resources Commission (NCWRC) for assistance in trapping, especially J. Collins. Thanks also is due to L. Hillman (USFS). Our pilot, B. Kindy, also deserves much thanks. R.W. Dimmick and W.G. Minser

[1] Present address: Missouri Department of Conservation, 1110 South College Avenue, Columbia, MO 65201.
[2] Present Address: U.S. Fish and Wildlife Service, 6620 Southpoint Dr., S, Jacksonville, FL 32216.

provided helpful comments on the manuscript.

STUDY AREA

The study was conducted on the Harmon Den Bear Sanctuary, Pisgah National Forest, North Carolina. The area is part of the Blue Ridge Physiographic Province (Fenneman 1938). The mountains are sharply dissected and the terrain is steep. Elevations range from 439 to 1,411 m; slopes average over 30% (Finlayson 1957). The area is described as a warm-temperate rain forest (Thornwaite 1948). Vegetation is diverse and changes dramatically with aspect, elevation, soil, and drainage. The general area is among the most botanically diverse temperate areas in the world (Whittaker 1956).

The majority (89%) of Harmon Den was in hardwood cover types, consisting of white oak-red oak-hickory (45%), yellow poplar-white oak-northern red oak (26%), yellow poplar (10%), scarlet oak (*Q. coccinea*) (5%), and chestnut oak (3%).

METHODS

Bears were captured with Aldrich foot snares using the methods described by Johnson and Pelton (1980). Captured animals were sedated, weighed, measured, and examined for external parasites. Initial captures were marked with ear tags and tattoos. Selected individuals were fitted with radio collars operating in the 150-152 Mhz range (Telonics, Mesa, Ariz.).

Three radio-telemetry methods were used to determine bear locations. Ground triangulation was done from identifiable points on topographic maps. In most instances 5-7 azimuths were taken for each animal during each tracking session; only 2 of these were used to delineate the position of an animal. These 2 azimuths met the following criteria: (1) the angle between the azimuths was between 60° and 120°; (2) the time interval between consecutive azimuths was less than 30 minutes; (3) signal integrity was good; and (4) there were no topographic obstructions between the receiver and the radio-tagged animal. Directional accuracy of the telemetry equipment was tested using preplaced transmitters at known locations.

Bears also were located from a Cessna 172 aircraft with separate antennae mounted on each wing strut. Aerial telemetry accuracy was tested using preplaced transmitters.

Transmitters dropped during 1985 and 1986 were refurbished raccoon transmitters, operating in the 150-152 MHz range (Wildlife Materials, Inc., Carbondale, Ill.) and wrapped in foam rubber 15-20 cm thick. For 1987, homemade transmitters operating on 164 MHz were provided by G. Alt, Pennsylvania Game Commission. A D-cell battery was attached to the transmitter package, wrapped in electrical tape, and then wrapped in the foam rubber packaging. Transmitter packages weighed 500 to 550 g.

Collared bears were located aerially (Mech 1983). After a good location was obtained, aircraft speed was reduced to 70-80 knots (129-148 km/hr) and above ground altitude reduced to 40-150 m. These factors varied depending on wind speed and topographic location of the collared bear (Beringer and Pelton 1986). As the desired spot was approached, the passenger held a transmitter package out the window and, at the pilot's command, dropped the package. Transmitters were dropped approximately 2 seconds per 40 m altitude ahead of the desired spot. The path of the dropped transmitter could be observed and recorded about 50% of the time. Landing location of the dropped transmitter was noted and compared to the aerial location marked on maps. Accuracy was checked by dropping transmitters on preplaced collars.

Dropped transmitters were retrieved within 1-3 days using ground homing techniques. After finding the package, steep sites were examined for skid marks to see if the package had rolled; and if it had, the actual impact sight was determined. A systematic search of the area was conducted for evidence of bear use. A drop site was defined as the habitat type that composed the area surrounding the dropped transmitter. We concluded that any bear sign within a site was made by our marked animal if the sign was within 50 m of the transmitter package and was less than 3 days old. Vegetation was sampled using a modified stratum rank method (Lindsey et al. 1961). Other data routinely collected included stand age, mast abundance, slope, and aspect. The site position was checked with topographic features before leaving.

The time periods for data collection were from June to October 1985, August to November 1986, and June to October 1987. We did not combine data from all 3 years because mast production varied during the period. Mast crops greatly influence bear habitat use and movements in the southern Appalachians (Garshelis and Pelton 1981, Quigley 1982, Carr 1983) and seasonal habitat-use patterns could potentially be masked by combining years with different species of oaks producing abundant mast. We therefore grouped 1986 and 1987 based on low acorn productivity (3.3 and 1.25, respectively, on scale of 1-10) but analyzed 1985 (6.03) data separately based on medium acorn production (NCWRC Mast Survey 1985-87). The methods of Neu et al. (1974) and Byers et al. (1984) were used to determine habitat selection. These techniques compare the amount of a given cover type available to the amount of use it receives. We compared the proportion of radio locations within a cover type to its availability. The 0.10 level of significance was used in the analysis because it appears to be appropriate for habitat-management decisions (Wood 1988). Vegetation data for the transmitter drops were grouped into categories similar to those produced by the USFS. We used the Forest Service's Continuous Inventory of Stand Condition (CISC) cover type maps for ground and aerial locations. When comparing our transmitter drop vegetation surveys to CISC maps, we considered the forest cover type equal if 2 of the 3 major tree species were the same or if the most abundant tree species was the same.

RESULTS

We used 1,697 ground locations, 204 aerial locations, and 111 transmitter drops to determine the habitat types used by radio-tagged bears. Of the 3 telemetry methods, ground telemetry was the least accurate. Azimuth deviation from true values were ±8.1° for 1985 and 8.6° for 1986-87. A 95% confidence limit was calculated to construct error polygons (Springer 1979). Average error polygon size was 15.8 and 5.6 ha for 1985 and 1986-87, respectively. Based on accuracy tests using preplaced transmitters, aerial locations were estimated to be accurate to within a 100 m diameter circle. The mean distance between preplaced and dropped transmitters (n = 15) was 70.7 m (SE = 8.5) and ranged from 15 to 133 m.

Habitat use as determined by the 3 tracking methods varied among methods. During 1985, traditional ground-tracking data suggested all bears used all cover types in proportion to their availability. Aerial locations suggested bears avoided yellow poplar stands ($P < 0.10$) and were indifferent to all other cover types. However, data from the transmitter drops revealed another picture of habitat selection. We found no bear locations in nonforest, pine, mixed hardwood, and yellow poplar stands. A selection for yellow poplar-white oak-northern red oak stands ($P < 0.05$) was noted as 43% of the dropped transmitters were found in these stands, yet this type represents only 25% of the area (Table 1). Use of chestnut and scarlet oak stands also was noted.

Differences in habitat use also were noted among the 3 tracking methods during 1986-87. Ground-tracking data suggested bears used yellow poplar stands less than expected and preferentially selected stands of white oak-red oak-hickory ($P < 0.10$). All other cover types were used in proportion to their availability (Table 2). Aerial-tracking data also indicated bears used yellow poplar stands less than expected ($P < 0.10$) and were indifferent to all other cover types (Table 2). Results from the transmitter drops were again somewhat different from the other 2 methods. Bears did not use nonforest, pine, and yellow poplar cover types. Bears selected for chestnut oak stands ($P \leq 0.05$). This

Table 1. Habitat use of 6 female black bears determined by ground tracking, aerial locations, and transmitter drops on Harmon Den, Pisgah National Forest, North Carolina, 1985.

		Radio locations		
Cover type	Availability (%)	Aerial tracking (n = 87)[a]	Transmitter drops (n = 54)	Ground tracking (n = 750)
Nonforest	1.4	2.0	0[b]	0.5
Softwood (pine)	5.6	5.6	0[b]	4.5
Mixed softwood-hardwood	3.9	3.7	0[b]	4.5
Yellow poplar	9.3	2.0[b]	0[b]	9.9
Chestnut oak	2.5	2.0	3.7	3.2
White oak-red oak-hickory	46.2	51.4	44.4	43.7
Yellow poplar-white oak-northern red oak	25.3	25.8	42.6[b]	25.8
Scarlet oak	5.8	7.5	9.3	7.9

[a] Number of locations per tracking method.
[b] Significant selection at $P \leq 0.10$.

Table 2. Habitat use of 8 female black bears determined by ground tracking, aerial locations, and transmitter drops on Harmon Den, Pisgah National Forest, North Carolina, 1986-87.

		Radio locations (%)		
Cover type	Availability (%)	Aerial tracking (n = 117)[a]	Transmitter drops (n = 57)	Ground tracking (n = 947)
Nonforest	0.5	3.7	0[b]	1.1
Softwood (pine)	1.8	5.5	0[b]	2.5
Mixed softwood-hardwood	7.7	9.2	3.5	6.3
Yellow poplar	3.5	0.9[b]	0[b]	1.3[b]
Chestnut oak	3.7	2.7	29.8[b]	2.9
White oak-red oak-hickory	54.6	56.0	42.1	60.8[b]
Yellow-poplar-white oak-northern red oak	26.8	20.2	22.8	23.4
Scarlet oak	1.4	1.8	1.8	1.7

[a] Number of locations per tracking method.
[b] Significant selection at $P \leq 0.10$.

cover type represented 3.7% of the home ranges, yet bears were found using it 30% of the time (Table 2). White and red oak species produced low mast values for 1986-87. The use of chestnut oak stands by bears may reflect tolerance of the tree to drought conditions, producing acorns when species from more productive sites (i.e., yellow poplar-white oak-northern red oak stands) failed to do so.

DISCUSSION

Transmitter drops appear to be a viable alternative to traditional telemetry techniques, especially when working in remote sites or areas lacking accurate or detailed cover type maps. We found that points placed on the topographic map during the flight and the locations of the dropped transmitter were the same in all cases but one; in this instance the transmitter was 200 m into a wooded area instead of on the edge of the woodline where it should have been.

Based on accuracy tests and transmitter drops at known sites, we believe our technique is accurate. In one case a transmitter was dropped at the site of a collar that had been dropped by a bear; the dropped transmitter and collar were less than 40 m apart. During 3 transmitter drop flights we were able to observe the transmitted bear we were attempting to locate because it was on a glade or rock outcrop. In all 3 cases the transmitter package was dropped on the same outcrop where the bear was spotted. Additionally, 4 transmitter packages were chewed on or torn apart by bears. Much of the accuracy of the transmitter drop procedure should be credited to the pilot's knowledge of the terrain and airplane (Beringer and Pelton 1986). Drawbacks of the transmitter drop technique are that night drops are impossible, it is very labor-intensive, and the success of this technique is probably related to the pilot's interest and experience (Hoskinson 1976).

For general home range purposes, ground tracking in the southern Appalachians may be satisfactory. However, more accurate findings regarding habitat use and analysis require more detailed information. Also, the power of statistical tests is severely limited by telemetry inaccuracies of ground tracking. The lack of apparent habitat selection we observed when using ground tracking is likely a reflection of the poor telemetry accuracy (White and Garrott 1986), and does not accurately evaluate small-scale habitat use because telemetry errors are too large.

Locating bears by aerial telemetry is more accurate than using ground telemetry; however, determining associated cover types of aerial locations is limited by the inaccuracies or inadequacies of cover type maps. The complex overstory/understory vegetation types make visual classifications of habitats from aerial observations subjective. This subjectivity, coupled with inaccurate maps, likely results in significant error when interpreting habitat use by bears. Ground evaluations of telemetry locations will eliminate cover type map inaccuracies. However, performing ground evaluations of aerial locations without transmitter drops on Harmon

Den is difficult because the complex topography makes exact ground locations difficult to determine.

We believe using transmitter drops to evaluate habitat use allows researchers to gather meaningful data in areas that are remote or lack accurate or detailed cover type maps. Also, this technique may be useful to evaluate microhabitat use. Dropped transmitters ensure that the researcher is in the correct spot and enables him to visually interpret bear sign that would not be possible from a vehicle or aircraft. The accuracy and precision of this technique could be enhanced with a helicopter because the timing of the transmitter drop would be less critical and it would be easier to follow the path of the dropped transmitter. Also researchers incorporating this technique should be familiar with the terrain and be able to read and interpret animal sign.

In Harmon Den, black bears are very difficult to observe. Virtually none have been seen while ground tracking, and less than 2% of aerial-tracking sessions resulted in visual observations. Transmitter drops allowed us to gather habitat-use information that was not possible using traditional radio-tracking methods. The technique provides valuable insights into social habits, foraging behavior, cover utilization, and other useful observations. Perhaps most important, it brings the researchers closer to their subject, something not possible when radio tracking from a vehicle.

LITERATURE CITED

BERINGER, J.J., AND M.R. PELTON. 1986. Transmitter drops: a method for ground truthing telemetry locations. Proc. East. Black Bear Workshop. 8:111-117.

BYERS, C.R., R.K. STEINHORST, AND P.R. KRAUSMAN. 1984. Clarification of a technique for analysis of utilization-availability data. J. Wildl. Manage. 48:1050-1053.

CARR, P.C. 1983. Habitat utilization and seasonal movements of black bears in the Great Smoky Mountains National Park. M.S. Thesis, Univ. Tennessee, Knoxville. 95pp.

FENNEMAN, N.M. 1938. Physiography of eastern United States. McGraw-Hill Book Company, New York, N.Y. 714pp.

FINLAYSON, C.P. 1957. The geology of the Max Patch Mountain area, Lemon Gap Quadrangle, Tennessee. Knoxville. 41pp.

GARSHELIS, D.L., AND M.R. PELTON. 1981. Movements of black bears in the Great Smoky Mountains National Park. J. Wildl. Manage. 45:912-945.

HOSKINSON, R.L. 1976. The effect of different pilots on aerial telemetry error. J. Wildl. Manage. 40:137-139.

HUPP, J.W., AND J.T. RATTI. 1983. A test of radio telemetry triangulation accuracy in heterogeneous environments. Proc. Int. Wildl. Biotelem. Conf. 4:31-46.

JOHNSON, K.G., AND M.R. PELTON. 1980. Prebaiting and snaring techniques for black bears. Wildl. Soc. Bull. 8:46-54.

LINDSEY, A., R.O. PETTY, D.K. STERLING, AND W. ZANADSELL. 1961. Vegetation and environment along the Wabash and Tippecanoe Rivers. Ecol. Monogr. 31:105-156.

MECH, L.D. 1983. Handbook of animal radio-tracking. University of Minnesota Press, Minneapolis, Minn. 107pp.

NAMS, V.O. 1989. Effects of radio-telemetry error on sample size and bias when testing for habitat selection. Can. J. Zool. 67:1631-1636.

NEU, C.W., C.R. BYERS, AND J.M. PEAK. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION. Hard-mast surveys 1985-87. Unpubl. data, Raleigh, N.C.

QUIGLEY, H.B. 1982. Activity patterns, movement ecology, and habitat utilization of black bears in the Great Smoky Mountains National Park, Tennessee. M.S. Thesis, Univ. Tennessee, Knoxville. 140pp.

SPRINGER, J.T. 1979. Some sources of bias and sampling error in radio triangulation. J. Wildl. Manage. 43:926-935.

THORNWAITE, C.W. 1948. An approach toward a rational classification of climate. Geog. Rev. 38:55-94.

WHITE, G.C., AND R.A. GARROTT. 1986. Effects of biotelemetry triangulation error on detecting habitat selection. J. Wildl. Manage. 50:509-513.

WHITTAKER, R.H. 1956. Vegetation of the Great Smoky Mountains. Ecol. Monogr. 26:1-50.

WOOD, G.W. 1988. Effects of prescribed fire on deer forage and nutrients. Wildl. Soc. Bull. 16:180-186.