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BUREAU OF WILDLIFE MANAGEMENT  
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**TITLE:** Black Bear Research and Management

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**TITLE:** Black Bear Reproduction in Northcentral Pennsylvania

**PERIOD COVERED:** 1 July 2014 to 31 June 2015

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

**WORK LOCATION(S):** Northern Clinton County

**PREPARED BY:** Mark Ternent

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**ABSTRACT** During June-September 2014, we captured and ear-tagged 87 black bears on a study area in northcentral Pennsylvania, which was the highest number of bears handled in any year since the beginning of the study. Capture success was 2.9 trap-nights/bear. We monitored 53 adult female bears fitted with radio-transmitters during 2014; 1 dropped her collar in the fall and 3 were harvested, leaving 49 adult female bears available for reproductive monitoring at winter dens, of which 45 were visited during February-March 2015. Using all data collected since the beginning of the study, minimum cub-bearing age for adult females was 3 years; mean litter size was 2.6 cubs; sex ratio of cub litters was 48% female to 52% male, and mean interval between litters was 2.05 years. The mean annual natality rate (number of cubs/breeding age female/year) was 1.3; the mean annual parturition rate (percent of adult females with cubs) was 50.5%, and the mean annual recruitment rate was 0.8 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 these 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 have been shown to influence key reproductive parameters in black bears, including age of first cub production, litter size, amount 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 new 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 those 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 in a new area may take years of study. This report adds data collected during the 2014 field-season to results reported previously and provides a summary of results observed to date in a north central study area.

## METHODS

The study was conducted in northern Clinton County 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 6 regions and sequentially trapped each region for 8 consecutive days beginning 10 June and ending 26 August. We used Aldridge foot snares and barrel-style traps at an approximate density of 1 trap/4 km<sup>2</sup> to capture bears. Ten trap sites, 8 equipped with barrel traps and 2 with foot snares, were typically used during each trapping round. 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 CO<sub>2</sub>-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  $\geq 1$  year old (Harshyne et al. 1998). For female bears, we noted vulva swelling, teat condition (darkly pigmented and enlarges 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 415 trap-nights (1 trap set for 1 night = 1 trap-night), resulting in the capture of 87 bears (34 males, 53 females). Since the beginning of the study, trapping effort has totaled 4,019 trap-nights, averaging 309 trap-nights per year, and resulted in the first-time capture of 314 bears (Table 1).

Trapping success was below average during 2014 despite the record-number of bears handled and resulted in 2.9 trap-nights per capture (Table 1). This compared to a rate of 4.3 trap-nights per capture during 2013 and an annual mean of 6.8 trap-nights per capture during the previous 12 years.

An additional 391 bears have been tagged as cubs or yearlings during visits to winter dens, including 72 during February and March of 2015. Since the beginning of the study, 705 bears have been tagged on the study area, excluding 14 cubs that were tagged and added to litters as orphans but not yet captured as residents and 3 tagged cubs that were removed from the study area after being orphaned.

### Reproduction

*Natality.*--Between March 2003 and March 2015, we visited 298 dens of adult female bears that were of reproductive age ( $\geq 3$  years old). Mean number of cubs observed per breeding-age female per year was 1.3 (natality rate), and mean percent of breeding-age females with cubs was 50.5% (parturition rate; Table 2).

*Age of First Parturition.*--Between June 2002 and March 2015, we monitored 56 bears

until birth of their first litter. Mean age of primiparity from this sample was 3.7 years.

*Litter Size and Sex Ratio.*--Between March 2003 and March 2015, we observed 407 cubs belonging to 158 litters. Mean sex ratio in litters where gender was known for all cubs was 48% female to 52% male ( $n = 149$  litters). Litter size ranged from 1 to 4 cubs and averaged 2.6 cubs per litter (Table 3). Frequency of litters was: 1-cub litters, 17 (11%); 2-cub litters, 46 (29%); 3-cub litters, 74 (47%); and 4-cub litters, 19 (12%). Two additional litters were documented, but litter size was unknown because we were unable to enter a den located in a rock crevice and choose not to approach another den after seeing the adult female leave; however, multiple cubs were heard vocalizing at both sites.

Age of the mother was known for 156 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 79 litters that were observed in dens as cubs during 2003-2015 by revisiting radio-collared mothers in dens 1 year later or by recapture or harvest of all littermates. Eighty-one percent of litters had at least 1 cub survive to yearling age; 52 litters (66%) had no mortality, 12 litters (15%) had some mortality, and 15 litters (19%) had no surviving cubs.

An additional 55 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 33 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 0.8 yearlings/adult female age 4 or older/year and ranged from 0.5 to 1.1 (Table 4). This estimate was biased low because of an inability to count all yearlings present at 31 dens where bears ran before being immobilized, and thus, represents the minimum known recruitment.

*Litter Interval.*--We documented 91 litter intervals for 46 bears during 2002-2015. Mean litter interval was 2.04 years, and included 88 2-year intervals, 2 3-year intervals, and 1 4-year interval (Table 5).

We excluded a 26-year-old female and a 16-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 16-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 2015. 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 2002-2015.

<b>Year</b>	<b>Number of bears captured</b>	<b>Number of captures</b>	<b>Trap-nights</b>	<b>Success (trap-nights/capture)</b>	<b>Number of first-time captures</b>	<b>No. of cubs or yearlings tagged in dens and not previously captured</b>	<b>Total number of bears tagged</b>
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	39	56
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 <sup>d</sup>	24	55
2010	19	19	277	14.6	14	27	41
2011	34	37	313	8.5	19	33	52
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	35	52
2015	0 <sup>c</sup>	0 <sup>c</sup>	0 <sup>c</sup>	0 <sup>c</sup>	0 <sup>c</sup>	72	72
Pooled	592	703 <sup>a</sup>	4,019	5.7	314	391 <sup>b</sup>	705
Mean	46	54	309	6.8	24	28	50

<sup>a</sup> Excludes 3 cubs that were captured and released without being tagged.

<sup>b</sup> Excludes 14 orphan cubs tagged and relocated to the study area, 24 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.

<sup>c</sup> Trapping season begins 1 July.

<sup>d</sup> 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, 2003-2015.

<b>Year</b>	<b>Number of breeding-age<sup>a</sup> female dens visited<sup>b,c</sup></b>	<b>Number of females with cubs</b>	<b>Number of cubs produced</b>	<b>No. of cubs per female (natality rate)</b>	<b>% of females with cubs (parturition rate)</b>
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
Pooled	298	157	410	1.4	53
Mean	22.9	12.1	31.5	1.3	50.5

<sup>a</sup>  $\geq 3$  years old.

<sup>b</sup> Excludes 4 dens where number of cubs could not be confirmed: 1 in 2008, 1 in 2009, and 2 in 2015.

<sup>c</sup> 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 2003-2015.

<b>Age of Mother</b>	<b>(n)</b>	<b>Litter size</b>		
		<b>Range</b>	<b>Mean</b>	<b>SD</b>
3	11	1 – 3	1.5	0.688
4	20	1 – 4	2.3	0.733
5	23	1 – 4	2.6	0.788
6	17	1 – 3	2.5	0.624
7+	83	1 – 4	2.9	0.813
unknown <sup>a</sup>	2	3 – 3	3.0	
Pooled	156 <sup>b</sup>	1 – 4	2.6	0.838

<sup>a</sup> Of reproductive age, but actual age from cementum analysis not yet known.

<sup>b</sup> Four litters where 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, 2003-2015.

<b>Year</b>	<b>Number of females <math>\geq</math>4 yrs-old examined at dens</b>	<b>Number of yearlings observed</b>	<b>Yearlings/ Female (recruitment rate)</b>	<b>Percent of females with yearlings</b>
2003	3	3	1.0	67
2004	13	6	0.5	38
2005	22	10	0.5	32
2006	24	17	0.7	38
2007	16	15	0.9	38
2008	19	12	0.6	37
2009	22	24	1.1	55
2010	20	12	0.6	30
2011	20	17	0.9	40
2012	18	20	1.1	44
2013	30	19	0.6	27
2014	31	28	0.9	55
2015	39	18	0.5	28
Pooled	277	201	0.7	38
Mean	21.3	15.5	0.8	41

Table 5. Number of years between successful litters (litter interval) for female black bears in northcentral Pennsylvania monitored during 2002-2015. Litters were considered successful if at least one cub survived to age 1.

<b>Number of females black bears for which <math>\geq</math>2 successive litters were documented</b>	<b>Number of litter intervals observed</b>	<b>Frequency of litter intervals</b>			<b>Mean interval length (yrs)</b>
		<b>2-year interval</b>	<b>3-year interval</b>	<b>4-year interval</b>	
46	91	88	2	1	2.04