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TITLE: Black Bear Research and Management

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TITLE: Black Bear Harvest and Population Monitoring

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WORK LOCATION: Statewide

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ABSTRACT In 2017, the statewide black bear population was estimated to be 18,790 bears with a 95% confidence interval of 15,374 to 22,118 bears, and was unchanged from the 2016 population estimate. Hunters purchased 172,709 bear licenses, which resulted in the harvest of 3,438 bears: 10 during the early season, 493 during the archery season, 1,852 during the general season, and 1,083 during the extended season. The 2017 harvest ranked as the ninth highest on record, and several new benchmarks were set. First, a harvest of 493 bears during the archery season was a record high and resulted from moving archery bear season into the second-to-last week of archery deer season. Second, the harvest of 1,083 bears in the extended season also was a new record, due in part to favorable weather and expanded opportunity. However, opening-day harvest in the general season was a record low because of widespread rain. Only 694 bears were taken on the opening day, which was less than half of the 5-year average. Harvest recovered on the second day, and the 2017 season marks the only year in over 4 decades to have a second-day harvest that exceeded the opening-day harvest. Eight hundred forty-nine bears were captured and tagged statewide during 2017. Harvest rate was 3.8% during the archery season and 9.7% during the general season. In the area open to extended hunting, mean harvest rate across affected Wildlife Management Units (WMU) was 19.1%. Three WMUs had harvest rates in the 20 to 25% range, which is considered sufficient for stabilizing growth in black bear populations; 3 exceeded 25%, which can reduce populations if repeated, and 8 were below 20%, which is typically insufficient to stop population growth. Eighteen percent of the 2017 harvest was cubs-of-the-year. Among bears 1-year-old or older, sex ratio was 50% female; among cubs, sex ratio was 46% female. Bear hunting seasons similar to 2017 are recommended for 2018.

OBJECTIVE

To document bear harvest and population trends, and to make bear management recommendations based on these trends.

METHODS

We captured bears using culvert traps or foot snares set in nuisance and non-nuisance situations during May–October, and by visiting winter dens in February and March. Each captured bear was marked with a uniquely numbered metal ear tag in each ear, and a first premolar tooth was extracted for age determination from bears over 12 months old. Some bears also were weighed, tattooed on the inside upper lip, or fitted with a radio-transmitting neck collar. All capture and handling of bears was done by Game Wardens, land management staff, biologists, and wildlife technicians employed by the Game Commission.

Tagging was encouraged throughout the primary bear range by assigning capture objectives to 54 counties. Capture objectives mirrored harvest distribution and summed to 700. We asked personnel responsible for tagging bears to use their local county objective as a trapping goal.

Bear hunting occurred during 4 seasons: an early season in Wildlife Management Unit (WMU) 2B, 5B, 5C, and 5D concurrent with archery (16 September-11 November), muzzleloader (14-21 October) or special firearms (19-21 October) seasons for white-tailed deer; a statewide archery bear season during 30 October-4 November, a statewide general bear season during 18 and 20-22 November, and an extended bear season in select WMUs during the general firearms deer season. Length of the extended season varied based on location, and occurred during 27 November-2 December in WMU 3B, 3C, and 3D; 27 November-9 December in WMU 2B, 5B, 5C, and 5D, and 29 November-2 December in WMU 1B, 2C, 3A, 4B, 4C, 4D, and 4E.

Hunters were required to purchase a bear license in addition to a general hunting license before participating in a bear season. Bear licenses could be purchased at any license-issuing location and were unlimited. The annual bag limit was 1 bear per licensed hunter in all seasons combined.

Successful hunters were required to present their bear for inspection at a check station within 24 hours of harvest. While checking bears, we recorded sex, age (cub or adult), harvest location, time of death, and marking (ear tag or tattoo) information. We collected a premolar tooth for ageing, weighed the bear, and interviewed the hunter to obtain name, address, and biographical data. Cause of death, location, sex, age, and tag information also was collected from any dead bear reported to the Game Commission outside the hunting season (e.g., vehicle collisions, damage or nuisance removals, loss due to disease, and poaching incidents).

We maintained a database of all reported captures, harvests, and nonharvest mortalities. We used bears captured in the 12 months before the hunting season as marked animals and bears killed during the hunting season as a recapture sample to estimate population size using the unbiased Lincoln-Petersen equation (Seber 1982). Bears with ear tags from previous years were treated as unmarked unless recaptured in 2016 to reduce the effects of tag loss (Alt et al. 1985),

dispersal (Alt 1978), and undetected mortality. Marked bears that were known to die prior to the hunting season (recapture period) were excluded from population estimate calculations.

Population estimates were calculated for individual WMUs and the entire state. When estimating population size for the entire state, we limited the recapture period to the general hunting season to be consistent with estimation procedures used in prior years. When estimating population size for individual WMUs, we pooled all bear hunting seasons (early, archery, general, and extended) into a single recapture period. Population estimates were not calculated for WMUs that had 10 or fewer bears marked during 2017.

We calculated harvest rate (percent of the population removed by hunting) as the proportion of tagged bears that were harvested, regardless of where they were harvested or in which season. Harvest rates were calculated for the entire state and individual WMUs with >10 bears marked and not recovered dead prior to the hunting season.

RESULTS

Captures and Tagging

Eight hundred forty-nine bears were captured 951 times between 24 November 2016 and 17 November 2017. This compares with 952 bears and 1,094 captures the previous year. Thirty-six percent of the bears handled during 2017 were captured in nuisance situations (38% in 2016).

Capture objectives were met or exceeded in 27 of 54 counties, while 6 counties outside the primary bear range that have no assigned capture quota also tagged bears (Table 1). The number of counties meeting at least 75% or more of their assigned tagging objective decreased from the previous year (36 versus 41 counties in 2016).

Twenty-seven tagged bears (3.2%) died prior to the fall hunting season; 1 also died during the early hunting season, and 31 died during the archery season, leaving a sample of 790 bears for computing the statewide population estimate. The most common cause of death prior to hunting season was automotive collisions (21 of 27, 78%).

Population Estimates

Statewide Population.--The 2017 statewide population estimate was 18,790 bears with a 95% confidence interval of 15,374 to 22,118 bears (Table 2). The 2017 estimate represented a slight decrease from the 2016 estimate (19,382); however, confidence intervals from both years overlapped suggesting that the 2 estimates were not statistically different. The statewide population estimate has been stable at 18,000 to 20,000 bears since 2013.

Individual WMUs.--Data were available to estimate population size in 14 WMUs (Table 3). Estimates were not calculated for Units 1A, 1B, 2A, 2B, 4E, 5A, 5B or 5C because of insufficient tagging or no harvest.

Wildlife Management Unit 2G had the largest population estimate and WMU 2E had the smallest estimate. Two WMUs had density estimates that were ≥ 1.0 bear per square-mile (2G and 4C), and 2 had estimated densities < 0.25 bear per square-mile (2E and 4A).

Harvest

Bear License Sales.--Hunters purchased 172,709 bear licenses during 2017, which was a 0.5% decrease from the previous year (173,580 licenses). A general increase in bear license sales has steadily occurred during the past 20 years.

Although an increasing trend in license sales has not impacted bear populations, hunter participation should be closely monitored. During the 1970s when a bear license was not required, an estimated 250,000 hunters pursued bears and populations declined (Lindzey et al. 1983). At present levels, licensed hunters outnumber bears approximately 9 to 1.

Harvest Size and Location.--Hunters killed 3,438 bears during 2017, which included 10 bears during the early season, 493 bears during the archery season, 1,852 bears during the general season, and 1,083 bears during the extended season (Table 4). The 2017 harvest was a 2.6% decrease from the 2016 harvest, and ranked ninth in recorded harvests.

Despite ranking ninth, several records were set in 2017. First, a harvest of 493 bears during the archery season was a new record high. Prior to 2017, archery bear season occurred the week before the general season and was not concurrent with any other big game seasons except for wild turkey in some WMUs. However, in 2017, archery bear season was moved to the second-to-last week of the archery deer season and harvest increased substantially. A harvest of 1,083 bears in the extended season also was a new record high, due in part to favorable weather for hunting and the re-opening of WMU 3A. Yet, despite their significant increases, both the archery and extended season take were within acceptable limits for current population goals.

Conversely, in the general season, harvest dramatically declined because of widespread heavy rain during nearly all hunting hours of the opening day. Only 694 bears were taken on the opening day (Table 4), which was less than half of the 5-year average. In fact, the last time opening-day harvest dropped below 700 bears was in 1982. Harvest recovered on the second day with hunters killing 735 bears, which was 20% above the 5-year average, and remained high the rest of the season. The 2017 season is the only year in over 4 decades to have a second-day harvest that exceeded the opening-day harvest.

Bears were taken in 57 of Pennsylvania's 67 counties. The top 10 counties in 2017 were Lycoming (252 bears), Tioga (214 bears), Pike (193 bears), Potter (161 bears), Wayne (156 bears), Sullivan (156 bears), Clinton (153 bears), Bradford (112 bears), Warren (109 bears), and Luzerne (108 bears).

Bears were harvested in 22 of 23 WMUs. Harvest decreased from the previous year in 10 WMUs, remained the same in 4, and increased in 9 (Table 5). The WMUs with the most noticeable changes were 2G, which declined 129 bears from the previous year, and 3B, which increased 136 bears.

Harvest Rate.--Of the 821 tagged bears assumed to be alive at the start of the statewide archery season, 31 were killed yielding a harvest rate of 3.8%, which was a 3-fold increase from the rate observed during 2016 (1.3%; Table 4). Harvest rate during the general season was 9.7%,

which was well below the 5-year mean and the previous year (13.9% and 13.3%, respectively; Table 4). Total harvest rate for the area open to extending hunting was 19.6% and the mean rate across affected WMUs (excluding 1B, 2B, and 5B,C, and D because of low tag numbers) was 19.1% (Table 4).

Three WMUs had harvest rates in the 20 to 25% range, which is considered sufficient for stabilizing growth in black bear populations; 3 exceeded 25%, which can reduce populations if repeated, and 8 were below 20%, which is typically insufficient to stop population growth. Harvest rate could not be calculated for WMUs 1A, 1B, 2A, 2B, 4E, 5A, 5B, or 5C because of insufficient tagging, 2 of which had moderate harvest and were open to extended hunting (1B and 4E; Table 5).

Sex and Age Composition.--Eighteen percent of the harvest was cubs-of-the-year, which was typical of recent years. Among bears determined to be 1 year old or older, the sex ratio was 50% female, and across WMUs ranged from 27% (WMU 5C) to 63% (WMU 3C). Among cubs, the sex ratio was 46% female, and across WMUs ranged from 33% (WMU 5A) to 57% (WMU 2F).

Hunter Success Rate.--Approximately 2.0% or 1 in 50 hunters who purchased a bear license were successful in 2017 (Table 4). This value was similar to the 5-yr and 10-yr means, which were 2.1% and 2.2%, respectively.

Weights of Harvested Bears.--Weights were obtained for 3,016 bears, which was 88% of the harvest. Sixty-nine percent of the bears not weighed occurred in the archery season where bears are typically checked in the field by Wildlife Conservation Officers.

One hundred fifteen bears (3.8% of the harvest) weighed 400 pounds or more and 48 (1.6%) weighed over 500 pounds calculated live-weight. These percentages were down from 2016 when 217 bears (6.5%) weighed 400 pounds or more and 80 bears (2.4%) weighed 500 pounds or more. The largest bear had a live weight of 707 pounds and was harvested in WMU 3D, Monroe County during the extended season.

The average live-weight of all bears harvested during 2017 was 179 pounds (175 pounds in 2016). The average weight of bears taken during the archery season was slightly higher than the average weight of bears taken during either the general or extended seasons (183 lbs vs. 178 lbs and 179 lbs, respectively). This trend also occurred in prior years.

Non-Hunting Mortalities

Four hundred fifty-six bear mortalities were documented outside of the hunting season during 2017. They included 348 automotive collisions, 7 illegal shootings, 27 damage removals, and 74 other miscellaneous causes of death (Table 6).

Sixty-six percent of the bears examined in the *Other* category had symptoms of mange. Reports of bears with mange have increased in number and distribution during the past 15 years (Sommerer 2014), but the reasons for an increase and an estimate of prevalence in the population are unknown although research into these questions is ongoing (Brown and Terner 2018).

RECOMMENDATIONS

1. Continue monitoring hunter participation during 2018 by requiring purchase of a bear license and listing all bear hunting seasons on the annual Game Take Survey.

2. Accurately measure tag-returns (in order to estimate population size and harvest rate) by operating check stations during all days of the general season and select days of the extended season. When check stations are not being operated, require harvested bears to be field-checked by agency staff. Mandatory checking of all harvested bears, whether at established check stations or in the field, should continue.

3. Tag a minimum of 700 bears during 2018, including bears recaptured from previous years. Make tagging of bears in WMUs with extended seasons a priority; in particular, tagging needs to increase in WMU 1B now that harvest has substantially increased due to expanded hunting opportunity.

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Table 1. Number of bears tagged by county and region, tagging objectives, and percent each objective was filled during 2017.

Region	County	No. Bears Captured	Tagging Objective	% Filled
North- West	Butler	3	6	50
	Clarion	9	8	>100
	Crawford	0	6	0
	Erie	0	3	0
	Forest	5	10	50
	Jefferson	14	10	>100
	Lawrence	0	0	n/a
	Mercer	1	4	25
	Venango	11	9	>100
	Warren	13	11	>100
	Entire Region	56	67	84
South- West	Allegheny	1	2	50
	Armstrong	2	9	22
	Beaver	1	0	>100
	Cambria	28	19	>100
	Fayette	12	14	86
	Greene	0	0	n/a
	Indiana	4	14	29
	Somerset	22	23	96
	Washington	0	0	n/a
	Westmoreland	42	25	>100
	Entire Region	112	106	>100
North- Central	Cameron	26	12	>100
	Centre	24	29	83
	Clearfield	34	24	>100
	Clinton	127	31	>100
	Elk	38	19	>100
	Lycoming	20	32	63
	McKean	30	21	>100
	Potter	42	22	>100
	Tioga	13	26	50
	Union	2	15	13
	Entire Region	356	231	>100
South- Central	Adams	1	0	>100
	Bedford	12	12	100
	Blair	7	9	78
	Cumberland	2	0	>100
	Franklin	0	4	0
	Fulton	5	6	83
	Huntingdon	28	18	>100
	Juniata	12	7	>100
	Mifflin	24	11	>100

Table 1 cont.

Region	County	No. Bears Captured	Tagging Objective	% Filled
South-	Perry	3	4	75
Central cont.	Snyder	5	4	>100
	Entire Region	1	0	>100
North-	Bradford	100	75	>100
East	Carbon	19	16	>100
	Columbia	13	14	93
	Lackawanna	1	7	14
	Luzerne	15	14	>100
	Monroe	13	21	62
	Montour	24	26	92
	Northumberland	0	1	0
	Pike	2	4	50
	Sullivan	63	31	>100
	Susquehanna	15	14	>100
	Wayne	8	9	89
	Wyoming	22	19	>100
	Entire Region	20	10	>100
South-	Berks	215	186	>100
East	Bucks	9	7	>100
	Chester	1	0	>100
	Dauphin	0	0	n/a
	Delaware	0	5	0
	Lancaster	0	0	n/a
	Lebanon	1	0	>100
	Lehigh	4	3	>100
	Montgomery	4	3	>100
	Northampton	0	0	n/a
	Schuylkill	7	3	>100
	York	8	14	57
	Entire Region	34	35	97
Statewide (all regions)		849 ^a	700	>100

^a Does not equal to sum of column because some bears were captured in more than one county and have been counted in each counties' capture numbers.

Table 2. Lincoln-Petersen mark-recapture population estimates for black bears in Pennsylvania, 1992-2017.

Year	Number of tagged bears available for recapture ^a	Population estimate	95% Confidence Interval	
			Lower	Upper
1992	301	8,252	6,726	10,618
1993	356	8,880	7,370	11,062
1994	386	8,525	6,945	10,870
1995	439	9,269	7,957	11,055
1996	420	8,596	7,266	10,454
1997	566	10,057	8,213	11,204
1998	441	9,902	8,588	11,666
1999	404	11,957	9,659	15,394
2000	388	15,340	12,796	18,963
2001	428	15,387	12,989	18,721
2002	564	15,104	12,753	18,341
2003	586	16,064	13,609	19,105
2004	551	13,810	11,636	16,525
2005	506	15,901	13,550	18,810
2006	558	15,121	12,705	18,142
2007	566	13,363	11,112	16,202
2008	592	17,504	14,762	20,911
2009	806	17,852	15,449	20,749
2010	702	18,375	15,572	21,824
2011	753	17,831	15,405	20,763
2012	695	16,255	13,868	19,179
2013	748	18,518	15,592	22,134
2014	844	18,320	15,558	21,698
2015	864	20,503	17,428	24,256
2016	900	19,382	16,549	22,823
2017	790	18,790	15,374	23,118

^a Bears that were tagged in the current year and not discovered dead prior to the general hunting season (i.e., recapture period). See Table 1 for total number of captures in 2017.

Table 3. Lincoln-Petersen mark-recapture black bear population estimates by Wildlife Management Unit (WMU) in the primary bear range during 2017.

WMU	Area (mi ²)	Population estimate	Est. number of bears/mi ²	Lower 95% CI	Upper 95% CI
2C	3,100	1052	0.34	726	1613
2D	2,487	1143	0.46	522	2810
2E	1,262	68	0.05	52	114
2F	2,411	1319	0.55	806	2329
2G	3,115	3641	1.17	2647	5130
2H	999	414	0.41	289	643
3A	1,508	1176	0.78	606	2613
3B	2,218	1678	0.76	1164	2590
3C	2,191	2103	0.96	1030	4729
3D	2,103	1701	0.81	1283	2342
4A	1,736	406	0.23	233	831
4B	1,591	429	0.27	271	788
4C	1,717	2448	1.43	948	6900
4D	2,743	1540	0.56	1053	2370
4E	1,736	a	a	a	a

^a Insufficient tagging to estimate population size.

Table 4. Statewide black bear hunting season and harvest statistics, 2013-2017

Year	Season length (days)	Season dates	Harvest				Harvest rate (%)	Number of licenses sold	Hunter success (%)	Hunters /bear
			First day	Second day	Third day	Total				
2013	57 ^a	21 Sep-16 Nov	1	0	1	12	--			
2013	5 ^b	18-22 Nov	57	43	39	197	1.6			
2013	4	23, 25-27 Nov	1,356	760	214	2,521	13.5	167,439	2.1	48
2013	6 ^c	2-7 Dec	305	142	96	780	26.2 ^d			
2014	57 ^a	20 Sep-15 Nov	1	0	0	9	--			
2014	5 ^b	17-21 Nov	37	30	33	171	1.3			
2014	4	22, 24-26 Nov	1,640	454	250	2,449	13.3	173,523	1.9	52
2014	6 ^c	1-6 Dec	243	122	88	739	24.7 ^d			
2015	57 ^a	19 Sep-14 Nov	1	0	0	12	--			
2015	5 ^b	16-20 Nov	72	45	41	209	1.6			
2015	4	21, 23-25 Nov	1,706	569	280	2,724	13.2	175,314	2.1	47
2015	6 ^c	30 Nov-5 Dec	223	43	35	803	25.6 ^d			
2016	57 ^a	17 Sep-12 Nov	3	0	0	12	--			
2016	5 ^b	14-18 Nov	68	49	30	225	1.3			
2016	4	19, 21-23 Nov	1,315	651	369	2,602	13.3	173,580	2.0	49
2016	6 ^c	28 Nov-3 Dec	166	38	40	691	22.4 ^d			
2017	57 ^a	16 Sep-11 Nov	0	0	0	10	--			
2017	6 ^b	30 Oct-4 Nov	63	90	48	493	3.8			
2017	4	18, 20-22 Nov	694	735	258	1,852	9.7	172,709	2.0	50
2017	6 ^c	27 Nov-2 Dec	213	103	158	1,083	19.1 ^d			

^a Early season.

^b Archery season.

^c Extended season.

^d Mean WMU harvest rate combining all seasons in WMUs open to extended hunting.

Table 5. Black bear harvest statistics by Wildlife Management Unit (WMU), 2017.

WMU	Area (mi ²)	Number of bears tagged ^a	Harvest rate	Total harvest	Total harvest/10 mi ²	Early season harvest	Archery season harvest	General season harvest	Extended season harvest	% Change in total harvest from 2016
1A	1,847	2	^b	17	0.1	0	3	14	0	-50
1B	2,117	1	^b	103	0.5	0	9	60	34	-34
2A	1,811	7	^b	3	0.0	0	0	3	0	50
2B	1,363	2	^b	4	0.0	3	1	0	0	0
2C	3,100	80	0.19	207	0.7	0	36	96	75	-27
2D	2,487	25	0.08	131	0.5	0	28	103	0	30
2E	1,262	11	0.55	39	0.3	0	11	28	0	-35
2F	2,411	50	0.16	232	1.0	0	37	195	0	-28
2G	3,115	206	0.13	474	1.5	0	69	405	0	-21
2H	999	65	0.20	87	0.9	0	12	75	0	-19
3A	1,508	21	0.14	213	1.4	0	34	115	64	27
3B	2,218	54	0.26	457	2.1	0	50	191	216	42
3C	2,191	31	0.10	262	1.2	0	26	86	150	54
3D	2,103	113	0.24	417	2.0	0	51	187	179	17
4A	1,736	20	0.20	96	0.6	0	20	76	0	-22
4B	1,591	22	0.27	130	0.8	0	13	40	77	-15
4C	1,717	30	0.03	157	0.9	0	39	49	69	9
4D	2,743	82	0.18	296	1.1	0	33	93	170	-9
4E	1,736	4	^b	94	0.5	0	16	33	45	11
5A	1,301	1	^b	7	0.1	0	4	3	0	600
5B	2,640	1	^b	1	0.0	1	0	0	0	0
5C	2,473	8	^b	11	0.0	6	1	0	4	0
5D	835	1	^b	0	0.0	0	0	0	0	0

^a Excluding bears that were documented dead prior to hunting season.

^b Harvest rate could not be determined because of an insufficient number of tagged bears, or no tagged bears were harvested.

Table 6. Black bear mortalities documented outside of the legal hunting season in Pennsylvania, January-December, 1995–2017. Category “Other” includes cases of unknown cause of death, malnutrition, disease (including being euthanized for mange), predation, non-vehicle accidents (i.e., collisions with trains), unsuccessful cub reintroductions, handling accidents, and self-defense killings.

Year	Property or agriculture damage^a	Automobile collisions	Illegal shootings	Other	Total
1995	12	251	21	29	313
1996	3	216	14	25	258
1997	6	277	23	32	338
1998	4	262	24	21	311
1999	3	342	19	22	386
2000	25	305	20	26	376
2001	12	312	13	28	365
2002	11	378	22	42	453
2003	25	444	22	61	552
2004	28	354	18	42	442
2005	12	289	8	28	283
2006	12	382	17	51	462
2007	10	314	22	37	383
2008	21	357	14	60	452
2009	35	404	21	61	521
2010	27	405	16	68	516
2011	37	418	12	97	564
2012	34	408	9	115	566
2013	35	411	14	99	559
2014	31	438	14	112	595
2015	23	383	15	73	494
2016	32	494	9	132	667
2017	27	348	7	74	456

^a Includes both agency and landowner removals.