

SURVIVAL OF ORPHANED BLACK BEARS RELEASED IN THE SMOKY MOUNTAINS

JAY E. CLARK,¹ Department of Forestry, Wildlife and Fisheries, P.O. Box 1071, University of Tennessee, Knoxville, TN 37901-1071, USA, email: clarkje@okstate.edu

MICHAEL R. PELTON, Department of Forestry, Wildlife and Fisheries, P.O. Box 1071, University of Tennessee, Knoxville, TN 37901-1071, USA, email: mpelton.utk.edu

BRANDON J. WEAR,² Department of Forestry, Wildlife and Fisheries, P.O. Box 1071, University of Tennessee, Knoxville, TN 37901-1071, USA

DARYL R. RATAJCZAK,³ Appalachian Bear Center, P.O. Box 364, Townsend, TN 37882, USA

Abstract: Rehabilitation and release of orphaned bears into the wild offers bear managers an alternative to euthanasia or transfer of bears to captive facilities. The objective of our study was to estimate short-term survival of orphaned American black bears (*Ursus americanus*) rehabilitated and released into the Smoky Mountains. Between January 1998 and July 1998, we released 11 rehabilitated orphaned bears (6 males, 5 females) into the Smoky Mountains of Tennessee and North Carolina. Age of bears at time of release ranged from 11 to 18 months old. We monitored released bears via radiotelemetry from January 1998 to October 1998. Although we documented no mortality of bears, the fate of 2 bears in the study was unknown. Maximum survival (assuming 2 bears of unknown fate survived) to 180 days post-release was 1.00 (95% CI = 0.22–1.00), and minimum survival (assuming 2 bears with unknown fate died) to 120 and 180 days post-release ranged from 0.90 (95% CI = 0.69–1.00) to 0.77 (95% CI = 0.26–1.00), respectively. Our results indicated that short-term survival (to 180 days) of rehabilitated orphaned bears was high and may be a viable alternative for managers dealing with orphaned bears.

Ursus 13:269–273 (2002)

Key words: black bear, days post-release, orphaned bears, rehabilitation, release, survival, *Ursus americanus*

Dealing with orphaned bear cubs or yearlings is a recurring problem for many wildlife agencies (Stiver et al. 1997). Orphaned bears are often found when females abandon their cubs as a result of environmental conditions (e.g., fire or drought) or anthropogenic disturbance at the den, or when they are killed in vehicular or hunting-related incidents. Several techniques have been used to release orphaned bears into the wild: adoption by a foster mother (Clarke et al. 1980, Alt and Beecham 1984, Carney and Vaughan 1987), reintroduction with the natural mother (Seibert et al. 1999), release after a period of captivity (Alt and Beecham 1984), and release of cubs in artificial or selected den sites (Jonkel et al. 1980; J. Beecham, Idaho Fish and Game, Boise, personal communication, 1997). However, studies to evaluate the survival of released orphaned bears are lacking.

The Appalachian Bear Center (ABC), located in Townsend, Tennessee, is a non-profit organization established to rehabilitate orphaned or injured black bears for return to the wild. Between October 1997 and June 1998, ABC received 10 orphaned cubs from the Tennessee Wildlife Resources Agency and 1 yearling from Great Smoky Mountains National Park (GSMNP) to be rehabilitated and released into the wild. The objective of our study

was to estimate short-term survival (to 180 days) of these orphaned bears returned to the wild.

STUDY AREAS

Research was conducted in the 9,135-ha Tellico Bear Reserve (TBR) in Tennessee and in the Cataloochee area of GSMNP in North Carolina (Fig. 1). Both areas lie within the Unaka Mountain Range of the southern Blue Ridge Province. TBR is surrounded by the Tellico Ranger District (approximately 50,000 ha) of Cherokee National Forest. The southeastern boundary of TBR is located along the Tennessee–North Carolina state line. The Cataloochee area is located in the southeast quadrant of GSMNP and is surrounded by private lands and Pisgah National Forest to the south and east. Elevations range from 230 m to 1,668 m in TBR and from 866 m to 2,000 m in the Cataloochee area of GSMNP. Both areas are characterized by mountainous terrain with steep slopes, narrow valleys and coves, and fast-flowing streams. Hunting is not permitted within TBR or GSMNP, but is permitted on adjacent lands around both areas. Both states have fall bear seasons, and hunting with dogs is the primary hunting technique.

METHODS

Bears were rehabilitated in two 0.20-ha outdoor enclosures at ABC designed to mimic a natural habitat setting. Enclosures contained numerous trees and an artificial stream that served as a water source. The enclosures were

¹ Present address: Oklahoma Cooperative Fish and Wildlife Research Unit, 404 LSW, Oklahoma State University, Stillwater, OK 74078, USA, clarkje@okstate.edu

² Present address: Big Creek Ranger Station, 236 Big Creek Park Road, Newport, TN 37821, USA

³ Present address: Tennessee Wildlife Resources Agency, Hunter Education and Range Facility, 3200 Brother Boulevard, Bartlett, TN 38133

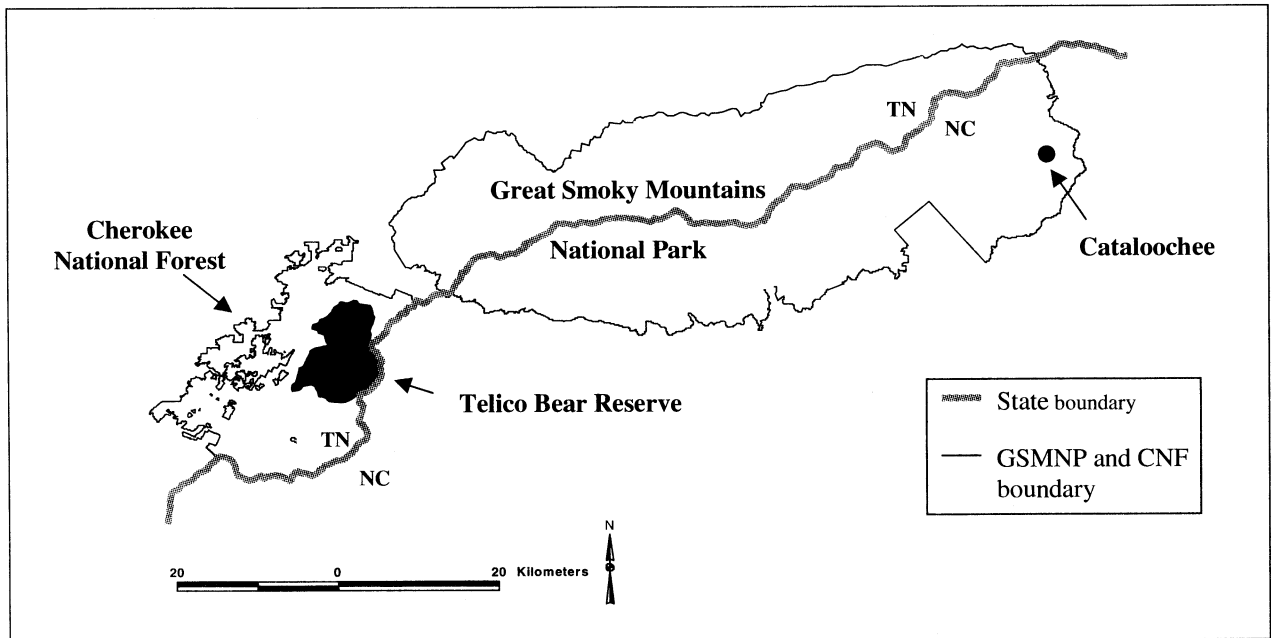


Fig. 1. Study area and release sites of rehabilitated orphaned black bears in the Smoky Mountains.

surrounded by a 3-m chain link fence lined with 5 strands of high-tensile electric fencing and 2.4-m blinds, which served as visual barriers. Bears were fed mostly natural foods. Acorns (*Quercus* spp.) and hickory nuts (*Carya* spp.) composed about 60% of food items. Other food items included apples (18%), dry dog food (18%), various fruits, and rainbow trout (*Oncorhynchus mykiss*; 4%). We threw food over the fence from behind the blinds to scatter food items and force bears to forage.

When bears had gained sufficient mass (>19 kg) to be released, they were captured from the enclosures with box traps. We determined the minimum release mass based on our knowledge and known weights of yearling bears from den data. No additional criteria were used to assess prerelease condition. We immobilized bears with a combination of ketamine hydrochloride (200 mg/ml), xylazine hydrochloride (100 mg/ml), and mepivacaine hydrochloride (20 mg/ml) injected intramuscularly at a dosage of 1 ml/22.7 kg estimated body weight. A wetting agent was applied to the eyes of each bear after immobilization to prevent desiccation. All bears were eartagged, tattooed on the upper lip and inner thigh, and measured to record morphometric data. We fitted each bear with a radiocollar equipped with an activity sensor and a mortality sensor with a 6-hour delay (Telonics, Mesa, Arizona, USA). Radiocollars were attached with a cotton spacer designed to breakaway in <1 year. Before transport, yohimbine was administered intravenously at a dosage rate of 1 ml/18.8 kg as an antagonist for the xylazine hydrochloride. Bears were released into TBR in January ($n = 5$) and March ($n = 5$) and into the Cataloochee area of GSMNP in July

($n = 1$).

Bears were monitored by aerial and ground telemetry 2–3 times/month to estimate survival. The pulse rate of the radiosignal was recorded to determine if the radiocollar was emitting a mortality signal. When a mortality signal was recorded, we retrieved the collar to determine the fate of the bear (i.e., mortality or dropped collar). We also recorded the first and last monitored date and the straight-line distance from the release site to the location where the collar was retrieved. No efforts were made to recapture or visually locate bears after release; therefore, condition of bears following release could not be assessed. We estimated survival via the Kaplan-Meier method (Pollock et al. 1989) and backdated release dates to determine survival of bears as days post-release. We divided post-release days into 12 intervals of 15 days for a total of 180 days. We recorded the censored date (i.e., the time interval a bear was removed from the number of bears at risk) at the time interval of the last recorded active signal.

RESULTS

Between October 1997 and June 1998, 11 orphaned bears were rehabilitated at ABC. Bears weighed 5–18 kg ($\bar{x} = 10$ kg) at time of arrival and 19–32 kg ($\bar{x} = 25$ kg) at release. Rehabilitation time for bears ranged from 55 to 146 days ($\bar{x} = 94$ days). Average weight gain of bears was 0.2 kg/day (Table 1).

Released bears were monitored for survival from January 1998 to October 1998. Of the 11 radiocollared bears, 7 dropped their collar and were censored at the time of

Table 1. Characteristics of orphaned black bears rehabilitated and released into the Smoky Mountains of Tennessee and North Carolina, 1998.

| Bear ID | Sex | Arrival weight (kg) | Release weight (kg) | Rehab time (days) | Weight gain (kg/day) | Radio days ^a | Collar distance from release site (km) | Fate of bear at date censored |
|---------|-----|---------------------|---------------------|-------------------|----------------------|-------------------------|--|-------------------------------|
| ABC 08 | M | 9 | 32 | 95 | 0.2 | 160 | 3.4 | Alive ^b |
| ABC 09 | M | 10 | 22 | 146 | 0.1 | 233 | | Alive ^c |
| ABC 12 | M | 11 | 25 | 78 | 0.2 | 123 | | Unknown |
| ABC 14 | F | 8 | 27 | 134 | 0.1 | 58 | 8.8 | Alive ^b |
| ABC 15 | F | 12 | 20 | 72 | 0.1 | 64 | 0.9 | Alive ^b |
| ABC 17 | F | 12 | 29 | 62 | 0.3 | 123 | 5.0 | Alive ^b |
| ABC 18 | F | 10 | 32 | 60 | 0.4 | 123 | 34.9 | Alive ^b |
| ABC 19 | F | 5 | 19 | 122 | 0.1 | 225 | | Alive ^c |
| ABC 20 | M | 18 | 28 | 119 | 0.1 | 145 | 2.8 | Alive ^b |
| ABC 21 | M | 7 | 21 | 94 | 0.2 | 0 | 0.6 | Alive ^b |
| NPS 01 | M | 7 | 24 | 55 | 0.3 | 46 | | Unknown |
| Average | | 10 | 25 | 94 | 0.2 | 130 | 8.8 | |

^a Minimum number of days post-release that a bear was recorded as having an active signal (i.e., known to be alive).

^b Determination of fate based on retrieval of dropped collar and search of vicinity where collar was found.

^c Bear was alive and wearing an active collar at the end of the study.

the last recorded active signal, 2 bears were still active and censored at the end of the study, and 2 were of unknown fate (i.e., 1 collar was never retrieved and radio contact with 1 bear was lost). Straight-line distance from release site to the dropped collar location ranged from 0.6 km to 34.9 km (Table 1). We documented no mortality of bears in the study. Although we did receive 1 unconfirmed report of a small radiocollared bear approaching a campsite, there were no confirmed nuisance encounters involving released bears. During preparation of this manuscript, a bear reported above as an unknown fate (ABC 12) was legally harvested in North Carolina during the fall hunting season of 1999. However, we treated ABC 12 as an unknown fate in our analysis as to not bias our survival results (White and Garrot 1990). Although other bears were known to have moved outside the study areas and may have been susceptible to harvest, none were reported in 1998 harvest data for North Carolina or Tennessee.

Because the fate of 2 bears was unknown, we performed 2 separate analyses to estimate minimum and maximum survival (Heisey and Fuller 1985, White and Garrot 1990). The maximum survival estimate was calculated by censoring the 2 bears with unknown fates at the time of the last recorded active signal. Because no mortality was recorded, an estimate of variance and lower 95% confidence interval could not be calculated given the formula provided by Pollock et al. (1989). Therefore, we used an alternative method to calculate the lower 95% confidence interval (Clark 1999; G.C. White, Colorado State University, Fort Collins, personal communication, 2001). The maximum survival estimate to 120 and 180 days post-release was 1.00 (95% CI = 0.65–1.00) and 1.00 (95% CI = 0.22–1.00), respectively. The minimum survival estimate represented a more conservative estimate of survival, because the 2 bears with unknown fates were counted as

mortalities during the time interval immediately following their last recorded active signal. The minimum probability of survival to 120 and 180 days post-release was 0.90 (95% CI = 0.69–1.00) and 0.77 (95% CI = 0.26–1.00), respectively.

DISCUSSION

Age of self-sufficiency for black bear cubs has been documented at 5.5 months (Erickson 1959) and 6.5 months (Payne 1975). Brown bears (*Ursus arctos*) have demonstrated self-sufficiency at 7 months of age (Johnson and LeRoux 1973). Alt and Beecham (1984) reported successful releases with pen-reared cubs ≥ 5 months old. All cubs released in this study were between 11 and 18 months old. Therefore, survival likely was not negatively affected by the age of bears in our study.

Alt and Beecham (1984) considered releases successful if bears were recaptured in a non-nuisance situation after 30 days. Failure resulted if bears caused chronic nuisance problems or were found dead. Of 39 reintroduced bears, they documented 15 successes, 4 failures, and 20 unknown fates. Although our sample size was much smaller ($n = 11$), we documented success of releases with more certainty via radiotelemetry. During our study, we documented 10 bears alive >45 days and 7 bears alive >122 days. Therefore, based on the definition of successful releases by Alt and Beecham (1984), at least 10 of the 11 releases were successful.

Short-term survival of bears in our study did not seem to be affected by the time of year that bears were released. Jonkel et al. (1980) recommended releasing orphaned cubs during the denning season or when natural foods were abundant after achieving sufficient weight gain in captivity. Furthermore, Alt and Beecham (1984) suggested that survival was increased in their study partly because of the

adequate availability of natural foods. In our study, 10 of 11 bears were received for rehabilitation in the fall and released in January or March. Although natural foods are usually not abundant during this time of year, released bears likely had sufficient fat reserves to survive until early summer when soft mast would become available. Orphan bears in Idaho placed in natural or artificial dens during December have successfully constructed their own dens after abandoning their original den (J. Beecham, personal communication, 1997). We were unable to confirm any denning activity, but we did find the collar of ABC 21 near a ground nest with multiple scats in the vicinity of the nest.

The timing of releases in relation to the start of bear hunting season could have negative effects on short-term survival. Although bears were released into nonhunted areas and some were known to move into areas where hunting was legal, our study concluded before the 1998 hunting season. Thus, our results could have been different if releases occurred closer to the onset of bear hunting season or if bears had been released into hunted populations.

MANAGEMENT IMPLICATIONS

Rehabilitation and release of orphaned bears into the wild may offer a valuable management alternative. Historically, orphaned bears had to be destroyed, sent to zoos and other captive facilities, or fostered to adult females with cubs that were radiocollared for research (Jonkel et al. 1980). However, if rehabilitated and released orphaned bears had a low probability of survival in the first couple of months after release, the cost and effort of rehabilitating a small number of bears may not be attractive to managers. Our results indicated high short-term survival (to 180 days) of rehabilitated and released orphaned bears. Thus, rehabilitation and release of orphaned bears can be successful and may be a viable alternative to managers. Furthermore, rehabilitation and release of orphaned bears may have implications and uses concerning the augmentation of small bear populations or repatriation into former ranges (Stiver et al. 1997) or may serve as a management alternative for threatened or endangered bear species (Jonkel et al. 1980, Alt and Beecham 1984).

Long-term survival of rehabilitated and released bears was not evaluated in our study and may have implications concerning the contribution of released bears to the wild population. For example, 5 females were rehabilitated and released in our study. If the probability of survival to reproductive maturity (≥ 3.5 years old) for these females was greater than 0.50, their potential contribution to the population in the form of producing and rearing young could be substantial. This is particularly true if

they survive to produce multiple litters. Two orphaned female cubs released in Idaho were radiocollared for 5 years after reaching adulthood and both produced multiple litters (J. Beecham, personal communication, 1997). Future studies evaluating orphaned bear releases should focus on long-term survival, reproductive contribution to local populations, and the influence of rehabilitation methods on survival of bears after release.

ACKNOWLEDGMENTS

Financial support was provided by the National Park Service, Friends of Great Smoky Mountains National Park, University of Tennessee-Knoxville, Appalachian Bear Center, Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, and bear hunter associations from Cocke and Sevier counties in Tennessee. We also appreciated personnel from North Carolina Wildlife Resources Commission, Tennessee Wildlife Resources Agency, and the National Park Service for assistance in transporting bears and locating collars. We owe a special thanks to C.D. Scott, W.H. Stiver, and K.D. Delozier. We appreciated the comments and suggestions of A.M. Saxton, J.D. Clark, F.T. Van Manen, and E.C. Hellgren.

LITERATURE CITED

- ALT, G.L., AND J.J. BEECHAM. 1984. Reintroduction of orphaned black bear cubs into the wild. *Wildlife Society Bulletin* 12:169-174.
- CARNEY, D.W., AND M.R. VAUGHAN. 1987. Survival of introduced black bear cubs in Shenandoah National Park, Virginia. *International Conference on Bear Research and Management* 7:83-85.
- CLARK, J.E. 1999. Capture and on-site release of nuisance black bears and survival of orphaned black bears released in the Great Smoky Mountains. Thesis, University of Tennessee, Knoxville, Tennessee, USA.
- CLARKE, S.H., J. O'PEZIO, AND C. HACKFORD. 1980. Fostering black bear cubs in the wild. *International Conference on Bear Research and Management* 4:163-166.
- ERICKSON, A.W. 1959. The age of self-sufficiency in the black bear. *Journal of Wildlife Management* 23:401-405.
- HEISEY, D.M., AND T.K. FULLER. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. *Journal of Wildlife Management* 49:668-674.
- JOHNSON, L.J., AND P. LEROUX. 1973. Age of self-sufficiency in brown/grizzly bear in Alaska. *Journal of Wildlife Management* 37:122-123.
- JONKEL, C.J., P. HUSBY, R. RUSSELL, AND J. BEECHAM. 1980. The reintroduction of orphaned grizzly bear cubs into the wild. *International Conference on Bear Research and Management* 4:369-372.
- PAYNE, N.F. 1975. Unusual movements of Newfoundland black bears. *Journal of Wildlife Management* 39:812-813.
- POLLOCK, K.H., S.R. WINTERSTEIN, C.M. BUNCK, AND P.D. CURTIS.

1989. Survival analysis in telemetry studies: the staggered entry design. *Journal of Wildlife Management* 53:7–15.
- SEIBERT, S.G., W.H. STIVER, K.D. DELOZIER, AND M.R. PELTON. 1999. Reuniting black bear cubs to their natural mother. Eastern Workshop on Black Bear Research and Management. 14:58–59.
- STIVER, W.H., M.R. PELTON, AND C.D. SCOTT. 1997. Use of pen-reared black bears for augmentation or reintroductions. International Conference on Bear Research and Management 9:145–150.
- WHITE, G.C., AND R.A. GARROT. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, California, USA.

Received: 1 October 2000.

Accepted: 27 March 2001.

Associate Editor: Immell.