Importance of Limiting Vehicle Access on Wildlife Management Areas in Middle Georgia for Black Bear Management

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Abstract: In Georgia, there are three geographically separated black bear (*Ursus americanus*) populations (North, Middle, and South). The middle population is the smallest and most isolated. Recent land purchases were made in part to conserve habitat for this population of bears. Our objectives were to determine if: 1) bear use of WMAs changes when the area is open or closed to hunting and 2) bear visitation rates to bear bait stations differ if roads are open to vehicular traffic. Both male and female bears used WMAs more during closed periods (males = 56.8% and females = 76.4%) than during open periods (males = 31.0% and females = 66.5%). Visitation rates to bear bait stations differed between closed roads (53.8%) versus open roads (23.2%). It is important that agencies managing public lands for black bears consider temporal and/or spatial regulation of human access to such areas, or parts thereof. We recommend more research to evaluate the use of spatial and/or temporal regulation of access on public lands to determine the proper balance between human access for recreational use and management for black bears.

Key words: bait stations, black bear, disturbance, limited access, *Ursus americanus*, wildlife management areas.

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Throughout North America, black bear (*Ursus americanus*; henceforth bear) populations have been reduced from past historical records (Dickson 2001, Pelton 2001). Habitat conversion, degradation, fragmentation, and past unregulated harvest have contributed to the decline of the species (Pelton 2000, 2001), though the species has recovered and currently thrives in several locations (Pelton, 2000, 2001, 2003). In Georgia, there are three geographically separated bear populations (north, middle, and south). The north population (*U. a. americanus*) is the largest and is associated with the Mountains, and Ridge and Valley physiographic regions northward, along the Appalachian Mountain range, and is considered a contiguous population to Canada. The south population (*U. a. floridanus*) is the second largest and is associated with the flatwoods in the Lower Coastal Plain surrounding the Okefenokee National Wildlife Refuge and is contiguous with a bear population in North Florida. The middle population (*U. a. americanus*) is the smallest population and is associated with the Upper Coastal Plain south and east of Macon, Georgia not considered contiguous with any other regional or intrastate population.

Most wildlife game populations are monitored and managed through regulations, either through harvest regulation or providing areas of protection. Even in protected areas, disturbance by humans may affect bear movements and habitat use. We believe it is important to understand bear use of areas managed by federal, state, or local governments regardless of whether bears are hunted or not. In Georgia, we manage at the state level on lands called wildlife management areas (WMAs). Recent state land purchases over the last decade within middle Georgia were, in part, acquired to conserve habitat for the middle Georgia bear population. After the state purchased these lands for WMAs, Department of Natural Resources wrote a 50-year management plan for the areas that incorporated bear management.

The middle population has been shown to have low genetic variability (Miller 1995), and there are some concerns about the amount of barriers within and around the middle population and the effects of human actions that can alter bear behavior. Dixon et al. (2007) observed that anthropogenic barriers to movement appeared to have limited the dispersal capabilities of Florida black bears, thus reducing gene flow among populations that are geographically close. In Florida, Maehr et al. (2003) stated that roads appeared to form home-range boundaries and may have facilitated edge effects that diminished the quality of otherwise suitable forested habitat. Bear use of bear bait stations were observed to be used greater inside sanctuaries than outside (Powell et al. 1998). In Arkansas, even barge traffic affected bears crossing rivers (White et al. 2000). Examples of barriers for the middle Georgia population are urban environments, agricultural land uses, and interstate highways. Thus, all of this has led us to more closely examine the effects of some of our WMA management activities (wildlife harvest seasons and road status) on the middle population. We used two existing sources of data: a recently concluded radio–telemetry/GPS collar bear project (Cook 2007, Sanderlin 2009) and our annual bear bait station survey in and around the WMAs to investigate the use of WMAs by bears. Our objectives were to determine if: 1) bear use of WMAs changes when the area is open or closed to hunting and 2) bear visitation rates to bear bait stations differ if roads are open to vehicular traffic.

Study Area

We monitored bears in portions of Bleckley, Houston, Pulaski, and Twiggs counties (137,305 ha) in the Upper Coastal Plain physiographic region of Georgia. Bear trapping effort occurred on Oaky Woods (7851 ha) and Ocmulgee (8597 ha) WMAs with additional trapping on proximal private properties. The trapped area was composed of 29% wetlands (forested = 23%, open water = 1%, emergent = 1%, and shrub/scrub = 4%; GDNR 1996; NWI 1999) along the Ocmulgee River. During our study, mean annual temperature was 18.5 C and mean annual rainfall was 113.5 cm, which was similar to long-term means of 18.2 C and 113.9 cm, respectively (1948–2010; NCDC 2011).

In general, the hunting seasons on our WMAs were 15 August to the end of February and the first Saturday after 19 March to 15 May each year. Therefore, we categorized the WMAs into two categories (i.e., hunting season [open] or non-hunting season [closed]) based on these hunting dates for each WMA. Basically, the WMA closed periods were approximately the first three weeks in March and 16 May to 14 August each year. We categorized roads into two categories (i.e. open or closed) based on road closure to vehicular traffic during the course of the survey. Open roads were typically county roads (both dirt and paved), state highways, roads opened for timber harvest activities, and roads opened for visitor access (e.g., public fishing area, shooting range, etc.).

Methods

Captures

We trapped bears using Fremont bear foot snares from April through August 2003 through 2006. We anesthetized bears using a mixture of 4.4 mg/kg of ketamine HCL (Ketaset, Burns Veterinary Supply Incorporated, Farmers Branch, Texas) and 2.0 mg/kg of xylazine HCL (Rompun, Haver–Lockhart Inc., Shawnee, Kansas; Kreeger 1996). Immobilized bears were given 1.8 mg/kg of Tolazoline at 1 to 1.5 hrs after induction to reverse the effects of xylazine HCL. Bears were fitted with a 650 g very high frequency (VHF) radio telemetry collar and some male bears were fitted with a GPS equipped radio-telemetry collar. All collars were 51 mm wide and were equipped with mortality and activity sensors (Advanced Telemetry Systems [ATS], Inc., Isanti, Minnesota). We attached leather spacers (4 mm thick, 4 cm wide and 8.9 cm in length) between the two loose ends of the collar so the collars would break free after approximately a year to reduce the chance of neck injuries (Bond et al. 2009).

Monitoring

Bears were located 3–4 times/wk by ground radio-telemetry from April 2003 through August 2004. The only bears monitored after August 2004 had GPS collars. We triangulated bear locations using the loudest signal method, with the midpoint (i.e., bearing) between the azimuths at the two edges of the signal (Springer 1979). We used a minimum of two bearings as close to a 90° angle intersection as possible (i.e., no less than a 60° and no more than 120° angle intersection; White and Garrott 1990). We attempted to get as close as possible to the bear using roads when performing triangulation (usually <1 km). We did not hike to bears for locations to avoid disturbance and bias of locational data. We collected all bearings <15 min apart. Data from GPS collars was collected when the spacers broke and the collar dropped or the bear slipped the collar (location data was retrieved from April 2003 through June 2007). For this study, we combined GPS data with both bi-angulation and triangulation data.

Two problems commonly associated with resource selection studies are pooling data across animals with different numbers of relocations and ignoring temporal or spatial autocorrelation among relocations (Thomas and Taylor 2006). To address these issues, we reduced the number of relocations used from GPS-collared bears by selecting no more than one relocation per day to reduce autocorrelation and finally randomly deleting relocations until the sample size was similar to VHF-collared bears.

Bait Stations

Bait station surveys have been used as an index to determine distribution and relative trends in black bear populations in north Georgia since 1983 (GDNR 2012). In 2007, we initiated a bait station survey in middle Georgia. Stations were located primarily along roads on Oaky Woods (Houston County) and Ocmulgee WMAs (Bleckley, Pulaski, and Twiggs counties). Similar to Abler (1988), surveys were conducted annually in July, baits (3 partially-opened cans of sardines) were nailed to trees, spaced approximately 0.81 km on all study areas, then were later checked for bear visitation (e.g., cans removed, clawed trees, cans bitten, etc.), and cans and nails were removed. The lone exception between our stations and what Abler (1988) described is that we used a 7-day interval between nailing the baits to trees and checking for bear visitations whereas he used 4-, 8-, and 12-day intervals. The number of stations changed from year to year based on land ownership.

Statistical Analyses

We used a 2–step process to determine which collared bears had the potential of using the WMAs (Bond et al. 2001). The probability that bears were close enough to use the WMAs was examined by buffering the WMAs' boundaries with the second largest distance between locations for males (23,094 m) and females (6028 m). We did not use the largest distance between locations to avoid the influence of a possible outlier. Next, we overlaid the bear locations and the WMAs' buffer. If any locations for each individual bear were within that buffer, we considered that WMA potentially useable to that bear and included it in our sample for analysis.

We conducted our WMA use statistical analysis in a 3-step process. We separated the number of relocations by sex and used a 2x2 contingency table and a G-test of independence with William's correction (Sokal and Rohlf 1981) to test the null hypothesis that bear use of WMAs was independent of bear's sex. Then, for males and females separately, we used a 2x2 contingency table and a G-test of independence with William's correction to test the hypothesis that bear use of WMAs was independent of hunting season status. Finally, following the methods of McGowan (2004), we used a Z-test (Milton and Tsokos 1983) to determine if bear use of WMAs differed between the hunting season and the non-hunting season. For all tests, $\alpha = 0.05$ and Z-tests were one-tailed.

We conducted our road closure statistical analysis in a two-step process. We pooled the number of bait stations hit and missed by road closure status and used a 2x2 contingency table and a G-test of independence with William's correction (Sokal and Rohlf 1981) to test the null hypothesis that bear use of bait stations was independent of road closure status. Then, following the methods of McGowan (2004), we used a Z-test (Milton and Tsokos 1983) to determine if bear use of bait stations differed between open roads and closed roads. For all tests, $\alpha = 0.05$ and Z-tests were one-tailed.

Results

We analyzed data from 26 bears (17 males and 9 females). Twenty-one bears using telemetry locations (12 males, 5.1 mean years of age; 9 females, 7.7 mean years of age) that were collected from 2003 to 2004 and 5 male bears using GPS locations (3.6 mean years of age) that had locations from 2003 to 2007. All males and females had locations within the buffered area of the WMAs. Our bears were relocated 5405 times between 2 April 2003 and 13 June 2007. The bears with VHF collars were relocated an average of every 2.8 days, for an average of 130 relocations per bear. The GPS-collars on 5 male bears collected relocation data an average of once every 0.6 days for an average of 535 relocations per bear. However, after we reduced the data set we used for analysis from GPS-collared bears the data set included only one relocation every 2.8 days for an average of 130 relocations per bear, similar to VHF bears.

Bear use of WMAs was not independent of bear's sex ($G_{adj} = 294.31$, $p < 0.001$). With a follow-up Z-test, we determined that female use of WMAs was greater ($Z = 18.02$, $P < 0.001$) than males. A total of 70.0% of all female locations were within WMA boundaries compared to 39.6% of all male locations. We conducted further analysis for males and females separately because of differences in WMA use by sex.

Female use of WMAs was not independent of hunting season status ($G_{adj} = 14.17$, $P < 0.001$). With a follow-up Z-test, we determined that female use of WMAs was greater ($Z = 3.86$, $P < 0.001$) during the non-hunting season than during the hunting season when the WMA was open for recreational use. A total of 76.4% of female locations were on WMAs during the closed season compared to 66.5% during the open hunting season.

Male use of WMAs was not independent of hunting season status ($G_{adj} = 118.85$, $P < 0.001$). With a follow-up Z-test, we determined that male use of WMAs was greater ($Z = 11.06$, $P < 0.001$) during the non-hunting season than during the hunting season when the WMA was open for recreational use. A total of 56.8% of male locations were on WMAs during the closed season compared to 31.0% during the open hunting season.

From 2007 to 2013, we used an average of 123.4 bear bait stations/year (range 104 to 162). Bear use of bait stations was not independent of road closure status ($G_{adj} = 65.20$, $P < 0.001$). With a follow-up Z-test, we determined that bear use of bait stations was greater ($Z = 8.87$, $P < 0.001$) on closed (53.8%) versus open (23.2%) roads.

Discussion

Areas open to human access have been shown to modify bear behavior and movements. We observed from our study that the status of access on WMAs impacted the use of these WMAs by both male and female bears. Both male and female bears used WMAs more during closed periods (males = 56.8% and females = 76.4%) than during open periods (males = 31.0% and females = 66.5%). Female bears in our study used WMAs greatly during the non-hunting season, which coincides mostly with their breeding season. The males in our study likely increased their use of WMAs in search of mates during the breeding season. In the fall, Young and Ruff (1982) theorized that bears used dense spruce cover for seclusion when their study area was opened for hunting of other game species. Harding and Nagy (1980) observed that grizzlies were affected by human disturbance avoiding camps by >1 km and abandoning dens that had been disturbed. Powell et al. (1996) observed that bait stations were visited significantly greater inside a sanctuary than outside, and bears that stayed on sanctuaries had greater survival (Beringer et al. 1998).

We also observed that road closure affected bears' use of roads during the non-hunting season. In Florida, Maehr et al. (2003) stated that roads appeared to form home-range boundaries and may have facilitated edge effects that diminished the quality of otherwise suitable forested habitat. Heyden and Meslow (1999) observed that black bears were negatively associated with roads and were more likely to occur at increasing distances from the nearest road. Most of the roads in their study area were open to the public; consequently vehicular traffic could have caused considerable disturbance to bears (Heyden and Meslow 1999). Bait station visits have been observed to be greater along trails than roads (Powell et al. 1996). Many other studies have documented that black bears denned >0.3 km from roads (Tieje and Ruff 1980, Goodrich and Berger 1994, Gaines 2003), which may be an adaptive strategy to reduce the potential of human disturbance (Gaines 2003). McLellan and Shackleton (1988) observed that grizzly bears used habitats <100 m from roads less than expected independent of vehicular traffic volume, suggesting that even a few vehicles can displace bears. Mace et al. (1996) observed that vehicular traffic volumes of >10 cars/day resulted in grizzlies avoiding roads. Reynolds-Hogland et al. (2007) and Reynolds-Hogland and Mitchell (2007) observed that female black bears denned the closest to gated roads and the farthest from open gravel roads and that overall bears avoided areas within 800 m of open gravel roads. They theorized that bears may have been avoiding poachers, campers, hikers, bikers and legal hunters (Reynolds-Hogland and Mitchell 2007). Beringer et al. (1998) concurred on the belief that road access may increase bears' vulnerability to illegal harvest. However, on closed roads, bears used road edges (Hellgren et al. 1991), most likely because of the food plants associated with road edges (Hellgren and Vaughan 1988). Brody and Pelton (1989) observed that regardless of season or sanctuary status road crossings by bears were based on type of road, with abandoned roads being used most and possibly acting as travel corridors. Therefore, closed roads can become useful bear habitat for feeding areas and travel corridors.

From our research and reviewing the literature, it is important for agencies managing public lands for black bears to consider having temporal and/or spatial regulation of vehicular access to those areas. Powell et al. (1996) stated that for small sanctuaries, increasing the size may increase bear survivorship. McLellan and Shackleton (1988) stated that unless vehicle access and people with firearms are controlled, grizzly bear populations would become highly vulnerable. McLellan (1990) stated that long term forest management plans should include reducing access to maintain viable grizzly bear populations across large landscapes to ensure continued existence of adequate seasonal foraging sites with cover. Heyden and Meslow (1999) and Hellgren et al. (1991) stated that limiting public access by roads will be beneficial for black bears by allowing undisturbed use of roads and roadsides as feeding and travel corridors. One of Pelton's (2001) 8 basic components to good black bear management was to control human access through road gating, designation of no-hunt zones, or perpetuation of natural escape cover to provide black bears refugia. Even Habitat Suitability Models have been formulated with human avoidance as a component of the model (Rogers and Allen 1987, Van Manen and Pelton 1997). Our data revealed increased use of our WMAs by bears in the non-hunting season and behind gated roads, and we believe that limiting access is the proper management technique for our bears and propose keeping these WMAs and associated roads closed as much as possible after turkey season (16 May) to the beginning of small game season (squirrel and hog, 15 August).

Management implications

In regions where bear populations are isolated from one another, an important management consideration for bears is to manage lands by limiting disturbance to bears either temporally and/or spatially, which may be accomplished by limiting vehicular access through road closures. We agree with Hellgren et al. (1991) that management of access appears to be a current important component that will more than likely become of greater importance as use of public lands increases. We recognize that public lands are exactly that, lands owned by the public and do not need to be completely closed off to human access. However, in an effort to balance the sometimes competing objectives of public use and resource conservation, we suggest that limiting vehicular access to an area or a portion of those managed areas could be an important consideration of a black bear management strategy. We recommend more research to evaluate the use of spatial and/or temporal regulation of access on public lands to determine the proper balance between human access for recreational use and management for black bears.

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