

SURVIVAL AND REPRODUCTION OF TRANSLOCATED VIRGINIA BLACK BEARS

LISA M. COMLY-GERICKE, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, 106 Cheatham Hall, Blacksburg, VA 24061-0321, USA, email: lmgeric@westvaco.com
MICHAEL R. VAUGHAN, Virginia Cooperative Fisheries and Wildlife Research Unit, Virginia Polytechnic Institute and State University, 106 Cheatham Hall, Blacksburg, VA 24061-0321, USA, email: mvaughan@vt.edu

Abstract: Since 1987, the Virginia Department of Game and Inland Fisheries has translocated 221 nuisance black bears (*Ursus americanus*) from the periphery of Shenandoah National Park in northwestern Virginia to southwestern Virginia in an attempt to reestablish a viable bear population in southwestern Virginia. Forty-three bears released in 1990 and 1991 were radiocollared and monitored from June 1990 to March 1992 to determine the fates and demographic parameters of the translocated bears. Nineteen of the 43 bears died during the study, radio contact was lost with 10, 2 dropped their radiocollars, 1 resumed nuisance activity and was recaptured; the remaining 11 bears were alive when the study ended. Estimated survival was 0.23; male and female survival rates were similar ($P = 0.385$). Automobile collisions were the major cause of mortality for both male and female bears. Reproduction was observed in 1 den in the 1990–91 denning season and in 4 dens in the 1991–92 season. No translocated bears returned to the original capture sites.

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Translocation is the intentional transport and introduction or reintroduction of wildlife into new or previously occupied habitats in an attempt to establish, reestablish, or augment a population (Griffith et al. 1989). Many state wildlife agencies use translocation to manage nuisance animals, especially black bears. In a 1985 survey of translocations conducted in 45 states (Boyer and Brown 1988), black bears were the most commonly translocated animal (156 animals in 10 states). Bears were restored to historical habitat and provided to zoos, but relocation of nuisance animals was the most frequently cited reason for translocation.

Like most southeastern black bear populations (Pelton 1986), bear numbers in southwestern Virginia have declined due to habitat alteration and overexploitation. During 1987–92, the Virginia Department of Game and Inland Fisheries (VDGIF) translocated nuisance black bears from the periphery of Shenandoah National Park in northern Virginia to southwestern Virginia in an attempt to reestablish a viable bear population there and to reduce nuisance activity near the Park.

In 1990 we began a radiotelemetry study to determine the fates and demographic parameters of the translocated bears and to evaluate the effectiveness of the translocation management strategy. Herein, we report on the fates, survival rates, and reproduction of the translocated bears.

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STUDY AREA

This study was conducted on the 46,540-ha Mount Rogers National Recreation Area in southwestern Virginia from June 1990 to March 1992. The Recreation Area was within Jefferson National Forest and included parts of Carroll, Grayson, Smyth, Washington, and Wythe counties. Lower elevations of the Recreation Area were composed of mixed hardwoods, while red spruce (*Picea rubens*) and Fraser fir (*Abies fraseri*) were found at higher elevations. Study area topography was mountainous, and included Mt. Rogers, the highest peak (1,746 m) in Virginia.

The primary management objectives on the Recreation Area during the study were to provide recreation, to enhance wildlife populations, and to provide livestock grazing benefits, thereby maintaining the rural character of the area. Timber harvest was a secondary management objective. In 1990, the Forest Service reported 723,000 visitor-days (12 hours of use) of use on the Recreation Area (P. Dorr, U.S. Forest Serv., Marion, VA, pers. commun., 1992). Land adjacent to the Recreation Area was primarily agricultural. The counties in and adjacent to the study area have been closed to bear hunting since 1988 and 1989.

METHODS

Nuisance bears, primarily from the periphery of Shenandoah National Park in northwestern Virginia, were trapped by VDGIF personnel. Bears were marked with 2 numbered metal ear tags and a lip tattoo and equipped with a bimodal radiocollar (Advanced Telemetry Systems, Inc., Isanti, Minn.). A breakaway cotton spacer was in-

serted in each collar to minimize neck injury and to allow for collar retrieval prior to battery failure (Hellgren et al. 1988). Each bear was weighed, its sex determined, and a premolar was extracted for aging by cementum annuli (Willey 1974). Bears <3 years old were classified as subadults; bears \geq 3 years were classified as adults.

Bears were transported by truck in cages to the Mount Rogers Recreation Area by VDGIF personnel and released at predetermined sites. Attempts were made to distribute bears throughout the Recreation Area. Release sites were 300–400 km from the original capture sites.

Bears were located from fixed-wing aircraft and by ground triangulation. Ground locations were plotted on 7.5-minute United States Geological Survey topographical maps and recorded as Universal Transverse Mercator (UTM) coordinates. Aerial locations were recorded as LORAN-C coordinates and converted to UTM coordinates.

Bears were monitored until denning. Den sites were visited and when possible, accessible bears were immobilized during the 1990–91 and 1991–92 denning periods. Bears were weighed, and their general condition assessed. Radiocollars were checked for fit during the 1990–91 period and removed during the 1991–92 period. If present, cubs were weighed, measured, and their sex determined. The remaining dens of female bears were monitored for cub vocalizations.

Given the 2-year birth interval of Virginia bears (Carney 1985), we assumed that female bears captured after 1 August that were not lactating or accompanied by cubs had been bred prior to translocation. We made no assumption about the reproductive status of females moved prior to 1 August because we did not know if these females were in estrus at time of capture nor did we know the density of bears in the release area.

Survival was estimated using Pollock et al.'s (1989) modification of the Kaplan-Meier procedure (Kaplan and Meier 1958). The log-rank test (Savage 1956, Kalbfleisch and Prentice 1980:17, Cox and Oakes 1984:104) was used to compare survival among male and female bears and 1990 and 1991 releases. Survival was compared over the full term of the study and for the 9 month July–March interval, the interval common to the 1990 and 1991 releases. We tested for significance at the 0.05 level. We plotted mortality over 30-day intervals post-release to look for trends.

Some bears were not monitored the full term of the study because we lost radio contact with them. Following the medical and engineering terminology (Kalbfleisch and Prentice 1980, Cox and Oakes 1984), bears were classified as censored after no contact for >4 months, as we

were unable to determine their fates. Survival estimates were calculated using only the time periods when bears were actively monitored.

RESULTS

During 1987–91, 212 nuisance bears were translocated to southwestern Virginia; 168 were released in the 5 counties of the study area during 1988–91. Forty-three bears (24M:19F; Table 1) were radiocollared, monitored, and their fates (Table 2) determined over the 22 months of the study. Mortality was confirmed for 19 (11M:8F; 43%) of the collared bears. Radio contact was lost with 10 bears (7M:3F; 23%) for >4 months (these bears were censored). Two females dropped their radiocollars, and 1 female was recaptured due to nuisance activity. Collars were removed from 5 bears (1M:4F; 12%) during the 1991–92 denning period, and 6 bears (5M:1F; 14%) remained equipped with radiocollars at the end of the study.

Automobile collisions accounted for 10 (4M:6F) of the 19 confirmed mortalities (Table 3). Three (3M) bears were legally harvested outside the study area, and 2 (1M:1F) bears were illegally harvested in the study area. Four (3M:1F) bears died of unknown causes (i.e., cause of death could not be determined at recovery).

Fourteen (74%) of the 19 mortalities occurred within 120 days post-release (Fig. 1). Survival appears to have levelled off after 150 days post-release. Only 3 of 19 mortalities occurred >150 days after release.

Cumulative survival over the 22 months of the study was 0.23 for all bears (Table 4). There was no difference ($P = 0.385$) between male (0.12) and female (0.37) survival. There was no difference ($P = 0.121$) in survival over the first 9 months (Jul–Mar) post-release between the 1990 (0.53) and 1991 (0.31) releases. Survival of bears released in 1990 did not differ ($P = 0.185$) between July 1990–March 1991 (0.53) and July 1991–March 1992 (0.78). Survival over the July 1991–March 1992 interval was greater ($P = 0.029$) for bears released in 1990 (0.78) than for bears released in 1991 (0.31).

Table 1. Age and sex of radiocollared black bears released into the 5 counties of the Mt. Rogers National Recreation Area, Virginia, 1990–91.

	1990		1991		Total
	Subadult	Adult	Subadult	Adult	
Male	5	7	3	9	24
Female	2	11	1	5	19
Total	7	18	4	14	43

Table 2. Fates of radiocollared black bears released in the Mt. Rogers National Recreation Area, Virginia, 1990–91.

Fate	Male		Female		Total
	Subadult	Adult	Subadult	Adult	
Known mortality	3	8	0	8	19
Known alive ^a	1	4	1	0	6
Censored ^b	4	3	0	3	10
Dropped collar ^c	0	0	1	1	2
Recapture–nuisance	0	0	0	1	1
Collar retrieved ^d	0	1	1	3	5
Total	8	16	3	16	43

^a Alive and collared as of 17 Mar. 1992, last date transmitters were monitored.

^b Censored if not located for >4 months.

^c Collars dropped >1 week post-release.

^d Collars removed from live bears by end of study.

Survival rates for all bears were lowest in August 1990 (0.71) and November 1991 (0.72). Survival was 100% for all bears during January–March 1991 and 1992.

Eleven adult females were released in 1990; 4 had cubs with them at the time of release. The reproductive status of three was unknown; one female was censored and another died prior to denning. Two of the adult females released in 1990 that survived until denning were assumed to have been bred. Cubs were not found in dens of these females during the 1990–91 denning period.

Five adult females were translocated in 1991; 4 died prior to the denning period. The surviving female was assumed to have been bred prior to translocation, but no evidence of cubs was found in her den during winter 1991–92.

During winter 1991–92, cubs were found in 4 dens of females released in 1990, indicating that breeding occurred in the study area. Mean litter size was 2.75 (3 litters of 3, 1 of 2). Sexes of cubs in 1 den were un-

known. Of the 3 dens where cub sex was known, the sex ratio was 1:1. Cub survival following den checks was unknown because collars were removed from adults in the dens.

DISCUSSION

Automobile collisions were the major mortality source for both male and female bears (Table 3). Seven of the 10 bears killed by automobiles were killed on 1 of 2 interstate highways adjacent to the study area. Beringer et al. (1990) reported that movements of bears in North Carolina were inhibited by high traffic volumes, and bears avoided Class I roads (traffic volume >10,000 vehicles/day). The North Carolina bears were resident bears in the area, and our translocated bears did not appear to avoid roads with high traffic volumes.

Table 3. Cause of death for 19 radiocollared black bears released in 5 counties of the Mt. Rogers National Recreation Area, Virginia, 1990–91.

Cause	Male		Female		Total
	Subadult	Adult	Subadult	Adult	
Vehicle collisions	1	3	0	6	10
Legal harvest	1	2	0	0	3
Illegal kills	0	1	0	1	2
Unknown ^a	1	2	0	1	4
Totals	3	8	0	8	19

^a 1 suspected vehicle related mortality, 2 recoveries of skeletal remains and collar only, 1 possible mortality related to handling.

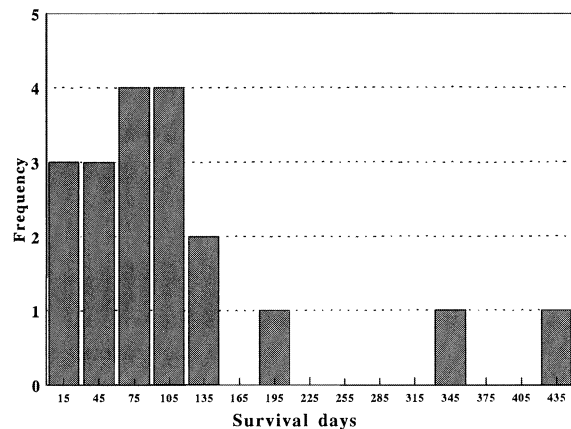


Fig. 1. Distribution of mortality over 30-day intervals post-release for black bears released in the Mt. Rogers National Recreation Area, Virginia, 1990–91.

Table 4. Monthly survival estimates, July 1990–March 1992, for radiocollared black bears released in the 5 counties of the Mt. Rogers National Recreation Area, Virginia.

Month	All bears (<i>n</i> = 43)	Males (<i>n</i> = 24)	Females (<i>n</i> = 19)	1990 Releases (<i>n</i> = 25)	1991 Releases (<i>n</i> = 18)
7/90	1.00	1.00	1.00		
8/90	0.71	0.50	1.00	0.71	
9/90	1.00	1.00	1.00	1.00	
10/90	0.95	1.00	0.92	0.95	
11/90	0.83	0.88	0.80	0.83	
12/90	0.93	0.83	1.00	0.93	
1/91	1.00	1.00	1.00	1.00	
2/91	1.00	1.00	1.00	1.00	
3/91	1.00	1.00	1.00	1.00	
4/91	0.92	0.80	1.00	0.92	
5/91	1.00	1.00	1.00	1.00	
6/91	1.00	1.00	1.00	1.00	1.00
7/91	0.90	0.75	1.00	0.89	1.00
8/91	0.93	0.86	1.00	1.00	0.83
9/91	0.95	0.90	1.00	1.00	0.92
10/91	0.90	0.90	0.90	1.00	0.83
11/91	0.72	0.78	0.67	0.88	0.60
12/91	0.92	1.00	0.83	1.00	0.80
1/92	1.00	1.00	1.00	1.00	1.00
2/92	1.00	1.00	1.00	1.00	1.00
3/92	1.00	1.00	1.00	1.00	1.00
Cumulative Survival	0.23	0.12	0.37	0.38	0.31

The high mobility of bears may result in an increased mortality rate (Pelton 1982). Translocated bears were released in unfamiliar territory and through their movements following release, had a high probability of encountering mortality sources. Survival of the translocated bears appears to have levelled off after 150 days post-release, possibly because bears were familiar with the area and had established home ranges by this time.

Female survival (0.37) appeared to be greater than male survival (0.12), but the difference was not significant ($P = 0.385$). Bears released in 1990 had similar ($P = 0.121$) survival over their first 9 months post-release to bears released in 1991, but survival from July 1991 to March 1992 for bears released in 1990 was greater ($P = 0.029$) than for those released in 1991. This is likely explained by the former's greater familiarity with the area and home range establishment by the start of this interval. The July 1991 to March 1992 interval encompassed the initial 120-day period of lower survival for the 1991 releases while the same interval exceeded the levelling off survival limit (150 days) for the 1990 releases.

One of the 43 collared bears translocated was known to resume nuisance activity. Trapping and moving bears may reduce further nuisance activity. In an earlier Virginia study, Fies et al. (1987) found that only 3% of relocated nuisance bears were known to resume nuisance activity. McLaughlin et al. (1981) reported that only 15% of 75 nuisance bears translocated in northcentral Pennsylvania resumed nuisance activity.

Homing of bears back to their capture sites has been reported by many researchers (Sauer et al. 1969, Harger 1970, Payne 1975, Beeman and Pelton 1976, Alt et al. 1977, Rutherglen and Herbison 1977, McArthur 1981, McLaughlin et al. 1981, Rogers 1986a). No returns to capture sites were documented during this study, but a high rate of censorship (i.e., disappearance; $n = 10$, 23%) was observed. Two of the legally harvested bears were killed 80 and 192 km in a homeward direction from their release sites. Several of the bears killed by automobiles had also moved toward home from their release sites.

Translocation success appears to depend on distance the bear is moved from its capture site. In the earlier Virginia study by Fies et al. (1987), none of the 33 recovered bears translocated >64 km from their capture sites were recovered within 10 km of their original capture sites. Beeman and Pelton (1976) analyzed the Great Smoky Mountains National Park relocations between 1967 and 1974 and found a strong inverse relationship between distance moved and probability of the bear returning to the capture area. A similar relationship was found by McArthur (1981) in Glacier National Park. Studies have shown that bears moved >64 km should be outside of their familiar territory and therefore less likely to return home (Sauer et al. 1969, Alt et al. 1977, McLaughlin et al. 1981, Rogers 1986b). All bears in this study were translocated at least 300 km, and based on the literature, it is unlikely that homing back to capture sites was a significant contributing factor to the high censorship observed.

Of the 43 bears radiocollared, 67% died ($n = 19$) or were censored ($n = 10$) over the course of the study. One bear was recaptured and 2 bears dropped their collars. Eleven of the 43 bears (26%) were known to have survived the 22-month term of the study. Assuming that all censored bears were alive at the end of the study, <50% of the bears survived for 22 months. Reproduction did occur among bears released in 1990, indicating that the density of bears in the area is sufficient for breeding encounters. The long-term success of the translocation effort remains to be evaluated.

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