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TITLE: Black Bear Harvest and Population Monitoring

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COOPERATING AGENCIES: Pennsylvania Game Commission Biologists, Technicians, and Wildlife Conservation Officers

WORK LOCATION: Statewide

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ABSTRACT In 2010, several changes to bear hunting were implemented; the archery season was opened statewide and lengthened by 3 days, opening-day of the general season was moved to Saturday, and the extended season was closed. As a result, a record 161,119 bear licenses were sold, but harvest did not noticeably increase. Hunters killed 3,090 bears: 268 in the archery season and 2,822 in the general season, which ranked fifth in annual bear harvests. Harvest did not increase despite greater participation because hunter success was 1.9% and harvest rate was 15.2%, which were both below average relative to recent years. Low harvest rates typically occur in years that have inclement weather on opening day or poor availability of fall foods, but neither condition was common in 2010 and the factors that lead to a low harvest rate are unclear. We estimated the statewide pre-season black bear population to be 18,375 bears with a 95% confidence interval of 15,572 to 21,824, which was nearly identical to the 2009 estimate. However, 11 Wildlife Management Units (WMUs) had harvest rates below 20% that were insufficient to stabilize bear populations. We recommend reopening the extended season in 9 WMUs and continuing with a Saturday-opener for the general season and a statewide 5-day archery season. We were unable to measure harvest rate or population trend in 4 WMUs that now account for 10% of the harvest because an insufficient number of bears were tagged prior to hunting season. Tagging should be made a priority in these 4 WMUs and any where extended hunting is approved for 2011.

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 Wildlife Conservation Officers, 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 2 statewide seasons: an archery-only season during 15-19 November, and a general season during 20 and 22-23 November. An extended season that typically occurred during the week after the general season was closed in 2010.

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), kill location, time of death, ear tag and 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 bears reported to the Game Commission outside the hunting season (e.g., vehicle collisions, damage or nuisance removals, 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 2010 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 Wildlife Management Units (WMUs) and the entire state. When estimating population size for the entire state, we limited the recapture period to the general 3-day 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 (archery and general) into a single recapture period. Population estimates were not calculated for WMUs that had <10 bears marked before the recapture period (hunting season).

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 individual WMUs with ≥ 10 marked bears and for the entire state. Recommendations, including season dates and locations for the 2011 hunting season, were formulated by reviewing trends in harvest rate, population estimates, and harvest characteristics relative to current management objectives.

RESULTS

Captures and Tagging

Seven hundred forty-nine bears were captured 799 times between 6 December 2009 (day after the 2009 extended bear hunting season) and 14 November 2010 (day before the 2010 archery bear hunting season). This compares with 843 bears in 2009. Forty-one percent of the bears were captured in a nuisance situation (51% in 2009).

Capture objectives were met or exceeded in 25 of 54 counties (Table 1). The number of counties meeting at least 75% or more of their capture objective was identical to the previous year (31 counties).

Thirty-two tagged bears (4.3%) died prior to hunting season and 15 died during the archery bear season, leaving a sample of 702 bears for computing the statewide population estimate. The most common cause of death prior to hunting season was automotive collisions.

Population Estimates

Statewide Population.--The 2010 statewide population estimate was 18,375 bears with a 95% confidence interval of 15,572 to 21,824 bears (Table 2). The 2010 estimate was very similar to the 2009 estimate and confidence intervals from both years overlapped.

Individual WMUs.--Data were available to estimate population size in 11 WMUs (i.e., WMUs where 10 or more bears were tagged); estimates were not calculated for Units 1A, 1B, 2A, 2B, 2D, 2E, 4E, 5A, 5B, 5C or 5D.

Unit 2G had the largest population estimate and Units 4A and 4B had the smallest estimates. Three WMUs had density estimates that were ≥ 1.0 bear per forested square-mile; the lowest estimated density was 0.3 bear per forested square-mile in WMU 4A.

Eight WMUs (2C, 2F, 2G, 3A, 3C, 3D, 4A, and 4B) have an increasing trend in recent population estimates, 5 (2D, 2E, 4C, 4D, and 4E) have a stable trend, and 1 (3B) has a declining trend (Fig. 1).

The trend in WMU 3C had been stable prior to 2010. This Unit is traditionally part of the extended season, but was excluded in 2009 because of insufficient tagging for population monitoring. The extended season closure in 2009 may have contributed to the higher population estimate observed in 2010.

Harvest

Bear License Sales and Hunter Effort.--A record 161,119 bear licenses were sold during 2010, which was a 9.1% increase above the number sold in 2009 (147,722 licenses). Approximately 3% were nonresidents. Seventeen percent of all licensed hunters in 2010 purchased a bear license.

Bear license sales likely increased because opening day of the firearms season, which had traditionally been Monday, occurred on Saturday. A Saturday opener has again been approved for 2011, but the firearms season also was lengthened to 4 days and the 6-day extended season was reopened in all or part of 9 WMUs. Thus, further increase in bear license sales should be closely monitored. During the 1970s when a bear license was not required, an estimated 250,000 hunters pursued bears and bear populations noticeably declined (Lindzey et al. 1983).

Harvest Size and Location.--Hunters killed 3,090 bears during 2010, which included 268 bears during the archery season and 2,822 bears during the general season (Table 4).

Bears were harvested in 53 of Pennsylvania's 67 counties. No bears were taken in Lehigh County despite 2 bears being harvested there in 2009, but bears were harvested in Cumberland and Erie counties, which had no harvest in 2009. The top 10 counties in 2010 were Clinton, Lycoming, Tioga, Clearfield, Potter, Cameron, Pike, Centre, Fayette, and Huntingdon, respectively.

Bears were harvested in 18 WMUs; harvest decreased from the previous year in 8 WMUs, remained the same in 3, and increased in 11 (Table 5). The largest increases occurred in WMUs 2C and 3C, which harvested 61 and 46 bears more, respectively, than in 2009.

Moderate declines, ranging from 27 fewer bears in WMU 4E to 133 in 2G, occurred in 7 WMUs (2F, 2G, 3A, 3B, 4C, 4D, and 4E; Table 5). Four of these WMUs had previously been open to extended hunting, which was not available in 2010, and explains in part their reduced harvest. In the remaining 3 WMUs (2F, 2G, and 3A), the reason for a reduced harvest is not clear, especially with opening day occurring on Saturday instead of Monday, but it may have been a function of fall food availability.

Harvest Rate.--Of the 717 tagged bears assumed to be alive at the start of the statewide archery season, 15 were killed yielding a harvest rate of 2.1%. This was double the rate previously observed when archery season was limited to 9 WMUs and 2 days (Table 4). Harvest rate during the general season was 15.2%, which was below average (Table 4).

Five WMUs (2F, 3A, 3C, 3D, and 4B) had relatively low harvest rates that ranged between 10% and 15% (Table 5), and all 5 have increasing population trends. Hunting seasons may need to be added or extended in these units if harvest rates continue to be low. Only WMU 4A had a harvest rate that exceeded 25% (Table 5).

Harvest rate could not be estimated in 4 WMUs (1B, 2D, 2E, and 4E) because of insufficient tagging; yet collectively, these units accounted for 10% of the statewide harvest, and in the case of 2D, harvest was almost 150 bears. Better tagging effort in these units should be a priority in 2011.

Hunter Success Rate.--Approximately 1.9% or 1 in 52 hunters who purchased a bear license were successful in 2010, which was slightly below average (2.3%). Like harvest rate, the success rate observed in 2010 was most similar to values observed in 2007 (Table 4).

Timing of Kills --Sixty-two percent of the general season harvest occurred on opening-day (Saturday), 28% occurred on the second day, and 10% occurred on the last day (Table 4). These percentages were very similar to previous years despite moving opening day from Monday to Saturday in 2010.

Average Weights of Harvested Bears.--Weights were obtained for 2,940 bears, which was 95% of the harvest. Seventy-three percent of the bear that were not weighed occurred in the archery season, when bears were checked in the field by Wildlife Conservation Officers instead of being examined at check stations.

One hundred one bears (3.3% of the harvest) weighed 400 pounds or more and 37 (1.2% of the harvest) weighed over 500 pounds calculated live weight. These values were nearly identical to those observed in 2009, when 115 bears weighed 400 pounds or more (3.3%) and 38 weighed over 500 pounds (1.1%).

The largest bear had a field-dressed weight of 742 pounds and a calculated live weight of 876 pounds. The average live-weight of all bears harvested during 2010 was 177 pounds (169 pounds in 2009). The average weight of bears taken during the archery season was slightly higher than the average weight of bears taken during the general season (203 lbs vs. 175 lbs, $P = 0.0003$).

Non-Hunting Mortalities

Five hundred sixteen bear mortalities were documented outside of the hunting season during 2010. They included 405 automotive collisions, 16 illegal shootings, 27 damage removals, and 68 other miscellaneous causes of death. These values were very similar to those observed in 2009 (Table 6).

Of the 516 non-hunting mortalities, 5.8% had visual symptoms of mange (hair loss, emaciation, crusted skin). During the previous 3 years, the percentage of non-season mortalities with symptoms of mange ranged between 4.2% and 5.9%. Reports of bears with mange have increased in number and distribution during the past decade, but the reasons for an apparent increase and an estimate of actual prevalence in the population are unknown.

RECOMMENDATIONS

1. Continue monitoring hunter participation during 2011 by requiring purchase of a bear license, mandatory checking of harvested bears, 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 bear hunting season, and during select days of the extended season that traditionally have higher harvest. When check stations are not being

operated, e.g., during the archery season or parts of the extended season, require harvested bears to be field-checked by agency staff.

3. Increase tagging effort and success in WMUs 1B, 2D, 2E and 4E where insufficient tagging has prevented estimation of population size despite annual harvests that now exceed 30 bears and collectively accounted for 10% of the 2010 harvest. Tag additional bears if possible in WMUs open to extended hunting, where population monitoring is a priority.

4. Open the general bear season on Saturday (19 November 2011). Moving the opening day to Saturday in 2010 did not appear to change the daily distribution of the harvest, increase hunter success, or significantly increase the total harvest. Harvest rate during the general season should ideally be near 20%.

5. Reinstate the extended season in 9 WMUs, to include a 6-day extended season (28 November-3 December 2011) in WMUs 3A, 3B, 3C, and 4E; and a 4-day extended season (30 November-3 December 2011) in WMUs 3D, 4C, 4D, 5B, and 5C. The extended season was closed in 2010 to evaluate the effects of moving the opening day of the general season. Total harvest rate (all seasons combined) should ideally be between 20% and 35% in WMUs open to extended hunting.

6. Provide a statewide 5-day archery season the week before the general season (14-18 November 2011). Expanding the archery season to all WMUs and lengthening the season from 2 days to 5 in 2010 resulted in a 2% harvest rate, which is compatible with providing a statewide general season.

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Table 1. Number of bears tagged by county and region, tagging objectives, and percent each objective was filled during 2010.

Region	County	No. Bears Captured	Tagging Objective	% Filled
North-West	Butler	1	6	17
	Clarion	4	8	50
	Crawford	0	6	0
	Erie	0	3	0
	Forest	5	10	50
	Jefferson	7	10	70
	Lawrence	0	0	n/a
	Mercer	2	4	50
	Venango	3	9	33
	Warren	14	11	>100
	Entire Region	36	67	54
South-West	Allegheny	1	7	14
	Armstrong	3	8	38
	Beaver	0	0	n/a
	Cambria	14	19	74
	Fayette	7	13	54
	Greene	0	0	n/a
	Indiana	11	13	85
	Somerset	30	22	>100
	Washington	0	0	n/a
	Westmoreland	58	24	>100
	Entire Region	124	106	>100
North-Central	Cameron	28	12	>100
	Centre	16	29	55
	Clearfield	11	24	46
	Clinton	80	31	>100
	Elk	21	19	>100
	Lycoming	28	32	88
	McKean	25	21	>100
	Potter	20	22	91
	Tioga	23	26	88
	Union	6	15	40
	Entire Region	258	231	>100
South-Central	Adams	0	0	n/a
	Bedford	13	12	>100
	Blair	7	9	78
	Cumberland	3	0	>100
	Franklin	3	4	75
	Fulton	6	6	100
	Huntingdon	18	18	100
	Juniata	10	7	>100
	Mifflin	15	11	>100

Table 1 cont.

Region	County	No. Bears Captured	Tagging Objective	% Filled
South-	Perry	8	4	>100
Central cont.	Snyder	5	4	>100
	Entire Region	88	75	>100
North-	Bradford	18	16	>100
East	Carbon	2	14	14
	Columbia	3	7	43
	Lackawanna	14	14	100
	Luzerne	22	21	>100
	Monroe	26	26	100
	Montour	1	1	100
	Northumberland	0	4	0
	Pike	71	31	>100
	Sullivan	28	14	>100
	Susquehanna	6	9	67
	Wayne	20	19	>100
	Wyoming	0	10	0
	Entire Region	211	186	>100
South-	Berks	10	7	>100
East	Bucks	0	0	n/a
	Chester	0	0	n/a
	Dauphin	7	5	>100
	Delaware	0	0	n/a
	Lancaster	1	0	>100
	Lebanon	0	3	0
	Lehigh	0	3	0
	Montgomery	1	0	>100
	Northampton	13	3	>100
	Schuylkill	9	14	64
	York	1	0	>100
	Entire Region	42	35	>100
Statewide (all regions)		749 ^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-Peterson mark-recapture population estimates for black bears in Pennsylvania, 1991-2010.

Year	Number of tagged bears available for recapture ^a	Population estimate	95% Confidence Interval	
			Lower	Upper
1991	79	7,019	5,100	11,284
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

^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 2010.

Table 3. Lincoln-Peterson mark-recapture black bear population estimates by WMU in the primary bear range during 2010.

WMU	Forested area (mi ²)	Population estimate	Est. number of bears/forested mi ²	Lower 95% CI	Upper 95% CI
2C	2,321	1,557	0.7	1,132	2,229
2D	1,719	a	a	a	a
2E	966	a	a	a	a
2F	2,210	1,572	0.7	776	3,530
2G	3,747	4,632	1.2	3,513	6,256
3A	1,149	1,439	1.3	755	3,014
3B	1,706	1,233	0.7	802	2,021
3C	1,529	951	0.6	472	2,132
3D	1,874	1,829	1.0	1,274	2,732
4A	1,192	353	0.3	222	699
4B	1,034	343	*	180	758
4C	1,277	418	0.3	236	857
4D	1,964	1,040	0.5	700	1,661
4E	904	a	a	a	a

^a Insufficient number of bears tagged for estimate calculations.

Table 4. Statewide black bear hunting season and harvest statistics, 2002-2010.

Year	Season length (days)	Season dates	Harvest				Harvest rate (%)	No. licenses sold	Hunter success (%)	Hunters /bear
			First day	Second day	Third day	Total				
2002	3	25-27 Nov	1,498	602	412	2,512	16.5	122,046	2.2	45
2002 ^a	6	2-7 Dec	89	26	19	174	24.5 ^b			
2003	3	24-26 Nov	1,575	879	401	2,855	17.6	123,911	2.4	41
2003 ^a	6	1-6 Dec	82	27	15	149	18.4 ^b			
2004	3	22-24 Nov	1,751	571	104	2,426	17.4	132,181	2.2	44
2004 ^a	6	29 Nov-4 Dec	259	120	21	548	22.8 ^b			
2005	3	21-23 Nov	2,329	624	402	3,355	20.9	142,062	2.9	34
2005 ^a	6	28 Nov-3 Dec	384	114	46	807	24.5 ^b			
2006 ^c	2	15-16 Nov	58	21		79	<1.0			
2006	3	20-22 Nov	1,651	626	292	2,569	16.8	139,371	2.2	45
2006 ^a	6	27 Nov-2 Dec	215	138	40	476	21.2 ^b			
2007 ^c	2	14-15 Nov	32	9		41	<1.0			
2007	3	19-21 Nov	1,190	501	335	2,026	15.0	135,584	1.7	67
2007 ^a	6	26 Nov-1 Dec	72	83	43	293	16.1 ^b			
2008 ^c	2	19-20 Nov	36	34		70	1.1			
2008	3	24-26 Nov	2,014	607	330	2,951	16.9	145,795	2.4	42
2008 ^a	6	1-6 Dec	163	90	66	439	23.0 ^b			
2009 ^c	2	18-19 Nov	90	26		116	0.6			
2009	3	23-25 Nov	2,163	630	259	3,052	17.0	147,728	2.4	42
2009 ^a	6	30 Nov-5 Dec	122	62	83	345	31.6 ^b			
2010 ^c	5	15-19 Nov	115	36	32	268	2.1			
2010	3	20, 22-23 Nov	1,755	794	273	2,822	15.2	161,119	1.9	52

^a Extended season.

^b Total harvest rate after all seasons in WMUs open to extended hunting.

^c Archery season.

Table 5. Black bear harvest statistics by WMU, 2010.

WMU	Area (mi ²)	Forested (mi ²)	Number bears tagged	Harvest rate	Total harvest	Harvest/ 10 mi ² forest	Archery season harvest	General season harvest	% Change in harvest from 2009
1A	1,868	957	2	^a	11	0.1	0	11	38
1B	2,142	1,320	3	^a	42	0.3	2	40	17
2A	1,832	1,111	0	^a	1	0.0	0	1	0
2B	1,379	791	1	^a	0	0.0	0	0	0
2C	3,136	2,321	115	19	308	1.3	20	288	25
2D	2,516	1,719	9	^a	146	0.8	11	135	14
2E	1,276	966	9	^a	94	1.0	9	85	22
2F	2,439	2,210	30	10	202	0.9	15	187	-28
2G	4,162	3,747	175	19	894	2.4	62	832	-13
3A	1,526	1,149	35	11	199	1.7	19	180	-22
3B	2,277	1,706	62	18	234	1.4	21	213	-20
3C	2,183	1,529	31	10	119	0.8	18	100	63
3D	2,209	1,874	121	15	284	1.5	51	233	3
4A	1,756	1,192	12	33	135	1.1	6	129	8
4B	1,606	1,034	24	13	54	0.5	5	49	26
4C	1,833	1,277	22	18	90	0.7	14	76	-36
4D	2,778	1,964	54	22	245	1.2	12	233	-45
4E	1,756	904	9	^a	31	0.3	2	29	-47
5A	1,316	433	1	^a	0	0.0	0	0	0
5B	2,800	772	3	^a	0	0.0	0	0	-100
5C	2,195	975	3	^a	2	0.0	1	1	100
5D	845	284	1	^a	0	0.0	0	0	0

^a Harvest rate could not be determined because of an insufficient number of tagged bears.

Table 6. Black bear mortalities documented outside of the legal hunting season in Pennsylvania, January-December, 1995–2010. Category “Other” includes cases of unknown cause of death, malnutrition, disease, 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

^a Includes both agency and landowner removals.

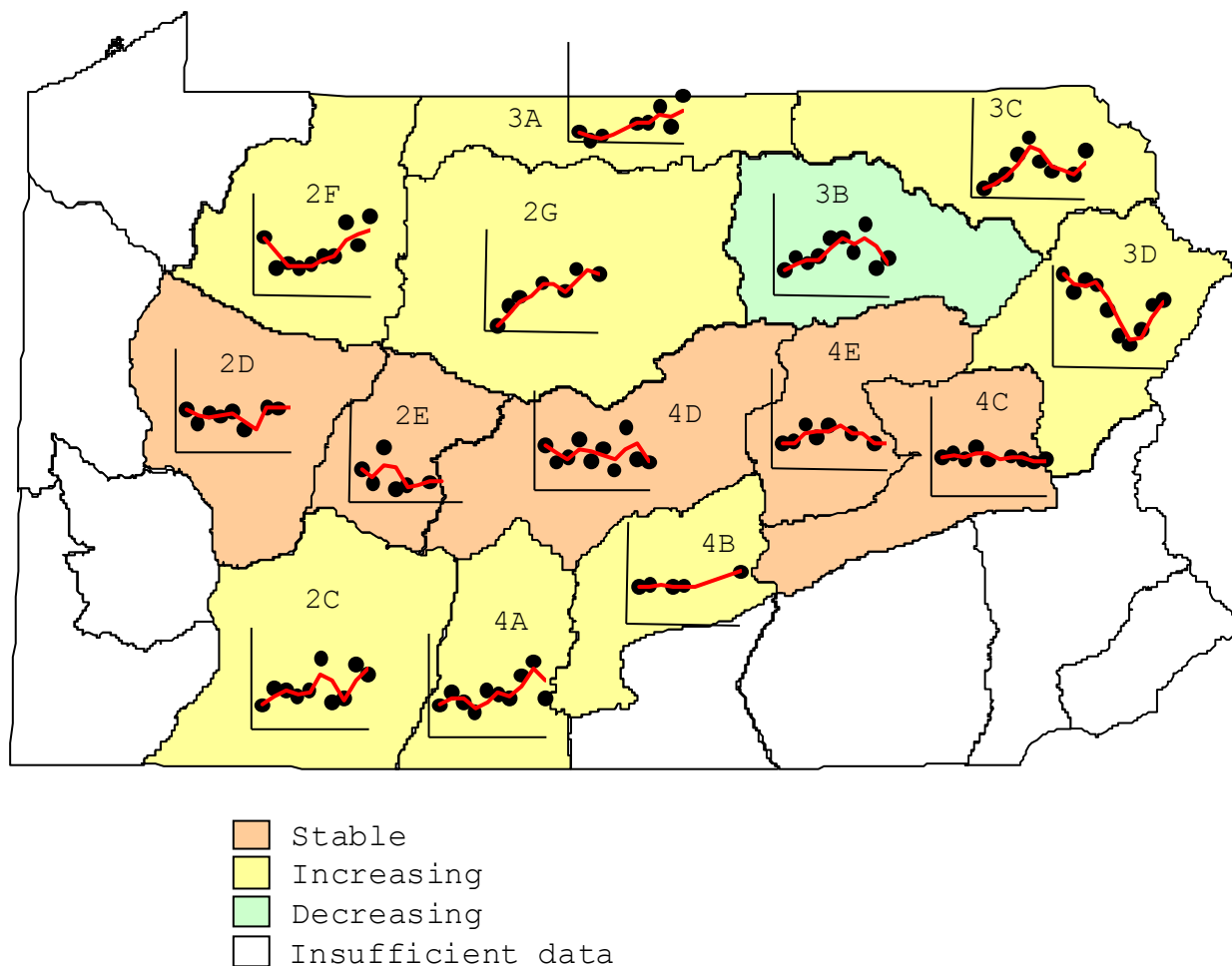


Figure 1. Trend in black bear population estimates during the past 10 years, 2001–2010, by WMU. Population estimates are calculated annually using a Lincoln-Peterson mark-recapture estimator. Year and population estimate are displayed on the x- and y-axis, respectively. All y-axes cover a range of 2,000 bears, although lower and upper endpoints vary. Solid red lines are 2-period moving average trendlines.