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TITLE: White-tailed Deer Research/Management

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TITLE: Deer Health, Forest Habitat Health, Deer Harvests, and Deer Population Trends by Wildlife Management Unit (WMU)

PERIOD COVERED: 1 July 2007 through 30 June 2008

COOPERATING AGENCIES: Pennsylvania Cooperative Fish and Wildlife Research Unit (PCFWRU), Pennsylvania Department of Conservation and Natural Resources (DCNR), Pennsylvania State University (PSU), and U.S. Forest Service (USFS)

WORK LOCATION(S): Statewide

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ABSTRACT We monitored Wildlife Management Unit (WMU) deer health, forest habitat health, and deer population trends using reproductive parameters from road-killed does, advanced tree seedling and sapling regeneration (ATSSR) from the Pennsylvania Regeneration Study, deer harvest estimates and compositions, and field studies. During the summer and fall of 2007, epizootic hemorrhagic disease, or EHD, was detected in deer in southwestern Pennsylvania. WMU 2A had the greatest number of reported deer deaths during the outbreak. Because the Game Commission uses information from hunters to assess deer population status, we conducted a survey to learn more about the affect of this EHD outbreak on deer hunting in WMU 2A. Deer health was judged to be "above target" in 2 WMUs, "at target" in 19 WMUs, "below target" in 1 WMU. Forest habitat health was judged to be good in 2 WMUs, fair in 15 WMUs, and poor in 4 WMUs. Hunters harvested 323,070 deer (109,200 antlered and 213,870 antlerless) in the 2007-08 deer seasons. Deer populations in most WMUs remained stable. Antlerless allocations were designed to reduce the population in 3 urban/suburban WMUs, increase the population in 3 WMUs, and keep the population steady in all remaining WMUs. We recommend the continuation of current regulations to monitor deer populations, and modification of antlerless allocations to change the antlerless deer harvests.

OBJECTIVE

To monitor deer health, forest habitat health, deer harvests, and deer population trends by WMU.

METHODS

Deer Health

To obtain data on deer health, Wildlife Conservation Officers examined female deer killed by various causes from 1 February through 31 May 2007. They recorded location (county, township, and WMU), date killed, cause of death, and number and sex of embryos for each doe on a form attached to a deer jaw envelope. They measured embryos so that we could determine conception and projected birth dates and removed 1 side of the lower jaw from each deer for age determination. Jaws were forwarded to Region Wildlife Management Supervisors, who along with the Deer Section, made the age assignments in July 2007. Personnel in the Bureau of Automated Technology Services (BATS) processed the reproductive data and provided summary reports for the state and each WMU.

Based on results from published studies (Cheatum and Severinghaus 1950, Verme 1965, Verme 1967, Verme 1969, Hesselton and Sauer 1973, Hesselton and Jackson 1974, McCullough 1979, Stoll and Parker 1986, Folk and Klinstra 1991, Osborne et al 1992, Taylor 1996, Swihart et al 1998), we used embryo counts per adult female (2-years-old and older) to assess deer health in each WMU. We chose a target of 1.50 embryos per adult female for deer to be considered healthy. Because of difficulties in gathering sufficient samples for 1-year-old females, 2-year-old females, and 3-year-old and older females, we combine 2-year-old and 3-year-old and older groups into a single group ("adult female"). This grouping also makes our data set comparable to previously published work. The value of 1.50 was chosen for the following reasons: 1) 1.50 embryos per adult female (2-year-old and older female) corresponds to a population producing at a high and sustainable level (Downing and Guynn 1985), 2) based on more than a dozen studies from the United States and Canada, a value of 1.50 embryos per adult female represents the middle ground between deer with low and high nutrition, and 3) 1.50 embryos per adult doe is achievable for Wildlife Management Units in Pennsylvania. Studies used to assess the suitability of 1.50 embryos per adult female come from states and provinces including Michigan, Manitoba, Ohio, New York, and Pennsylvania.

Because our reproduction point estimate is based on a sample, we conducted a two-tailed *t* test for differences between the sample mean and our target of 1.50 embryos per adult female. This approach differs from our previous use in 2006 and 2007 of strict cutoffs. We believe this approach is better because it is consistent with the approach we use for tree regeneration and provides a framework to assess not only the point estimates, but also variation.

Decision Rules Used to Determine Deer Health.--

1. Does 3-year estimate of embryos per adult female have a coefficient of variation (CV) of ≤ 13%[a]?

    a. YES. Is the WMU's point estimate of embryos per adult female statistically different from 1.50?

        i. NO. Deer health is "at target".

        ii. YES. Is the point estimate above 1.50?
            1. YES. Deer health is "above target".
            2. NO. Deer health is "below target".

b. NO. Larger sample sizes are needed to achieve desired levels of estimator precision. Deer health will be assessed based on point estimate and small sample size noted.

[a] – A coefficient of variation (CV) of approximately <13% is considered sufficient for accurate population management (Skalski and Millspaugh 2002, Skalski et al. 2005, Millspaugh et al. 2006). At this time, it typically requires pooling of 3 years of data to achieve CVs of less than 13%.

Forest Habitat Health

We used forest regeneration to assess forest habitat health. Forest regeneration is not just a measure for the benefit of the forest, but also for deer and wildlife. For deer, seedling and sapling trees provide food and cover. As a result, measuring regeneration is an important measure of the sustainability of a forest, and available food and cover that benefit deer and other wildlife.

To obtain data on forest regeneration, advanced tree seedling and sapling regeneration (ATSSR) data are collected as part of a systematic sampling scheme from public and private lands in WMUs from the Pennsylvania Regeneration Study being conducted as part of the Forest Inventory Analysis (FIA) by Pennsylvania Department of Conservation and Natural Resources (DCNR), Pennsylvania State University (PSU), and U.S. Forest Service (USFS). Subsets of all plots are collected each year, with a complete sampling of plots occurring every 5 years. ATSSR from 2 groupings of tree species are available from the Pennsylvania Regeneration Study. The measure selected for use in deer management is the grouping of dominant canopy species and species capable of achieving high canopy status. "The composition of the ATSSR has a direct impact on the future composition of the forest overstory (Marquis and others 1994). To cover the range of future forest character and client needs 2 composition groupings are used. The first groups tree species by preference for timber management. The second composition grouping represents the forest's ability to regenerate the existing dominant canopy. Dominant species include those that contribute at least 2% of the State's total-tree biomass and are able to grow into the existing canopy; Other High Canopy species include all others that are capable of attaining canopy dominance" (McWilliams et al. 2004:13-14).

We requested ATSSR data for dominant canopy species and species capable of achieving high canopy status by WMU from the USFS and DCNR. Determination of adequate regeneration was based on levels of deer browse impact observed in the area of each plot. For example, a greater number of saplings are required to replace the existing canopy where deer impact is "very high" compared to fewer saplings required where deer impact is "very low". The scaled levels of deer impact indicate deer population size in relation to food availability in a given area (i.e., carrying capacity). Areas with ample food to support the local deer population will be evident by very low to medium deer impact. Areas lacking food to support the local deer population will be evident by high to very high deer impact. These critical stocking guidelines were derived from extensive literature reviews and decades of research on deer-habitat interactions (Marquis et al. 1992). The use of browse impact and associated stocking levels represents a considerable improvement to the habitat health measure for 2008. Because of the sampling scheme used in the Pennsylvania Regeneration Study, it takes 5 years to visit all sample plots.

Based on input from cooperating agencies that designed and conduct the Pennsylvania Regeneration Study and an internal Game Commission review of the forest habitat health measure, we defined forest habitat as "good" if 70% or more of the sampled plots contained adequate regeneration. If

less than 50% of the plots contained adequate regeneration, forest habitat health was considered "poor". "Fair" falls between levels for "good" and "poor".

Similar to the deer health measure, the forest habitat health measure is based on a sample of plots from across a WMU and we use a statistical test to assess regeneration levels. By using a statistical test to assess differences from predetermined levels (e.g., 70%), we take into account both the point estimate and associated variation.

Forest health estimates can be statistically compared to target level using a chi-square goodness of fit test. The chi-square test determines whether the estimate is different from the target based on statistical procedures. For example, a chi-square test could show the estimate of 66% is not statistically different from the target of 70%. Since reliability of statistical tests is related to sample sizes, forest habitat health determinations are made based on 5-year data sets to maximize sample size and reliability of statistical tests.

Decision Rules Used to Determine Forest Habitat Health.--We developed a set of criteria to assign a value of "Good", "Fair", or "Poor" for forest habitat health. A WMU's forest habitat health was considered "good" if the observed percentage of plots with adequate regeneration was greater than, equal to, or not significantly different than 70%. If a WMU's forest habitat health was not significantly different from 70% and not significantly different from 50%, then forest habitat health was considered "fair". A WMU's forest habitat health also was considered "fair" if: 1. the observed percentage of plots with adequate regeneration was equal to 50%; or 2. between 50% and 70% and significantly less than 70%; or 3. not significantly different than 50%. A WMU's forest habitat health was considered "poor" if the observed percentage of plots with adequate regeneration was significantly less than 50%.

Deer Harvest Estimates and Composition

To estimate deer harvests and collect data for monitoring deer population trends, 33 data collection teams examined deer in assigned areas across the state. Each team collected data for 3 days during the first week of the regular firearms season, 2 days during the second week of the season, and 2 days after the close of the season. Data collected included age, sex, location of harvest (WMU, county, and township), and hunting license number from ear tags. Deer teams determined deer age as 6 months (fawn), 18 months (yearling), or at least 30 months (adult) using tooth wear and replacement (Severinghaus 1949). Aging teams also removed incisors from males 30-months-old or older for age determination by cementum annuli analysis. Data collection teams also recorded points of antlers to determine antler characteristics by age class.

A data entry company was contracted to enter deer aging and harvest report card data. BATS validated and processed harvest data and ran harvest data analysis programs. For each WMU the analyses included: the number of antlered and antlerless deer checked by aging teams, the number of antlered and antlerless deer checked by deer aging teams and reported by hunters, the total number of antlered and antlerless deer reported by hunters, age and sex composition of the harvest, and reported regular firearms, muzzleloader, and archery harvests.

Deer harvests were estimated using mark-recapture methods. When estimating deer harvests, we used a closed, 2-sample Lincoln-Petersen estimator where deer were considered marked when they were checked in the field by deer aging teams. Recapture occurred when marked deer were reported on report cards sent in by hunters.

Because reporting rates in Pennsylvania vary by year, antlered and antlerless deer, and management unit (Rosenberry et al. 2004), deer harvest estimates were calculated for antlered and antlerless deer in each WMU using Chapman's (1951) modified Lincoln-Petersen estimator. This estimator is recommended (Nichols and Dickman 1996) because it has less bias than the original Lincoln-Petersen estimator (Chapman 1951).

During the summer and fall of 2007, epizootic hemorrhagic disease, or EHD, was detected in deer in southwestern Pennsylvania. EHD is a common but sporadic viral disease of white-tailed deer, and is contracted by the bite of infected insects called "midges." In more northern states, such as Pennsylvania, EHD occurs less frequently. Therefore, effective immune responses by deer in these areas are reduced resulting in higher mortality rates than in areas where the disease occurs more commonly. Deer displaying clinical signs of EHD usually die within 5 to 10 days. EHD is not transmittable to humans. Fortunately, cold temperatures kill the insects that spread the EHD virus and the infection of new deer stops.

Wildlife Management Unit (WMU) 2A had the greatest number of reported deer deaths during the 2007 EHD outbreak. Because the Game Commission uses information from hunters to assess deer population status, we conducted a survey to learn more about the affect of this EHD outbreak on deer hunting in WMU 2A. Survey methods are found in Appendix 1.

Deer Population Trends

We used multiple methods to monitor deer population trends including a modified sex-age-kill (SAK) model (Eberhardt 1960, Creed et al. 1984, Skalski and Millspaugh 2002), antlerless hunter success index (i.e., estimated antlerless harvest divided by the number of antlerless licenses), and an antlered harvest index (i.e., estimated antlered harvest for a WMU).

We modified the standard SAK model to account for Pennsylvania’s antler restrictions to monitor deer population trends. Modifications involve estimation of 1.5-year-old and 2.5-year-old and older male populations. Population trend monitoring relies on research data from Pennsylvania (e.g., Long et al. 2005), harvest estimates, and deer aging data. Population monitoring began with adult males (males 1.5 years of age and older) and progressed to females and fawns.

The modified SAK procedure began by estimating males 2.5 years of age and older from harvest estimates and adult male harvest rates. Once the population of males 2.5 years of age and older were estimated, we determined the 1.5-year-old male population. Because protection levels of 1.5-year-old males varied among WMUs and harvest rates could also vary, we worked back in time to generate harvest rates for 1.5-year-old males. First, we determined the pre-hunt population of 1.5-year-old males in the preceding year using current year population estimate of 2.5-year-old males, survival rate from 1.5 to 2.5 years of age, and estimated harvest of 1.5-year-old males in the preceding year. Harvest rate of 1.5-year-old males from the preceding year was then calculated using the pre-hunt population and estimated harvest of 1.5-year-old males. Current year population of 1.5-year-old males was determined using a 3-year running average of harvest rates of 1.5-year-old males from the 3 previous years. Following determination of the 1.5-year-old males and males 2.5 years of age and older, calculation of female, fawn, and the total populations followed procedures similar to Skalski and Millspaugh (2002).

When interpreting results from the modified SAK procedure, it is important to know that due to the nature of population reconstruction methods, such as those used in the SAK procedure, the most accurate population estimate for a particular year occurs at some point in the future when data for each cohort of deer is complete (Skalski et al. 2005). Consequently, for the most recent years, population numbers should be viewed as indices rather than estimates (Skalski et al. 2005). Second, due to necessary assumptions of this population monitoring procedure, population numbers used to assess trends should be viewed as relative (i.e., whether trends are increasing, decreasing, or remaining stable), not absolute numbers. As we accumulate more years of data and results from on-going internal and external evaluations, refinements to this procedure will occur.

Population trends are reported as changes from year to year (λ) and are calculated as $\lambda = \frac{\hat{N}_{t+1}}{\hat{N}_t}$ where $\hat{N}_{t+1}$ is the deer population in year *t+1* and $\hat{N}_t$ is the deer population in year *t* (Skalski et al. 2005). A value of $\lambda = 1.00$ would indicate no change in deer population. Values greater than 1.00 indicate increases and values less than 1.00 indicate decreases. Deer management objectives and recommendations are based on population trends. As a result, we do not make management recommendations in response to individual λs, but rather we based management recommendations on multi-year trends.

We identified population trends as increasing, decreasing, or stable based on graphical and statistical methods, specifically the Mann-Kendall Test for Trend (Mann 1945, Kendall and Gibbons 1990). We chose this test because it provides a statistical test of trend in data without complex calculations and does not require actual differences between years. Since effective state agency deer programs must consider public involvement and perceptions, it is important that we assess trends with a test that is statistically appropriate, utilizes information available to the public (e.g., a graph of estimates over time), and is relatively easy to explain.

Winter Mortality Survey

A winter mortality survey was not completed this year. A pilot study was conducted by the Deer Section to evaluate use of distance sampling (Buckland et al. 1993) to estimate winter mortality across large areas. Unfortunately, a number of problems were encountered, including sampling issues, landscape obstacles, and the probability of finding enough dead deer for adequate precision to the estimate. As a result, we will develop survey protocols to use this method when warranted by severe winter weather or other mortality event.

RESULTS

Deer Health

WCOs examined 1,003 females during the 2007 pre-fawning season. Six hundred and fifteen were pregnant and 598 were usable for determining conception dates. Twenty-five percent of the fawns, and 88% of the adults were pregnant. Pregnant fawns averaged 1.20 embryos/female. Pregnant adults averaged 1.74 embryos/female. The average reproductive rates for pregnant and barren fawns and adults were 0.30 and 1.50 embryos/female, respectively. The average reproductive rate for all females was 1.01 embryos/doe. The median conception date for all females was 16 November. Ninety-two percent of all breeding occurred between 16 October and 16 December, with the median date fawns bred as 30

November, 2 weeks later than adult females. The median projected birth date for all fetuses examined was 2 June. Over the last 7 years, conception timing has changed little (Table 1).

WMU deer health assessments were based on reproduction from 3 consecutive years, 2005 to 2007. We pooled these 3 years because annual sample sizes are too small to make reliable inferences. Of 22 WMUS, we identified 2 with "above target" deer health, 19 with "at target" deer health, and 1 with "below target" deer health (Table 2).

Forest Habitat Health

WMU forest habitat health assessments were based on the 5 years of the Pennsylvania Regeneration Study from 2003 to 2007. We identified 2 WMUs with good forest habitat health, 15 with fair forest habitat health, and 4 with poor forest habitat health (Table 3). Results from this report cannot be compared to previous reports because of the addition of deer browse impact in assessing regeneration adequacy.

Deer Harvest Estimates and Composition

PGC personnel checked an average of 334 (range: 31 to 560) antlered deer and 821 (range: 161 to 1,654) antlerless deer per WMU during the 2007 firearms season (Table 4). Based on deer checked and report cards sent in by successful hunters, hunters harvested an estimated 323,070 deer in the 2007-08 deer seasons (Table 4). The antlered harvest was 109,200, a decrease of 19% from the 2006-07 harvest of 135,290. The antlerless harvest was 213,870, down 5% from 226,270 in 2006-07. Harvests on the opening day of the 2007 firearms season, as reported by hunters on report cards, were approximately half (47% for antlered deer, 53% for antlerless deer) of the 2006 opening day harvests. Reported antlerless harvests during the remaining days of the firearms season made up more of the opening day loss than for antlered deer.

Antlered harvests were composed of 56% 1.5-year-old males and 44% 2.5-year-old and older males (Table 6). Compared to years prior to implementation of antler restrictions during the 2002-03 hunting seasons, the age structure of the antlered harvest has increased, as has the number of 2.5-year-old and older bucks harvested (Table 6). Antlerless harvest composition has changed little since 1997-98 hunting seasons (Table 7).

Results of cementum annuli age analysis of adult males from the 2006 firearms season showed that most adult males were 2.5-years-old (71%). Twenty-one percent were 3.5-years-old, 5% were 4.5-years-old, and the remaining 3% were 5.5-years-old or older.

Results of the deer hunter survey in WMU 2A, regarding the impacts of the EHD outbreak, are found in Appendix 1.

Deer Population Trends

Population changes (λs) for most WMUs were less than 1.00 from 2006 to 2007 based on preliminary population estimates for 2007 (Table 8). Decreases in some WMUs from 2006 to 2007 likely resulted from a decrease in antlered deer harvest. Whether this decrease is due to lower deer populations or change in antlered harvest rate is not known at this time. Following the 2008-09 hunting seasons, antlered deer harvest data will provide more information upon which a better assessment can be made.

Deer Management Recommendations

Most deer hunting seasons and regulations will remain in place for the 2008-09 hunting seasons. These regulations include a 12-day concurrent antlered and antlerless firearms season for all hunters; a 7-day antlerless muzzleloader season in October; a 3-day antlerless rifle season in October for junior, senior, disabled, and military license holders; sale of unsold antlerless licenses, up to 2 per hunter, that remain after all hunters have had an opportunity to purchase one; and field possession regulations that allow a hunter to harvest another deer after tagging the first deer harvested. The most significant change occurred when the Board of Commissioners approved a 5 day antlered and 7 day concurrent firearms season in WMUs 2D, 2G, 3C, and 4B in place of the 12-day concurrent firearms season. This change will be evaluated for the next 4 years for social and biological impacts.

The Board also approved the 2007-08 antlerless deer license allocation (Table 5). Allocations were intended to hold most WMU population trends steady with 6 exceptions. Reducing deer populations in WMUs 2B, 5C, and 5D remained the objective. In WMUs 4B, 4E, and 5A, antlerless license allocations were set to facilitate a population increase based upon an evaluation of deer and forest habitat health, deer population trends, and recommendation from a Citizen's Advisory Committee (see Project Job No. 21012).

RECOMMENDATIONS

1. Increase annual WMU sample sizes of females collected for monitoring deer health.

2. Identify and develop additional analyses and measurements to improve the forest habitat health measure's ability to account for factors other than deer that affect forest regeneration and to most directly monitor deer impacts on forest regeneration.

3. Maintain deer aging sampling effort. Current numbers of deer checked in the field provide reasonably precise harvest estimates in most WMUs. Harvest estimates are least precise in smaller WMUs where it is more difficult to collect sufficient data.

4. Continue to evaluate validity of assumptions and population monitoring procedures through internal and external peer-review. Prioritize research needs based on internal and external reviews.

5. Develop a protocol for implementing distance sampling techniques to assess deer mortality due to severe winter weather or other mortality event.

6. Continue concurrent antlered and antlerless firearms seasons for all hunters. This provides more hunting opportunities to hunters and maintains consistency in hunting seasons that is important to monitoring population trends. In addition, the antlerless allocation can control the antlerless harvest without changing season length.

7. Continue antler restriction regulations to allow rigorous evaluation of their effects on the deer population and changes in hunter support over time.

8. Continue to allow hunters to purchase and use the entire antlerless allocation.

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Table 1. Number of females examined, median conception date for females with conception date data, percent of females bred between 16 October and 16 December, mean embryos per adult female (≥ 2 years of age), and adult female pregnancy rates from 2000 to 2007, Pennsylvania. NOTE: This information is provided for public information, but is not used to make deer management recommendations. WMU level data is used for management recommendations.

Year	*n*	Median conception date	Percent bred 16 October to 16 December	Mean embryos per adult female[a]	Adult female pregnancy rates (%)[a]
2000	1,075	14 November	90	1.60	93
2001	942	17 November	91	1.58	93
2002	520	14 November	86	1.63	93
2003	618	14 November	93	1.59	93
2004	601	15 November	90	1.53	91
2005	883	14 November	90	1.51	92
2006	632	11 November	89	1.54	89
2007	1,003	16 November	92	1.50	88

[a] Embryo counts and pregnancy rates adjusted to account for females that were lactating when collected in late spring. As a result of this change, these results may not agree with previous reports.

Table 2. Number of adult does examined and assessment of deer health by WMU based on samples collected from 2005 to 2007, Pennsylvania.

WMU	*n*	Embryos per adult female	Deer health assessment
1A	78	1.50	AT TARGET
1B	61	1.69	ABOVE TARGET
2A	91	1.37	AT TARGET
2B	165	1.59	AT TARGET
2C	117	1.38	AT TARGET
2D	87	1.60	AT TARGET
2E	19	1.58	AT TARGET
2F	67	1.39	AT TARGET
2G	40	1.68	AT TARGET
3A	30	1.50	AT TARGET
3B	59	1.36	AT TARGET
3C	36	1.53	AT TARGET
3D	79	1.28	BELOW TARGET
4A	99	1.52	AT TARGET
4B	50	1.50	AT TARGET
4C	47	1.36	AT TARGET
4D	65	1.55	AT TARGET
4E	35	1.66	AT TARGET
5A	22	1.64	AT TARGET
5B	56	1.55	AT TARGET
5C	123	1.60	AT TARGET
5D	42	1.71	ABOVE TARGET

Table 3. Number of plots sampled, percent with adequate regeneration, and qualitative assessment of forest habitat health by WMU. Data are based on samples collected from 2003 to 2007, Pennsylvania. Results cannot be compared to previous reports because of changes in methods.

WMU	*n*	% plots with adequate regeneration	Forest health assessment
1A	70	53	Fair
1B	85	35	Poor
2A	67	46	Fair
2B	39	59	Fair
2C	165	56	Fair
2D	98	57	Fair
2E	54	54	Fair
2F	155	34	Poor
2G	259	42	Poor
3A	62	61	Fair
3B	144	59	Fair
3C	79	53	Fair
3D	135	54	Fair
4A	83	58	Fair
4B	83	63	Good
4C	80	60	Fair
4D	98	53	Fair
4E	43	74	Good
5A	29	66	Fair
5B	40	58	Fair
5C	39	23	Poor
5D	4	No Data	--

Table 4. Number of deer checked by PGC personnel, number of report cards sent in by successful hunters, and estimated harvests for antlered and antlerless deer by WMU, Pennsylvania, 2007-08.

	Antlered			Antlerless		
WMU	**Deer checked**	**Report cards**	**Harvest[1]**	**Deer checked**	**Report cards**	**Harvest[a]**
1A	281	1,666	4,900	1,092	4,696	12,500
1B	489	1,741	6,000	1,654	3,898	11,400
2A	298	1,952	6,600	1,158	4,757	14,300
2B	133	1,435	4,400	640	4,807	15,300
2C	560	2,783	8,400	1,241	4,780	11,600
2D	447	3,032	9,100	1,430	6,829	18,100
2E	226	1,267	3,600	421	2,122	6,400
2F	469	1,703	4,800	775	2,591	7,100
2G	430	2,313	5,100	523	2,536	6,600
3A	356	1,345	3,400	829	3,064	7,800
3B	454	1,890	5,900	1,115	3,729	10,200
3C	529	1,971	5,300	836	3,252	9,600
3D	304	1,506	3,600	658	3,098	7,000
4A	235	1,517	4,500	533	2,774	6,700
4B	296	1,367	3,500	549	1,877	4,500
4C	355	2,183	4,800	854	3,936	9,400
4D	407	2,260	5,800	796	3,271	8,100
4E	192	1,562	3,300	702	3,464	8,100
5A	71	844	2,400	170	1,815	3,900
5B	388	2,641	6,000	1,107	5,400	11,100
5C	387	2,842	6,500	818	8,706	18,900
5D	31	549	1,000	161	2,656	5,200
Unk.		113	300		29	70

[a] Estimated harvests are rounded to the nearest 100 or 1,000 based on precision of harvest estimate. Unknown WMU harvests are rounded to the nearest 10 due to the small number.

Table 5. Antlerless license allocations by WMU, 2003-04 to 2008-09, Pennsylvania.

WMU	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1A	44,000	48,000	40,000	42,000	42,000	42,000
1B	37,000	33,000	27,000	30,000	30,000	30,000
2A	45,000	55,000	55,000	55,000	60,000	55,000
2B	45,000	68,000	68,000	68,000	68,000	68,000
2C	65,000	75,000	53,000	49,000	49,000	49,000
2D	58,000	58,000	56,000	56,000	56,000	56,000
2E	29,000	23,000	21,000	21,000	21,000	21,000
2F	44,000	44,000	30,000	28,000	28,000	28,000
2G	52,000	52,000	29,000	19,000	26,000	26,000
3A	28,000	32,000	27,000	29,000	29,000	26,000
3B	45,000	48,000	41,000	43,000	43,000	43,000
3C	40,000	37,000	32,000	27,000	27,000	27,000
3D	50,000	50,000	38,000	38,000	38,000	37,000
4A	37,000	43,000	35,000	29,000	29,000	29,000
4B	38,000	49,000	35,000	31,000	23,000	23,000
4C	46,000	44,000	39,000	39,000	39,000	35,000
4D	58,000	55,000	40,000	40,000	40,000	40,000
4E	38,000	38,000	38,000	38,000	38,000	30,000
5A	28,000	32,000	28,000	25,000	22,000	19,000
5B	60,000	64,000	56,000	53,000	53,000	51,000
5C	66,000	71,000	71,000	79,000	84,000	92,000
5D	20,000	20,000	20,000	20,000	20,000	22,000

Table 6. Number of antlered deer aged, age composition of harvests, and approximate number of 2.5-year-old and older males harvested in Pennsylvania, 1997-98 to 2007-08. Three and 4-point antler restrictions started in 2002-03. Percentages may not add up to 100 percent due to rounding.

Year	*n*	% 1.5-year-old males	% 2.5-year-old and older males	No. of 2.5-year-old and older males harvested
1997-98	18,563	81	19	33,600
1998-99	21,350	81	19	34,500
1999-00	20,011	80	20	38,900
2000-01	22,145	82	18	36,600
2001-02	18,893	78	22	44,700
2002-03	11,688	68	32	52,900
2003-04	11,367	56	44	62,600
2004-05	10,555	50	50	62,000
2005-06	9,062	52	48	57,800
2006-07	10,819	56	44	59,500
2007-08	8,014	56	44	48,048

Table 7. Number of antlerless deer aged and age composition of harvests in Pennsylvania, 1997-98 to 2007-08. Percentages may not add up to 100 percent due to rounding.

Year	*n*	% 0.5-year-old males	% 0.5-year-old females	% 1.5-year-old and older females
1997-98	28,743	24	20	56
1998-99	24,913	23	20	57
1999-00	18,502	24	20	56
2000-01	30,460	22	20	58
2001-02	25,450	22	18	60
2002-03	30,077	22	18	60
2003-04	28,236	21	18	61
2004-05	24,640	22	18	61
2005-06	19,459	23	19	58
2006-07	19,074	23	19	58
2007-08	17,770	24	20	56

Table 8. Change (λ[a]) in deer density by WMU, 2004 to 2007, Pennsylvania[b].

WMU	2004	2005	2006	2007
1A	0.96	1.03	1.12	0.72
1B	0.96	1.05	1.07	0.95
2A	0.97	1.01	0.93	0.91
2B	1.07	1.07	1.12	0.78
2C	0.85	0.96	1.03	1.10
2D	0.92	0.96	1.02	0.88
2E	0.83	1.14	0.88	0.91
2F	0.90	0.88	0.93	0.85
2G	0.89	0.95	1.06	0.77
3A	1.00	0.95	0.90	0.97
3B	1.00	0.94	0.96	1.09
3C	0.90	0.92	1.10	0.83
3D	0.87	0.94	0.95	0.95
4A	0.90	0.78	1.35	1.29
4B	0.89	0.83	1.24	0.80
4C	1.03	0.90	0.97	0.87
4D	0.85	0.90	1.14	0.82
4E	0.88	1.08	0.83	0.93
5A	1.00	0.81	1.07	1.06
5B	0.91	0.96	1.04	0.87
5C	0.97	1.03	0.92	0.94
5D	1.13	0.83	0.79	0.83

[a] $\lambda = 1.00$ indicates no change in deer density. Values greater than 1.00 indicate increases, less than 1.00 indicate decreases.

[b] λs from prior years may not match λs previously reported because λs are updated as new harvest and population data become available.

Appendix 1. 2008 Pennsylvania Deer Hunter Survey: Effect of epizootic hemorrhagic disease on hunter behavior in WMU 2A

INTRODUCTION AND METHODS

During the summer and fall of 2007, epizootic hemorrhagic disease, or EHD, was detected in deer in southwestern Pennsylvania. EHD is a common but sporadic viral disease of white-tailed deer, and is contracted by the bite of infected insects called "midges." In more northern states, such as Pennsylvania, EHD occurs less frequently. Therefore, effective immune responses by deer in these areas are reduced resulting in higher mortality rates than in areas where the disease occurs more commonly. Deer displaying clinical signs of EHD usually die within 5 to 10 days. EHD is not transmittable to humans. Fortunately, cold temperatures kill the insects that spread the EHD virus and the infection of new deer stops.

Wildlife Management Unit (WMU) 2A had the greatest number of reported deer deaths during the 2007 EHD outbreak. Because the Game Commission uses information from hunters to assess deer population status, we conducted this survey to learn more about the affect of this EHD outbreak on deer hunting in WMU 2A.

We selected survey participants from the 2005 and 2006 Game Take Survey. The Game Take Survey annually surveys a 2% random sample of Pennsylvania's general hunting license purchasers. The survey sample included respondents of the 2005 and 2006 Game Take Surveys who hunted deer in WMU 2A. We conducted this survey using standard mail survey protocols (Dillman 1978) including a initial mailing followed by a postcard reminder. We did not conduct a second mailing because the response rate after the first mailing and reminder exceeded 70%.

Completion of this survey involved numerous bureaus within the Pennsylvania Game Commission including; Bureau of Wildlife Management (survey design, mailing preparations, data entry and analysis), Bureau of Automated Technology Services (Game Take database services) and Bureau of Administrative Services (mailroom services).

RESULTS

Response Rates

We sent surveys to a total of 713 individual hunters. Mailings resulted in 25 non-deliverable surveys (i.e., moved with no forwarding address, death, etc.) and 488 usable responses for a response rate of 71%. We present results as a single number (e.g., 55%). These estimates have an associated 95% confidence interval of approximately ± 4%. For example, if 55% of the respondents agreed with a statement and, the survey were repeated numerous times, the interval from 51% (55-4) to 59% (55+4) would include the actual percent of hunters who agreed with the statement 95% of the time.

ALL SURVEY RESPONDENTS

The majority of survey respondents (82%) hunted deer in WMU 2A during the 2007-08 hunting seasons. For the 18% who did not hunt deer in WMU 2A in 2007-08 hunting seasons, almost a third (30%) said EHD was the reason they did not hunt in 2A. Results that follow only include those hunters who hunted deer in WMU 2A during the 2007-08 hunting seasons.

SURVEY RESPONDENTS WHO HUNTED IN WMU 2A IN 2007-08

The average deer hunter spent 8.8 days hunting in WMU 2A. For most hunters (54%) this was the same amount of time spent hunting in WMU 2A as in the 2006-07 hunting seasons. Some (13%) hunted more and a third (32%) hunted less.

Some hunters hunted less due to EHD. The presence of EHD caused 23% of hunters to hunt less and 5% hunted more. For most (72%), EHD did not affect the number of days spent deer hunting in WMU 2A.

EHD reduced the willingness of hunters to harvest an antlered deer (23% were less willing to harvest an antlered deer) and antlerless deer (34% were less willing to harvest an antlerless deer). Hunters saw fewer deer (79% saw fewer) and 16% harvested a buck and 34% who purchased antlerless licenses harvested an antlerless deer.

Most hunters purchased the same number of antlerless licenses (77%), but 15% said they purchased fewer antlerless licenses. Of those who purchased fewer antlerless licenses, 66% purchased fewer antlerless licenses because of EHD. For

the 2007-08 deer seasons, the WMU 2A antlerless allocation increased to 60,000 from 55,000 the previous year. Of the 60,000 available, 56,550 were purchased.

EHD had little effect on where hunters hunted. Only 8% of hunters said EHD caused them to hunt in a different area.

CONCLUSION

Hunters harvested 17% fewer deer in WMU 2A during the 2007-08 hunting seasons compared to the 2006-07 hunting seasons. Unfortunately, identifying a single reason for this decline is impossible.

First, the presence of EHD in WMU 2A clearly affected some hunters' behavior and willingness to harvest deer. From 23% to 34% of hunters were less willing to harvest a deer because of EHD. In addition, 23% of hunters said they spent less time hunting because of EHD. Less willingness of hunters to harvest deer combined with less time spent hunting could explain some of the decline in deer harvest.

Second, deer harvests on the opening day of the 2007-08 firearms season dropped significantly from 2006-07. In WMU 2A, approximately 55% fewer antlered deer were harvested on the opening day as compared to 2006-07. For antlerless deer, approximately 45% fewer antlerless deer were harvested on the opening day as compared to 2006-07. For both antlered and antlerless deer, the remainder of the season could not make up for these differences. As a result, poor firearm season opening day harvests could explain some of the decline in deer harvest.

Finally, EHD created an unusual mortality event. Reports of dead deer in this WMU started in the summer and continued through the fall. Because of rapid decomposition and other practical and resource limitations, attempts to estimate the number of dead deer in the WMU were impossible. However, increased mortality from EHD and the resulting smaller deer population could explain some of the decline in deer harvest.

All three factors – changes in hunter behavior, lower opening day harvests, and smaller deer populations – could have contributed to lower deer harvests in WMU 2A. As managers, our primary concern is whether a smaller deer population

caused the reduced harvest. Unfortunately, the effect of a smaller deer population cannot be singled out because of the other confounding factors. Consequently, the recommendation for the 2008-09 antlerless allocation was to return to the previous level of 55,000 antlerless licenses. By returning to the same level of hunter effort – and barring another highly unusual year for EHD or opening day harvests – a clearer picture of deer population trend may be seen following the 2008-09 hunting season.

Although this survey did not provide a single explanation to the status of the deer population in WMU 2A, it did provide important information. Knowing EHD affected hunter behavior and willingness to harvest deer prevented false interpretations of deer harvest declines. In addition, this knowledge can be referenced in the future when similar situations present themselves.

LITERATURE CITED

Dillman, D. A. 1978. Mail and telephone surveys: the total design method. John Wiley & Sons, New York, New York, USA.

Appendix. 2008 Pennsylvania Deer Hunter Survey: How did epizootic hemorrhagic disease affect deer hunting in Wildlife Management Unit 2A? – Summary Results

***** PERCENTAGES MAY NOT ADD UP TO 100% DUE TO ROUNDING AND NO RESPONSES*****

Response Rate Information:

$$\frac{\text{488 Surveys Returned}}{\text{713 Surveys Mailed} - \text{25 Nondeliverable Surveys}} = 71\% \text{ Response Rate}$$

1) Did you hunt deer in Wildlife Management Unit 2A* (WMU 2A) during the 2007-08 hunting seasons? (**Circle one number**)

82% YES If YES, go to **QUESTION 3**
18% NO If NO, go to **QUESTION 2**

2) Was the disease EHD the reason you did not hunt in WMU 2A during the 2007-08 hunting seasons?

30% YES Please go to end of survey and follow instructions for returning the survey
70% NO Please go to end of survey and follow instructions for returning the survey

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The remaining results only apply to hunters who hunted deer in WMU 2A during the 2007-08 hunting seasons

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3) How many days did you hunt deer in the WMU 2A? Average = **8.8 days**

4) Did you hunt deer for more, fewer, or about the same number days in WMU 2A during 2007-08 than in 2006-07 hunting seasons? (**Circle one number**)

32% I HUNTED FEWER DAYS
13% I HUNTED MORE DAYS
54% I HUNTED ABOUT THE SAME NUMBER OF DAYS

5) How did the presence of the disease EHD affect the number of days you hunted deer in 2007-08 compared to 2006-07? (**Circle one number**)

23% I HUNTED FEWER DAYS BECAUSE OF EHD
5% I HUNTED MORE DAYS BECAUSE OF EHD
72% EHD DID NOT AFFECT THE NUMBER OF DAYS I HUNTED DEER

6) Did you see more, fewer, or the same number of deer in WMU 2A in 2007-08 than in 2006-07? (**Circle one number**)

3% I SAW MORE DEER
79% I SAW FEWER DEER
18% I SAW ABOUT THE SAME NUMBER OF DEER

7) Did you harvest an antlered deer in WMU 2A? (**Circle one number**)

16% YES
84% NO

8) How did the presence of the disease EHD affect your willingness to harvest an antlered deer? (**Circle one number**)

23% EHD REDUCED MY WILLINGNESS TO HARVEST AN ANTLERED DEER
1% EHD INCREASED MY WILLINGNESS TO HARVEST AN ANTLERED DEER
76% EHD DID NOT AFFECT MY WILLINGNESS TO HARVEST AN ANTLERED DEER

9) How many antlerless deer did you harvest in the WMU 2A?

For those who purchased at least 1 antlerless license:

66% HARVESTED 0 ANTLERLESS DEER
23% HARVESTED 1 ANTLERLESS DEER
9% HARVESTED 2 ANTLERLESS DEER
2% HARVESTED 3 OR MORE ANTLERLESS DEER

10) How did the presence of the disease EHD affect your willingness to harvest an antlerless deer? (**Circle one number**)

34% EHD REDUCED MY WILLINGNESS TO HARVEST ANTLERLESS DEER
2% EHD INCREASED MY WILLINGNESS TO HARVEST ANTLERLESS DEER
63% EHD DID NOT AFFECT MY WILLINGNESS TO HARVEST ANTLERLESS DEER

11) How many antlerless licenses did you purchase for WMU 2A?

20% PURCHASED 0 ANTLERLESS LICENSES
39% PURCHASED 1 ANTLERLESS LICENSE
32% PURCHASED 2 ANTLERLESS LICENSES
9% PURCHASED 3 ANTLERLESS LICENSES
1% PURCHASED 4 ANTLERLESS LICENSES

12) Did you purchase more, fewer, or the same number of antlerless licenses for WMU 2A in 2007-08 as you did in 2006-07 hunting seasons? (**Circle one number**)

6% I PURCHASED MORE
15% I PURCHASED FEWER
77% I PURCHASED THE SAME NUMBER

13) How did the presence of the disease EHD affect the number of antlerless licenses you purchased? (**Circle one number**)

12% BECAUSE OF EHD, I PURCHASED FEWER ANTLERLESS LICENSES
1% BECAUSE OF EHD, I PURCHASED MORE ANTLERLESS LICENSES
84% EHD DID NOT AFFECT THE NUMBER OF ANTLERLESS LICENSES I PURCHASED

14) Did you hunt in the same area in WMU 2A in 2007-08 as you did in 2006-07? (**Circle one number**)

78% YES, I HUNTED THE SAME AREA
5% NO, I HUNTED A DIFFERENT AREA
17% I HUNTED IN THE SAME AREA AND IN A DIFFERENT AREA

15) How did the presence of the disease EHD affect your choice of hunting area in 2007-08? (**Circle one number**)

8% BECAUSE OF EHD, I HUNTED IN A DIFFERENT AREA IN 2007-08 THAN IN 2006-07
81% I HUNTED IN THE SAME AREA IN 2007-08 AS I DID IN 2006-07
8% I HUNTED IN A DIFFERENT AREA, BUT NOT BECAUSE OF EHD