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TITLE: Black Bear Research and Management

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TITLE: Black Bear Reproduction in Northcentral Pennsylvania

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COOPERATING AGENCIES: Pennsylvania State University Cooperative Fish and Wildlife Research Unit; Department of Conservation and Natural Resources Sprout State Forest

WORK LOCATION(S): Clinton and Centre County

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ABSTRACT During June-September 2017, we captured and ear-tagged 64 black bears on a study area in northcentral Pennsylvania. Capture success was 3.8 trap-nights/bear, which was below average. We monitored 49 adult female bears fitted with radio-transmitters during 2016; 1 dropped her collar in the fall, 7 were harvested, 2 died after failing to be recovered by hunters, and 1 was killed by a vehicle leaving 38 adult female bears available for reproductive monitoring at winter dens, of which 37 were visited during February-March 2017. Using all data collected since the beginning of the study, minimum cub-bearing age for adult females was 3 years; mean litter size was 2.7 cubs; sex ratio of cub litters was 45% female to 55% male, and mean interval between litters was 2.03 years. The mean annual natality rate (number of cubs/breeding age female/year) was 1.4; the mean annual parturition rate (percent of adult females with cubs) was 50.7%, and the mean annual recruitment rate was 0.7 yearlings/adult female age 4 or older/year. Female bears monitored in this study were less productive than bears previously studied in northeast Pennsylvania. Continued monitoring is recommended to: 1) improve the precision of parameter estimates; 2) monitor for changes in reproduction, survival, and animal health as directed by strategy 1.3.4 of the current Bear Management Plan; and 3) advance long-term datasets for use in other research applications.

OBJECTIVE

To estimate reproductive parameters (age of primiparity, litter size, litter interval, and recruitment) for black bear populations in northcentral Pennsylvania.

INTRODUCTION

Previous studies of black bear demographics focused primarily on populations in northeast Pennsylvania (Alt 1981, Alt 1983, Alt 1989). However, land use, topography, habitat composition, soils, and human population levels differ significantly between northeast Pennsylvania and other areas of the state where bears also occur. Habitat differences can influence key reproductive parameters in black bears, including age of first cub production, litter size, length of time between litters, and cub survival (e.g., Elowe and Dodge 1989, Costello et al. 2003, and others). Thus, findings reported from northeastern Pennsylvania may not be representative of black bear productivity in other parts of the state.

Historically, black bear populations across Pennsylvania were managed according to broad, statewide objectives, but managing populations at the level of individual Wildlife Management Units (WMUs) was proposed with implementation of a bear management plan (Ternent 2006). Managers will need reliable estimates of black bear productivity at the WMU level in order to develop unit-specific population models. However, if reproductive parameters differ geographically, using values reported for northeastern Pennsylvania in all WMUs could result in inaccurate models.

Because black bears do not produce young until they are at least 3 years old or older, and usually only produce young every other year thereafter, collecting sufficient data to reliably estimate reproductive parameters can take years of study. This report incorporates data collected during the 2016 field-season to results reported previously and provides a summary of results observed to date in a study area representative of north central Pennsylvania.

METHODS

The study was conducted in portions of Clinton and Centre counties on the Sproul State Forest immediately south of Renovo, Pennsylvania. The study area was bounded on the north by the West Branch of the Susquehanna River, on the east by State Route 120, on the south by the southern boundary of the Sproul State Forest, and on the west by State Route 144.

We divided the study area into 4 regions and sequentially trapped each region for 8 consecutive days beginning 18 May and ending 26 August. We used Aldridge foot snares and barrel-style traps at an approximate density of 1 trap/4 km² to capture bears. Traps were baited with waste pastries and checked daily.

Captured bears were immobilized with a 2:0.8 mixture of ketamine hydrochloride (4.4 mg/kg) and xylazine hydrochloride (1.8 mg/kg) delivered by CO₂-propelled darts. Each bear was tagged in each ear with a uniquely numbered metal tag, style 56-L, size 36.5 × 9.5 mm (Hasco Tag Company, Dayton, Kentucky). The lower ear tag number also was tattooed on the inside of the upper lip for bears ≥1 year old. Eartags missing from recaptured bears were replaced.

Female bears weighing >90 pounds were fitted with standard VHF-transmitting neck collars (Advanced Telemetry Systems, Isanti, Minnesota). We used a leather splice when fitting

radio-collars to ensure that the collar belting would eventually separate in the event of transmitter failure or loss.

We recorded date, capture location, sex, weight, and a series of body measurements for each bear, and collected an upper first premolar for age determination from bears ≥ 1 year old (Harshyne et al. 1998). For female bears, we noted vulva swelling, teat condition (darkly pigmented and enlarged versus pink and small), presence of lactation, and sighting of offspring. We used yohimbine hydrochloride (0.15 mg/kg) to reverse immobilization after handling was complete, and remained at the trap site until ambulatory recovery was observed.

We visited dens of radio-collared females in February and March to ascertain reproductive status. Adults and if necessary yearling bears, were immobilized with a mixture of ketamine hydrochloride (4.4 mg/kg) and xylazine hydrochloride (1.8 mg/kg). Immobilized bears were kept in their dens during handling unless removal was needed for access or to improve respiration. We adjusted the fit or replaced radio-collars as needed, and replaced missing ear tags and tattoos. Cubs were removed from dens without immobilization, weighed, and fitted with ear tags identical to those used on adults. All bears were returned to dens after handling, and we attempted to seal den entrances with brush or snow before leaving.

RESULTS

Tagging

Traps were maintained for 364 trap-nights (1 trap set for 1 night = 1 trap-night), resulting in the capture of 64 bears. Since the beginning of the study, trapping effort has totaled 4,679 trap-nights, averaging 312 trap-nights per year, and resulted in the first-time capture of 339 bears. An additional 481 bears also have been tagged as cubs or yearlings during visits to winter dens, including 57 during February and March of 2017. In all, 820 bears have been tagged on the study area since 2002 (Table 1). This excludes 11 cubs that were tagged and added to litters as orphans but not yet recovered on the study areas and 3 tagged cubs that were removed from the study area after being orphaned.

Trapping success was better than average during 2016 and resulted in 3.8 trap-nights per capture (Table 1). This compared to an annual mean of 6.6 trap-nights per capture during the previous 14 years.

Reproduction

Natality.--Between March 2003 and March 2017, we visited 361 dens of adult female bears that were of reproductive age (≥ 3 years old). Mean number of cubs observed per breeding-age female per year was 1.4 (natality rate), and mean percent of breeding-age females with cubs was 50.7% (parturition rate; Table 2). Natality and parturition rates were higher in 2017 than any other year of study, primarily because several bears that had produced cubs in 2016 experienced whole-litter mortality and rebred, producing cubs again in 2017. Why these particular bears lost their 2016 litters prior to mid-summer is unknown.

Age of First Parturition.--Between June 2002 and March 2017, we monitored 61 bears until birth of their first litter. Mean age of primiparity was 3.6 years.

Litter Size and Sex Ratio.--Between March 2003 and March 2017, we observed 503 cubs belonging to 190 litters. Mean sex ratio in litters where gender was known for all cubs was 45% female to 55% male ($n = 258$ litters). Litter size ranged from 1 to 5 cubs and averaged 2.7 cubs per litter (Table 3). Frequency of litters was: 1-cub litters, 18 (9.5%); 2-cub litters, 56 (29.6%); 3-cub litters, 90 (47.6%); 4-cub litters, 24 (12.7%); and 5-cub litters, 1 (<0.1%). Thirteen additional litters were documented, but litter size was unknown because we were either unable to access the den or choose not to approach the den because the female was alert and likely to flee before being immobilized.

In 2017, we observed the first occurrence of a 5-cub litter during this study out of 15 years of den visits and 189 litters. The adult female was 9 years-old, first tagged as a yearling in a den in 2009. To date, this bear has had 4 litters: a 2-cub litter in 2011, 3-cub litter in 2013, 4-cub litter in 2015, and the 5-cub litter in 2017. Her weight in 2017 was estimated to be 170 pounds.

Age of the mother was known for 202 litters examined. Younger mothers tended to have smaller litters than older mothers (Table 3). There also was a slight tendency for small litters, particularly 2-cub litters, to be first-time litters more so than 3- or 4-cub litters.

Litter Survival and Recruitment.--We documented the fate of 94 litters that were observed in dens as cubs during 2003-2017 by revisiting radio-collared mothers in dens 1 year later or by recapture or harvest of all littermates. Eighty-two percent of litters had at least 1 cub survive to yearling age; 63 litters (67%) had no mortality, 14 litters (15%) had some mortality, and 17 litters (18%) had no surviving cubs.

An additional 64 litters were tagged but not completely observed at dens 1 year later because the mother had died, could not be located, ran before we arrived at the den, or was in a den that was inaccessible. However, some cub survival to yearling age was known to occur in 41 of these litters based on partial sightings of fleeing bears at dens or recapture or harvest of bears.

We estimated annual recruitment (number of yearlings/adult female/year) by dividing the number of yearlings observed in dens by the number of 4-year-old or older females monitored that year. Three-year-old females were excluded because they were too young to have yearlings. Mean recruitment was 0.7 yearlings/adult female age 4 or older/year and ranged from 0.4 to 1.1 (Table 4). This estimate was biased low because of an inability to count all yearlings present at 54 dens where bears ran before being immobilized, and thus, represents the minimum known recruitment.

Litter Interval.--We documented 121 litter intervals for 58 bears during 2002-2017. Mean litter interval was 2.03 years, and included 1 1-year interval, 116 2-year intervals, 3 3-year intervals, and 1 4-year interval (Table 5).

We excluded a 26-year-old female and an 18-year-old female from litter interval calculations. Although nipple characteristics at the time of capture indicated both had previously produced cubs, cubs were not documented during subsequent years, and we believe both had reached reproductive senescence. Body weights for both bears were typical of other reproducing females on the study area. The 26-year-old bear was harvested during the 2010 hunting season,

and the 18-year-old bear continues to be monitored.

RECOMMENDATIONS

1. Continue to capture, ear-tag, and monitor reproduction of radio-collared female bears in north central Pennsylvania during 2017. Begin trapping efforts before 15 July to maximize capture success.

2. Use the data being collected to report on additional population characteristics such as age- and sex-specific survival rates, cause-specific mortality rates, abundance, and the influence of variations in timing of denning on harvest rates and abundance estimation.

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Table 1. Number of bears ear-tagged on a study area in northcentral Pennsylvania during 2002-2017.

Year	Number of bears captured	Number of captures	Trap-nights	Success (trap-nights/capture)	Number of first-time captures	No. of cubs or yearlings tagged in dens and not previously captured	Total number of bears tagged
2002	25	30	196	6.5	25	0	25
2003	57	66	376	5.7	46	3	49
2004	47	48	358	7.5	29	17	46
2005	41	43	319	7.4	17	41	58
2006	35	38	282	7.4	22	26	48
2007	40	44	297	6.8	22	16	38
2008	29	31	233	7.5	19	25	44
2009	55	60	286	4.8	31 ^d	24	55
2010	19	19	277	14.6	14	27	41
2011	34	37	313	8.5	19	35	54
2012	59	65	327	5.0	29	22	51
2013	64	79	340	4.3	24	52	76
2014	87	143	415	2.9	17	38	55
2015	38	42	296	7.0	13	72	85
2016	64	95	364	3.8	12	26	38
2017	^c	^c	^c	^c	^c	57	57
Pooled	694	840 ^a	4,679	5.8	339	481 ^b	820
Mean	46	56	312	6.6	23	30	51

^a Excludes 3 cubs that were captured and released without being tagged.

^b Excludes 11 orphan cubs tagged and relocated to the study area, 32 cubs that were handled at dens but too small to tag, and 3 cubs that were born on the study area, tagged, but then moved to other litters outside the study area after being abandoned at dens.

^c Trapping season begins 1 July.

^d Includes one unknown cub that was killed by another bear while in a trap. Carcass could not be found to confirm presence/absence of ear tags; assumed to be untagged.

Table 2. Annual number of cubs observed per breeding-age female black bear (natality rate) and percent of females with cubs (parturition rate) on a study area in northcentral Pennsylvania, 2003-2017.

Year	Number of breeding-age^a female dens visited^{b,c}	Number of females with cubs	Number of cubs produced	No. of cubs per female (natality rate)	% of females with cubs (parturition rate)
2003	3	1	3	1.0	33
2004	18	8	19	1.1	44
2005	26	17	48	1.8	65
2006	25	12	29	1.2	48
2007	16	7	19	1.2	44
2008	19	10	27	1.4	53
2009	21	7	21	1.0	33
2010	23	12	31	1.3	52
2011	20	12	36	1.8	60
2012	18	10	25	1.4	55
2013	31	21	49	1.6	68
2014	35	14	35	1.0	40
2015	43	26	68	1.6	60
2016	31	10	27	0.9	32
2017	32	22	66	2.1	72
Pooled	361	189	501	1.4	53
Mean	24.1	12.7	33.5	1.4	50.7

^a ≥ 3 years old.

^b Excludes 13 dens where number of cubs could not be confirmed: 1 in 2008, 1 in 2009, 2 in 2015, 7 in 2016, and 2 in 2017.

^c Excludes inaccessible dens where presence of cubs was unknown.

Table 3. Size of cub litters observed at dens of radio-collared female black bears in northcentral Pennsylvania during 2003-2017.

Age of Mother	(n)	Litter size		
		Range	Mean	SD
3	10	1 – 3	1.5	0.224
4	22	1 – 4	2.4	0.140
5	28	1 – 4	2.6	0.165
6	21	1 – 3	2.5	0.131
7+	108	1 – 5	2.9	0.079
Pooled	189 ^a	1 – 5	2.7	0.061

^a Thirteen litters in which litter size was unknown are excluded.

Table 4. Number of one-year-old (yearling) black bears recruited into the population annually per adult female bear age 4 or older on a study area in northcentral Pennsylvania, 2003-2017.

Year	Number of females \geq4 yrs-old examined at dens	Number of yearlings observed	Yearlings/ Female (recruitment rate)	Percent of females with yearlings
2003	3	3	1.0	67
2004	12	5	0.4	33
2005	24	10	0.4	29
2006	31	22	0.7	39
2007	22	17	0.8	36
2008	20	13	0.7	40
2009	22	24	1.1	50
2010	21	14	0.7	33
2011	22	18	0.8	41
2012	23	25	1.1	43
2013	32	21	0.7	28
2014	32	32	1.0	53
2015	44	21	0.5	32
2016	44	31	0.7	41
2017	34	9	0.3	21
Pooled	386	265	0.7	37
Mean	25.7	17.7	0.7	39

Table 5. Number of years between successful litters (litter interval) for female black bears in northcentral Pennsylvania monitored during 2002-2017. Litters were considered successful if at least 1 cub survived to age 1.

Number of females black bears for which \geq2 successive litters were documented	Number of litter intervals observed	Frequency of litter intervals				Mean interval length (yrs)
		1-year interval	2-year interval	3-year interval	4-year interval	
58	121	1	116	3	1	2.03