MANAGEMENT AND BIOLOGY OF WHITE-TAILED DEER IN PENNSYLVANIA 2009-2018

PGC Photo – Joe Kosack

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EXECUTIVE SUMMARY

The white-tailed deer (*Odocoileus virginianus*) is recognized as Pennsylvania's state animal. Balancing white-tailed deer impacts is the fundamental issue affecting a majority of Pennsylvania's deer management decisions. The Pennsylvania Game Commission's purpose is to manage deer to the best of its ability for deer and those people who seek them, unintentionally interact with them, or experience damage from them.

The Pennsylvania Game Commission is legally mandated to manage wildlife, including deer, for the benefit of all Pennsylvanians, as well as all wildlife and the habitat that supports their existence. Pennsylvania's Constitution and Game and Wildlife Code direct the Game Commission to protect, manage, and preserve wildlife and their habitat within the Commonwealth for the benefit of all people, including generations yet to come. Based on this direction, the Game Commission adopted the mission statement "to manage all wild birds, wild mammals, and their habitats for current and future generations."

Although the Game Commission's mission provides general guidance, specific goals must be written for each program area. For the deer management program, management goals from 2009 to 2018 are to: (1) manage deer for a healthy and sustainable deer herd; (2) manage deer-human conflicts at levels considered safe and acceptable to Pennsylvanians; (3) manage deer impacts for healthy and sustainable forest habitat; (4) manage deer to provide recreational opportunities; and (5) improve the public's knowledge and understanding of deer and the deer management program. Game Commission staff uses these guidelines when making deer management recommendations to the Board of Game Commissioners.

These goals are the result of a public involvement process. During development of the Game Commission's 2003-2007 deer management plan, the agency invited individuals representing the interests of sportsmen, agriculture, forestry, environmental conservation, urban-suburban municipalities, the legislature, and the Game Commission to identify deer management goals. The group unanimously agreed to 6 goals, which were later consolidated into the first 3 goals listed above. Goals (4) and (5) were added to the 2009-2018 deer management plan to recognize the importance of recreation and outreach to a successful deer management program. These goals were presented at 7 public open houses during fall 2007. Results from the open houses indicated strong public support for each of the 5 goals.

The mission and deer management goals are important forms of public input, and in most cases, will outweigh other forms of public input. However, the mission and goals cannot always provide the necessary information for specific issues. As a result, the Game Commission also uses other methods of public involvement in its deer management program such as public meetings, surveys, and Citizen Advisory Committees.

The Game Commission follows an adaptive management approach to deer management. Adaptive management is characterized by establishing clear and measurable objectives, implementing management actions, monitoring those management actions and whether they achieved the objectives, and adapting policy and management actions as necessary. Adaptive

management recognizes deer management decisions must be made without the luxury of perfect information. Consequently, the focus of adaptive management is on monitoring responses to management actions and learning. By managing white-tailed deer in this way, the Game Commission can effectively adapt management as conditions change.

Deer population management integrates data-driven objectives for deer and forest habitat health with value-driven objectives for deer-human conflicts. First and foremost, the Game Commission must achieve its duties and responsibilities to wildlife and habitat. Deer and forest habitat health measures meet this need. However, objectively defining deer-human conflicts is impossible because of the range of values and perceptions exhibited by people. Rather than attempt to quantify deer-human conflicts, the Game Commission uses Citizen Advisory Committees to help assess deer-human conflicts.

Deer management objectives are no longer defined by deer densities. Instead, deer management objectives are defined by measures of deer health, forest habitat health, and deer-human conflicts. The change from defining deer management objectives by deer densities to specific measures for each goal has ensured the controversy that has accompanied deer management endeavors in this state and countless others for decades remains. Although the Game Commission acknowledges the desire of hunters and the public to know how many deer are in Pennsylvania at any given time, the Game Commission has a duty to implement a responsible and credible deer management program that addresses deer management goals through the most efficient use of available data.

Responsible deer management cannot be a popularity contest. As Pennsylvania's history demonstrates, deer management was, is, and will continue to be an issue where complete agreement by all stakeholders is unlikely. To accomplish the goals provided by the public, the Game Commission's deer management program must be based on the best available information and made in the best interest of white-tailed deer, Pennsylvania's wildlife and natural resources, and all citizens for today and tomorrow. Balancing the science and biology of deer management with the values of citizens will continue to be the greatest challenge for the Game Commission's deer program.

GOALS, OBJECTIVES, & STRATEGIES

GOAL 1. MANAGE DEER FOR A HEALTHY AND SUSTAINABLE DEER HERD

Objective 1.1. Maintain reproduction at or above 1.50 embryos per adult doe

Strategies

1.1.1. Annually collect reproductive data from road-killed deer
1.1.2. Maintain sample sizes of road-killed deer collected to ensure good precision (Coefficient of Variation (CV) ~ 13%) of embryo per adult doe estimates for a 3-year sample
1.1.3. Increase sample sizes to permit annual estimation of embryos per adult doe with good precision (CV ~ 13%) by 2011

Objective 1.2. Monitor deer population trends

Strategies

1.2.1 Annually collect sex, age, and harvest information from field-checked deer with trained personnel
1.2.2 Maintain 95% efficiency rating for trained deer aging personnel by providing annual training for new personnel and evaluating all deer aging personnel every 3 years
1.2.3 Annually collect deer harvest information via report cards and other methods
1.2.4 Annually estimate antlered and antlerless harvest with sufficient precision (CV • 13%) by WMU
1.2.5 Annually estimate antlerless hunter success by WMU
1.2.6 Annually calculate deer population indices by WMU
1.2.7 Propose seasons, bag limits, and antlerless license allocations by April of each year that affect deer populations to maintain, and, where appropriate, promote improvement in deer reproduction, forest health, and deer-human conflicts
1.2.8 Complete current field studies to evaluate current and potential population monitoring techniques by 2013
1.2.9 Conduct review of scientific literature and other state deer programs to identify new deer population monitoring techniques by 2018
1.2.10 Conduct research to test and evaluate potential population monitoring techniques as needed

Objective 1.3. Identify and implement additional measures of deer health as needed to improve effectiveness of deer management program

Strategies

1.3.1. Evaluate practicality and utility of collecting antler beam diameter data from road-killed deer by 2011
1.3.2. Conduct review of scientific literature and other state deer programs to identify potential deer health measures by 2014 and every 5 years thereafter
1.3.3. Conduct research to test and evaluate potential deer health measures as needed

Objective 1.4. Monitor disease risks that could affect wild and captive deer populations

Strategies

1.4.1. Annually collect samples from deer for Chronic Wasting Disease testing
1.4.2. Monitor, as needed, other disease risks in white-tailed deer

Objective 1.5. Reduce disease risk factors to free-ranging wild deer population and increase public knowledge and compliance with the elimination of these risk factors

Strategies

1.5.1. Collect and test deer exhibiting visible symptoms of illness, as needed
1.5.2. Collect and test captive deer escapees for diseases, as needed
1.5.3. In cooperation with the Pennsylvania Department of Agriculture, strengthen regulations to minimize risk to wild deer from captive cervid operators through 2018
1.5.4. In cooperation with the Pennsylvania Department of Agriculture, encourage compliance with cervid herd monitoring programs through 2018
1.5.5. Review and update information and education materials explaining feeding impacts on deer, wildlife, and people by 2012 and every 3 years thereafter
1.5.6. Implement educational program to discourage activities that facilitate transmission of disease, as needed

Objective 1.6. Increase citizens' awareness and understanding of deer-related diseases

Strategies

1.6.1. Annually review and update information and educational materials explaining Chronic Wasting Disease and post on website

1.6.2. Review and update information and educational materials explaining Lyme disease and the limited role of deer populations in the disease's occurrence by 2010 and every 3 years thereafter and post on website

1.6.3. Review and update information and educational materials explaining Epizootic Hemorrhagic Disease by 2011 and every 3 years thereafter and post on website

1.6.4. Develop information and educational materials on other important diseases affecting deer and people, as needed, and post on website

GOAL 2. MANAGE DEER-HUMAN CONFLICTS AT SAFE AND ACCEPTABLE LEVELS

Objective 2.1. Maintain deer-human conflicts at levels where the Citizen Advisory Committees recommend deer populations remain the same or increase

Strategy

2.1.1. Annually conduct 3 to 5 Citizen Advisory Committees according to established schedules and protocols so that each WMU is visited every 5 years
2.1.2. Annually review Citizen Advisory Committee process and recommend changes
2.1.3. Review Citizen Advisory Committees as a means of gathering public input and recommend changes, as needed, by 2011
2.1.4. Review scientific literature and other state deer programs to identify potential deer-human conflict measures by 2011 and every 5 years thereafter
2.1.5. Conduct research to test and evaluate potential deer-human conflict measures as needed
2.1.6. Develop a statewide Wildlife Complaint Database by 2013

Objective 2.2. Provide opportunities for landowners to achieve their deer management objectives

Strategies

2.2.1. Continue the Deer Management Assistance Program (DMAP) through 2018
2.2.2. Continue the Agricultural Deer Depredation Permit program (Red Tag) through 2018
2.2.3. Work with public land DMAP participants (i.e., State Forest, State Parks, National Forest, and Army Corps of Engineers) to standardize deer management assessment protocols and DMAP protocols
2.2.4. Hold annual meetings with public agencies to increase communication and understanding of deer management and how it affects their management activities.
2.2.5. Conduct survey of participating landowners to assess effectiveness and administration of DMAP by 2014
2.2.6. Conduct survey of participating landowners to assess effectiveness and administration of Red Tag by 2016
2.2.7. Modify the Deer Management Assistance and Agricultural Deer Depredation Permit programs as needed to improve their effectiveness

Objective 2.3. Improve the effectiveness of hunting in developed areas

Strategies

- *2.3.1. Classify WMUs as "developed" based on level of development and/or rate of development by 2014 and review and update every 5 years thereafter*
- *2.3.2. Maintain special antlerless-only seasons in developed WMUs through 2018*
- *2.3.3. Maintain an archery safety zone of 50 yards through 2018*
- *2.3.4. Allow use of crossbows during all archery seasons in developed WMUs through 2018*
- *2.3.5. Annually recommend WMU antlerless allocations to ensure adequate antlerless hunting opportunities in developed WMUs*
- *2.3.6. Publish a guide, "Planning and Implementing a Controlled Deer Hunt" by 2011*
- *2.3.7. Support and encourage expansion of Hunters Sharing the Harvest program*
- *2.3.8. Evaluate baiting regulation in WMUs 5C and 5D using hunter surveys, deer harvests, and field study and make recommendation to continue or discontinue by 2009*
- *2.3.9. Conduct research to determine deer movement patterns in response to hunting activity in developed areas by 2015*
- *2.3.10. Conduct hunter survey and harvest data analysis to evaluate impact of crossbows during archery seasons and antlerless-only seasons in developed WMUs by 2016*
- *2.3.11. Conduct survey of developed area landowners to evaluate effectiveness of hunting to reduce deer-human conflicts by 2018*
- *2.3.12. Conduct research to test and evaluate potential hunting-related deer management tools as needed*

Objective 2.4. In addition to hunting, provide options to reduce deer impacts on landowners and communities

Strategies

- *2.4.1. Discourage deer feeding and support local ordinances that prohibit deer feeding in developed areas through 2018*
- *2.4.2. Annually provide permits on a request basis to communities to lethally remove deer in accordance with Deer Control Permits*
- *2.4.3. Develop a written policy on deer fertility control agents by 2009, then review and update the policy as needed*
- *2.4.4. Review and revise regulations regarding Deer Control Permits*
- *2.4.5. Investigate potential deer management tools via review of scientific literature and field study by 2012*
- *2.4.6. Develop a standard operating procedure for issuing permits in accordance with Deer Control Permits by 2012*
- *2.4.7. Identify approved, management options that reduce deer impacts by 2014*

2.4.8. Develop regulations to permit use of approved management options on developed properties in all WMUs by 2015
2.4.9. Develop an Urban Deer Control Program to allow the taking of deer outside regular hunting seasons in developed areas by 2015
2.4.10. Conduct survey of landowners in developed areas to evaluate effectiveness of options to reduce deer-human conflicts in developed areas by 2018
2.4.11. Conduct research to test and evaluate current and potential management tools as needed

Objective 2.5. Inform political and community leaders, residents, and hunters about deer management options and opportunities in developed areas

Strategies

2.5.1. Conduct survey to identify educational needs of communities, community leaders, landowners, and hunters in developed areas by 2010
2.5.2. Develop an urban deer webpage as part of a PGC urban wildlife webpage by 2010
2.5.3. Create a module on deer biology and management options in developed areas to be part of a "Living with Wildlife" workshop series by 2011
2.5.4. Develop displays with information and educational materials for shows and fairs by 2011 and update as needed
2.5.5. Train PGC staff and/or community leaders to conduct the deer module of the "Living with Wildlife" workshop series by 2012
2.5.6. Review and update guidelines for writing a community deer management plan by 2013 and every 5 years thereafter
2.5.7. Develop recommendations for using approved management options and publish management options guide by 2014
2.5.8. Develop an urban deer hunting guide to encourage and inform hunters of deer hunting opportunities in urban areas by 2014
2.5.9. Conduct seminars/workshops for leaders (county commissioners, township supervisors, borough and town managers, police departments, mayors, conservation organizations) in developed areas informing them about deer management options and opportunities as requested

Objective 2.6. Encourage positive relationships between hunters and communities in developed areas

Strategies

2.6.1. Identify characteristics that landowners and communities consider when determining qualifications needed for hunters to hunt in their community by 2010
2.6.2. Create a landowner/hunter database template to be used by communities and municipalities. Provide supporting documentation explaining how

GOAL 3. MANAGE DEER FOR HEALTHY AND SUSTAINABLE FOREST HABITAT

Objective 3.1. Maintain deer impacts on forested areas at levels that support sustainable forest habitats

Strategies

- *3.1.1 Annually request advance tree-seedling and sapling regeneration (ATSSR) data from the USDA Forest Service, Northeastern Forest Inventory and Analysis Unit to monitor forest habitat health for each WMU*
- *3.1.2 Secure funding to increase data collection if ATSSR data do not provide good precision (CV ~ 13%) of regeneration estimates based on the 5-year sampling period, as needed*
- *3.1.3 Adapt sampling protocols based on data trends and information gaps, as needed*
- *3.1.4 Conduct research to evaluate additional forest health and deer impact measures as needed by 2015*
- *3.1.5 Conduct evaluation of the first 10 years of forest habitat health and deer impact data in relation to deer population management by 2017*
- *3.1.6 Promote habitat manipulations that improve the sustainable threshold of forested habitats by 2013*

Objective 3.2. Identify, evaluate, and implement measures of deer impacts on forest habitat, as needed, to improve effectiveness of deer management program

Strategies

- *3.2.1. Conduct review of scientific literature and other state deer programs to identify potential forest health and deer impact measures by 2014 and every 5 years thereafter*
- *3.2.2. Conduct research to investigate roles of habitat availability and interspersion on deer-forest interactions by 2016*
- *3.2.3. Conduct research to evaluate effectiveness of DMAP as an alternative to deer deterrent fencing by 2018*
- *3.2.4. Incorporate research results into deer management recommendations and programs where needed*

Objective 3.3. Promote habitat management that is compatible with needs of deer, diverse native wildlife species, and citizens

Strategies

- *3.3.1. Develop educational materials that encourage manipulation of natural vegetation (e.g., burning, disking, timber management) by 2011*

3.3.2. Identify, test, and demonstrate sustainable, cost-effective deer habitat management techniques by 2015
3.3.3. Provide public land managers with information to manage deer and their habitats by 2017
3.3.4. Incorporate and support use of prescribed fire to manage habitat on public and private lands by 2018

Objective 3.4. Increase public's understanding of the role of deer and other factors on forested habitats

Strategies

3.4.1. Develop educational materials explaining deer-forest relationships by 2011
3.4.2. Develop website with links to PGC Habitat Management Manual by 2013
3.4.3. Develop handouts using photo points from FIA by 2015

GOAL 4. MANAGE DEER TO PROVIDE RECREATIONAL OPPORTUNITIES

Objective 4.1. Provide annual deer hunting opportunities

Strategies

4.1.1. Annually provide a concurrent firearms season for antlered and antlerless deer following Thanksgiving
4.1.2. Annually provide fall and post-Christmas archery seasons
4.1.3. Annually provide a fall muzzleloader season for antlerless deer
4.1.4. Annually provide a fall rifle season for antlerless deer for junior, senior, disabled permit holders, and active military license holders
4.1.5. Annually provide a post-Christmas flintlock-only season
4.1.6. Annually allocate antlerless licenses based on deer management objectives in each WMU
4.1.7. Support legislation to allow Mentored Youth to take antlerless deer with a mentor's antlerless license or DMAP permit

Objective 4.2. Establish deer hunting seasons to achieve WMU deer management objectives

Strategies

4.2.1. Annually propose seasons and bag limits to achieve deer management objectives
4.2.2. Annually evaluate ability of hunting seasons and opportunities to achieve deer management objectives
4.2.3. Evaluate hunting season and opportunity needs of deer hunters by 2010 and every 3 years thereafter
4.2.4. Evaluate the effect of the October firearms seasons on antlered and antlerless deer movements by 2010
4.2.5. Evaluate traveling behavior of deer hunters beyond their local county or WMU by 2012

Objective 4.3. Use antler restrictions to increase adult male harvest

Strategies

4.3.1. Annually monitor age structure of the antlered harvest
4.3.2. Annually monitor antlered deer hunter success rates
4.3.3. Complete publication on biological and social effects of antler restrictions by 2009
4.3.4. Monitor deer hunter satisfaction with antler restrictions by 2010 and every 3 years thereafter

4.3.5. Adjust antler restrictions as needed to meet biological (e.g., protection of at least 50% of yearling males), deer management, and hunter satisfaction (e.g., majority support) objectives

Objective 4.4. Provide alternative deer hunting opportunities on State Game Lands, where appropriate

Strategies

4.4.1. Determine hunter interest in alternative deer hunting opportunities on State Game Lands by 2010
4.4.2. Evaluate deer response to hunting pressure on State Game Lands by 2011
4.4.3. Identify alternative deer hunting opportunities and specific management objectives on State Game Lands by 2011
4.4.4. Conduct feasibility analysis of alternative deer hunting opportunities on State Game Lands to meet deer, habitat, and hunting objectives by 2012
4.4.5. Recommend alternative deer hunting opportunities on State Game Lands that meet deer, habitat, and hunting objectives by 2013

Objective 4.5. Increase awareness and promote other recreational opportunities besides hunting

Strategies

4.5.1. Continue to discourage deer-related recreational activities that create potential for deer-human conflicts, such as deer feeding
4.5.2. Conduct a statewide survey of Pennsylvania residents to identify wildlife-related recreational activities and interests by 2011
4.5.3. Develop quantifiable objectives for deer-related recreational activities other than hunting by 2014
4.5.4. Inform public about deer-related recreational opportunities by 2016

GOAL 5. IMPROVE PUBLIC'S KNOWLEDGE AND UNDERSTANDING OF DEER AND THE DEER MANAGEMENT PROGRAM

Objective 5.1. Solicit public input and suggestions regarding deer program

Strategies

5.1.1. Conduct an ongoing public request for input from interested groups and individuals for suggestions regarding changes to deer management practices by 2011
5.1.2. Investigate each suggested deer management practice, complete a review document, and make available to the public within 1 year of submission
5.1.3. Establish statewide stakeholder committee to provide communication and discussion on the deer management program by 2010. The committee would meet at least once annually to discuss management plan implementation and other topics as needed

Objective 5.2. Assess public knowledge and needs regarding deer and deer management

Strategies

5.2.1. Annually track letters and complaints to identify issues of importance
5.2.2. Use pop-up surveys on the website to assess what information users are seeking and if their informational needs are met by 2010
5.2.3. Conduct surveys of deer hunters' opinions, knowledge, and understanding of deer and deer management by 2010 and every 3 years thereafter
5.2.4. Conduct surveys of general public's opinion, knowledge, and understanding of deer and deer management by 2012 and every 5 years thereafter
5.2.5. Use limited-term, issue-specific focus groups to assess public knowledge, needs, and support of deer management issues as needed

Objective 5.3. Provide information and educational materials regarding deer biology, management, recreational opportunities, and the impacts deer have on landscapes and people to interested individuals and groups

Strategies

5.3.1. Publish an article as part of the series, "Life and Times of the Whitetail" in Game News each month
5.3.2. Annually distribute the "Deer Chronicle" each summer and fall
5.3.3. Periodically conduct a public open house in each PGC region between January and April Commission meetings varying locations each year
5.3.4. Annually publish a special feature press release per field research project
5.3.5. Bi-annually conduct a deer-habitat tour in each region

5.3.6. Organize deer management web pages to make them user-friendly by 2009
5.3.7. Annually maintain a webpage titled, "Ask a deer biologist" for discussion of public questions and concerns
5.3.8. Develop web-based informational and instructional presentations by 2011 and annually thereafter
5.3.9. Create visual tools for public to recognize differences in habitat quality by 2011
5.3.10. Develop multi-media presentations on deer and deer management as needed
5.3.11. Collaborate with broadcast media to feature aspects of deer program as needed
5.3.12. Develop materials for use in school programs as needed
5.3.13. Present deer and deer management programs to the public as requested and practical

Objective 5.4. Assess Game Commission employee knowledge and provide information to assist them in achieving Objective 5.2

Strategies

5.4.1. Continue the PGC Deer Communications Working Group through 2018
5.4.2. Annually, conduct at least one informational and instructional meeting for all Game Commission employees
5.4.3. Bi-annually conduct employee surveys to assess understanding of deer and deer management program and to collect input on outreach needs

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ACKNOWLEDGEMENTS

The current deer program is not a new or unique program. It is a compilation of knowledge gained over decades by biologists, foresters, and other natural resources professionals. The work and words of wisdom from earlier wildlife professionals are referenced throughout this plan. In some cases, the content of the current plan is based in large part on earlier Game Commission publications. Despite being decades old, these works remain relevant today.

Many people including employees of the Pennsylvania Game Commission, Cooperative Fish and Wildlife Research Unit staff at Pennsylvania State University, undergraduate and graduate students and volunteers helped to collect the data and information presented in this document. All data contained herein are subject to revision from corrections, improved analyses, and/or regrouping of data.

INTRODUCTION

"The White-tailed deer is today Pennsylvania's most striking game animal. At the same time, it is also the Commonwealth's most complicated game problem"

Pennsylvania Game News, Editorial, October 1947

White-tailed deer (*Odocoileus virginianus*) are one of the most important big game species in the United States. Deer affect people in countless ways, both positive and negative. Balancing white-tailed deer impacts is the fundamental issue affecting a majority of Pennsylvania's deer management decisions. The Game Commission's purpose is to do what's best for deer, habitat, and Pennsylvanians who seek them, interact with them, or suffer damage from them. These important considerations illustrate the need for a comprehensive deer management plan.

A deer management plan organizes management, research, and outreach efforts toward specific goals and objectives. It also facilitates agency accountability by providing details and implementation schedules to the public. Program success can be measured through plan implementation.

REGULATORY AUTHORITY AND RESPONSIBILITIES

The Pennsylvania Constitution states, "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people" (Pennsylvania Constitution, Article 1, Section 27). Pennsylvania's Game and Wildlife Code directs the Game Commission to protect, manage, and preserve wildlife and their habitat within the Commonwealth (Title 34, Sections 322 and 2102). The Pennsylvania Game Commission is legally mandated to manage wildlife, including deer, for the benefit of all Pennsylvanians, as well as all wildlife and the habitat that supports their existence.

Based on direction from the state Constitution and Game and Wildlife Code, the Game Commission adopted the mission statement "to manage all wild birds, mammals, and their habitats for current and future generations." Additionally, the Code guides the agency to use hunting and trapping to manage wildlife populations and to preserve and promote our special heritage of hunting and furtaking by providing adequate opportunity to hunt and trap the wildlife resources of this Commonwealth (Title 34, Sections 103 and 322).

MANAGEMENT PHILOSOPHY

Managing white-tailed deer falls under the jurisdiction of the Game Commission as provided by Pennsylvania's Constitution and Game and Wildlife Code. White-tailed deer are the state animal and a valued part of Pennsylvania's wildlife community that can impact other species, their habitat, and people. The Game Commission must manage deer and deer impacts for all

stakeholders. Management decisions cannot focus solely on building a bigger deer herd, setting a deer harvest record each year, or interests of a specific stakeholder group.

Future implications of management action must always be considered. Deer management decisions cannot be made to simply satisfy today's desires or to increase deer numbers for the next hunting season without regard to future impacts on wildlife and habitat resources. Managing white-tailed deer is an integral part of achieving the Game Commission's mission of safeguarding wildlife resources and habitats for present and future Pennsylvanians.

The Game Commission follows an adaptive management approach to deer management. Adaptive management is characterized by establishing clear and measurable objectives, implementing management actions, monitoring those management actions and whether they achieved the objectives, and adapting policy and management actions as necessary. Adaptive management recognizes deer management decisions must be made without the luxury of perfect information. We cannot accurately predict months or years in advance what the deer population will be, what people will want, or what habitat will look like. Consequently, the focus of adaptive management is on monitoring responses to management actions and learning. By managing white-tailed deer in this way, the Game Commission can effectively adapt its management program as conditions change.

ORIGIN OF DEER MANAGEMENT GOALS

Deer management goals from 2009 to 2018 are to (1) manage deer for a healthy and sustainable deer herd, (2) manage deer-human conflicts at levels considered safe and acceptable to Pennsylvania citizens, (3) manage deer impacts for healthy and sustainable forest habitat, (4) manage deer to provides recreational opportunities, and (5) improve the public's knowledge and understanding of deer and the deer management program. Game Commission staff uses these guidelines when making recommendations about deer management in Pennsylvania.

These goals are the result of a public involvement process. During development of the Game Commission's 2003-2007 deer management plan, the agency engaged stakeholders to gather input on management goals. A "stakeholder" is any person who has an interest in or is impacted by an issue. As noted, deer affect everyone in Pennsylvania from hunters to citizens who try to grow crops or gardens to those who drive on Pennsylvania's highways. Individuals representing the interests of sportsmen, agriculture, forestry, environmental conservation, urban-suburban municipalities, the legislature, and the Game Commission participated.

This group gathered in July 2002 (Appendix 3) and was presented with the history of deer management in Pennsylvania and the associated issues and controversies. The group was asked to identify the primary characteristics of an "award-winning" deer management plan. The group unanimously agreed to 6 goals, which were later consolidated into the first 3 goals listed above.

Goals (4) and (5) are added to the 2009-2018 deer management plan to recognize the importance of recreation and outreach to a successful deer management program. Each of these goals was originally identified by the stakeholders in 2002 and was subsequently presented at 7 public open

houses during the fall of 2007. Results from open houses indicate strong public support for each of the 5 goals (Appendix 4).

STATUS & ACCOMPLISHMENTS OF 2003-2007 DEER MANAGEMENT PLAN

The 2003-2007 deer management plan represented the first comprehensive effort by the Game Commission to identify deer management goals, objectives, and strategies. The following table provides a summary of the progress made in achieving the goals, objectives, and strategies of the 2003-07 deer management plan.

GOAL: MANAGE DEER FOR A HEALTH DEER HERD

Objective 1.1. Identify a suite of population condition indices that will evaluate the health of deer populations and monitor trends in indices in each Wildlife Management Unit through 2007.

Strategy	Status	Comments
1. Develop by April 2003 a deer population model to estimate abundance, monitor trends, and describe future trends in abundance, and calculate antlerless allocations.	Completed April 2006	Use of an initial population model from 2003 was discontinued in 2005. A new approach was formulated and implemented for April 2006.
2. Annually estimate abundance, track population trends, and calculate antlerless allocations by April through 2007.	Ongoing	Using 3 indices, population trends are assessed each year in time for April Commission meeting.
3. Annually collect data to assess health of herd in each WMU through 2007.	Ongoing	Completed each year in time for April Commission meeting.
4. Develop protocol and collect additional data on condition indicators for potential indicators by October 1, 2004.	Ongoing	Additional data are not collected, but proposals have been developed for consideration.
5. Annually propose seasons, bag limits, and antlerless license allocations that improve trends in indicators identified above.	Ongoing	Completed each year in time for April Commission meeting.

Objective 1.2. Implement management programs to control disease risks and surveillance programs to detect diseases that potentially could threaten the health of statewide deer populations, humans, or livestock in Pennsylvania and implement strategies to minimize disease transmission by 2004.

Strategy	Status	Comments
1. Develop technical capability and protocol to respond to deer exhibiting clinical signs of disease by December 2003.	Completed April 2006	Hiring of wildlife veterinarian and completion of Standard Operating Procedure 40.4
2. Conduct annual random and targeted surveillance programs for diseases that affect white-tailed deer when appropriate.	Ongoing	More than 200 hunter-killed elk and more than 18,000 hunter-killed deer have been submitted for CWD testing.
3. Develop and implement a program in concert with other regulatory authorities (e.g., the Pennsylvania Department of Agriculture [PDA]) to regulate the importation and release of captive cervids in Pennsylvania by December 2003.	Ongoing	Various CWD-related activities continue such as developing a CWD response plan (September 2005), enforcing a parts importation ban (December 2005), and other collaborative activities with PDA
4. Develop and implement an educational program that discourages recreational and supplemental feeding of deer by July 1, 2004.	Ongoing	"Please don't feed the deer" brochure was completed in May 2007 and public programs are given as requested

GOAL: REDUCE DEER-HUMAN CONFLICTS

OBJECTIVE 2.1. Develop seasons, bag limits, and hunting methods that enable landowners to achieve their deer management and/or land-use objectives through 2007.

Strategy	Status	Comments
1. By April 2004, revise Deer Management Assistance Program (DMAP) to allow all landowners to achieve their land-use objectives.	Completed April 2004	
2. By December 31, 2005, evaluate the effectiveness of "red tag" program and modify the program to maximize its effectiveness in reducing economic losses to tolerable levels for agriculturalists.	Not Completed	Modifications to "red tag" did occur in 2006 that eliminated requirement to be enrolled in public access programs for farmers in WMUs 5C and 5D.

OBJECTIVE 2.2. Provide technical assistance for administering deer management programs to interested landowners by 2003.

Strategy	Status	Comments
1. As part of DMAP (Strategy 2.1.1.), provide technical assistance to landowners through reviewing deer management plans.	Ongoing	Annual activity of regional Wildlife Management Supervisors.

OBJECTIVE 2.3. Evaluate the feasibility by June 30, 2004 and, if deemed feasible, implement a citizen task force (CTF) approach to setting deer population goals in each management unit.

Strategy	Status	Comments
1. By December 2003, survey other state wildlife management programs that are using a CTF approach to goal setting and assess their satisfaction and success. Identify critical or key elements and procedures of successful programs.	Completed August 2005	Completed as part of proposal to test CAC process.
2. Complete at least one trial deer CTF for a management unit by February 28, 2004, and provide recommendations to Commission on using a CTF for goal setting.	Completed March 2006	A pilot CAC was completed in March 2006 in WMU 4B.

3. If CTF approach is recommended, provide public notice about using this approach using PGC website, news releases, Game News articles, and presentations at workshops and club meetings.	Completed June 2006	News release describing results of pilot project issued in June 2006. Currently, news releases are used to solicit nominations and volunteers to participate in CACs.
4. If CTF approach is recommended, develop and implement deer population goals for each management unit over a 5-year period (2004-2008) using CTFs.	Ongoing	Completed pilot in 2006. Began multi-WMU CACs in 2007 and expect completion in 2011. Through August 2009, 15 of 22 WMUs have a completed CAC.

OBJECTIVE 2.4. Develop an effective management program for managing deer in urbanized landscapes by 2006.

Strategy	**Status**	**Comments**
1. Develop educational materials about indirect management strategies (e.g., repellents, fencing, habitat manipulation) and direct management strategies (e.g., recreational and controlled hunting programs, trap-and-kill, sharpshooting) by June 30, 2004. Educational materials will include the pros and cons regarding management efficiency, safety, and costs associated with each management option.	Ongoing	Guide to deer management in developed areas was completed in 2007 and is available on the website. Other related publications are available on the website.
2. By December 31, 2004, develop an urban deer management program that allows cities, suburban dwellings, and communities/residential associations to select a deer management option that is appropriate for their respective area to achieve their goals and objectives.	Ongoing	Plan for managing deer in developed areas was completed in May 2006. Implementation of this plan's strategies continues.

GOAL: MANAGE DEER TO MAINTAIN, AND, WHERE APPROPRIATE, RESTORE HEALTH OF THE ECOSYSTEM (modified to MANAGE DEER FOR HEALTHY FOREST HABITAT in April 2006 to reflect feasible benefit of managing deer impacts)

OBJECTIVE 3.1. Identify a suite of plant and animal species to serve as feedback loops for evaluating the impact white-tailed deer have on wildlife communities and establish achievable goals for the suite of species for each WMU by 2007.

Strategy	Status	Comments
1. Conduct a forest restoration area study (2003-2007) to quantify indicator species recovery at local level and determine feasibility in employing this approach at the statewide level for future deer management practices.	Not Completed	

OBJECTIVE 3.2. Inform and educate all interested Pennsylvanians about deer management issues, the role deer have in Pennsylvania ecosystems, and the importance of regulated hunting in managing deer herds throughout the Commonwealth.

Strategy	Status	Comments
1. Develop educational materials by December 2004 and routinely conduct educational workshops for the public-at-large about deer ecology and the role of deer in ecosystems through 2007.	Ongoing	Programs, interviews, and radio and television appearances occur on a regular basis.

OBJECTIVE 3.3. Conduct scientific research and inform the public about research results and explain implications for wildlife management practices to media outlets, in seminars, and educational workshops through the Commonwealth.

Strategy	Status	Comments
1. Increase public outreach efforts and inform the public about findings of ongoing research activities through 2007.	Completed August 2007	Public outreach efforts continue with formation of a Deer Communications Working Group. Outreach efforts suffered when the deer program lost 2 outreach biologist positions in 2003 & 2004 that were not replaced.
2. Conduct human dimension surveys to assess public support and knowledge regarding proper deer management.	Not Completed	

HISTORY OF DEER AND DEER MANAGEMENT IN PENNSYLVANIA

EXPLOITATION AND RECOVERY

Prior to European settlement in Pennsylvania, deer populations were likely limited by extensive tracts of mature forests, predation from wolves (*Canis lupus*) and mountain lions (*Felix concolor*), and Native American hunters (McCabe and McCabe 1984). Early attempts were made to regulate deer hunting in the Commonwealth beginning in 1721 (McCabe and McCabe 1984), but typically laws were passed and no one enforced them. Hardly anyone, consequently, obeyed them. Deer populations sustained relatively unregulated removals through the 1700s, but in the 1800s, losses to subsistence and market shooting, and habitat changes caused deer populations to decline dramatically.

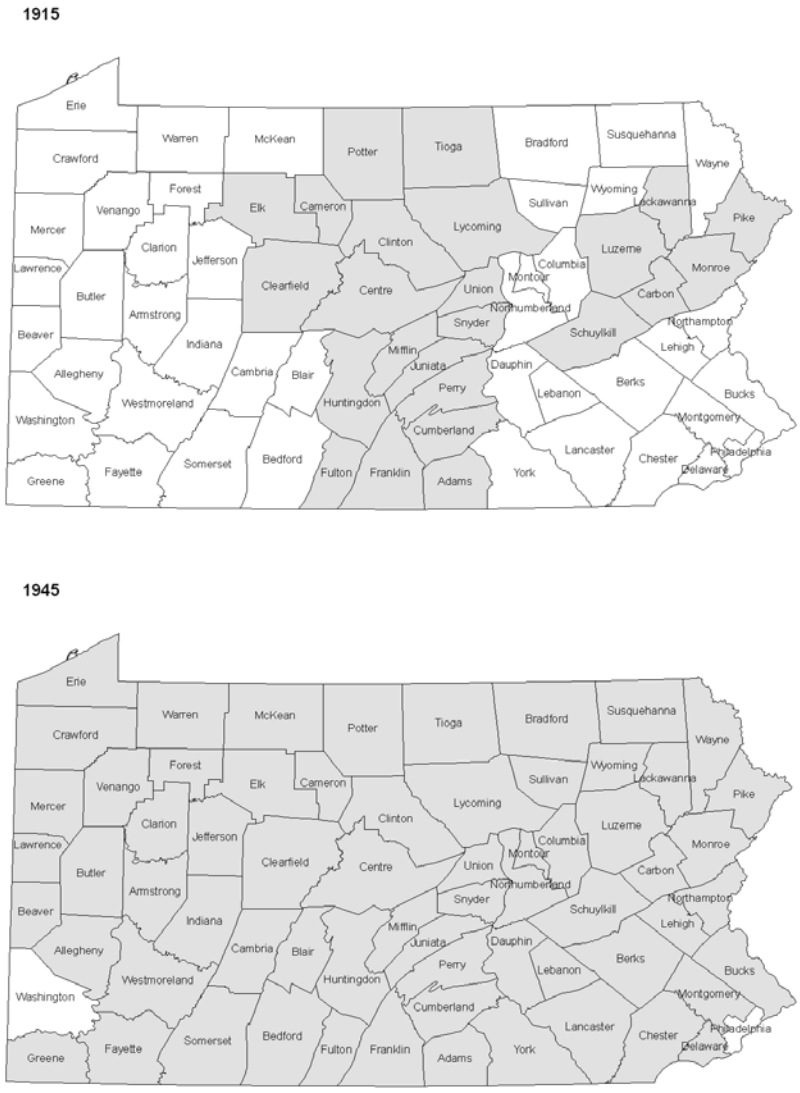
Deer were scarce throughout the Eastern and Midwestern United States around 1900 (McCabe and McCabe 1984), including Pennsylvania. The Pennsylvania Game Commission (PGC) was created in 1895 for the purpose of protecting and conserving game. Game protectors began enforcing deer harvest laws in 1897. The PGC released about 1,200 deer from 1906 to 1925 to restore the state's herd. The state's long-standing two-deer seasonal bag limit was reduced from two to one in 1905. The deer population recovery was further buoyed by enactment of a law in 1907 that protected antlerless deer. Prior to that, the harvest of antlerless deer was regulated with liberal statewide bag limits that didn't promote either local or statewide population management. The 1907 law quickly fostered opinions among Pennsylvanians that it was unsporting to shoot antlerless deer because it would impinge the herd's ability to recover. The protection afforded by this law, coupled with the increasing abundance of excellent deer range – early successional habitat – created by extensive logging during the late 1800s and early 1900s, provided outstanding conditions for deer populations to rebound. This comeback is one of the greatest success stories in the history of wildlife management (Kosack 1995).

Deer populations rebounded quickly (Figure 1). Increasing from about 1,000 deer in 1905 to about 1,000,000 in 1928 (Leopold et al. 1947), the white-tailed deer found the conditions of the early 1900s very favorable. In response to deer population increases and increasing impacts on crops and forests, additional deer management regulations were added including allowing landowners to kill deer for crop damage (1923) and the establishment of an antlerless season (1923). Public reaction to killing antlerless deer was often less than supportive, despite documented crop damage and range deterioration.

Documentation of deer impacts on crops and forests took many forms from the 1930s to 1950s. In 1931, a bulletin titled "The deer problem in the forests of Pennsylvania" was published. It provided photographic and field observations of deer impacts on forest regeneration from across Pennsylvania (Clepper 1931). In 1947, Aldo Leopold and others completed a survey of deer populations across the United States and stated of Pennsylvania, "There is a large literature on the Pennsylvania deer problem" (Leopold et al. 1947). Then in 1950, the Game Commission

published a special issue of the Game News titled “Pennsylvania’s deer problem” with the purpose of explaining the issues facing deer management (Latham 1950).

Figure 1. Counties where antlered deer harvests were reported by hunters, Pennsylvania 1915 and 1945.



Despite documentation and attempts to explain deer impacts and management, the issue of reducing deer populations and antlerless harvests remained a mainstay of the deer management controversy and disagreements between hunters and the Game Commission. From 1923 to 1956, the PGC closed antlerless deer season 13 times. The season closures were usually in response to public uneasiness that deer numbers were down, not a concern that the hunting harvest or winter mortality were too excessive. Although antlerless seasons have been held annually since 1957,

controversy over antlerless harvests and deer impacts continues. In 2008, calls for closing or shortening the antlerless deer season continue and calls for reduced deer impacts remain.

FOREST-BASED DEER MANAGEMENT

The Game Commission started deer carrying capacity studies on mixed-oak and northern hardwood forests in the 1960s and continued this work into the 1990s (Tzilkowski et al. 1994a, b). Based on these studies, in 1979 the Game Commission adopted a deer management system based on overwinter deer density objectives for each county. The system – used for about 25 years – assigned to each county an overwinter deer density objective based on the amount and quality of woodlands found in it. These objectives were set below a county's biological carrying capacity to ensure forest regeneration and minimize problems in agricultural, suburban and urban areas. Overwinter population objectives were used because winter is a critical time when deer foods are most limited.

Different forest size classes provide varying amounts of food. Seedling-sapling stands (brush to five-inch diameter trees) supply the most; sawtimber (trees larger than 11 inches in diameter) and non-commercial timber are in the middle; and pole timber (five to 11 inch diameter trees) are the least productive. Based on the carrying capacity studies, the Game Commission established the following overwinter objectives for these size classes: seedling-sapling, 60 deer per square mile; saw and noncommercial timber, 20; pole timber, 5; and non-forested areas, 0 (Drake and Palmer 1991). Non-forested areas, mainly agricultural and developed lands were arbitrarily assigned a carrying capacity of 0 because of conflicts caused by deer on these lands. Forested land figures for each county were determined through a U.S. Forest Service inventory conducted about every 10-12 years. County data were then applied to the deer densities established for each size class.

During their 25 years of use, county deer density objectives were rarely achieved and often disputed by hunters who claimed there were few or no deer where they hunted. At the end of the 20th century, Cameron County was the only county where the objective was met. Forty-five of the remaining 61 counties – the 5 special regulation counties were not assigned objectives based on forest characteristics – were 50% or more above objective and about half of these counties had 2 times the objective. After decades of use, setting deer density objectives and attempting to achieve them on a county-by-county basis was not working.

CURRENT DEER MANAGEMENT

With adoption of the 2003-2007 deer management plan, the method of defining deer management goals changed. Instead of management objectives based on density of deer in an area, measures of deer health, forest habitat health, and deer-human conflicts defined management objectives. Consequently, the number of deer in an area became secondary to measures of deer health, forest habitat health, deer-human conflicts, and deer population trends.

This shift has not been popular with all stakeholders given the Game Commission used deer densities to judge deer management success for decades. Critics of the impact-based deer management program view the change to goal-specific measures and deer population trends as

less credible than assigning a specific deer density objective to each Wildlife Management Unit. People want to know how many deer there are in Pennsylvania. And, when the Game Commission doesn't provide an answer, they question how the agency can possibly have the information it needs to manage white-tailed deer.

Like most things in deer management, this debate is not new, nor is it unique to Pennsylvania. More than 20 years ago, this topic was addressed by two wildlife biologists with expertise in deer management and population dynamics. In each case, they clearly stated that although deer population estimates are not necessary for deer management, understanding population trends and impacts on the environment are important (Hayne 1984, McCullough 1984).

Although, it is clear the credibility of a deer management program should not rest solely on its ability to answer the question of how many deer live in Pennsylvania, being able to accurately monitor the trend of deer populations remains important to the Game Commission's deer management program. Consequently, the Game Commission expends significant resources to monitor deer population trends.

Instead of using the specific number of deer in an area as a deer population measure, we monitor the trend of the deer population. In other words, instead of focusing on whether there are 20 or 30 deer per forested square mile, the Game Commission now concentrates on whether the population trend across several years is changing. Deer management recommendations are based on deer impacts on themselves, the forest, and the people, not a single number. If the forest is healthy, the deer are healthy, and people are tolerant of the level of deer-human conflicts, then it doesn't matter if there are 20 or 30 deer per square mile. The goals of the deer management plan have been met.

Today, the Game Commission's deer management program has access to valuable data that did not exist prior to 2001. The existence of forest regeneration data from across the Commonwealth gives the agency the opportunity to more directly assess the impact of deer on forest habitats. In addition, use of Citizen Advisory Committees provides a standard method of gathering public input on the value-driven measure of deer-human conflicts. The change from deer densities to goal-specific measures recognizes that improvements can and should be made when more and better information becomes available for deer management.

Given the long history of using deer density numbers in Pennsylvania, public and media expectations for and reliance on deer density information for each Wildlife Management Unit are understandable. However, any conclusion that a deer program without exact deer density estimates is not credible is not supported by the science and experience of deer biologists and managers throughout North America. While the Game Commission acknowledges the desire of hunters and the public to know how many deer are in Pennsylvania, we have a duty to implement a responsible and credible deer management program that addresses deer management goals through the most efficient use of available data.

HUNTING SEASONS AND BAG LIMIT CHANGES

"The deer problem in my mind will never be settled until you open the season on both doe and bucks, and have only one season for both and allow no deer to be shot under a certain size. This has been the remedy in other states and has been found to work to the satisfaction of every one." -- Dr. W. H. Moore, state president of the Izaak Walton League of America addressing the PGC at May 16, 1930 board meeting.

Pennsylvania deer hunting has a long tradition. From the first deer season in 1721, to the concurrent firearms season today, deer hunting has been and continues to be an important part of Pennsylvania's hunting heritage and deer management program. After a series of open and closed deer hunting seasons through the first third of the 20th century, the Game Commission has approved deer hunting seasons each year since 1935.

But, the process of setting deer hunting seasons and bag limits has not been without controversy. In 1928, in an effort to reduce the rapidly increasing herd, the agency closed the traditional buck season and held an antlerless deer hunt in 54 of the state's 67 counties. It was a revolutionary step forward in deer management. However, many hunters disagreed.

The uproar over harvesting "mother" deer shook both the Commission and the state's hunting fraternity. Antlerless licenses were bought and burned. Newspaper ads proclaimed "…only yellow hunters shoot does." "No doe hunting" signs went up as fast as printers could make them. Hunters were convinced the 1928 antlerless-only season would wipe out the herd, but the Game Commission stayed its course and hunters took more than 25,000 antlerless deer. This was double the total number taken during the 1927 bucks-only season.

In 1938, faced with a burgeoning deer herd, the agency again closed buck hunting and adopted another antlerless–only season. Once again many hunters complained. They yelled even more loudly after more than 170,000 deer were taken – surpassing the state's best annual harvest by more than 65,000 animals. Dissatisfied hunters exclaimed to everyone who would listen that "Pennsylvania's deer herd is ruined!" Yet, during the next two years, hunters shot another 250,000 deer.

A review of deer management efforts from the late 1920s to the mid 1940s shows closed antlerless deer seasons led to many conflicts and high malnutrition losses. During this era, the Game Commission frequently closed antlerless seasons in response to pressures exerted by hunters, preservationists, and legislators. Deer were managed under broad guidelines. The herd was, after all, Pennsylvania's sparkling gem. It was a supplemental food source for thousands of households, boosted local economies, and provided countless hours of recreation. Given the benefits, everyone had an opinion on deer management.

The 1950s brought changes in Pennsylvania's deer management program. In 1951, the legislature eliminated the Game Law's abrogation clause (enacted in 1949) that permitted residents to close, by petition, antlerless seasons in their respective counties. By the close of the 1950s, antlerless deer seasons had become a yearly standard of the deer management program. The last closed antlerless deer season was 1956.

During the early 1980s, Pennsylvania's deer population increased substantially. Antlerless harvests were insufficient to dampen population growth due to weather, land posting, low allocations, and insufficient demand for antlerless licenses. In addition, overwinter survival and reproduction improved. In 1983, the Game Commission allocated a record 536,650 antlerless licenses to curb herd growth; only 519,000 were sold. Over the next four years the Commission continued to increase the annual allocation. But license sales seemed to reach a saturation point between 500,000 and 550,000; hunters simply were not buying them. It became necessary to modify the allocation program.

In the late 1980s, hunters continued to harvest a record numbers of bucks (Table 1). The rising buck harvest indicated the herd was still growing, even though the agency was allocating more antlerless licenses and hunters were taking more deer. The agency's inability to sell the entire annual antlerless license allocations was impeding efforts to reduce the herd, and deer conflicts with other land uses increased.

Table 1. Deer harvests, antlerless allocations, and hunter success rates, Pennsylvania 1986-2008.

Year	Total Deer Harvest	Antlered Harvest	Antlerless Harvest	Antlerless Allocations	Antlered Hunter Success[1]	Antlerless License Success
1986	300,014	150,359	149,655	565,500	0.15	0.29
1987	334,789	157,547	177,242	617,700	0.16	0.32
1988	381,399	163,106	218,293	679,300	0.16	0.33
1989	388,601	169,795	218,806	692,100	0.17	0.32
1990	415,561	170,101	245,460	806,100	0.17	0.31
1991	388,015	149,598	238,417	847,200	0.15	0.28
1992	361,224	163,159	198,065	716,650	0.16	0.29
1993	408,557	165,214	243,343	748,000	0.17	0.33
1994	395,081	157,030	238,051	780,000	0.16	0.31
1995	430,583	182,235	248,348	656,000	0.19	0.32
1996	350,997	153,432	197,565	724,350	0.16	0.24
1997	397,016	176,677	220,339	639,900	0.19	0.32
1998	377,489	181,449	196,040	890,700	0.20	0.26
1999	378,592	194,368	184,224	797,200	0.22	0.28
2000	504,600	203,221	301,379	836,550	0.22	0.36
2001	486,014	203,247	282,767	780,250	0.24	0.37
2002	517,529	165,416	352,113	1,029,350	0.21	0.35
2003	464,890	142,270	322,620	973,000	0.18	0.34
2004	409,320	124,410	284,910	1,039,000	--	0.28
2005	354,390	120,500	233,890	879,000	0.16	0.27
2006	361,560	135,290	226,270	859,000	0.18	0.27
2007	323,070	109,200	213,870	865,000	0.15	0.25
2008	335,850	122,410	213,440	849,000	0.17	0.26

[1] – Antlered hunter success rate based on antlered harvest divided by number of deer hunters. Number of deer hunters via survey not available in 2004.

To deal with inadequate harvests, in 1988 the Commission implemented a statewide program to allow hunters to purchase unsold antlerless licenses. For the first time, hunters could take more than one antlerless deer per year. The agency allocated 679,300 antlerless licenses. Under the new program, the entire allocation was issued to hunters. Through the late 1980s and early 1990s, increased allocations and hunter harvests stopped deer population growth and reduced the deer population by the mid 1990s.

This reduction in the deer population brought about the same negative response from hunters as in the past. In a series of nine public meetings held across the state in 1995, hunter complaints of seeing too few deer and requests to close antlerless deer seasons were again heard. Allocations were cut in many areas and unsold licenses were no longer available to hunters. As a result of lower antlerless deer harvests, deer populations ballooned. At the turn of the century, Pennsylvania's deer population was likely as high as it had ever been and contained nearly twice as many deer as recommended by forest-based deer management objectives.

In the early 2000s, the Game Commission again modified the framework of Pennsylvania's deer hunting season to reduce whitetail populations. More antlerless tags were allocated and the separate buck and antlerless deer seasons were combined to maximize hunter opportunities for harvesting antlerless deer. Historically, there was a two-week buck season followed by a three-day antlerless season that started on the Monday following the last day of buck season. The concurrent antlered and antlerless firearms season was put in place to give hunters more time to hunt antlerless deer and to reduce the impact of weather on the harvest during 3-day antlerless seasons. Giving hunters more time and flexibility in when, where, and how they hunt is important today when many activities compete for hunters' free time (Responsive Management 2004). A two-week season, during which hunters can hunt both antlered and antlerless deer, provides the time and flexibility for today's deer hunters.

The concurrent firearms seasons in 2004 and 2005 provided a good example of the effectiveness of the 2-week season. The opening two days of the 2005 season were plagued by poor weather. Fog and low visibility on the opening day were followed by wind and rain on the second day. Statewide, the harvest the first 2 days dropped from 49% of the firearms harvest in 2004 to 35% during 2005. For the first week, the firearms harvest dropped from 78% in 2004 to 68% in 2005. In other words, the second week of antlerless hunting in 2004 accounted for 1/5 of the harvest. In 2005, the second week accounted for 1/3 of the harvest. If the season were only 1 week long, the effectiveness of the antlerless allocation likely would have been reduced in 2005. Instead, the effectiveness of the antlerless allocation to harvest antlerless deer remained stable between 2004 and 2005 (i.e., it took approximately 4 licenses to kill an antlerless deer in both years, in spite of the differences in weather).

Reducing the impact of weather on antlerless harvests is important for deer management. Antlerless allocations are the primary management tool used to change deer population trends. However, allocations must be set 7 months before the opening of the concurrent firearms season. To properly allocate antlerless licenses, effectiveness of antlerless licenses must be predictable from year to year. In other words, managers should be able to predict how many tags it will take to harvest a deer to make recommendations for the number of tags needed to harvest a particular number of antlerless deer. For example, if it takes 4 tags to harvest a deer one year, but only 3

tags to harvest a deer the next year, the antlerless harvest will be higher than expected. The reverse also can be true in some years; if it takes more tags to harvest a deer, the antlerless harvest will be less than expected. Clearly, the more predictable the antlerless harvest is, the better deer managers can allocate licenses to achieve specific management objectives.

Today, many hunters incorrectly blame reduced deer populations on the concurrent season. Critics want the deer program to "go back to the ways things were," and they often associate high deer populations of the past with the 2-week antlered season followed by a few days of antlerless hunting. Ignored in this viewpoint are the record antlerless allocations and record antlerless deer harvests from 2000 to 2004. These allocations were intended to reduce deer populations, and subsequently, they have in many areas since 2000. The 2-week concurrent season is not killing "extra" antlerless deer. Within a consistent season structure, the allocation controls the number of deer killed during the antlerless hunting seasons and maintaining a consistent season structure is advantageous to accurately predicting the impact of future allocations on deer population trends.

Hunting season and bag limit challenges faced by today's deer management program are no different than they were 80, 50, or 10 years ago. Hunting is the primary tool used to change deer population abundance, and hunting seasons and bag limits are often the focus of disagreement between the Game Commission and hunters. Some hunters judge success by how many deer they see in the local area where they hunt. The Game Commission determines success based on attainment of its mission and deer management goals across the state. Often, these views are not compatible. However, the Game Commission must manage deer in accordance with its legal duties and responsibilities and, at times, this will result in recommendations of seasons and bag limits to which some hunters will be opposed. Responsible deer and wildlife management cannot be a popularity contest. It must be grounded in the best available data with consideration for Pennsylvania's wildlife and natural resources, for today and tomorrow.

DEER BIOLOGY AND ECOLOGY

TAXONOMY, DISTRIBUTION, ANATOMY, AND PHYSIOLOGY

White-tailed deer are ungulates, or hoofed mammals, belonging to the family *Cervidae*. White-tailed deer successfully live across a wide range of habitats. They can survive near the Arctic in Canada, in tropical forests of South America, or in the midst of a suburban development. Consequently, deer are found throughout Pennsylvania.

White-tailed deer are the oldest living species of deer (Geist 1998). From the earliest recorded explorations of North America, references to deer are common (McCabe and McCabe 1984).

Deer are mobile and agile animals. They actually walk on their toenails that are keratinized tissue similar to human fingernails. Like fingernails, hooves on white-tailed deer continue to grow and become larger with age. Deer can run 40 miles per hour for short bursts, maintain speeds of 25 miles per hour for longer periods, and clear obstacles up to nine feet high or 25 feet wide. Air-filled hairs of their coats enable them to swim easily.

The white-tailed deer's coat and color change throughout the year. Deer are more reddish with a thin coat during summer months. Their summer coat is shed in late summer or early fall and replaced with a thick, brownish-grey winter coat. This winter coat consists of both dense underfur and hollow, outside guard hairs that provide additional insulation and protection during the winter. The winter coat is shed in mid to late spring. Hair color is alike in both sexes. In adults, the belly, throat, areas around the eyes, insides of the ears and the underside of the tail are white all year long. Both melanistic (darker than normal) and albino (white) deer occur but are rare. Partial albinos, sometimes called "piebalds" or "calico" deer, occur more frequently, but are still reported in less than 1 percent of the population.

Fawns are born with a spotted coat. When a fawn is lying on the ground or in dry leaves, this coat looks like the sun hitting the ground after it passes through the treetops. This provides excellent camouflage for the fawns. Their summer coats are molted about the same time as the fall molt in adults when fawns assume the same brownish-grey winter coat as adults.

Seasonally, deer lose weight during winter and regain weight during the spring, summer, and fall months (Mautz 1978). However, there are differences in metabolic demands between the sexes; males lose weight as they expend energy during the fall breeding season or rut whereas metabolic demands on females are greatest during summer when rearing fawns (Moen 1976). The enormous amount of energy expended during the rut often predisposes males to have higher winter mortality rates than females (Mautz 1978, Clutton-Brock et al. 1982, Gaillard et al. 1993, Owen-Smith 1993). As a result of the energy requirements needed for lactation, females spend more time feeding during summer months and may abandon fawns if they are not in good physical condition during the summer (Beier 1987).

Females tend to be smaller than males of the same age from the same area. Deer weights vary considerably, depending upon age, sex, diet and the time of year. For example, breeding-age bucks may weigh 25 to 30 percent more at the onset of the breeding season than they do at its conclusion. Hence, a 140-pound buck in December might have weighed approximately 180 pounds in September.

Whitetails have a keen sense of smell and hearing that help them detect danger. Deer can bleat, grunt, whine, and when alarmed or suspicious, make loud "whiew" sounds by forcefully blowing air through their nostrils. Does whine to call their fawns and fawns bleat to call their mothers.

Two distinguishing characteristics of white-tailed deer include antlers and a four-part stomach. Males grow a new set of antlers each year. On rare occasions, a female deer will grow antlers. In Pennsylvania, Donaldson and Doutt (1965) found about one of every three to four thousand antlered deer were females. Female deer with antlers in velvet were most often functional females. Those with hardened antlers were most often cryptorchid males (Donaldson and Doutt 1965).

Although antler growth is evident on male fawns, the button-like protrusions are not prominent. A buck's first set of antlers begins to grow when it's about 10 months old. Size of a buck’s antlers will be influenced by nutrition, genetic characteristics of its mother and father, and age. Bucks will produce their largest antlers after reaching physical maturity at 4 to 5 years of age.

Antlers generally begin to grow in March or April. Growing antlers are covered by a skin called "velvet." This velvet is covered with soft hairs and contains blood vessels that supply nutrients to the growing antlers. By August or early September, antler growth ceases, followed by calcification, and shedding of velvet. Buck may rub their antlers on saplings, shrubs, or rocks to remove velvet. Polished antlers are carried throughout most of the breeding season, which can last into late winter. It is quite normal for some bucks to still have antlers in late winter. Natural variation and general health of the deer contribute to the timing of antler drop which occurs any time from December through March. A new set of antlers begins to grow again in March or April, triggered by increasing daylight and hormonal cues.

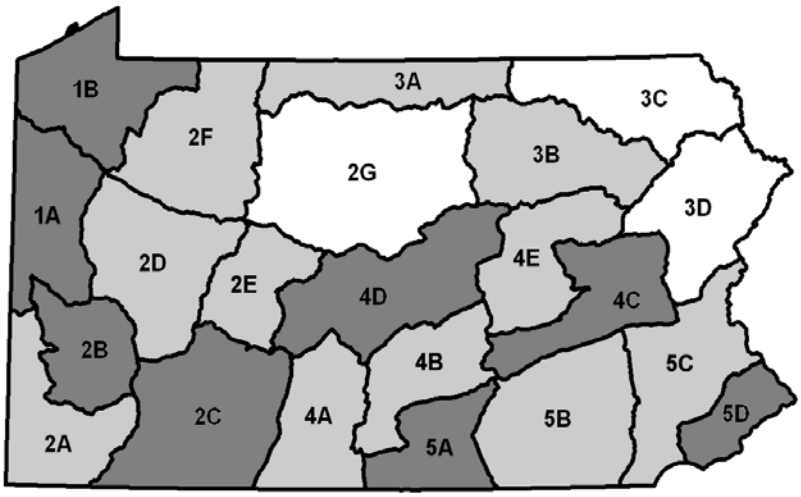
The four-chambered stomach of the white-tailed deer provides a number of survival advantages. First, food can be consumed without thorough chewing and stored in the stomach. This food can then be regurgitated at a later time, such as when safely bedded in cover, and chewed more. Second, parts of the stomach contain microorganisms that permit deer to gain adequate nutrition from the food they eat. These microorganisms break down undigestable materials into products that can be digested. When different foods are eaten, the microorganisms inhabiting deer stomachs need to change. Sudden changes in diet can cause digestive problems. For this reason, some attempts at emergency winter feeding have failed. Despite full stomachs, deer starve to death because the microorganisms needed for digestion were unable to adapt to the new food in time.

REPRODUCTION

Deer reproduction rates generally are higher in regions with an abundant food supply. Thus, deer occupying farmland regions typically have higher reproduction rates than deer in forested regions (Haugen 1975, Gladfelter 1984, Kerr and Peterson 1988, Fuller 1990). Further, reproduction rates vary with the age of the female. Adult females have the highest reproduction rates followed by yearlings then fawns. In farmland regions, a high percentage of fawns and almost all yearling and adult females breed each year (Haugen 1975, Gladfelter 1984). In contrast, female fawns are less likely to reproduce in forested regions where the food supply is less abundant (Kerr and Peterson 1988) and yearling females may not breed if they are malnourished in fall (Verme 1969, McCullough 1979). Fawns in farmland regions tend to be heavier, which allows them to reach puberty earlier (Haugen 1975, Gladfelter 1984, Verme and Ozoga 1987). Verme and Ozoga (1980) found that as little as a 10 percent reduction in food consumption inhibits skeletal growth and fat accumulation. Limited food thereby stunts the growth of female fawns in deteriorated habitats and prevents them from breeding in poor ranges.

Reproduction in Pennsylvania varies by age of female and Wildlife Management Unit. Based on examination of road-killed females in the winter and spring, reproductive rates can be determined. About a quarter of one-year old females (i.e., bred as fawns) are pregnant each year, but this varies by Wildlife Management Unit (Figure 2). In some Wildlife Management Units, nearly 50 percent of fawns are pregnant, but in others few are pregnant. Each year, about 90 percent of adults (2 years-old and older) are pregnant.

Figure 2. Pregnancy rates of female fawns (<1 year of age) collected by the Pennsylvania Game Commission (n = 1,177) by Wildlife Management Unit. Areas in white have fawn pregnancy rates of less than 10% and areas in dark grey have fawn pregnancy rates of more than 30%. Areas in light grey are between 10 and 30 percent. Pennsylvania, 2006-2008.

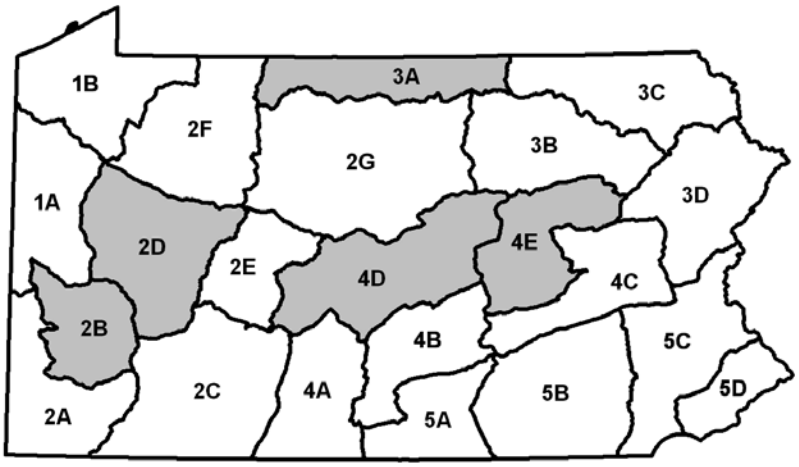


Similar to pregnancy rates, embryos per female vary by age of female and Wildlife Management Unit. Pregnant adult females have about 1.8 embryos/female. Embryo counts of adult does vary by Wildlife Management Unit (Figure 3). On average, pregnant fawns have slightly more than 1 embryo/female, indicating some twinning occurs in fawns. Twinning is common in adult females, and triplets also occur (Table 2). When combining pregnant and barren females of all age classes, the average reproductive rate across the state is about 1.0 embryo/female.

Table 2. Frequency of singles, twins, and triplets by fawn and adult females, Pennsylvania, 2008

Age	Singles	Twins	Triplets
Fawns	100	29	0
Adults	112	333	22

Figure 3. Embryo counts of adult females (≥2 years of age) collected by the Pennsylvania Game Commission (n = 1,478) by Wildlife Management Unit. Areas in white have embryo counts not different from 1.50. embryos per adult doe. Areas in grey have embryo counts of more than 1.50 embryos per adult doe. Pennsylvania, 2006-2008.



The deer mating season in Pennsylvania begins as early as September and can last into February. Most adult does are bred in November, with fawn breeding extending through December into February. Overall, most does are bred from mid-October to mid-December (Rosenberry and Wallingford 2002, Figure 4).

MORTALITY

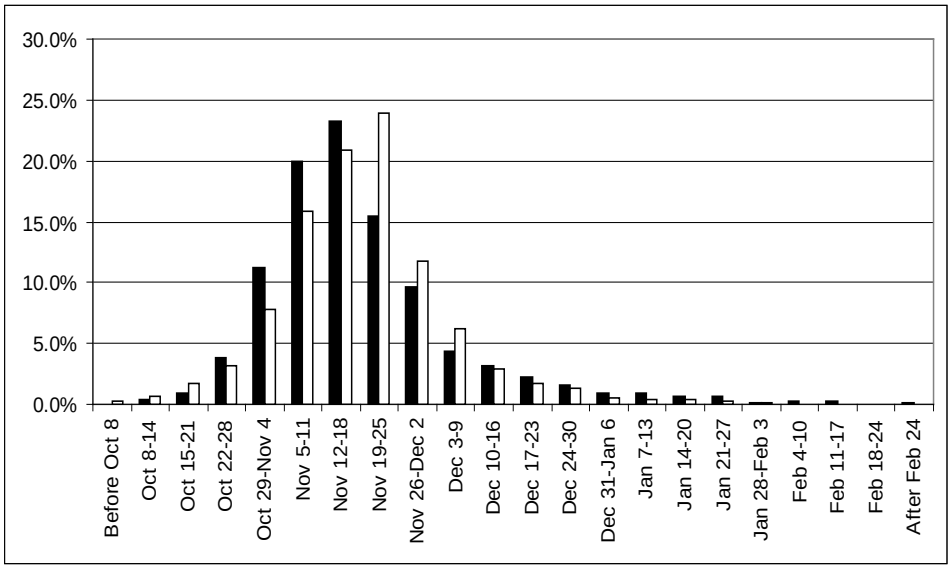
Summer mortality is generally low for all sex and age classes (Nelson and Mech 1981, Dusek et al. 1989, Nixon et al. 1991, Van Deelan et al. 1997). Fawns have higher mortality rates than

other age classes, and are most susceptible to predation during summer months (Shultz 1982, Dusek et al. 1989).

In Pennsylvania, predators were the leading source of fawn mortality taking about 20 percent of fawns on two study areas. Black bears and eastern coyotes were the primary predators. Most predation occurred during the fawn's first three months of life. Starvation, disease, and infections also were significant sources of fawn mortality (Vreeland et al. 2004, Table 3).

Although deer-vehicle collisions are the primary source of mortality that occurs during summer months for yearling and adult deer (Gladfelter 1984, Nixon et al. 1991), deer killed during the hunting season account for most annual mortality (Nelson and Mech 1981, Nixon et al. 1991, Van Deelan et al. 1997). Some researchers have hypothesized that hunting-related crippling losses are variable and unpredictable, and might double the reported harvest in some states (Hardin and Roseberry 1976, Beattie et al. 1980, McPhillips et al. 1985, Nixon et al. 1991, Krueger 1995). Poaching also accounts for some annual mortality (Beattie et al. 1980, Nixon et al. 1991).

Figure 4. Conception dates of adults (filled bars) and fawns (open bars), Pennsylvania 2000-2003.



In Pennsylvania, hunting is the most significant cause of mortality for deer at least 6 months of age (Table 4). Hunting mortality of antlered deer declined following implementation of new antler restrictions in 2002. Prior to antler restrictions, harvest rate for antlered deer was around 80 percent. After 2002, harvest rates from radio-tagged antlered deer were 31% for yearling males and 59% for adult males. Harvest rates for antlerless deer (i.e., fawns and adult females) are driven by the antlerless allocation that change annually and by Wildlife Management Unit.

Winter mortality is generally higher for deer occupying northern climates or predominately forested areas than for deer in southern climates or agricultural areas (Gladfelter 1984, Nixon et al. 1991, Van Deelan et al. 1997). This is largely caused by winter weather conditions being

more severe in northern regions and farmland deer tend to be in better physical condition at the onset of winter (Verme and Doepker 1988, Grund 2001). Verme and Doepker (1988) estimated 77,000 deer died during a severe winter in northern Michigan, of which 82 percent were fawns.

Table 3. Percentage of deaths by cause of mortality within 34 weeks of capture of fawns in Penns Valley and Quehanna Wild Area, central Pennsylvania, May–January, 2000-2002.

	Penns Valley	Quehanna Wild Area
Mortality Cause	**%**	**%**
Predation	17	70
Natural Causes[1]	38	19
Vehicles	15	3
Hunting	11	3
Farm Machinery	6	0
Poaching	2	3
Bizarre Accidents[2]	4	0
Deer Depredation[3]	4	0
Unknown[4]	2	2
Censored[5]	13	7

[1] – Excludes predation. Causes included starvation and diseases.
[2] – One fawn fell down an abandoned well and another became tangled in a fence.
[3] – Legally killed by farmers with deer depredation permits.
[4] – No carcass found. Collars were cut off and discarded within 10m of road.
[5] – Contact was lost with transmitter or only collars were recovered with no evidence to suggest death occurred. These percentages not included in column totals.

Table 4. Percentage of deaths by cause of mortality of white-tailed deer ≥6 months-of-age from numerous study areas in Pennsylvania, 2002-2007.

Mortality Cause	**%**
Hunting	71
Vehicles	8
Natural Causes	7
Unknown	6
Illegal Activity	6
Predation	1

In Pennsylvania, an index of winter mortality (measured in dead deer per mile of stream bottom walked) was used until 2005 as a relative measure of winter impacts on deer populations. During mild winters, about 0.15 dead deer per mile of stream bottom were found statewide

during these surveys. The highest number of deer recorded for this index occurred in 1978, when a statewide average of 1.94 deer per mile of stream bottom was found.

DEER ACTIVITY AND MOVEMENT PATTERNS

"There never was a mass exodus from the traditional deer woods, only a gradual overflow of a few animals here and there with a rapid increase in their numbers in the more favorable areas through normal reproduction."
Stanley Forbes and others (1971), The white-tailed deer in Pennsylvania

In the early 1900s, deer were plentiful in the northern forests, but were still scarce in the urban areas and the southern farm areas of Pennsylvania (Figure 1). Today, differences in deer abundance between the northern forests and urban and southern areas have reversed. Deer are abundant in some of the most developed areas and less abundant in some of the most forested areas. The difference is not due to a recent migration of deer from forests to developed areas. Following gradual expansion of deer populations during the first half of the 1900s, deer in developed areas found nearly ideal living conditions – ample food in the form of agricultural crops, gardens, and landscaping, with few risks. Increased development limits hunters' access to land in most developed areas. Today, there are well-fed deer, reproducing at high rates (Figures 2 and 3), with low risk of being killed by hunters in developed areas. In contrast, deer in more forested areas have less agricultural crops, lower reproduction (Figures 2 and 3), and greater hunting access.

Deer tend to be most active at dawn and dusk (Micheal 1970, Kammermeyer and Marchinton 1977, Ivey and Causey 1984, Beier and McCullough 1990, Fritzen et al. 1995) but activity patterns will vary across seasons and can be affected by environmental conditions. For example, deer tend to be inactive when temperatures are very hot or very cold and other factors such as wind speed, cloud cover, and relative humidity may also affect deer activity patterns (Beier and McCullough 1990).

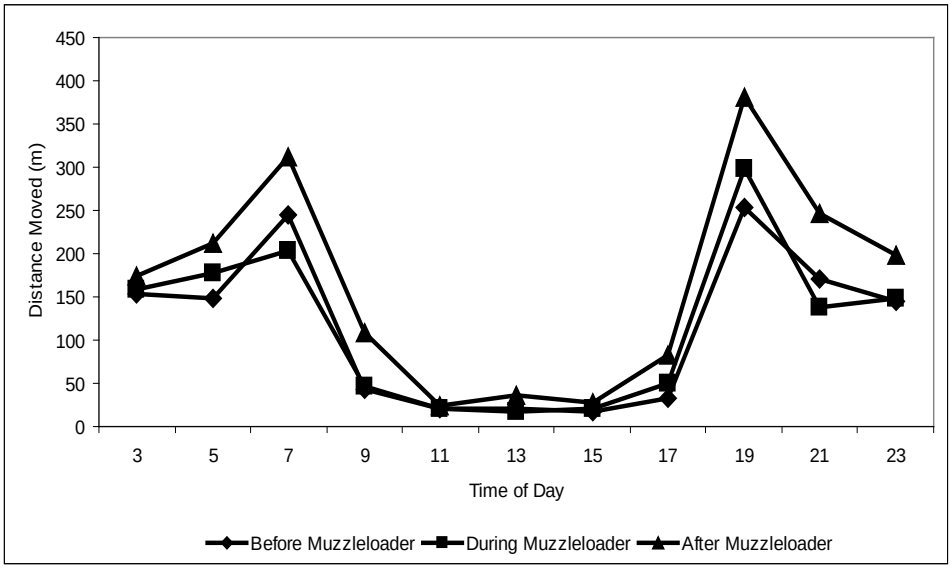
In Pennsylvania, Global Positioning System (GPS) collars that use satellites to record deer locations have provided detailed information on deer activity patterns. For example, antlered deer were found to be most active at sunrise, sunset, and night; before, during, and after the October rifle and muzzleloader seasons (Figure 5), illustrating that these early firearms seasons had little effect on deer activity patterns.

In Pennsylvania, antlered deer activity does not appear to be affected by moon phase. Antlered deer moved similar distances at night during new and full moons and continued to move more at night and less during the day, regardless of moon phase (Laubach and Blattenberger 2007).

On a seasonal basis, deer in northern climates tend to be most active during spring and fall and least active during winter (Hoskinson and Mech 1976, Moen 1978, Beier and McCullough 1990, Grund 1998). Deer activity is usually highest during fall because of their breeding behavior and their need to increase food consumption when preparing for winter. In winter, deer will typically become active later in the morning as temperatures increase (Beier and McCullough 1990). Several studies suggest deer decrease their activity in winter because food availability is limited during this season (Coblentz 1970, McCullough 1985, McCullough and Ullrey 1985). Thus,

deer will reduce their metabolic demands to conserve energy and more closely match their energy intake (Ozoga and Verme 1970, Moen 1976). A marked increase in deer activity occurs during the spring, as a result of the high metabolic demands associated with the last trimester of pregnancy in females and the nutritional demands associated with antler growth in males (Moen 1978, Beier 1987). Similarly, metabolic demands are high during summer as does produce milk for their fawns and males continue to develop antlers (Moen 1978).

Figure 5. Median distances moved by antlered deer wearing GPS radio collars during 2-hour time intervals the week before, during, and after the October muzzleloader and firearms season. Sunrise occurred around 0730hrs and sunset occurred around 1830hrs. Pennsylvania, 2002-2004.



The size and shape of a deer's home range varies with deer density, sex, landscape conditions, and season of the year (Sanderson 1966, Harestad and Bunnell 1979, Loft et al. 1984). Deer occupying better habitats can fulfill all their necessary requirements in smaller areas whereas deer residing in poorer ranges must travel further distances to find suitable food and cover (Sanderson 1966, Loft et al. 1984). Home range size and deer density tend to be inversely related (Sanderson 1966, Loft et al. 1984), as long as the number of deer does not adversely affect habitat conditions. Males generally have larger home ranges than females and home ranges tend to be largest in fall and spring (Nelson and Mech 1981).

In Pennsylvania, field data indicate adult deer will range within a square mile area most of the time, but this can vary by season. For antlered males, home ranges were largest during the fall and smallest during the summer (Laubach and Blattenberger 2007, Table 5).

Females may live their entire lives within a short distance of where they were born. The social organization of the whitetail is largely matriarchal with the most common social group being an adult doe, her fawns and her yearling female offspring. Sometimes three or four generations of related does are present in a family group.

Table 5. Home ranges of antlered males wearing GPS radio collars, Pennsylvania 2002-2005.

Season	Area (ha)	Area (acres)
January to April	285	704
May to August	180	445
September to December	322	795

When fawning season arrives in late May, adult females leave the family group and remain alone to bear and rear their fawns. Once a pregnant female leaves the family circle to bear her fawns, her yearling offspring are left on their own for the summer. At this time, young males, and occasionally females, may disperse from the area where they were born.

Yearling males also may disperse during the fall. The cause of male dispersal in the fall is uncertain. Some results suggest the presence of the mother causes dispersal (Holzenbein and Marchinton 1992). Other results indicate presence of the mother has no effect (Nixon et al. 1991, Shaw et al. 2006) and yearling male dispersal in the fall appears related to social interactions among yearling males (Rosenberry et al. 2001, Shaw et al. 2006).

Whether they disperse in the spring or fall, yearling bucks will typically travel about 5 miles on average (Nelson 1993, Rosenberry et al. 1999); however, distances of more than 20 miles are possible. Average dispersal distance appears related to percent of forest cover (Long et al. 2005).

In Pennsylvania, approximately 7 out of 10 yearling males will disperse from the area where they were born (Long 2005, Long et al. 2008). Similar to other areas, yearling male dispersal in Pennsylvania occurs predominantly during the spring fawning season and fall breeding season (Figure 6). Males dispersing in the spring tended to disperse farther than males dispersing in the fall (Figure 7). On average, yearling males in Pennsylvania disperse approximately 5 miles.

Yearling does typically remain in the mother's home range and generally rejoin their mother and her new fawns between September and October. During the breeding season adult and yearling bucks tend to stay alone except when in pursuit of a female approaching estrus. After the breeding season in late January, yearling and adult bucks form loose associations of bachelor groups, usually two to four animals, which remain together throughout most of the winter and summer months. These groups break up around September when the rut starts.

DEER DISEASES

Deer, like all living animals, are subject to a variety of diseases and health problems. Some of these diseases are deer specific, but others can be transmitted to other animals, including humans. Although no major disease issues are evident in Pennsylvania's deer population at this time, deer managers must remain vigilant in monitoring and controlling disease outbreaks and those factors that could lead to disease problems in wild, free-ranging deer populations.

Figure 6. Dispersal probability of yearling male white-tailed deer in Pennsylvania. Monitoring periods were defined as two-week periods beginning the first full week of January for each year. The gray line represents dispersal prior to new antler restrictions (2002), and the black line represents dispersal following new antler restrictions (2003/04).

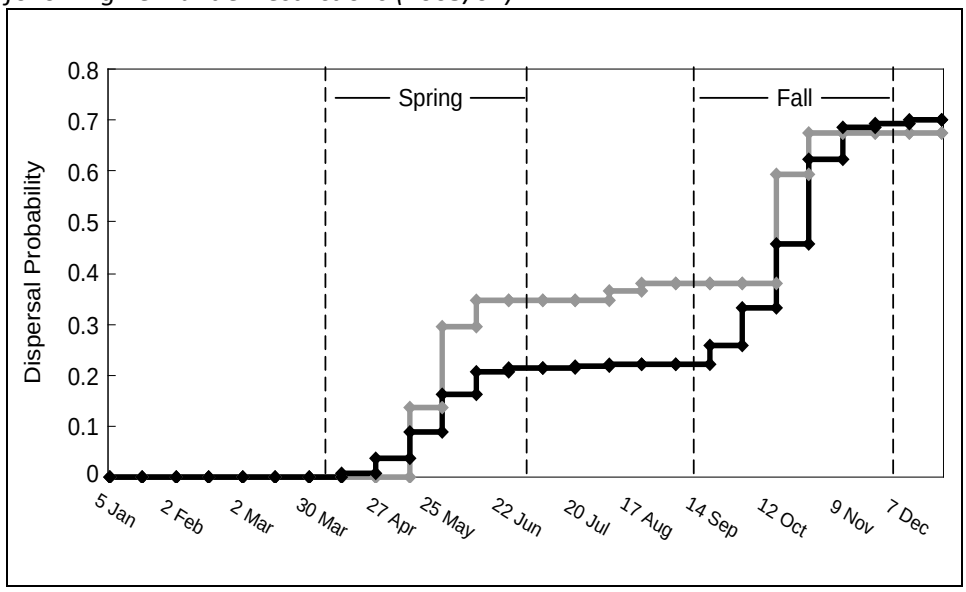
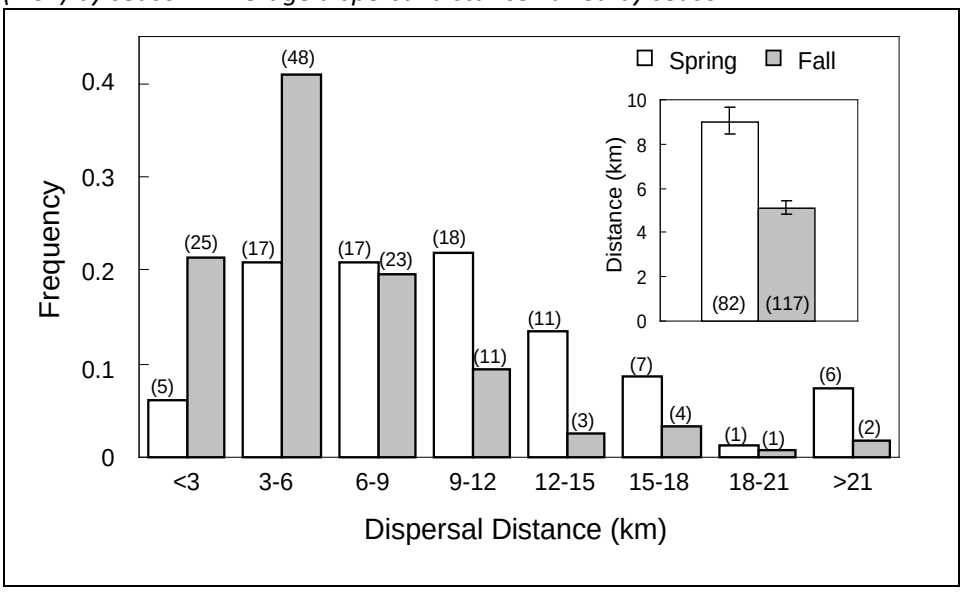


Figure 7. Dispersal distances in kilometers by season for yearling male white-tailed deer in Pennsylvania. Data for yearling bucks that did not disperse are not included. Inset shows mean dispersal distance (± SE) by season. Average dispersal distance varied by season.



The U.S. Department of Agriculture (USDA) has expressed increased concern about Foot-and-Mouth Disease (FMD) in recent years. FMD is a highly infectious and economically devastating viral disease that severely affects all domestic and wild ruminants such as cattle, pigs, sheep, goats, and deer species. FMD causes blisters on the feet, mouth and teats. Other clinical signs

include lameness, lethargy, loss of appetite, excessive salivation, and pregnant females infected with FMD may abort their fetuses. Some animals that are severely infected by the disease may die, but chronic debilitating infections are much more common. Several outbreaks throughout the world since 2000 have raised the concern of personnel in many agricultural and wildlife agencies in the U.S. The most serious impacts of FMD would be to the beef and dairy cattle industry. The USDA predicts FMD could cost the United States livestock industry billions of dollars in the first year. Deer would be important if FMD is detected in the U.S., because deer would likely become infected and would probably become a reservoir for the disease. This would allow livestock to become re-infected. which would increase the probability of having the disease persist and become endemic.

Bovine Tuberculosis (TB) is a contagious respiratory disease caused by the bacterium *Mycobacterium bovis*. Bovine TB infects warm-blooded animals, including humans, and is most commonly transmitted by close contact between individual animals. The federal government has tested cattle herds across the U.S. to control bovine TB, but the disease still occurs in cattle, penned exotic livestock, and occasionally wild deer. Michigan has been actively monitoring bovine TB in their free-ranging white-tailed deer herd since 1994. More recently, bovine TB was discovered in 11 cattle operations in northwestern Minnesota in 2005. Surveillance for the disease in hunter-harvested deer has confirmed 18 cases in free-ranging deer with more suspected samples pending. In 2006, Minnesota lost its bovine TB "free" status from the USDA. The status level was again dropped in 2008 with the discovery of additional bovine TB infected livestock operations and wild deer. This downgraded status subjects the Minnesota cattle industry to mandatory testing and places restrictions on the movement of cattle. The presence of bovine TB in a deer herd poses a significant problem. The health of Michigan's and now Minnesota's deer herd, livestock, and most importantly, state residents is now at risk to bovine TB.

Chronic Wasting Disease (CWD) belongs to a family of diseases known as transmissible spongiform encephalopathies (TSEs). TSEs are fatal diseases of the central nervous system. They cause microscopic holes in brain tissue giving it a sponge-like appearance. TSEs include such diseases as scrapie in sheep, bovine spongiform encephalopathy or "mad cow" in cattle, mink encephalopathy, and Creutzfeldt-Jakob disease in humans (Williams et al. 2002). First recognized in Colorado in 1967, CWD affects animals in the cervid family, primarily deer and elk. Since 1967, CWD has been found in both captive and free-ranging wild populations in a number of states and Canadian provinces (Spraker et al. 1997, Miller et al. 2000, Williams et al. 2002). New York and West Virginia are the closest states to Pennsylvania where CWD has been detected. The exact means by which CWD is spread from animal to animal is not known, but it is believed to be spread through body fluids, fecal material, or contaminated environments (Miller et al. 2004**,** Mathiason et al. 2006). No treatment or vaccine is known for CWD, and once infected, the disease is always fatal. Infected deer and elk can appear robust and healthy in the early stages of CWD. In experimentally infected captive deer, the time from exposure to onset of clinical signs of the disease was about 15 months and the average time to death was 23 months. Among deer and elk residing in facilities with a long history of CWD, most natural cases occur in 2-7 year-old animals (Williams et al. 2002). Clinical signs of the disease include poor body condition, weight loss, rough hair coat, tremors, stumbling, increased salivation, difficulty swallowing, and excessive thirst or urination but CWD positive animals can only be

confirmed though laboratory testing (Williams et al. 2002). There is no scientific evidence that CWD can, through natural routes of infection, be transmitted to either humans or livestock (Hamir et al. 2005, MaWhinney et al. 2006). The Game Commission has been actively testing wild deer for CWD since 1998. As of December 2009, CWD has not been detected in captive or wild deer herds in Pennsylvania. In the event of detecting CWD, the Game Commission will respond according to Pennsylvania's CWD Interagency Response Plan.

Lyme disease was first recognized in the U.S. in 1975. Lyme disease is caused by the spirochete *Borrelia burgdorferi* and is spread through the bite of an infected tick. The black-legged tick or deer tick (*Ixodes scapularis*) primarily spreads Lyme disease in the northeastern and north-central U.S., but the Lyme bacterium can be carried and spread by other species of tick (CDC 2006, Schulze et al. 2005). Lyme disease poses a significant threat to humans. If left untreated, it could lead to serious health issues including arthritis; nervous system symptoms including numbness, pain, and nerve paralysis; and problems with memory or cognition, fatigue, headache, and sleep disturbances (CDC 2006). Deer were once thought to be a factor in the transmission of Lyme disease serving as a reservoir for the disease during winter months and primary host for the adult deer tick (Davis et al. 1984, Habicht et al. 1987). However, further research has shown that deer are dead-end hosts for the disease and play no role in the transmission cycle (Underwood 2005, Perkins et al. 2006). Humans are most likely to contract Lyme disease from the bite of an infected nymph stage tick (Ostfeld et al. 2006). Woodland rodents, especially white-footed mice, are most likely to infect larval and nymph stages of *I. scapularis* with the Lyme disease bacterium (Ostfeld et al. 2006, Perkins et al. 2006). Deer play a part in the complex life cycle of *I. scapularis.* Adult ticks primarily feed on deer or other large vertebrates hosts in mid-autumn to complete their life cycle (Underwood 2005, Perkins et al. 2006). Reducing deer numbers in an area does not always reduce the number of ticks (Ostfeld et al. 2006, Perkins et al. 2006). Abundance of rodent hosts (i.e., mice and chipmunks) and acorns (rodent food supply) were found to be the most important factors affecting the risk of Lyme disease in a 13-year study. A 3-fold variation in deer abundance did not affect the risk of Lyme disease (Ostfeld et al. 2006).

Epizootic Hemorrhagic Disease (EHD) and Bluetongue are diseases of wild ungulates caused by viruses of the genus *Orbivirus* and are considered the most important infectious agents for white-tailed deer (Thomas 1981). EHD viruses are widespread throughout North America and periodically cause epidemics in wild deer populations. Severity of EHD outbreaks is variable and may be related to herd immunity. EHD is transmitted by various species of Culicoides midges. EHD outbreaks occur in late summer and early fall (Thomas 1981). This is thought to be related to seasonal wind patterns moving the insect vector northwards from endemic areas in the U.S. Signs and symptoms of EHD are variable, ranging from none to sickness or sudden death. Sick and dead animals are often found near water, as a result of the high fever that accompanies the disease. Other symptoms include swelling of the face, tongue, or neck; weakness and disorientation; lameness; extensive hemorrhaging in many tissues including the liver, intestinal tract, lungs, and heart; ulcers in the mouth, tongue, and stomachs; and curved and cracked hooves. EHD does not infect humans (Thomas 1981). Losses due to EHD have occurred in Pennsylvania in 1996, 2002, and 2007. While mortality associated with EHD may seem dramatic, local populations rebound quickly after an outbreak. And animals that survive an EHD infection develop antibodies that protect them from future outbreaks (Davidson 2006).

Transmission risks of diseases such as FMD, bovine TB, and CWD (Miller et al. 2000), are increased when deer are in close contact to one another. Thus, high deer densities or congregated animals at artificial feeding sites can increase transmission rates of these diseases in the population. EHD is not related to deer densities (Thomas 1981, Davidson 2006), but activities that concentrate deer can lead to increased exposure. Reducing deer numbers has been an inefficient technique for preventing Lyme disease (Duffy et al. 1994, Ostfeld et al. 2006).

POPULATION ECOLOGY

It is widely accepted in the scientific community that recruitment (i.e., the number of fawns born in spring that survive until fall) in white-tailed deer populations shows strong density dependent effects (McCullough 1979, 1984, 1987, 2001, White and Bartmann 1997). This means that the number of fawns recruited into the deer herd can decrease even though population numbers increase, because there is only so much food and cover available to a deer population. Therefore, the amount of food and cover per deer will decrease as deer numbers increase, which then results in fewer resources per animal.

Density impacts on deer populations

Each deer in a herd requires a certain amount of food (energy) and cover to survive and reproduce (Moen 1978). The impact deer densities have on survival and reproduction is negligible provided food and cover resources per deer are sufficient to meet their baseline metabolic requirements (McCullough 1987). When the amount of food available to individual deer is insufficient, deer will have lower body weights and bucks, particularly yearling males, will have antlers with fewer points and smaller beam diameters. Further, deer are predisposed to starvation and disease because of their deteriorated physical condition. However, the effect on survival is usually negligible because most mortality can be attributed to hunting (McCullough 1987).

The effects of deer density on recruitment are generally more apparent. Fawn recruitment rates are maximized at low population densities, but recruitment begins to decline when the amount of food available to each deer is not sufficient, which causes them to compete for food. Poor food availability reduces fawn recruitment rates because the lactating doe may not be able to adequately supply milk to her fawn.

To summarize, recruitment rates are highest when deer numbers are low, and recruitment rates begin to decline when the deer herd begins to compete for a fixed amount of resources. When a deer population is at its biological carrying capacity, the deer density may be at its highest, but recruitment of fawns will be at its lowest. To maintain a population at a particular level, the same number of deer recruited into a population also must be removed by hunting and natural mortality. The population will decrease if the number of deer that die exceeds the number of deer recruited into the population. Conversely, the population will increase if fawn recruitment exceeds the number of deer that die. The result of low fawn recruitment means fewer bucks and does can be harvested when populations are high or near biological carrying capacity.

DEER-HABITAT RELATIONSHIPS

"Sportsmanly chivalry has become so deep-rooted in the conservation-minded hunters of Pennsylvania that we are finding the second step in game restoration the hardest -- getting sportsmen to realize that it is just as important to limit the number of a species to within its food supply …"

Ross Leffler, January 29, 1931

Deer, being adaptable creatures, are found in a variety of environments; however, they are best suited to forested habitats. Forests provide deer with a place to eat, to rest, to escape, to bear and rear young. Like all other animals, deer have certain living requirements essential to their existence; food for nourishment and cover for protection are the two most important. To a deer, home is the forest.

The importance of food to deer is beyond question; deer must eat to survive. How well they live depends on the quality, quantity, and availability of food.

Although deer eat a great variety of vegetative material, not all plants or parts of plants are good deer forage; nor is every plant, or part of a plant, equally nutritious and palatable to deer at all times of year (Table 6).

Deer are capable of recognizing nutritional differences and select food accordingly. A general listing of preferred and non-preferred foods would be an oversimplification of the complex nature of the subject. Preferences should be considered in terms of availability in a particular area at a specific time. For example, in one study, deer preferred natural vegetation over a nutritionally complete deer pellet ration in spring when new leaves emerged (Liscinsky 1977).

Perhaps the best way to summarize the qualitative aspects of deer food is to relate some findings from detailed studies. Calcium and phosphorus needs are interrelated. Captive deer fed low energy, low calcium and phosphorus, or low protein diets were small in size compared to deer that were fed enough of a nutritionally complete ration to satisfy their needs (French et al. 1955). Some males on deficient diets only produced spikes as 2.5 year-old males, whereas males on complete diets produced at least 6 points as 2.5 year-olds. Study deer came from across Pennsylvania. Another study took wild male fawns from an area of poor habitat (i.e., southern Potter, eastern Cameron, and northern Clinton counties), released the animals in a large enclosure, and provided them with a complete ration of pelleted deer food. At 1 year and 3 months-of-age, males in the enclosure weighed approximately 30 percent more than wild deer of the same age from the same area with poor habitat and were of similar size to males of the same age from areas with good habitat (Liscinsky 1977).

Deer food requirements vary with sex, age, and season of year (Table 7, French et al. 1955). During the critical winter period the average adult deer should have about 5 pounds of dry-weight forage daily. In more visual terms, this amount of chopped-up twigs would nearly fill a half-bushel basket.

Table 6. Calories per pound for various plants eaten by deer (Harlow 1984, Pekins and Mautz 1988).

Species	Calories per pound
Acorns	2,300
Hemlock foliage	2,300
Hobblebush twigs	2,100
Maple twigs	2,100
Aspen	1,150
Pine foliage and twigs	1,100
Cedar	1,050

Table 7. Daily requirement (pounds and calories) of good quality, air-dry food, and equivalent of deer browse with usual moisture content for white-tailed deer by size. Results from French et al. 1955.

Deer Weight	Dry-air Food (pounds)	Calories	Browse (pounds)
50 to 60 pounds	2	3,600	4
100 pounds	3 to 4	6,300	6 to 8
150 pounds	5 to 6	9,900	10 to 12

Natural food availability directly affects deer health. From the age structure of a forest to unpredictability of mast and fruit crops, a complex relationship exists between deer and natural foods.

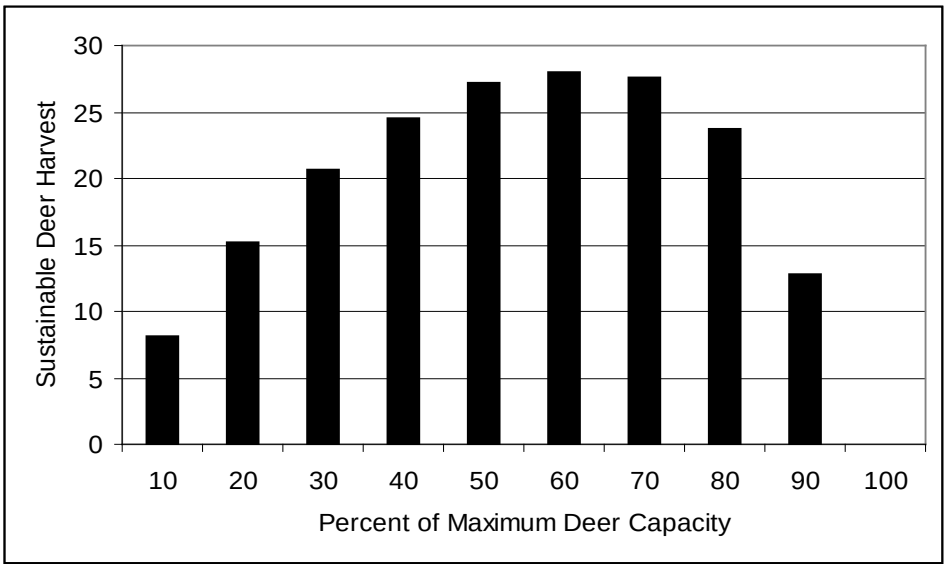
Different age forests can support different numbers of deer. In deer feeding capacity studies in Pennsylvania's northern hardwood and mixed oak forests, seedling/sapling stands could support the greatest number of deer, poletimber stands could support few or no deer, and sawtimber stands could support a moderate number of deer (Drake and Palmer 1986, 1991). These study results were the foundation for pre-2005 deer management objectives of 40-60 deer per square mile for seedling/sapling stands, 5-10 deer per square mile for poletimber stands, and 20 deer per square mile for sawtimber stands.

From a hunting perspective, the feeding capacity studies demonstrated the maximum number of deer that could be supported. However, a huntable population cannot be maintained at maximum numbers. To allow hunters to sustainably harvest deer, a population must be maintained at less than maximum carrying capacity. In fact, the largest hunter harvest of deer occurs at deer populations levels of approximately 50 to 60 percent of maximum carrying capacity (Figure 8; McCullough 1979, Downing and Guynn 1985).

In addition to food variability associated with different forest ages, availability of individual food items may vary. Acorns are a valuable, yet sporadic food source for deer. Abundant acorn crops can lead to increases in body weight and antler growth (Figure 9; Liscinsky et al. 1981, Wentworth et al. 1992, Kammermeyer and Carlock 2000). Acorn production is unpredictable. In a 27-year study in Huntingdon County, Pennsylvania, acorn production varied from 0 to 582

pounds per acre (Figure 10; Cogan 1995). In years without abundant acorn crops, deer must rely on other foods within their home-range.

Figure 8. An example of sustainable deer harvest compared to deer population size. Note the highest deer harvest occurs around 60 percent of the maximum deer population, not at the highest deer population. Graph based on the generalized sustained yield table in Downing and Guynn 1985.



Deer are dependent upon the habitat within their home range and typically do not travel far for food. They are creatures of habit and seldom make drastic behavior changes within a short period of time. When movements outside of their home range do occur, they are often related to social changes during the fawning and breeding seasons (Rosenberry et al. 1999, Shaw et al. 2006, Long et al. 2008). However, deer will alter movement patterns within their home range to take advantage of food and cover.

Vegetation that affords protection to an animal is commonly referred to as cover. Dense thickets, especially evergreens, usually jump to mind as being best for deer. This type of cover is perfect for winter. The key word is "protection" – protection from all enemies, be they man, beast, insects, or weather. Some kind of protection is needed during all seasons of the year, not just winter.

In Pennsylvania, the most essential cover component is probably winter protection within extensive hardwood stands. This kind of cover is best provided in areas protected from cold winds with southern exposures. Heavy snows can cause deer to move from high elevations to lower, protected valleys particularly into areas with conifer cover (Drake 1972). A source of natural foods in the vicinity of good winter cover is the ideal way to carry deer through this critical time of year. However, deer in good physical condition can fast for weeks if necessary (Ozoga and Verme 1970). When winters are mild and food abundant, cover becomes less important.

Figure 9. Relationship between acorn crops and yearling male antler beam diameters, Sproul State Forest, Pennsylvania, 1972-1978. Figure recreated from Liscinsky et al. 1981.

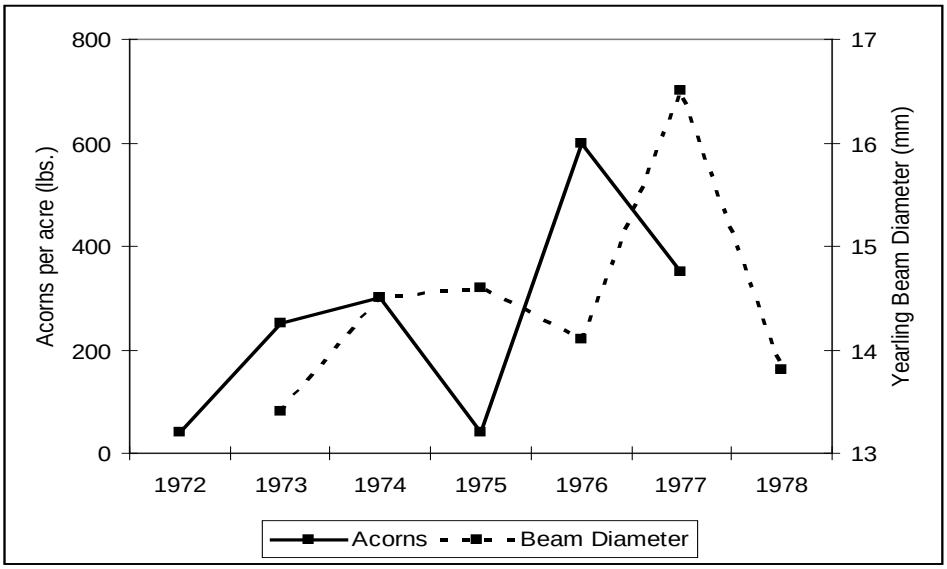
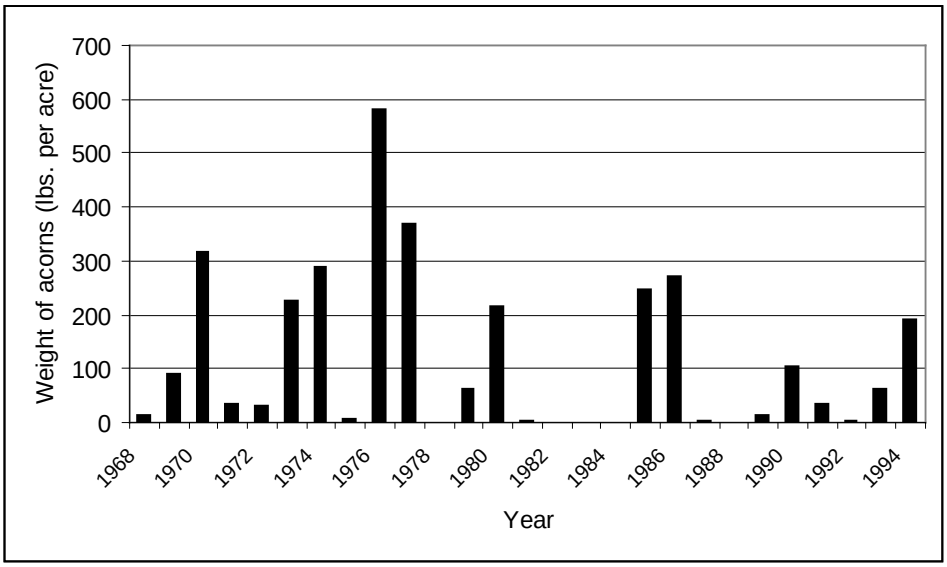


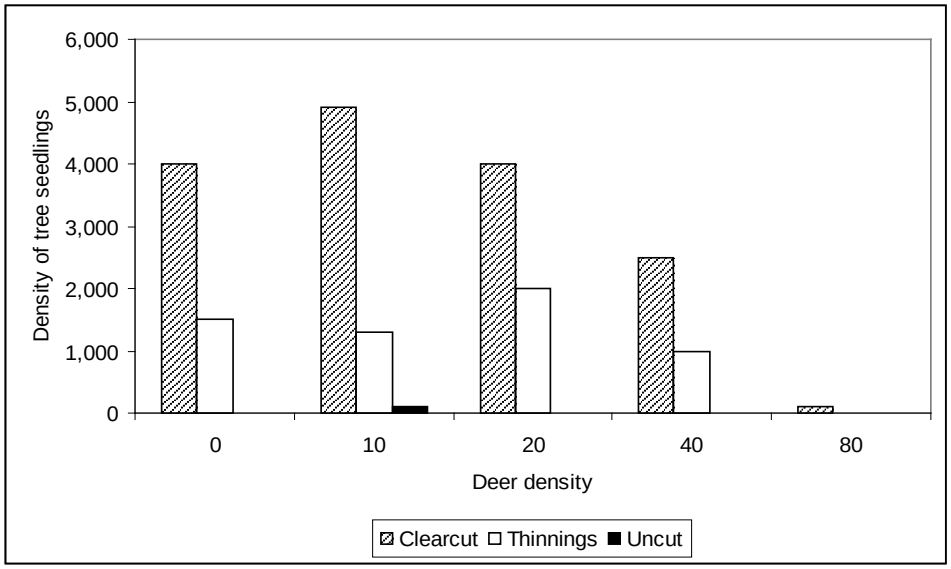
Figure 10. Weight (lbs.) of well-developed, sound acorns produced per acre in a mature mixed-oak stand in Huntingdon County, Pennsylvania 1968-1994.



Just as forest habitat can affect deer, deer can affect forests. Negative impacts of deer on forests in Pennsylvania have a long history dating back to the early 1900s (Clepper 1931). Increasing deer populations can degrade vegetation communities (Figure 11; Tilghman 1989) and habitat for other wildlife species (deCalesta 1994).

Deer density and its impact on forests is not a simple relationship. As shown in Figure 11, seedling density was affected by type of forest treatment regardless of deer density. Forest type and nearby landscape characteristics can affect deer impacts on forests as well (deCalesta and Stout 1997). It is important for managers to look at numerous factors when assessing potential deer impacts on forests.

Figure 11. Density of seedlings (seedlings per ha) at specific deer densities (deer per square mile) for 3 different forestry treatments (clearcut, thinning, uncut). Results based on sensitive-commercial species seedlings >0.9m from Tilghman 1989.



RECREATION, ECONOMIC SIGNIFICANCE, AND PUBLIC INTEREST

Deer have many positive values and provide many benefits to the Commonwealth. The state legislature – as well as many Pennsylvanians – so highly values the white-tailed deer that it has been officially designated as the "state animal" since 1959. The opening day of the rifle deer season is respected as a state "holiday" in localities throughout Pennsylvania; many school districts schedule this day off so students and teachers can hunt.

HUNTING

The white-tailed deer is one of the most widespread and popular game species in North America providing significant recreational value (Conover et al. 1995, Lynch 1997). According to the 2006 National Survey of Hunting, Fishing, and Wildlife-Associated Recreation, there are more than 10 million deer hunters in the U.S. or 94% of all big game hunters. Nationally, deer hunters spent more than 132 million days hunting deer (U.S. Department of Interior and U.S. Department of Commerce 2007a). Pennsylvania ranks second in the nation for the most participants of in-state hunters (U.S. Department of Interior and U.S. Department of Commerce 2007b).

Deer are the only species hunted in Pennsylvania by the majority of hunters (Responsive Management 2004). When asked to rate the importance of hunting to them personally, 41% of those interviewed rated it as "10" on a scale of 1 to 10 with 10 being very important. Eighty-eight percent gave a rating of "6" or higher (Responsive Management 2004). The most recent surveys indicate Pennsylvania has more than 700,000 deer hunters (Table 8). Nationwide, the number of hunters has been steadily declining. Since 1991, national hunter numbers have declined 11% (U.S. Department of Interior and U.S. Department of Commerce 2002, U.S. Department of Interior and U.S. Department of Commerce 2007a). Pennsylvania has experienced a 9% decline in general hunter numbers and a 22% decline in deer hunter numbers since 1994. Even with declines in deer hunter numbers, deer hunters in Pennsylvania spent more than 6.8 million days pursuing deer in 2006 (Table 8).

Many deer hunting opportunities exist in Pennsylvania, and hunter success has been relatively consistent and deer harvests have exceeded 300,000 for the past 20 years (Table 1). A hunting season has been held for deer every year since the 1800s, and an antlered and antlerless hunting season has been held every year since 1957. Archery stamps have been sold since 1951 and muzzleloader stamps since 1974. However, there is still considerable interest in expanding deer hunting opportunities in Pennsylvania (Responsive Management 2004).

RECREATION

Human society likely receives more benefits from deer than any other wildlife species (Conover 1997a). In fact, U.S. metropolitan residents gave deer a higher preference rating than any other mammalian wildlife species (Conover 1997a, Conover 1997b). Deer have a high positive

existence value. Existence values can be defined as a sense of well-being that people feel from knowing that deer exist and are thriving in nature (Conover 1997a). People value deer as a subject for learning more about nature and about deer themselves. They also are seen as an indicator of environmental quality (Stout et al. 1993).

Table 8. General hunting license sales, deer hunters, archery and muzzleloader stamps sold, and days spent deer hunting in Pennsylvania, 1986 to 2008.

Year	General Hunting License Sold	Total Deer Hunters[1]	Archery Stamps Sold	Muzzleloader Stamps Sold	Total Deer Hunter Days[1]
1986	1,166,771	1,019,644	246,099	79,182	Not available
1987	1,171,507	1,012,430	254,770	78,862	Not available
1988	1,164,420	1,006,994	264,796	92,619	Not available
1989	1,156,891	1,024,560	272,364	97,817	Not available
1990	1,160,780	1,013,974	285,352	105,620	7,561,815
1991	1,160,202	1,007,178	296,244	106,372	7,707,280
1992	1,156,736	1,008,725	309,012	103,309	7,615,521
1993	1,130,090	973,662	317,344	77,494	7,846,783
1994	1,116,832	983,703	322,378	76,071	8,843,314
1995	1,087,804	959,880	322,065	79,556	8,081,752
1996	1,088,733	940,127	328,193	83,996	8,511,025
1997	1,063,366	909,489	321,556	83,208	7,955,254
1998	1,069,627	899,965	328,451	90,421	8,046,895
1999	1,033,315	882,580	276,622	106,090	7,991,856
2000	1,038,846	913,646	284,223	137,737	8,190,304
2001	1,047,820	858,622	285,987	147,413	7,287,583
2002	1,017,154	793,502	283,055	166,076	6,875,037
2003	1,018,248	790,595	285,121	188,388	6,401,485
2004	1,013,866	No survey	284,493	200,193	No survey
2005	964,158	739,532	269,752	200,903	6,437,077
2006	945,892	762,936	268,751	198,291	6,858,281
2007	924,448	715,553	266,841	196,054	6,450,948
2008	926,892	708,069	271,023	195,809	6,465,879

[1] – Data from annual Game Take survey of a 2% random sample of Pennsylvania hunting license buyers

In 2006, more than 71 million Americans participated in various non-consumptive wildlife-related activities. This represents an 8% increase in participation from 2001 and a 13% increase in participation from 1996 (U.S. Department of Interior and U.S. Department of Commerce 2007a). Twenty-one million people participated in wildlife watching around the home for large mammals and 12 million people traveled away from home to observe, photograph, or feed large mammals (deer, bear, etc) in the U.S. in 2006 (U.S. Department of Interior and U.S. Department of Commerce 2007a). Pennsylvania ranks in the top 5 for most participants of in-state wildlife watchers (U.S. Department of Interior and U.S. Department of Commerce 2007b).

White-tailed deer are the most easily viewed of all large mammals in Pennsylvania. More than half of Pennsylvanians participate in wildlife viewing (Responsive Management 2003). Wildlife watchers outnumber sportsmen in Pennsylvania by more than 2 to 1 (U.S. Department of Interior and U.S. Department of Commerce 2003). More than 1.2 million people participated in large mammal wildlife watching around the home and 860,000 people participated in large mammal wildlife watching away from home. Activities included observing, photographing, and feeding (U.S. Department of Interior and U.S. Department of Commerce 2003).

Among the people who report watching wildlife in Pennsylvania, 59% are between the ages of 35 and 64, and 22% are 65 or older. Fifty-one percent are male, 55 percent live in urban areas, and 17% hunt (U.S. Department of Interior and U.S. Department of Commerce 2003).

ECONOMIC SIGNIFICANCE

Quantifying the economic influence of the white-tailed deer is not an easy task. Deer provide economic benefits through both hunting and non-hunting activities. America's 10.7 million big game hunters in 2006 spent $11.8 billion on trip and equipment expenses. This is a 21% increase from 1996 (U.S. Department of Interior and U.S. Department of Commerce 1997, U.S. Department of Interior and U.S. Department of Commerce 2007a). In Pennsylvania, hunters spent more than $11 million on deer-related licenses and tags (i.e., DMAP harvest permits, antlerless deer licenses, archery stamps, and muzzleloader stamps) in 2006 (Delutis 2007). This represents 38% of the total license revenue and does not include all general license sales that include an antlered deer tag. Based on the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey, big game hunters spent more than $488 million in Pennsylvania in 2001 (U.S. Department of Interior and U.S. Department of Commerce 2002). These costs included money spent on food, lodging, transportation, and equipment.

But hunting is not the only source of economic benefit from deer. Throughout the United States, 23 million people participated in wildlife-watching away from home and 67.8 million people participated in wildlife-watching around the home (U.S. Department of Interior and U.S. Department of Commerce 2007a). Total wildlife-watching expenditures which include trip-related expenses and equipment totaled $45.7 billion in 2006. This is a 21% increase from 1996 (U.S. Department of Interior and U.S. Department of Commerce 2007a). The total expenditures in Pennsylvania in 2001 associated with wildlife watching activities were more than $962 million. Pennsylvania residents spent $866 million in-state for wildlife watching-related activities in 2001 (U.S. Department of Interior and U.S. Department of Commerce 2003). Although it is impossible to quantify how many people spent how much to observe deer specifically, there is no doubt deer are a popular and observable species among wildlife watchers (Conover 1997a).

Based on this information, deer are clearly an economically beneficial species in Pennsylvania. However, deer also carry negative economic costs. And the majority of these costs are shouldered by individuals (Conover 1997a). Negative monetary values of deer include deer-vehicle collisions, damage to agricultural productivity, damage to timber productivity, and damage to households (Conover 1997a).

An estimated 1.5 million deer-vehicle collisions (DVCs) occur each year in the U.S. The average cost of vehicle repairs was $1,500 which means that total vehicle damage resulting from a collision with a deer exceeded $1 billion annually (Conover et al. 1995).

Based on their known market share in Pennsylvania, State Farm Insurance projected more than 98,000 deer-vehicle claims for all insurance companies in the state during July 1, 2006 – June 30, 2007. Repairing a vehicle may cost more than the national average in Pennsylvania as well ($2,200 in Pennsylvania [Witmer and deCalesta 1992]) resulting in even higher costs annually. It is also estimated that 29,000 people are injured and more than 200 fatalities occur annually in the U.S. as a result of a DVC (Conover et al. 1995). State Troopers reported 21 human fatalities resulted from DVCs on Pennsylvania's state and federal highway system from 1996-2001. Other studies report that four to five percent of all deer-vehicle collisions involve human injury (Hansen 1983).

Crop damage is a cost that is increasingly associated with white-tailed deer. More than any other wildlife species, deer are perceived to cause the most damage to crops (Conover and Decker 1991). Estimated crop damage caused by wildlife costs the United States agriculture industry almost $500 million each year (Wywialowski 1994, Conover et al. 1995).

In Pennsylvania, deer damage to crops is common. Major losses occur in corn, forages, and small grains. Orchards, nurseries, and vegetables that are grown in restricted areas also are heavily damaged. The annual crop loss to deer is estimated between $16 and $30 million (Forest Resources Extension 2007). The uneven distribution of this damage results in excessive losses for individual growers.

Deer browsing on small trees is the main source of deer damage to the timber industry. Excessive deer browsing can kill or retard tree growth, and both represent economic losses to the timber industry. There is a lack of economic data on deer damage to timber in most parts of the U.S. (Conover 1997a). The data that do exist give a glimpse of the losses. In the Pacific Northwest, estimates of annual financial loss in Oregon total $333 million (Nolte and Dykzeul 2002).

In some heavily forested areas of Pennsylvania, deer browsing has completely prevented the reestablishment of forest trees following cutting. Other areas have experienced altered species composition, reduced vegetation density and growth, limited forest management practices, and reduced amount of favorable habitat for other wildlife species (Marquis and Brenneman 1981). Nearly 30 years ago, timber losses to the Allegheny hardwood forest alone were estimated at $1,075 per acre (Marquis 1981). This is a loss of $367 million annually (Conover et al. 1995).

Deer browsing on ornamental trees, shrubbery, and gardens in suburban and residential areas is a common complaint and financially impacts homeowners each year (Connelly et al. 1987, Witham and Jones 1987, Conover 1997b). Wildlife damages incurred by metropolitan residents in the U.S. have been estimated at $3.8 billion annually. This is in addition to spending $1.9 billion and 268 million hours trying to solve or prevent the problem (Conover 1997b). Deer are not responsible for all of this damage. Only 4% of respondents to a 1997 survey reported a

problem with deer. Using this percentage, a conservative estimate of deer damage and preventive measure costs to households is $376 million (Conover 1997a).

PUBLIC INTEREST

One could make the argument that no other wildlife species in the Commonwealth can influence the lives of plants and animals more than the white-tailed deer. Although deer are not at the top of any food chain, they can have an enormous influence on habitat and other wildlife just by eating.

Deer, like people, have preferred foods and will select those they like first. After all the preferred plants are gone, deer will then move onto those they like less.

Deer can have a major impact on the natural community in which they live. As the number of deer increases, plants that are preferred by deer will become less abundant or may disappear (Ross et al.. 1970, Marquis 1981, Tilghman 1989, Healy 1997). Preferred plants (i.e., those that are highly palatable to deer) become scarce as deer densities increase, because there are too many animals consuming a fixed number of plants. The disappearance of highly palatable plants adversely affects other wildlife species that rely on these plants for food and cover that can cause a dramatic reduction of biodiversity in forest ecosystems (Whitney 1984, McShea and Rappole 1992, deCalesta 1994, 1997).

Necessary food and cover for a variety of songbirds and small mammals disappear from overbrowsed areas. At Catoctin Mountain Park in Maryland, for example, the unmanaged deer herd resulted in lower tree regeneration, less understory cover and biodiversity between 0.3 to 5 feet above the ground, and a lower density of ground-nesting birds than compared with the Frederick City Watershed Cooperative Wildlife Management Area, where deer were managed by the Maryland Department of Natural Resources (Bates et al. 2007).

An Allegheny National Forest study showed deer overbrowsing had the greatest effect on intermediate canopy-nesting birds. The study noted that species such as indigo buntings and eastern wood pewees disappeared from the forest when deer densities got too high (DeCalesta 1994). Birds are a vital part of our forest ecosystem. Consider the diet of these and other birds that depend on the area below the browse line. It often consists of insects and caterpillars including some that are potentially destructive to our forests and backyard shade trees.

Further, plants that are less palatable to deer may increase in abundance. The abundance of less palatable plants may inhibit regeneration of other plant species, further complicating succession. Finally, deer are at greater risk when they overbrowse their forest habitat. Previous studies have linked reduced recruitment and natural survival rates of deer to food availability and habitat conditions (McCullough 1979, DePerno et al. 2000). In general, when habitat conditions decline, so will deer populations.

DEER POPULATION MANAGEMENT

DEER POPULATION TREND OBJECTIVES

A deer population trend objective in each WMU is limited to one of three options; 1) increase, 2) decrease, or 3) remain the same. A decision on whether a population should increase, decrease, or remain the same will depend on deer management goals of healthy deer, healthy forest habitat, and acceptable levels of deer-human conflicts.

ROLE OF REGULATED HUNTING

The Game Commission uses hunting as the principal method for controlling deer numbers and deer impacts in the Commonwealth. Regulated hunting of deer has been proven to be an effective management tool, and the most efficient and least expensive technique for removing or managing deer numbers (Ellingwood and Caturano 1988). The Game Commission, as the state agency responsible for wildlife management, is directed by law to use hunting for management of game populations, including deer (34 Pa. Code, Section 103). Additionally, an important legal duty is to promote Pennsylvania's hunting heritage and provide adequate opportunities to hunt in the Commonwealth. At times, when regular hunting seasons prove insufficient or ineffective in adequately managing deer herd impacts, special laws, regulations and programs are used to facilitate the taking of additional deer.

CONSEQUENCES OF HARVEST MANAGEMENT OPTIONS

The long-term consequences of most deer management strategies are predictable based on what is known about the population ecology of deer and historical management practices. This section discusses deer harvest management strategies that are frequently suggested and/or endorsed by various groups.

No deer hunting

Unless winter weather conditions frequently impact deer thereby regulating their population (this happens along the northern fringe of their range), hunting is absolutely necessary to keep deer herds from growing beyond their biological carrying capacity (McCullough 1979). The "No deer hunting" strategy is promoted most by people and groups that do not support hunting. Farmers and foresters concerned about economic losses, all deer hunters, taxidermists, meat processors, and people concerned about deer-vehicle collisions or habitat and landscape damage typically do not support the "no hunting" alternative.

Antlered-only deer hunting

Similar to no deer hunting, bucks-only hunting results in the deer population quickly growing to its biological carrying capacity (McCullough 1987). This is because male deer are promiscuous breeders and one antlered male can breed with multiple females. Harvest of females is necessary

to control population growth. Although hunters would see many antlerless deer, their success rates likely would be low as a result of diminished fawn recruitment rates that occur when deer numbers are near or beyond their biological carrying capacity.

Regulated deer hunting

Regulated deer hunting, which includes harvesting both antlered and antlerless deer, has long been the primary tool used by wildlife agencies to manage deer populations (Woolf and Roseberry 1998). Regulated deer hunting provides a unique opportunity for those who participate, and is the most fiscally-responsible, effective technique available for controlling deer herd sizes given the technology available and regulations in place today.

A common argument against regulated deer hunting is that it increases deer reproduction rates. In other words, it is counter-productive to reducing deer populations, because deer will increase reproduction to compensate for fewer deer.

This may be true for individual deer, but not for a population. For example, if a population is at 50 percent of biological carrying capacity, individual females may produce 1.6 fawns per female (Downing and Guynn 1985). If the population is reduced to 30 percent of carrying capacity, individual females may produce 1.8 fawns per female. As a population is reduced in relation to biological carrying capacity, individual deer can produce more fawns. However, this increase in individual reproduction does not compensate for fewer deer.

A smaller deer population will produce fewer fawns. For example, if a population is at 50 percent of biological carrying capacity with 50 adult females, the population can produce 88 fawns. If the population is reduced to 30 percent of biological carrying capacity and contains 30 adult females, the population may produce 70 fawns (Downing and Guynn 1985). The smaller population produces fewer fawns, despite an increase in individual female reproduction.

Regulated deer hunting is an ongoing management action. For regulated deer hunting to be effective in managing deer populations at levels where impacts are acceptable, it must be done on a regular basis. Finally, hunting is not counterproductive to an objective to reduce deer populations. Although fewer deer may result in increases in individual reproductive output, this increase in reproductive output cannot compensate for lower deer numbers.

TRAP AND TRANSFER

Back in 1906, the Game Commission launched a deer stocking program to accelerate restoration of the deer herd. At the end of the 19-year program, 1,200 deer from Kentucky, Maine, Michigan, New Hampshire, New Jersey, North Carolina, Ohio, and Pennsylvania had been trapped and transferred throughout Pennsylvania (Kosack 1995).

Today, requests to transfer deer are still heard. But the times have changed. Although market killing and unregulated harvest reduced most game in Pennsylvania at the previous turn of the century, our last century turned with deer in every corner of the state. The need to move deer from one location to another to reestablish a population is long gone.

The call to move deer usually stems from the desire to preserve individual deer in urban and suburban environments. Excessive deer populations in these areas and lack of a strong hunting heritage prompt requests for moving deer out of neighborhoods where they are causing problems or are perceived to be in danger.

Over the last 100 years, our knowledge of deer biology, behavior, and disease has grown by volumes. Translocating deer moves the needs of those deer to the new location; a location that already supports deer. Unlike 1906, there are no areas devoid of our state animal, and no empty or excess habitat to support a new population. Moving deer places more stress on the existing habitat to support those additions.

When a deer is relocated, it's not just the deer. Disease agents and parasites also are relocated. Meningeal worm was introduced to Florida and Georgia from deer that were moved from Wisconsin and Pennsylvania in the 1920s (Keel 2009, Davidson 2006). Chronic Wasting Disease (CWD) which is a contagious, environmentally contaminating, and always fatal disease to deer and elk species was introduced into Saskatchewan in 1989 from an imported elk. It wasn't detected until 7 years later (Keel 2009). CWD has been found in New York and West Virginia and is believed to have been introduced from an outside source as well. Deer can be reservoirs for bovine brucellosis and tuberculosis, which have implication for not only deer, but also livestock. Deer also carry parasites like ticks, which serve as vectors of the human diseases such as Lyme disease and ehrlichioses.

Finally, transporting live deer is very stressful to them, and results in high mortality both during transfer and after release. Several studies document this, some demonstrating fewer than half of deer transferred survive more than a year in their new surroundings (Jones and Witham 1990, Mayer et al. 1995, Cromwell et al 1999, Missouri Conservationist 1999, Beringer et al. 2002). Of the 1,200 deer purchased between 1906 and 1925, the number that actually survived the release and contributed to the state's whitetail recovery is unknown. In addition to these low survival rates, deer captured from urban/suburban areas usually seek out comparable residential locations defeating any justification for this type of the program (Beringer et al. 2002, Cromwell et al. 1999).

As a result of the disease risk, stress and mortality risks, and lack of need for population restoration, the Game Commission does not permit the use of trap and transfer as a deer management option. For areas where deer impacts exceed acceptable levels, other population reduction methods exist, such as hunting or sharpshooting. Where more deer can exist in balance with habitat, wildlife, and people, the deer population can be increased by reducing antlerless deer harvests. Trap and transfer neither protects individual deer from stress and mortality, nor is it a needed method for deer population restoration.

FERTILITY CONTROL

Research on wildlife fertility control agents is more than four decades old. It has been fueled by desires to control overabundant wildlife causing conflicts with humans. Changing landscapes and increased interest in nonlethal methods of population control have spawned a debate over traditional wildlife management techniques and the role of wildlife fertility control agents. Some

members of the public believe fertility control to be more humane and morally acceptable than lethal management techniques. However, these perceptions do not take into account the efficiency, practicality, or safety of these drugs.

Fertility control agents for white-tailed deer are known as immunocontraception vaccines. These vaccines use the animal's immune system to produce antibodies that prevent pregnancy by interfering with proteins and hormones essential to reproduction. Currently, there are 2 types of immunocontraception vaccines that can be used in white-tailed deer: Porcine Zona Pellucida (PZP) and Gonadotropin Releasing Hormone (GnRH) (Fagerstone et al 2006). Advantages of PZP include: 1) breakdown in the gastrointestinal tract which precludes its entry into the food chain, 2) normally reversible when the antibody level declines in the body, and 3) reduced fertility in most female mammals. A single-shot has been effective in reducing fertility in white-tailed deer females for at least 5 years in some animals. Disadvantages of PZP are that it must be applied as an injection (no effective remote delivery) and it results in multi-estrous cycles (up to 7 cycles in treated deer) which could result in late season births if antibody levels fall below a critical threshold (Fagerstone et al 2006). Advantages of GnRH are that it: 1) is normally reversible when the antibody level declines in the body, 2) it is not sex specific and reduces fertility in most mammals, and 3) does not result in multi-estrous cycles. Disadvantages of GnRH are that it must be applied as an injection and it affects social behavior by reducing the sexual activity of both sexes. A single-shot of GnRH is effective for 1 to 2 years in reducing fertility (Fagerstone et al 2006). PZP remains experimental and has not been approved by the Food and Drug Administration (FDA) or Environmental Protection Agency (EPA). GonaCon was registered with the EPA as a restricted use pesticide in September 2009.

Although fertility control agents can stop reproduction in individual animals, effect on populations is the most important measure for deer management. Population modeling comparing the relative efficiency of reproductive control and lethal control in wildlife populations has been conducted. Results show that fertility control agents would be most effective in managing smaller wildlife species (rats and cowbirds) with high reproductive rates and low survival rates. Conversely, to achieve population reductions in those species with a low reproductive rate and high survival rate lethal control is more efficient (Fagerstone et al 2006). Deer have a low reproductive rate, compared to smaller wildlife species, and a life span of 10-12 years. Fertility control alone would probably not be effective in reducing the population. Modeling has shown that maintaining deer populations at a desired level is possible with long-lasting contraceptives (lasting 4 years) but reducing populations would be difficult without some lethal control (Fagerstone et al 2006).

In addition to population modeling, field studies of fertility control agents on deer populations have been conducted. The 2 largest and longest running field studies have occurred on Fire Island National Seashore in New York and National Institute of Standards and Technology (NIST) in Maryland. Fire Island National Seashore started using PZP in 1993. Population density on the most heavily treated area saw a 50% decline in the population by 2002. Initially, this area experienced a population increase after initiation of the study (Rutberg 2005, Underwood 2005). In other treated areas of Fire Island, population effects were not as clear. "One conclusion is perfectly clear, however; management horizons of at least a decade are not unreasonable when attempting to evaluate fertility control for managing free-ranging deer"

(Underwood 2005). The NIST PZP study began in 1993 as well. From 1993 to 1997, the deer population increased by 10.6% per year. From 1997-2002, the deer population decreased by 7.9% per year (Rutburg et al 2004). So after 10 years, the population and deer-vehicle collisions were the same as when the study was initiated. This population decline was precipitated by high mortality due to deer-vehicle collisions and low reproductive rates of untreated females associated with high deer densities (Rutburg et al 2004). As a result, effects of fertility control on deer populations remain ambiguous.

Stabilization or modest population reductions under relatively ideal conditions (i.e., small areas of 1 square mile or less, access to nearly all deer, isolated deer populations, and resources to support intensive field work) do not prove fertility control as a practical deer management tool. On Fire Island, deer population reduction occurred in one area but not in others (Underwood 2005). At NIST, factors other than fertility control, such as deer-vehicle collisions and high deer density, influenced deer population changes (Rutberg et al. 2004). And in both cases, fertility control was shown to be a multi-year process to stabilize deer populations.

Current fertility control agents are not timely deer management tools. By the time communities initiate action to manage local deer populations, conflicts are typically at crisis level. The questions regarding fertility control agents in these situations not only center on biological and financial feasibility but also timeliness. For a community contemplating use of contraceptives for deer management, a number of questions must be asked. First, do deer impacts exceed safe and acceptable levels? An affirmative answer to this question is a prerequisite for a community to take action to manage deer impacts. Otherwise, the debate will not focus on a solution, but rather on whether or not there is a problem. Second, can a community suffering unacceptable deer-human conflicts wait 10 years for the population and deer-human conflicts to stabilize? If a deer population can be stabilized using fertility control agents, populations still need to be reduced to alleviate deer-human conflicts. Is reducing a deer population via deer-vehicle collisions acceptable? “From a wildlife conflict resolution viewpoint, if you can’t stabilize or reduce a deer population with a contraceptive—no matter how well it works on treated individuals—you don’t have a management tool” (Rutberg 2005). Additionally, if this stabilization or reduction does not occur in a reasonable timeframe, you also do not have a management tool.

The Game Commission is struggling to control urban/suburban deer populations and continues to search for effective and practical tools to reduce these deer populations and thus deer-human conflicts. In Pennsylvania’s most developed areas, survival rates and reproductive rates create a situation where there is little room for error if contraceptives were to stabilize deer populations. For example, to stabilize a deer population with average non-hunting survival and reproduction rates, 95 percent of all adult females would need to be treated with a fertility control agent that was 90 percent effective to stabilize a deer population. It took 7 years to reach this level of treatment on the 570-acre NIST study site (Rutberg et al. 2004). Again, fertility control agents are not a short-term solution. Although the Game Commission understands the desire by some to use fertility control agents as an alternative to lethal methods, fertility control agents have not demonstrated an ability to reduce deer-human conflicts.

CONCLUSION

Different stakeholders want different deer densities for different reasons. These reasons range from individual beliefs and self-gratification to economics and environmental concerns. Table 9 also depicts the impracticality of pleasing everybody. The overarching goal is to create an effective deer management program that strives for a deer population that will preserve, protect, and enhance ecological communities, while striking a balance between the positive and negative impacts deer have on Pennsylvania's economy and residents.

Table 9. Deer densities that would likely be preferred by various stakeholders in Pennsylvania. Preferences are based on how each stakeholder is impacted by deer, and what is known about deer population ecology. Concept derived from Roseberry and Woolf (1991).

	Deer Density		
Stakeholder	**Low**	**Intermediate**	**High**
Anti-hunter opposed to recreational hunting	Unsatisfied	Unsatisfied	Satisfied
Hunters who want antlered-only hunting	Unsatisfied	Unsatisfied	Satisfied
People who want to see a lot of deer	Unsatisfied	Unsatisfied	Satisfied
Hunters who want high antlered harvests	Unsatisfied	Satisfied	Unsatisfied
Hunters who want high success rates	Unsatisfied	Satisfied	Unsatisfied
Deer processors and taxidermists	Unsatisfied	Satisfied	Unsatisfied
People interested in a healthy deer herd	Satisfied	Satisfied	Unsatisfied
People who are concerned about the environment	Satisfied	Unknown	Unsatisfied
Commuters concerned about deer-vehicle collisions	Satisfied	Unknown	Unsatisfied
Farmers concerned about crop damage	Satisfied	Unknown	Unsatisfied
Foresters concerned about forest regeneration	Satisfied	Unknown	Unsatisfied

PENNSYLVANIA'S DEER MANAGEMENT PROGRAM

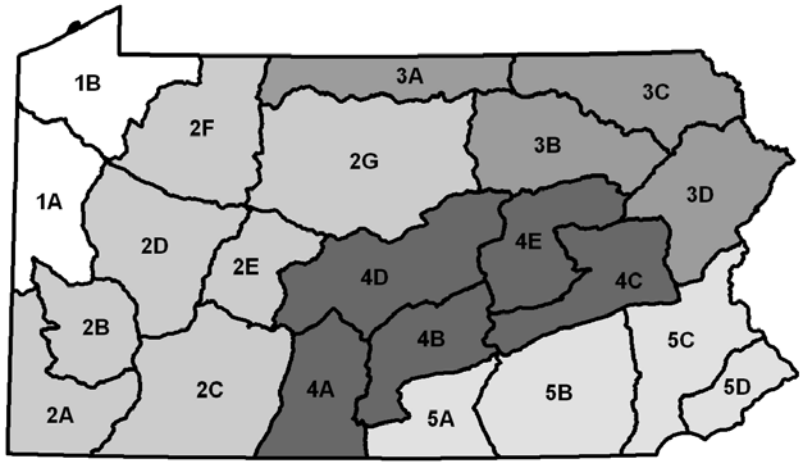
"It is the desire of the Commission to protect the deer herd for future generations but unless the number is kept below a point where the natural food supply will be adequate for ALL game, where natural timber growth and reforestation activities can be satisfactorily carried out, and where the orchards and crops of private citizens will not be required to supplement the food supply of the deer, such a decision on the part of the Commission, will, without doubt, meet with considerable opposition sooner or later. Such opposition would be very detrimental to the interests of deer hunters."

Pennsylvania Game News, December 1931

WILDLIFE MANAGEMENT UNITS (WMUs)

Pennsylvania is divided into 22 Wildlife Management Units (WMUs, Figure 12), that represent the basic geographic divisions used for deer management. These units reflects differences in landscape features and composition, land use practices, landownership (i.e., predominately public or privately-owned) and human density (Rosenberry and Lovallo 2003). Due to these differences, the capacity of the WMUs to support deer differs as well. All of the WMUs are bounded by easily recognized roads and rivers. Deer population parameters are collected in each WMU to monitor population trends and measure management indicators.

Figure 12. Pennsylvania's Wildlife Management Units (WMUs). WMUs are organized according to physiographic regions (1A-B = Northwestern Glaciated Plateau,2A-G = Appalachian Plateaus, 3A-D = Northeastern Glaciated Plateau, 4A-E = Ridge and Valley, 5A-D = Piedmont). Pennsylvania Game Commission, 2003.

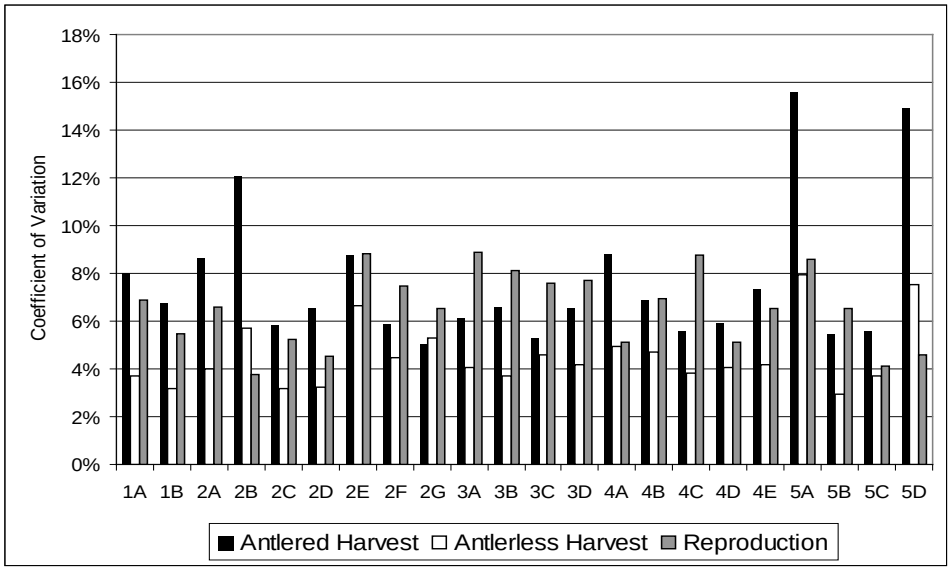


Size of WMUs remains a point of contention. Logically, small management areas appear to be a better alternative. Deer populations, land-cover, and landowner values vary at small scales. So, why not manage deer at similarly small scales?

Lawsuits and legislatively-sponsored audits of Pennsylvania's deer program demonstrate that deer management must be based on reliable data. The Game Commission does not have the financial, personnel, or logistical resources to collect enough data to support a large number of small management units.

Given today's scrutiny and expectations of deer management programs, the Game Commission has several choices. First, it can have a large number of small units for which it cannot collect enough data to support management recommendations with reliable information. Second, it can have a large number of small units, but group the small units into larger units for management purposes. This ensures adequate data to support management recommendations, but treats many management units equally. Finally, it can create fewer, larger management units where enough data can be collected to support recommendations with reliable knowledge and treat each management unit separately. The first choice is not a viable option for a responsible deer management program. The second choice describes the Game Commission's use of counties prior to 2003. Although the state contains 67 counties, counties were grouped into 31 groups for deer management purposes. The third choice is the Game Commission's preferred option and has been used since 2003. It most clearly conveys how deer management is applied to the different areas of the state, and it provides adequate data for management recommendations (Figure 13).

Figure 13. Coefficients of variation (CV) – or measures of precision of estimates – of data collected by the Game Commission for antlered harvests, antlerless harvests, and reproduction by Wildlife Management Unit. Data presented were used for the 2008-09 deer seasons and bag limits. A coefficient of variation (CV) of ≤ 12.5% is considered sufficient for accurate population management (Robson and Regier 1964, Skalski et al. 2005, Millspaugh et al. 2006).



Critics of Pennsylvania's large management units often point to other states that have large numbers of deer management units as a better option than Pennsylvania's method. However, deer biologists in these states face the same problems deer biologists in Pennsylvania face with public perceptions regarding small units. The following quote is from Wisconsin's Department of Natural Resource's "Management workbook for white-tailed deer". Wisconsin has more than 130 deer management units. It clearly demonstrates the universal debate between public expectations and scientific data collection for responsible wildlife management.

> *"It is commonly believed that smaller units result in more precise management, but the opposite is usually true. Fragmentation of units reduces precision of herd monitoring capability because sample sizes (age data, hunting pressure, and productivity) are smaller and subject to more inaccuracy. A simple split of a unit has the effect of increasing the imprecision of survey data by more than 40%, all else being equal. A change in any exterior unit boundary also compromises the unit history of at least one adjacent unit.*
>
> *Harvest and hunting pressure can be more precisely directed with small units. This is often the objective of public requests for revised units. However, this must be balanced with herd monitoring capability…At present [2001], most units are too small to provide reliable unit-specific data on annual antlerless age composition, current fawn production, and annual hunting pressure with current sampling methods. Similarly, adequate age samples of adult bucks are obtained from fewer than half of existing units…To account for smaller units, biologists must extrapolate from data in other nearby similar units and pool data from groups of units (or from several years) to attain sufficient sample sizes for analysis of trends. Pooling of data defeats one of the purposes of creating smaller units, by masking unit-specific trends." (Wisconsin Department of Natural Resources, 2001:3.2-3.3)*

Wisconsin's struggle with management unit size demonstrates three real challenges of state agency deer programs. First, small management units are inadequate for data collection. Second, having a large number of small management units does not prevent calls for even more and smaller management units. Finally, a large number of small management units will not satisfy deer hunters or stop disagreements over data results or management practices as evidenced by the recent audit of Wisconsin's deer population estimates (Millspaugh et al. 2006).

HUNTING SEASONS AND BAG LIMITS

Concurrent antlered and antlerless firearms season

Since 2001, a concurrent antlered and antlerless firearms season has been the primary deer hunting season in Pennsylvania. Beginning the Monday after Thanksgiving and continuing for two weeks, the concurrent firearms season continues a tradition of post-Thanksgiving firearms deer hunting dating back to at least 1915.

For today's deer hunters, though, the concurrent season was a change in tradition. Prior to 2001, the antlered and antlerless firearms seasons were separate. Hunters pursued antlered deer for two

weeks and antlerless deer for three days during the following week. The short antlerless season was often plagued by poor weather and required hunters to take additional days off to hunt. The concurrent firearms season reduces the impacts of weather on deer harvests and provide hunters with more time to hunt antlerless deer.

The 2007 firearms season demonstrated the benefit of a longer, concurrent firearms season. The number of report cards sent in by successful antlerless deer hunters dropped by approximately 50 percent on opening day from 2006. Following this opening day, newspapers across the state described opening day with headlines such as, “Pennsylvania hunters get watered-down opener”, “Weather dulls start of deer season”, “Opening day weather favors deer”, and “Foggy, wet start for deer hunters”. Despite this substantial drop on opening day, the overall antlerless season harvest was only 5 percent less than 2006 because daily antlerless harvests increased during the remaining hunting days.

October muzzleloader and rifle for antlerless deer

An October antlerless-only muzzleloader season began in the 2000 hunting seasons. In the first year, hunters with flintlock rifles were eligible to hunt antlerless deer for three days. In 2001, the October flintlock season was expanded to seven days, and in 2002, any muzzleloading long rifle was permitted.

An October firearms season for juniors, seniors, active military, and disabled person permit holders began in the 2001 hunting seasons. This season ran concurrently with the October muzzleloader season during the final 3 days (Thursday-Saturday), and has continued unchanged since its inception.

The original purpose of these seasons was to increase deer hunting opportunities and harvests and to remove antlerless deer prior to the peak of the breeding season. Although these seasons achieved each of these objectives, the antlerless deer being taken during these seasons are accounted for within the annual antlerless allocation. Consequently, these seasons do not result in a harvest of antlerless deer that is unaccounted for or unintentional.

Antlerless allocations

Antlerless allocations, within a consistent season structure, are used to manage antlerless harvests in Pennsylvania. In state deer programs, deer managers often control antlerless harvests by controlling opportunity to harvest an antlerless deer. This control may take the form of adjusting antlerless licenses within a consistent season structure or adjusting season length within a system where all hunters can harvest an antlerless deer (e.g., all hunters have an either sex harvest tag).

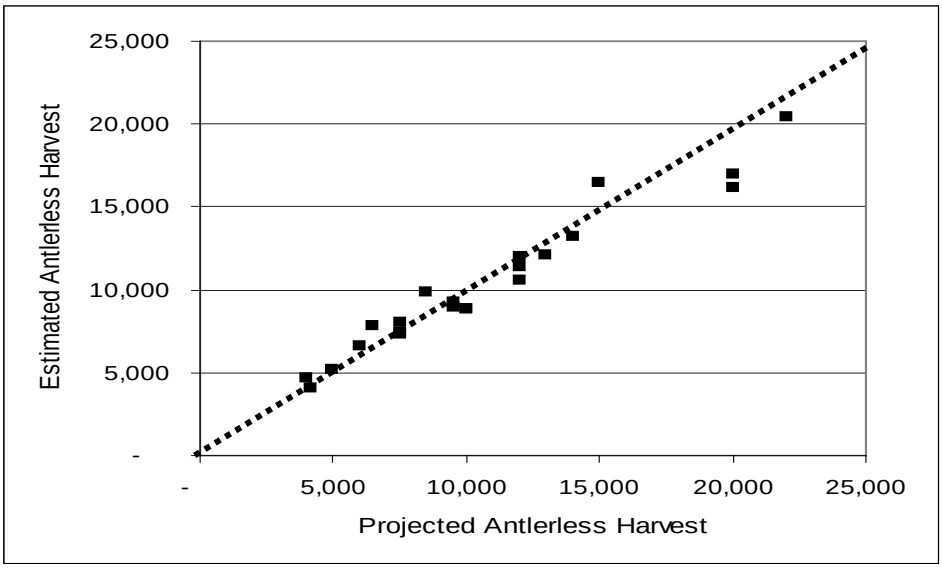
Adjusting antlerless allocations within consistent seasons has been used in Pennsylvania for decades. This system has proven reliable in Pennsylvania (Lang and Wood 1976).

Higher antlerless license allocations do not always indicate an objective to harvest more antlerless deer. As deer populations are reduced, hunter success rates should decline. When deer

populations are higher, it may take 3 antlerless licenses to result in the harvest one antlerless deer. However, when deer populations are lower, it may take 4 antlerless licenses to result in the harvest one antlerless deer. Consequently, it is possible to have higher antlerless license allocations, but with lower harvest objectives.

Although antlerless allocations ultimately control the antlerless harvest, changes in seasons can alter effectiveness of an antlerless allocation. For example, if an allocation remained the same, but the season was shortened, the antlerless harvest could decrease. Likewise, if the allocation remained the same and the season was lengthened, the antlerless harvest could increase. In each of the previous examples, other variables, such as weather and deer population size could affect the final harvest. Reducing the influence of season length and other, uncontrollable variables, on antlerless license effectiveness is the primary reason for maintaining consistent season length. By maintaining a consistent season that is long enough to minimize loss of hunting effort caused by inclement weather, effectiveness of antlerless allocations can be accurately predicted to achieve a particular harvest level (Figure 14).

Figure 14. Relationship between projected antlerless harvest and estimated antlerless harvest by Wildlife Management Unit, Pennsylvania 2007. The 2007 firearms season showed a drop of approximately 50% fewer deer harvested on opening day compared to 2006. However, the relationship of projected 2007-08 antlerless harvests – based on success rates from 2004 to 2006 – to estimated 2007-08 antlerless harvests was very strong. Perfect prediction would result in all points landing on the dashed, diagonal line.



Annual antlerless allocation recommendations are based on antlerless harvests, antlerless hunter success, deer population trends from previous years, and population trend objectives. Setting the antlerless allocation is a multi-step process.

First, a WMU deer population objective – whether to increase, decrease, or stabilize the deer population – is determined. The population objective is determined based on consideration of deer population trend, deer health and forest habitat health indicators, and input from Citizen Advisory Committees.

Second, the number of antlerless deer that need to be harvested to achieve the population trend objective is determined. For example, if the population objective is to stabilize a deer population and the population trend has been stable with a consistent antlerless harvest the previous years, the number of antlerless deer to be harvested would be similar to the previous years. If the objective was to decrease the population, the antlerless harvest would need to be higher. If the objective is to increase the population, the antlerless harvest would need to be reduced.

Finally, the number of antlerless licenses needed to achieve the projected harvest is determined. The allocation will be the projected antlerless harvest multiplied by the number of antlerless licenses it takes to harvest an antlerless deer. The number of antlerless licenses it takes to harvest an antlerless deer will be based on the most recent years. For example, if 10,000 antlerless deer are to be harvested and it takes 4 antlerless licenses to harvest an antlerless deer, then the allocation will be 40,000 (10,000 x 4).

Following this step-by-step procedure, the limited effect of season length becomes obvious. The allocation is set by first deciding the projected antlerless harvest. The projected antlerless harvest is not affected by any change in season length. If 10,000 antlerless deer were to be harvested with a 12-day concurrent season, then 10,000 antlerless deer would still need to be harvested with a 3-day antlerless-only season. Although the antlerless harvest would not change, the antlerless allocation would be affected by shortening the season length. For example, if 10,000 antlerless deer were to be harvested and it took 4 antlerless licenses to kill those deer with a 2-week concurrent season, then the allocation would be 40,000. However, if it took 5 tags to kill a deer with a 3-day antlerless-only season, then the allocation would need to be 50,000. Season length does not change the number of deer needing to be harvested, but does change the allocation to harvest those deer.

ANTLER RESTRICTIONS

In the late 1990s and early 2000s, deer populations in much of Pennsylvania greatly exceeded deer management objectives. The struggle to meet deer management objectives and the controversies that surrounded them were not new to Pennsylvania deer management (Latham 1950, Latham 1953, Kosack 1995). Most Pennsylvania hunters agreed deer populations should be controlled, but they had not supported previous efforts to reduce deer populations (Diefenbach et al. 1997).

Pennsylvania’s deer management program had tried to achieve deer management objectives in the past by increasing antlerless harvests. Although increased antlerless harvests successfully reduced deer populations, this strategy ultimately failed because hunter support declined and decisions were made to allow deer populations to return to high levels. To meet management objectives, the Game Commission employed a new strategy by providing new opportunities for hunters to harvest older antlered males while seeing fewer deer. It was hoped this new approach

would improve hunter tolerance for reduced deer populations and permit the Game Commission to meet its deer management objectives.

Prior to the new antler restrictions, Pennsylvania's antlered population was heavily harvested with 81% of all antlered deer being 1.5 years of age (based upon examination of 56,310 antlered deer between 1998 and 2000). In addition, Pennsylvania already had a one antlered deer per hunter limit. If deer harvest management was to reduce the harvest rate of antlered deer there were only two options available to increase the age structure of the antlered deer. They were: 1) a lottery, or allocation, limiting the number of hunters who could harvest an antlered deer each year or 2) antler restrictions. Antler restrictions were chosen because they provided all hunters with an equal chance to harvest a buck each year.

Pennsylvania's antler restrictions were designed to increase the number of adult males in the harvest. Realistically, the objectives were to protect at least half of all yearling antlered males and to make most adult males legal for harvest. Attempting to grow record book bucks was not, and is not, an objective of the antler restriction regulation.

The Game Commission considered 2 criteria for antler restrictions – antler points and antler spread. Hunters can judge each criterion in the field, but antler points were chosen as the primary criterion for two reasons. First, antler points provided greater flexibility in establishing restrictions that met the Game Commission's objectives. Point restrictions could be defined by any number of points; whereas, spread restrictions are usually judged on ear tip width. In many areas of Pennsylvania, a spread restriction of 15" (a common ear tip width estimate) would have protected nearly all 1.5 year-old males but also many 2.5 year-old and older males. This level of protection was incompatible with objectives. Second, antler points provided a larger data set upon which the regulation was based. Each year trained personnel collect age and antler point data from deer during the hunting season. In the 3 years prior to the change in antler restrictions, the Game Commission had age and antler point data on more than 50,000 antlered deer. In contrast, it had antler spread data on about 3,000 deer. Point data provided a more solid foundation for antler restrictions.

Based on protection levels of antler points, the state was divided into 3-points-to-an-antler and 4-points-to-an-antler restriction areas. The 4-point restriction area is located in the western part of the state and a 3-point restriction area includes the rest of the state. A 4-point restriction was needed in the western part of the state to protect more than half of all yearling bucks. A 3-point restriction would have protected less than 50 percent of yearling bucks.

An expanding research base supports the position that antler restrictions will have minimal impact on future antler development of Pennsylvania's deer herd.

First, yearling antler points appear to have limited impact on future antler development (Koerth and Kroll 2008). Studies have concluded yearling antler points to have low heritability (Williams et al. 1994, Lukefahr and Jacobson 1998) and should not be used for harvest schemes to alter the genetic composition of a population (Lukefahr and Jacobson 1998). Thus, use of yearling antler points, as a harvest criterion should have limited influence on future antler development. Antler points at 2.5 years of age have higher heritabilities (Williams et al.. 1994, Lukefahr and Jacobson

1998), but the Game Commission's antler restriction allows most 2.5 year-old males to be harvested.

Second, research on impact of sire on antler points is not applicable to our antler restriction. Research from the Kerr Wildlife Management Area in Texas concluded that antler points are related to genetics of the father (Harmel 1983). In this study, spike sires produced more spikes than a buck that had 6 points as a yearling. Sample sizes for this study were 8 spike-antlered sires and 1 six-point sire that was initially noted in the pens at 3.5 years of age as a buck with superior antler quality. Results of this study can be summarized as spike antlered males produce more spike offspring than a male with superior antler quality. These results apply to extremes – spike antlered males versus a superior quality male. Pennsylvania's antler restriction is not designed to compare the smallest antlers with the largest antlers. In the 3-point area, the relevant question concerning the impact of the proposed regulation is: What is the difference between antlered males with 2 or fewer points to an antler versus antlered males with 3 points or more to an antler? In the 4-point area, the relevant question is: What is the difference between antlered males with 3 or fewer points to an antler versus antlered males with 4 points or more to an antler? Research indicates there may be no relationship between yearling antler points and antler points at 4.5 years of age and older (Koerth and Kroll 2008).

Third, simulations of antler restrictions suggest no difference in antler growth between restrictions similar to our proposal and no restrictions. Strickland et al. (2001) conducted antler restriction simulations on a sample of 220 captive deer maintained on complete diets for optimal growth. Using a 75% harvest rate and a <6 antler-point restriction (both antlers combined), their results failed to show a statistical difference between 4.5 year-old antlers with or without an antler restriction. The average Boone and Crockett score of a 4.5 year-old buck with the restriction was 122, and without the antler restriction, the average 4.5 year-old buck scored 126. Besides a lack of statistical difference, there is no indication of biological significance of 4 Boone and Crockett points at 4.5 years of age on the reproductive success of bucks. Therefore, we do not expect a biologically significant decline in antler quality of Pennsylvania's deer population as a result of antler restrictions.

Fourth, most of Pennsylvania's antlered males are harvested after the breeding season. Around 75% of Pennsylvania's antlered deer harvest occurs during the firearms season in late November and early December. The peak of breeding is mid-November (Figure 4). As a result, most antlered males harvested in Pennsylvania already have passed their genes onto future generations. Timing of the firearms season further reduces the potential for negative genetic effects of antler restrictions in Pennsylvania.

Fifth, a few mature males are not dominating deer breeding (Sorin 2004, Shaw 2005, Sumners et al. 2007). In 2 different studies, yearling males successfully sired 14 percent and 22 percent of the offspring tested (Shaw 2005, Sumners et al. 2007). While the majority of fawns were sired by 3.5 old or older males, yearling and 2.5 year old males sire more than a third to almost half of fawns being born in a population (Shaw 2005, Sumner et al. 2007). In fact, most males only sire 1 litter annually (Sumners et al. 2007).

Sixth, multiple paternity is common. In 2002, multiple paternity was documented in captive deer (DeYoung et al. 2002). Twenty-six percent of litters with greater than 2 offspring had more than 1 sire. This information completely challenged some aspects of ungulate reproductive ecology that were thought to be understood. In 2004, the first case of multiple paternity in free-ranging white-tailed deer was documented in Michigan (Sorin 2004). Here, 22 percent of litters with 2 or more offspring had more than 1 sire. This research also showed the oldest males did not monopolize breeding, demonstrating that a few dominant males do not do all breeding (Sorin 2004). Further male dominance ranks were not necessarily predictable or stable during the breeding season (DeYoung et al 2006). Early genetic studies of paternity involved captive deer and those in non-hunted populations having older male age structures. White-tailed deer are hunted across Pennsylvania. Age structures in hunted populations are skewed toward younger age classes. However, even in publicly hunted areas, multiple paternity still has been documented (DeYoung et al. 2007). One study tested 6 different populations with different male age structures and found evidence of multiply paternity in 20 percent or more of litters with 2 or more offspring in all areas (DeYoung et al. 2007)

Finally, a male's mother also plays an important role in antler development (Harmel 1983, Lukefuhr and Jacobson 1998), but is nearly impossible to consider in statewide regulations. There are no methods to selectively remove females to improve antler characteristics. Therefore, 50 percent of the genetic contribution to future antler development is randomly selected.

Given all of this information, the complexity of the white-tailed deer's breeding ecology, and high genetic variation, large scale alteration to Pennsylvania's deer herd's genetics is unlikely.

DEER MANAGEMENT ASSISTANCE PROGRAM (DMAP)

The Deer Management Assistance Program (DMAP) gives public and private landowners the option of using hunters to manage deer on their property. By enrolling their land in this program, landowners are able to receive coupons for the harvest of antlerless deer, which they distribute to licensed hunters. Landowners are able to use hunters for deer management and hunters benefit through increased hunting opportunities.

Eligibility requirements changed throughout the first 3 years of this program. In 2003, only public landowners and private landowners enrolled in a Game Commission public access program such as Farm-Game, Safety Zone, and Forest-Game Cooperatives were eligible to participate. In 2004, DMAP was expanded by dropping the public access requirement allowing all public and private landowners who do not charge a fee to hunt, and hunting clubs of 1,000 or more acres that were established prior to 1 January 2000 to enroll. In 2005, the 1,000 or more acres requirement for hunting clubs was removed. In addition, hunters could receive up to 2 permits per enrolled property.

Landowner applications to enroll in DMAP must be received by July 1 and are reviewed by region Wildlife Management Supervisors. Following application approval, coupons are sent to landowners who distribute coupons to hunters. Hunters then redeem coupons for permits to harvest an additional antlerless deer on the specified DMAP property.

Hunters are required to return a postage-paid report card regardless of hunting success. In the first year of the program, 2003-04, approximately 50 percent of all DMAP participants returned report cards by the deadline in February. Because it was a new program and the reporting requirement differed from regular hunting license reporting requirements where report cards are required to report only a harvested deer, letters were sent to non-respondents to remind them to report regardless of harvest. A second mailing was then made to the remaining non-respondents. Following the second mailing, 99 percent of DMAP participants had reported. The second year, 2004-05, nearly 80 percent of hunters submitted their DMAP report cards. No additional mailings were made. However, hunters who did not submit a report card were not eligible to participate in 2005-06. This requirement was relaxed, and the hunter application ineligibility provision was removed if a report card was not received in 2006. Since 2006, hunter reporting rates have remained around 80 percent.

HARVEST DATA COLLECTION

To estimate deer harvests and collect data for monitoring deer population trends, more than 30 data collection teams examine deer in assigned areas across the state. Each team collects 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 include age, sex, location of harvest (WMU, county, and township), and hunting license number from ear tags. Deer agers determine deer age as 6 months (fawn), 18 months (yearling), or at least 30 months (adult) using tooth wear and replacement (Severinghaus 1949). Qualified deer agers undergo training every 3 years and must correctly age 95 of 100 jawbones. In some years, aging teams also remove incisors from deer 30-months-old or older for age determination by cementum annuli analysis. Data collection teams also record points of antlers to determine antler characteristics by age class. Bureau of Automated Technology Services (BATS) validates and processes harvest data and runs harvest data analysis programs.

HARVEST ESTIMATION

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

Counting the number of deer harvested each year is a basic part of deer management. In Pennsylvania, this task is enormous. The annual deer harvest involves hundreds of thousands of hunters, harvesting hundreds of thousands of deer over 5 months of deer hunting seasons across 45,000 square miles.

Commonly used methods available for counting the deer harvest include:

1. Check stations where hunters take their deer to a business or station to be checked;
2. Report cards where hunters mail in a postcard with harvest information;
3. Toll-free reporting where hunters call in harvest information; and

4. Internet reporting where hunters go on-line and provide harvest information

All of these methods provide the same information – a count of the number of deer reported by hunters. Using a count of deer reported by hunters is simple and easy to understand, but it is not perfect.

Just as these methods provide the same information (i.e., the number of deer harvested and reported), they are similar in that none of them, alone, provides the number of deer harvested but not reported.

At this point, deer biologists are faced with a dilemma. The number of deer harvested and reported by hunters is known, but how many deer were harvested but not reported? There are a number of options available. A deer biologist can:

1. Ignore deer not reported and only work with the number of deer reported (i.e., a minimum count);
2. Assume a certain percentage or number of harvested deer are not reported and assume this percentage does not change; and
3. Estimate the percent or number of deer harvested but not reported.

To get the most complete accounting of deer harvested, something must be done to account for the deer that are harvested but not reported.

Back in the mid-1980s, Pennsylvania deer biologists faced this problem of accounting for harvested deer that were not reported by hunters on harvest report cards. At the time, about 55 percent of successful hunters sent in their report cards. Following the 2007-08 hunting seasons, less than 40 percent of successful hunters sent in their report card. Fortunately, Pennsylvania uses a system to estimate harvested deer not reported and uses a science-based method of estimating total deer harvest.

To collect the needed information requires a substantial investment of personnel and resources. Each year, deer agers examine tens of thousands of harvested deer in Pennsylvania. Data collected from these deer form the basis of deer harvest estimates. The final piece of information needed is the postage-paid report card that successful hunters are required to submit for every deer they harvest.

When the data are available, the process of estimating deer harvests begins. Available data include:

1. The number of deer harvested AND reported by hunters on report cards
2. The number of deer examined by Game Commission deer aging teams
3. The number of deer examined by Game Commission deer aging teams AND reported by hunters.

The third piece of information is gained by comparing the deer checked in the field with report cards sent in by hunters. If a deer was examined by deer agers and the hunter submitted his report card, the deer is counted as examined AND reported.

With this known information, the deer harvest can be estimated. If the sample of examined deer is representative of the harvest then,

$$\frac{Number\ examined\ \&\ reported\ (\#3\ above)}{Number\ examined\ (\#2\ above)} = \frac{Number\ harvested\ \&\ reported\ (\#1\ above)}{Number\ harvested} \qquad (1)$$

Since 3 of the 4 variables are known, the equation can be solved for the fourth variable,

$$Number\ harvested = \frac{(Number\ harvested\ \&\ reported)\ (Number\ examined)}{Number\ examined\ \&\ reported} \qquad (2)$$

Here is an example to show that equations (1) and (2) are equivalent. If hunters reported 5 of the 10 deer examined by Game Commission deer aging teams, and hunters reported a total of 50 deer then,

$\frac{5}{10} = \frac{50}{Number\ harvested}$ (from equation 1 above) and

$Number\ harvested = \frac{(50)\ (10)}{5}$ (from equation 2 above).

For both equations 1 and 2, the *Number harvested* equals 100 deer.

Equation (2) is a common wildlife management estimation technique called “mark-recapture”, and this is the idea upon which the Game Commission’s bases its deer harvest estimates.

For example, in WMU 3C during the 2004-05 hunting season, Game Commission deer agers examined 522 antlered deer. Of these 522 deer, hunters reported 183 of them. Overall, hunters harvested and reported 2,437 antlered deer in WMU 3C.

Using equation #2, numbers from WMU 3C estimate the antlered harvest as:

$$Number\ harvested = \frac{(Number\ harvested\ \&\ reported)\ (Number\ examined)}{Number\ examined\ \&\ reported} \qquad (3)$$

$$Number\ harvested = \frac{(2{,}437)\ (522)}{183} = 6{,}951\ antlered\ deer\ harvested$$

However, the Game Commission reported 6,900 antlered deer harvested in WMU 3C in 2004-05. Why is this not the same number as was calculated in the example?

There are 2 reasons why the number in the example will not exactly match what was published.

First, the equation used in the example is the most basic mark-recapture procedure. When estimating deer harvests, the Game Commission uses a slightly different version of the mark-recapture equation from Chapman (1951) that has been shown to be better statistically than the basic equation. Differences in the procedures will affect the result slightly.

Second, the Game Commission rounds the harvest estimates to the nearest 100 or 1,000. This is done because it is recognized that the number 6,951 in the WMU 3C example is an estimate. As an estimate, one cannot say there were exactly 6,951 antlered deer harvested. However, because of the science-based methods used, "precision" of the estimate can be determined. Looking at the precision shows "how good" the estimate is. For example, an estimate with precision of plus or minus 5 percent is better than an estimate with precision of plus or minus 30 percent.

Rather than provide information to the public that appears exact but really is not, the Game Commission provides information that conveys not only the point estimate but also the precision of the estimate. This is done by rounding the harvests to the nearest 100s or 1,000s. Whether a harvest is rounded to the nearest 100 or 1,000 depends on the precision of the estimate.

The larger the sample size of deer examined and reported, the better the estimate. Because of the amount of data used in estimating deer harvests in Pennsylvania, most deer harvest estimates are rounded to the nearest 100. The one exception to this is for harvested deer for which the WMU is not known. Because there are so few of these deer (e.g., less than 100 statewide for antlerless deer), the "unknown" harvest is rounded to the nearest 10.

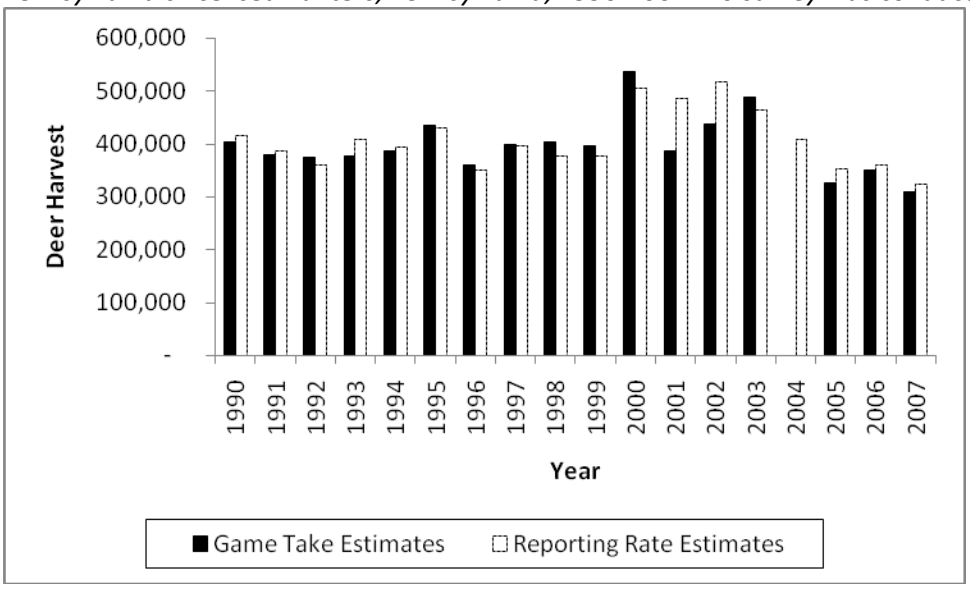
The Game Commission has and continues to monitor the performance of its deer harvest estimating procedures. For example, in 2003, the Game Commission completed an evaluation of its data collection and harvest estimating procedures. This evaluation was submitted to a scientific journal for an independent, scientific review by professional biologists and statisticians. Based on this review, the techniques used by the Game Commission were considered scientifically valid and published in the October 2004 issue of *The Journal of Wildlife Management*.

The Game Commission also has published articles investigating the performance of the procedures used to estimate deer harvests in Pennsylvania Game News. In 2001, an article titled, "Counting Deer", was published in the September issue. This article demonstrated the close agreement between deer harvest estimates from report cards and deer harvest estimates from mail surveys sent to approximately 20,000 hunters a year (Figure 15). This close agreement suggests the deer checked by Game Commission personnel each year are representative of all deer harvested in Pennsylvania.

There is no practical method that can count every deer harvested in Pennsylvania without 100 percent cooperation from hunters. The method used by the Game Commission is based on a

common wildlife management technique called mark-recapture. In addition, editors and reviewers of a scientific wildlife management journal have independently reviewed procedures used by the Game Commission to estimate deer harvests. As a result, the method used by the Game Commission provides science-based estimates of annual antlered and antlerless harvests for each Wildlife Management Unit.

Figure 15. Deer harvest estimates from report cards and deer checked in the field compared to deer harvest estimates from an annual, random survey of 2% of Pennsylvania's licensed hunters, Pennsylvania, 1990-2007. No survey was conducted in 2004.



MANAGEMENT INDICATORS

Management indicators serve a broad role in deer management. They provide guidance on the direction and evaluation of deer management within each WMU. To serve this important role, indicators must meet 4 criteria (Table 10).

Because habitat, deer impacts, deer density, and landowner and hunter expectations vary at scales smaller than WMUs, these indicators are not intended to micromanage local deer populations or habitat conditions. For those landowners who wish to use site specific techniques to achieve their goals, programs such as the Deer Management Assistance Program (DMAP), Political Subdivision (municipal) deer control permits, and Agricultural Damage (Red Tag) deer control permits are currently available. We encourage landowners to take advantage of these property-specific management tools in accordance with their management goals.

DEER HEALTH AND REPRODUCTION

To obtain data on deer health, Wildlife Conservation Officers and other personnel examine female deer killed by various causes from 1 February through 31 May each year. They record location (county, township, and WMU), date killed, cause of death, and number and sex of

embryos for each female on a form attached to a deer jaw envelope. They remove 1 side of the lower jaw from each deer for age determination. Deer biologists then assign each female an age.

Table 10. Criteria that must be met for a potential measure to be included in the Pennsylvania Game Commission's Deer Management Program.

Criteria	Explanations
Available	Data must be currently available for WMUs. Information must be available for application in management recommendations.
Representative	Data must be representative of WMUs. Appropriate sampling involves a random or systematic process to ensure data are representative at the WMU level.
Applicable	Data must be applicable across WMUs. Allows comparison across Pennsylvania and provides efficient data collection with limited resources.
Responsive	Changes in measure are related to deer abundance. Many factors influence natural resources; therefore, the performance measure must possess a demonstrated relationship with deer abundance.

Reproduction was chosen as a primary indicator of deer health because research has shown reproduction to be related to deer population health (McCullough 1979, Miller and Wentworth 2000). Differences in reproductive rates (embryos per female) have been demonstrated between female deer in good physical condition and those in poor physical condition (Verme 1965, Verme 1967, Verme 1969, Hesselton and Jackson 1974; Table 11).

Furthermore, reproductive rate has proved to be better for measuring physical condition of deer than kidney weight, kidney fat weight, kidney fat indices, hind foot length ratios, fat reserves, hematocrit, total serum protein, and blood urea nitrogen (Hesselton and Jackson 1973, Sams et al. 1998). Therefore, collecting reproductive data of female deer in each WMU provides information on the nutritional plane of the herd (Cheatum and Severinghaus 1950, Verme 1965, Hesselton and Jackson 1974, Abler et al. 1976, McCullough 1979, Stoll and Parker 1986, Taylor 1996).

Reproductive measures have been used in other areas to assess the nutritional plane and/or physical condition of deer (Cheatum and Severinghaus 1950, Hesselton and Sauer 1973, Hesselton and Jackson 1974, McCullough 1979, Woolf and Harder 1979, Stoll and Parker 1986, Folk and Klimstra 1991, Osborne et al. 1992, Petrick et al. 1994, Taylor 1996). In a classic study of white-tailed deer population dynamics, McCullough (1979) demonstrated the relationship between reproductive rates and deer population abundance in relation to the number of deer the habitat could support. As population size increased, reproductive rates declined. For female fawns, breeding stopped at high population sizes. In New York, Hesselton and Jackson (1974) demonstrated the need to separate data according to 3 age groups (fawn, yearling, and 3 years-of-age and older), as younger animals are more sensitive in reproductive response to environmental differences with female fawns being the most sensitive to range conditions. However, in practice,

reproductive data can be combined for all females (excluding fawns) because of sample size concerns or if there is no difference between reproductive rates of yearling and older females (Rosenberry et al. 2007).

Table 11. Reproductive rates based on nutrition and body condition.

	Low Nutrition/Poor Condition			High Nutrition/Good Condition		
	Fetuses/doe (% pregnant)			Fetuses/doe (% pregnant)		
Citation	Fawn	Yearling	Adult	Fawn	Yearling	Adult
Cheatum and Severinghaus 1950	0.03 (3%)	-	1.06 (79%)	0.34 (32%)	-	1.71 (94%)
Verme 1965[1]	-	-	0.95 (86%)	-	-	1.74 (89%)
Verme 1967[1]	0.05	0.50	1.31	1.18	1.53	1.78
Verme 1969[1]	-	0.62 (54%)	1.36 (86%)	-	1.63 (100%)	1.80 (100%)
McCullough 1979[2]	0.00[3]		1.21[3]	0.89[4]		1.70[4]
Hesselton and Sauer 1973	0.06	1.17	1.77	0.41	1.78	1.94
Hesselton and Jackson 1974	0.07 (4%)	1.02 (86%)	1.43 (88%)	0.53 (53%)	1.82 (98%)	1.73 (91%)
Stoll and Parker 1986	-	-	-	0.85 (68%)	1.89 (96%)	1.85 (97%)
Folk and Klimstra 1991	0.04 (4%)	0.63 (39%)	0.81 (42%)	-	-	-
Osborne et al. 1992	-	1.00 (60%)	1.14 (83%)	-	-	-
Taylor 1996	-	-	1.52 (86%)	-	-	-
Swihart et al. 1998	-	-	1.4	-	-	2.1
Woolf and Harder 1979[1]			1.4			
Ransom 1967						1.92

[1] Studies performed on captive deer.
[2] McCullough (1979) study area was a fenced area of about 1.8 miles[2]
[3] Corresponds to deer population at 70% of habitat carrying capacity
[4] Corresponds to deer population at 30% of habitat carrying capacity

Reproductive rates as measured as embryos per doe provide more direct information on deer health than fawn-to-doe ratios in the harvest. Unlike pregnancy and embryo counts, fawn-to-doe harvest ratios can be influenced by factors affecting fawn survival, such as levels of predation, habitat composition and quality, and winter severity, and by hunter selectivity towards adult females (Williamson 2003). Data from Pennsylvania demonstrates the variable effect of predation on fawn survival (Vreeland et al. 2004) and hunter selectivity on harvest fawn:doe ratios (PGC, unpublished data). As a result, low fawn-to-doe ratios in the harvest could result from predation, habitat, weather, low reproduction, or hunter selectivity. Using reproductive data, such as embryos per doe, eliminates the influence of factors affecting fawn survival between birth and the hunting season, and they provide reliable estimates of deer herd health (Miller and Wentworth 2000).

Reproduction and Deer Health Assessment

We selected 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 at maximum sustained yield based on a Generalized Sustained Yield table derived by Downing and Guynn (1985). Consequently, a population producing 1.50 embryos per adult female is reproducing at a healthy and sustainable level.

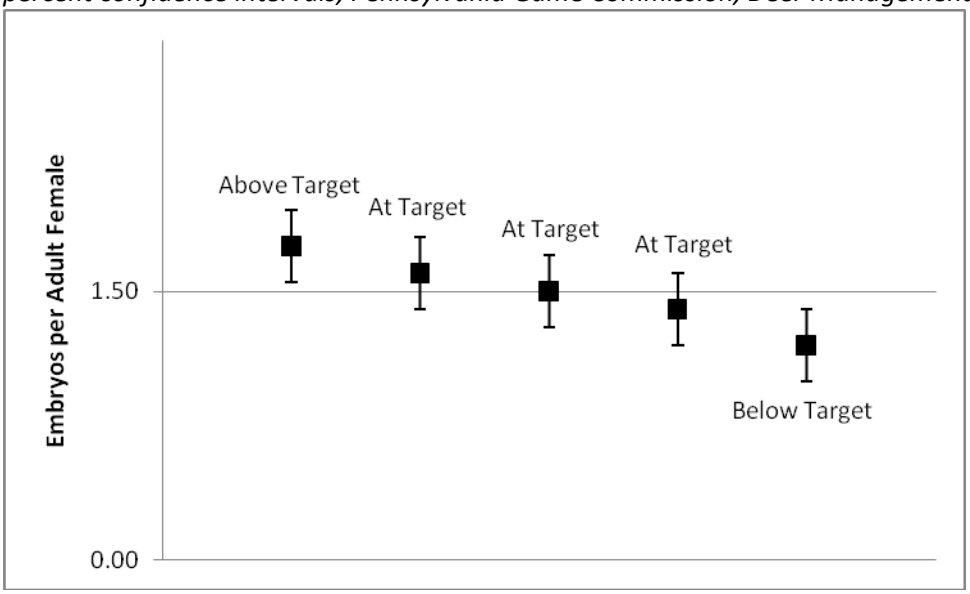
2. Other research studies support the conclusions based on the Generalized Sustained Yield table. More than a dozen studies from the United States and Canada (Table 11) show that a value of 1.50 embryos per adult female represents the middle ground between deer with low and high nutrition.

3. A target of 1.50 embryos per adult female 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.

The measure of reproduction is based on a sample of deer from across a Wildlife Management Unit. From this sample, point estimates and measures of variability are calculated.

The point estimate is the average number of embryos per doe. For example, if 5 does had 10 fawns, the point estimate would be 2 embryos per doe (10/5 = 2). The point estimate cannot be interpreted to say that every doe in the entire WMU has exactly 2 embryos because the point estimate is based on a sample of 5 deer, not every doe in the WMU. We use a two-tailed *t*-test for differences between a population mean and a hypothesized population mean to assess a WMU's deer health relative to the target of 1.50 embryos per adult doe (Figure 16). This differs from previous use of strict cutoffs in 2006 and 2007. This approach is more appropriate because it provides a framework to assess not only the point estimates, but also variation.

Figure 16. Graphical representation of target statistical level (1.50 embryos per adult female) for deer health assessment showing the point estimate with error bars representing 95 percent confidence intervals, Pennsylvania Game Commission, Deer Management Program.



Statistical Details of two-tailed t-test

The two-tailed *t*-test for differences between a WMU's population mean and our target of 1.50 embryos per adult female, is calculated as:

$$t = \frac{\overline{X} - \mu}{s_{\overline{X}}} \qquad (4)$$

where $\overline{X}$ is the point estimate of embryos per adult female for a WMU, μ is the target of 1.50 embryos per adult female, and $s_{\overline{X}}$ is the standard error of the point estimate of embryos per adult female for a WMU.

For example, if a WMU has a point estimate of 1.27 embryos per adult female and a standard error of 0.09 based on a sample of 89 adult females, the calculation for this WMU would be:

$$t = \frac{1.27 - 1.50}{0.09} = -2.556$$

The *t* statistic = -2.556 and is compared to a $t_{0.05(2),\,88} = 1.987$. Since |t| is greater than 1.987, we conclude that 1.27 embryos per adult female is significantly less than our target of 1.50 embryos per adult female. Use of a *t*-test is statistically appropriate for these data (Zar 1999).

Decision Rules Used to Determine Deer Health

1. Does the 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 available data, but efforts to collect larger sample sizes should be implemented.

[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%.

Supporting Measures of Deer Health

Fawn pregnancy rate: Fawn pregnancy rates are a helpful indicator of deer population levels in relation to habitat because fawns are sensitive to habitat conditions (Hesselton and Jackson 1974) and fawn breeding stops when deer populations are high in relation to available nutrition (McCullough 1979). Fawn breeding can be a useful indicator in all WMUs because fawn breeding has or does occur in all WMUs and research from more northern areas (i.e., New York, Michigan, Manitoba) indicate fawn breeding can occur at more northern latitudes.

Antler beam diameter: Antlers beam diameters from road-killed deer in the fall are a potential measure to assess buck health. Road-killed bucks provide a less biased sample than hunter-killed bucks. Antler beam diameters have been shown to be related to deer condition and nutritional level (Rasmussen 1985, Moen 1994, McCaffery and Rolley 2001). Another benefit to collecting antler data from road-killed bucks is data on antler points would be helpful in interpreting harvest and population estimates. For example, a higher average number of antler points could result in higher harvest rates and subsequently, higher antlered harvests and population estimates. Although we do not propose using antler points as a health measure, the data available from antlers would benefit other aspects of the deer program. An evaluation of the potential of measuring antler beam diameters is proposed.

Winter mortality surveys: A winter mortality survey has the potential to collect data on density dependent and density independent impacts of winter severity on Pennsylvania's deer herd. Unfortunately, the procedure used for decades was an index with unknown relationship to actual

winter mortality. Development of a protocol for implementing a survey to estimate mortality due to severe winter weather is ongoing.

Chronic Wasting Disease: Presence or absence of Chronic Wasting Disease is an obvious measure of deer herd health, and one the Game Commission has monitored since the late 1990s and continues to monitor.

FOREST HABITAT HEALTH AND REGENERATION

Consideration of possible data sources

Forest regeneration is an appropriate habitat measure because the ability to produce young trees indicates healthy and sustainable habitat capable of supporting wildlife, including deer. A number of data sets were considered to assess habitat health across WMUs. Each information source was analyzed for its ability to meet the 4 criteria in Table 10.

Natural Resources Inventory: The Natural Resources Inventory program is conducted by Natural Resources Conservation Service, an agency of the USDA. Information has been collected on soil, water, and other environmental factors on non-federal lands since the 1930s (Goebel 1998). Although it represents a comprehensive data source, Natural Resources Inventory data are too coarse-grained to be representative, responsive and applicable at the WMU scale (Table 12).

Bureau of Forestry Browsing Impact Survey: In winter 2006, the Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry (BOF) started a browsing impact survey across the State Forest System (Benner 2006). The results are available and responsive to deer impacts; however they are not representative or applicable, as only publicly owned state forests managed by BOF are surveyed.

BOF Rapid Assessment Forest Vegetation Monitoring Program: The BOF also developed the Rapid Assessment Forest Vegetation Monitoring Program (Rapid Habitat Assessment) in conjunction with the Pennsylvania Cooperative Fish and Wildlife Research Unit at Penn State University in 2006. By design, the technique is responsive to deer impacts on habitat. However, the scale required to provide meaningful information for deer management at the WMU level is currently limited logistically and fiscally. To date, only preliminary data have been collected.

PGC and DCNR Forestry Inventory and Analysis: The Game Commission and BOF measure habitat variables as part of continuous habitat monitoring on state lands. These inventory and analysis data are available and responsive to deer impacts; however, they only apply to State Game Lands and State Forests. This limits applicability and representation across WMUs with uneven distribution or low percentage of public lands because no private lands are sampled.

USDA Forest Service Forest Inventory Analysis and Pennsylvania Regeneration Study: The USDA Forest Service administers continuous forest monitoring through the Forest Inventory and Analysis Unit (FIA). Federal FIA data are collected systematically across a statewide grid on both private and public lands. This uniform grid ensures representative sampling within and among WMUs. In 2001, the Pennsylvania Bureau of Forestry initiated a statewide forest

regeneration assessment known as the Pennsylvania Regeneration Study (PRS). The study represents a subset of plots measured by Federal FIA, and ensures regeneration measurements are responsive to deer impacts. Using the four criteria in Table 10, continued use of regeneration data from PRS were deemed most appropriate for the Game Commission's Deer Management Program (Table 12).

Table 12. Potential data sources to assess habitat health in the Pennsylvania Game Commission's Deer Management Program.

Data Source	Available?	Representative?	Applicable?	Responsive?
Natural Resource Inventory	Yes	No	No	No
Browsing Impact Survey	Yes	No	No	No
Rapid Habitat Assessment	No	No	No	Yes
State FIA / DCNR	Yes	No	No	Yes
State FIA / PGC	Yes	No	No	Yes
Federal FIA / PA Regeneration Study	Yes	Yes	Yes	Yes

The Pennsylvania Regeneration Study (PRS)

To assess forest habitat health, the Game Commission annually requests PRS data via the Bureau of Forestry. The primary data relevant to the deer program are advanced tree seedling and sapling regeneration (ATSSR). At each PRS plot, established seedlings – defined as second-year or older seedlings (McWilliams et al. 2004a) – and saplings are counted and categorized by species. Additional information collected includes an assessment of deer impact, percent cover of competing vegetation, and other site limitations. At the Game Commission's request, data are compiled according to the number of plots adequately stocked with regeneration. This "adequate stocking" is the weighted number of seedlings and saplings required to replace the existing forest canopy at various levels of deer impact (Table 13). 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." 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 forest habitat health measure.

Non-deer factors influencing regeneration

A healthy forest can maintain and replace itself, but deer are not the only factor influencing forest health. Other important concerns are amount of light reaching the forest floor, soil conditions, diseases, pests, and competitive vegetation (Table 14). The ability to reduce the influence of non-deer factors on regeneration is a strength of PRS data.

Table 13. Deer impact levels, associated habitat condition, and stocking requirements of seedlings and saplings for Pennsylvania mixed hardwood forests.

Deer impact level	Habitat condition	Stocking requirement[1]
Very low	Seedlings/saplings common and free to grow with minimal browsing, diverse herbaceous community present.	15
Low	Seedlings/saplings common, widespread, light browsing, diverse herbaceous community present.	30
Medium	Seedlings/saplings present but browsed to uniformly low heights, only unpalatable herbaceous plants present.	50
High	Seedlings/saplings lacking, with "hedging" apparent from heavy browse pressure, few herbaceous plants.	100
Very high	Seedlings/saplings absent, heavy browse line apparent, only hardiest, unpalatable species present.	200

[1]Weighted score of seedlings and saplings present on the plot. Weights are assigned by SILVAH standards for regeneration in Pennsylvania mixed hardwood and oak forests (Marquis et al. 1994).

The amount of light reaching the forest floor can substantially affect the number of seedlings in a forest (Tilghman 1989). The number of seedlings found under a closed canopy may be less than the number of seedlings under a more open canopy. Because of the relationship between sunlight and regeneration, the PRS was originally designed to only measure regeneration plots with 40–75 percent stocking of the overstory.

Table 14. Examples of factors that can affect forest regeneration.

Factor	Reference
Light	Latham et al. 2005
Seed supply	Latham et al. 2005
Time since last removal of canopy trees	Latham et al. 2005
Extent of competitive vegetation	Latham et al. 2005
Soil chemistry	Latham et al. 2005
Soil moisture	Latham et al. 2005
Diseases	Latham et al. 2005
Insect Pests	Latham et al. 2005
Seed crop intervals	Latham et al. 2005
Number of diameter limit timber harvests	Latham et al. 2005
Application of herbicides	Latham et al. 2005
Fire suppression	Abrams 2002
Soil disturbance	Castleberry et al. 2000
Advanced seedlings present prior to harvest	Miller et al. 2004
Seed lost to predation	Hass and Heske 2005

Changing soil conditions can affect regeneration (Bailey et al. 2005). Some tree species, such as sugar maple, are more sensitive to certain soil characteristics (i.e., acidity), while others, such as

white pine and black birch, are more tolerant. Within the PRS, regeneration is assessed by tree species groups, not by regeneration of a single species. The Game Commission evaluates regeneration using the "canopy replacement" tree species group including canopy dominants and species capable of achieving high canopy status. This measure includes a broad collection of trees and is useful for evaluating the long-term sustainability of Pennsylvania's current forest canopy (Table 15; McWilliams et al. 2004a). This tree grouping also includes both acid sensitive and acid tolerant trees with each species given equal weight in assessing regeneration. In other words, a black birch seedling is equal to a sugar maple seedling in the assessment, thus reducing the influence of acid deposition on regeneration assessment. Individual tree species also demonstrate variable levels of susceptibility to tree diseases and pests (Morin et al. 2006). Again, using a group of tree species also lessens the influence of species-specific tree diseases and pests.

Competing vegetation, such as hay-scented fern can influence regeneration (Horsley 1983); however, evidence suggests when deer impact is low, regeneration may establish nonetheless. Proportion of competing vegetation is recorded at PRS plots.

Sampling Methods

ATSSR data are collected as part of a systematic sampling scheme from public and private lands in all WMUs from the Pennsylvania Regeneration Study (PRS) being conducted as part of the Forest Inventory Analysis (FIA) by the Pennsylvania Department of Conservation and Natural Resources (DCNR), U.S. Forest Service, and the Pennsylvania State University (PSU). A subset of all plots is collected each year, with all plots being sampled after 5 years.

ATSSR from two 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)" (McWilliams et al. 2004a:13-14).

Regeneration of canopy replacement tree species including species capable of achieving high canopy status provides a general assessment of forest habitat health. Advantages of the PRS data include: 1) they control for the amount of light penetrating the canopy by only sampling plots that receive enough light for regeneration (i.e., stocking of 40 to 75 percent); 2) by including a variety of species, the influence of specific factors that affect regeneration of individual species is reduced (e.g., seed source, insect pests, fire suppression, etc.); 3) they are useful for comparing WMUs because it represents the middle ground of regeneration data (McWilliams et al. 2004a); and 4) they include tree species of value to wildlife and Pennsylvania's wood products industry (Table 15). Finally, because many of these tree species are moderately or highly browsed by white-tailed deer (Table 15) and there is a relationship between changes in deer abundance and forest regeneration (Tilghman 1989, Drake and Palmer 1991, DeCalesta 1994, Tzilkowski et al. 1994a,b, Horsley et al. 2003), this measure should reflect changes in deer impact.

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

Table 15. Forest canopy groupings used by the Pennsylvania Regeneration Study with tree species associates, wildlife value, and deer browse preference. Wildlife values per Carey and Gill (1980) and Payne and Bryant (1998). Levels of browse preference by white-tailed deer during fall and winter (Latham et al. 2005) are provided to illustrate general characteristics of species.

Category	Tree Species	Wildlife Value	Browse Preference
Dominants	Eastern Hemlock	Excellent	High
	Red Maple[1]	Good	High
	Sweet (Black) Birch[1]	Good	High
	Beech	Good	High
	Ash[1]	Fair	High
	Yellow Poplar[1]	Fair	High
	Oaks[1]	Excellent	High
	White pine[1]	Excellent	Moderate
	Sugar Maple[1]	Good	High
	Hickories[1]	Fair	Low
	Black cherry[1]	Excellent	Low
Other High Canopy	Black gum[1]	Fair	High
	Aspen	Good	High
	Other Birches[1]	Good	Moderate/High
	Other Maples (except Norway and Striped)	Good	Moderate/High
	Cucumber tree	Good	Moderate
	Willow	Fair	Moderate
	Other Conifers	Fair to Excellent	Low/Moderate
	Hackberry	Fair	Low
	Black locust	Fair	Low
	Sweet gum	Fair	Low
	Honeylocust	Fair	(is browsed)
	Black walnut	Fair	(is browsed)
	Sycamore	Fair	(is browsed)
	Basswood[1]	Fair	(is browsed)
	Elm	Fair	(is browsed)
	Buckeye	Fair	Unknown
	Butternut	Good	Unknown
	Cottonwood	Fair	Unknown
	Balsam poplar	Fair	Unknown
	Kentucky coffeetree	Fair	Unknown
	Catalpa	Fair	Unknown

[1] – These species are of “medium” or “high” importance to Pennsylvania’s wood products industry (Latham et al. 2005).

Calculation methods for the forest habitat health assessment

The forest habitat health measure is based on a sample of plots from across a WMU. Obviously, no one could measure every square foot of a WMU to ascertain exact habitat conditions. Sampling allows managers to make inferences from an attainable number of plots. The use of "statistical cutoffs" ensures that such inferences are appropriate for the WMU at hand. For example, if a "hard-line cutoff" of 70% was imposed, such a rule would require that at least 70% of plots be adequately stocked to deem forest habitat health as "good." What if 68% of plots were stocked? Would it be appropriate to call habitat health fair based on the hard-line cutoff?

When data are collected according to proper sampling design, estimates can be statistically compared to 50% and 70% levels using a t-test. The t-test determines whether the estimate is different from the 50% or 70% level based on standard statistical procedures. In the above example, a t-test could show the estimate of 68% is not statistically different from the 70% level, but different from the 50% level. 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. For more information on the t-test, see "*Statistical Details of two-tailed t-test*" on page 63.

Decision Rules for Determining Forest Habitat Health

Assignment of "Good," "Fair," and "Poor" adhere to the following criteria: A WMU's forest habitat health will be considered "Good" if the observed percentage of plots with adequate regeneration is greater than, equal to, or not significantly different than 70%. If a WMU's forest habitat health is not significantly different from 70% and not significantly different from 50%, forest habitat health will be considered "Fair." A WMU's forest habitat health also will be considered "Fair" if observed percentage of plots with adequate regeneration is equal to 50%, or between 50% and 70% and significantly less than 70%, or not significantly different from 50%. A WMU's forest habitat health will be considered "Poor" if the observed percentage of plots with adequate regeneration is significantly less than 50% (Table 16, Figure 17).

The primary performance measures for deer and forest habitat health identified in this document provide a scientific foundation upon which deer management recommendations can be established and progress monitored. As with all scientific endeavors, measures will be reassessed and adjusted as circumstances change and new information becomes available (i.e., adaptive resource management). We expect to regularly evaluate and refine these measures to ensure management recommendations are based on the best available information.

Conclusion of deer and forest health measures

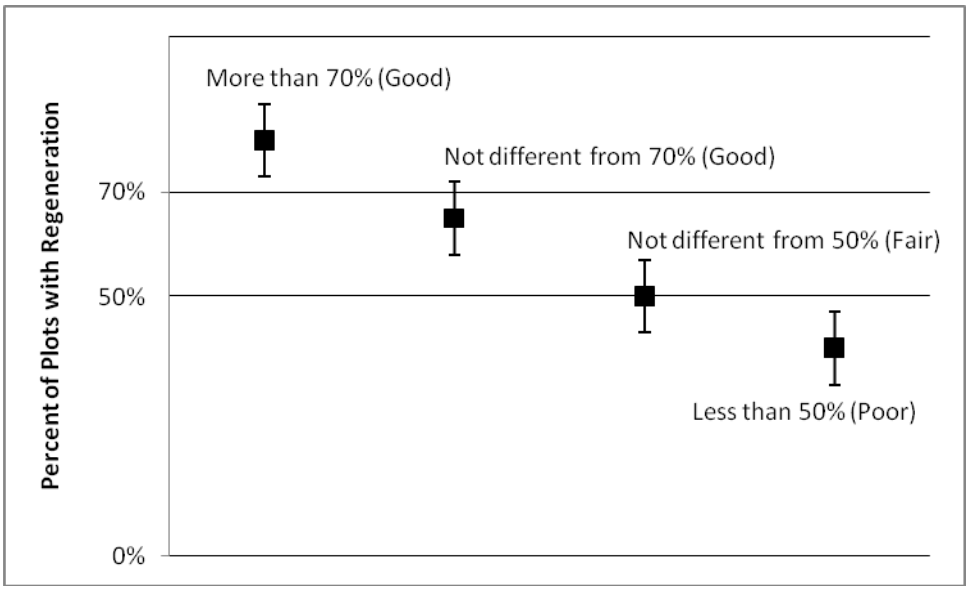
In addition, good deer health will not necessarily correspond to good forest health. Alternative food sources, such as agriculture, can elevate deer nutrition, but not increase forest regeneration (deCalesta and Stoudt 1997). For this reason, deer and forest health measures are evaluated separately.

Table 16. Forest health descriptions, percent of adequate regeneration, and description for forest health classifications used in the Pennsylvania Game Commission's Deer Management Program.

Forest health classification	Regeneration[1]	Description
Good	≥70%	Forest canopy replacement will occur without further actions to mitigate deer impacts.
Fair	50 - 70%	Forest canopy replacement can occur, but DMAP and some deer-deterrent fencing are required.
Poor	<50%	Forest canopy replacement will not occur without deer-deterrent fencing and DMAP.

[1]Percentage of plots with adequate regeneration.

Figure 17. Graphical representation of statistical cutoffs (percentage of plots with adequate regeneration) for the habitat health assessment showing the point estimate with error bars representing 95% confidence intervals, Pennsylvania Game Commission, Deer Management Program. Not all possibilities are noted on this graph.



PUBLIC INPUT INTO THE DEER PROGRAM

"…licensed hunters of this state must remember that there are over 9,000,000 additional residents of Pennsylvania who also have a stake in its wildlife…"

Ross L. Leffler, former Game Commission President, stated in 1944

Mission and goals

Public input into a deer management program can take many forms. The mission and deer management goals are important forms of public input. In most cases, this level of public input will outweigh others.

The mission of the Game Commission comes directly from the Commonwealth's Constitution and Game and Wildlife Code. Each of these documents has been signed and approved by elected representatives of the citizens of Pennsylvania. As such, they represent public input of the highest order.

Below the agency's mission are goals of the deer management program. As previously explained, deer management goals were identified by the public through public involvement processes (see Appendices 3 and 4) and adopted by the Game Commission.

The mission and goals provide overall guidance to the deer management program, but cannot always provide the necessary information for specific issues. As a result, the Game Commission also utilizes other methods of public involvement in its deer management program such as public meetings, surveys, and Citizen Advisory Committees.

Public meetings

The Game Commission regularly participates in public meetings. Each year in January, April, June, and October the Board of Commissioners holds a public meeting. During these meetings, members of the public can provide written and 5 minutes of oral testimony on any issue of their choosing.

Beyond quarterly Board of Commissioner meetings, the Game Commission participates in public meetings of varying formats. It regularly attends public meetings where presentations are given followed by question-and-answer periods. These are commonly conducted for sportsmen organizations, conservation groups, and legislators. The Game Commission has conducted public meetings in a variety of formats across the Commonwealth (Tables 17 and 18). Although other forms of public input may carry more weight in making management recommendations, public meetings still have their place in a responsible and responsive deer management program.

Deer Management Working Group (1998-2000)

In 1998, the Pennsylvania Deer Management Working Group (DMWG) was established with Board of Commissioners' endorsement. The DMWG's goal was "to increase dialogue and communication leading to the development of informed consent on deer management in Pennsylvania" (Williamson 2000). For this group, consent was defined as a unanimous agreement among the group members. The group, which had a 2-year charter, met 7 times to discuss numerous aspects of deer management. A final report of these activities and recommendations was delivered to the Board of Commissioners in January 2000. The group unanimously agreed to a number of findings and recommendations (Table 19). Many of these recommendations have been incorporated into the current deer management program in one form or another (e.g., Citizen Advisory Committees, Deer Management Assistance Program). Others, such as the recommendation for more than 67 deer management units were not adopted given the scientific and data collection reasons explained previously.

Table 17. Formats of public meetings conducted by the Game Commission.

Public Meeting Format	Description
Listening Meetings	Game Commission personnel sit in front of gathering and public expresses views and provides comments on deer management that are recorded. Typically a 1-2 hour meeting.
Open Houses	Informative displays available for individuals to view at their own pace. Game Commission personnel available to discuss issues and answer questions. Typically last for at least 5 hours.
Presentation Meetings	Game Commission personnel present program describing deer management program. Presentation is followed by a question-and-answer session. Typically a 1-2-hour meeting.

Table 18. Various public meetings conducted by the Game Commission across Pennsylvania in the last 15 years.

Public Meeting Format	Year(s)	Location(s)
Deer Program Listening Meetings	1995	9 meetings across the state
Deer Management Open Houses	1999	8 meetings across the state
Deer Management Presentation Meetings	2000-2002	Approximately 200 across the state
Deer Harvest Open House	2006	1 in Harrisburg
Deer Goals Open Houses	2007	7, 1 in each region plus 1 in Harrisburg
Deer Program Open Houses	2008	6, 1 in each region

Hunter surveys

Hunter opinions, attitudes, and behaviors influence deer management. Many disagreements over deer management policy have been based on speculation of what hunters want, think, and do.

Rather than rely on conjecture about hunters when making deer management recommendations, the Game Commission regularly uses surveys of hunters to gauge hunter opinions, attitudes, and experiences (Table 20). Surveys conducted by or supported by the Game Commission are a random sample of hunters based on hunting license back-tag numbers. Using this method ensures all hunters have an equal chance to participate in the survey.

In recent years, a number of surveys have been conducted prior to major regulation changes. For example, prior to changing to a concurrent firearms season for antlerless and antlered deer, a survey was conducted. This survey found 60% of hunters supported the concurrent season, an increase from 1995 when hunters were evenly split (Figure 18). Surveys also were conducted before and during the first 3 years of the 3- and 4-point antler restrictions to monitor hunter support (Figure 19) and hunting activity.

Table 19. Findings and recommendations from the DMWG, Pennsylvania, 2000 (Williamson 2000).

Findings

1. Private landowner values should direct private land goals.
2. Goals for public lands differ by agency.
3. Land ownership goals dictate a range of acceptable deer density targets. Deer density targets will not be allowed to be greater or less than endpoints on that range.
4. Targets and ranges must be determined using science and will be based upon the quality and quantity of habitat.
5. Quality and quantity of habitat is the essential determinate of deer density targets and funding of methods to improve habitat quality must be continually sought.
6. Regulatory flexibility is required.
7. Hunting is essential to the long-term sustainability of Pennsylvania's ecosystem.
8. The mission of the Pennsylvania Game Commission, as stated in the recent Strategic Plan, is endorsed by the working group.

Recommendations

1. Citizen task forces or other stakeholder groups should be used to provide input to the PGC on acceptable deer density targets.
2. The working group requests that the Commission approve the permit system tabled by the Commission that allows the taking of deer in forestry exclosures.
3. The working group requests that the Commission instruct staff to accommodate and promote, whenever possible, the efforts by interested groups to improve deer management.
4. The working group requests that the Commission adopt the working group's proposal for a "Large Landowner Antlerless Deer Management Permit" program.
5. The working group recommends that additional tools be given to sportsmen participating in the hunter/trapper/landowner link program in order to better control wildlife damage on participating landowner's properties (referred to as the "Small Landowner Program").
6. The working group recommends that the following considerations be incorporated into the design of deer management units:
    A. The division of the Commonwealth into 18 units is valid for data collection but these units are too large in area to adequately control hunter harvest.
    B. Deer management units (DMUs) should be sub-units of the proposed 18 data units. Small DMUs are necessary to better distribute hunter pressure, to focus harvest levels, and to better define areas of similar deer habitat. No specific number of DMUs was discussed, but there was general acceptance that the number of DMUs would most likely exceed the 67 county units currently used.

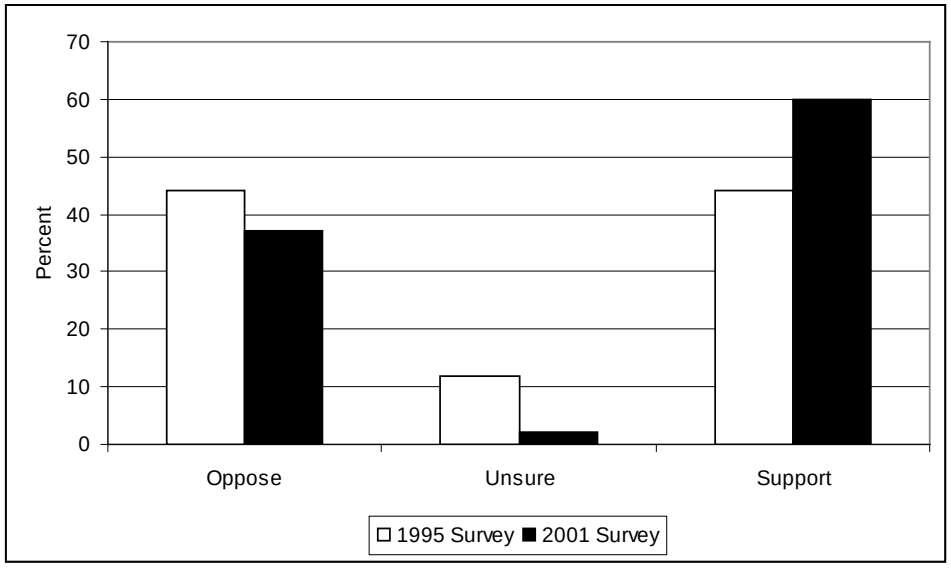
The need to manage the deer population for the benefit of all species is widely supported by hunters. In a 2002 survey, a majority of deer hunters agreed that deer affect plants and animals, and 9 out of 10 hunters agreed that deer populations should be balanced with natural food supplies (Wallingford et al. 2006). In a 2001 survey, 9 out of 10 hunters also agreed that managing game to promote healthy habitat for ALL wildlife species should be an extremely or very important consideration in wildlife management (Responsive Management 2001).

Table 20. Hunter surveys conducted by or contracted by the Game Commission, 1991-2008.

Year	Survey Topic	Conducted by
1991	Deer Hunter Survey	Game Commission[1]
1995	Deer Hunter Survey	Game Commission[1]
2001	Pennsylvania Hunter Survey	Responsive Management[2]
2001	Pennsylvania Hunter Survey	Pennsylvania State University[3]
2002-2005	Deer Hunter Survey	Game Commission[4]
2008	Effect of EHD on Hunter Behavior in WMU 2A	Game Commission[4]
2008-2010	Hunter Use of Bait Survey	Game Commission[5]

[1] – Results available by contacting the Bureau of Wildlife Management
[2] – See Responsive Management 2001
[3] – See Luloff et al. 2002
[4] – Results available in annual reports located on the Game Commission's website, www.pgc.state.pa.us
[5] – Results of ongoing research project not presently available

Figure 18. Hunter support and opposition towards a 2-week concurrent firearms season for antlered and antlerless deer. Results from hunter surveys conducted in 1995 by the Game Commission and 2001 by Responsive Management, Pennsylvania 1995 and 2001.



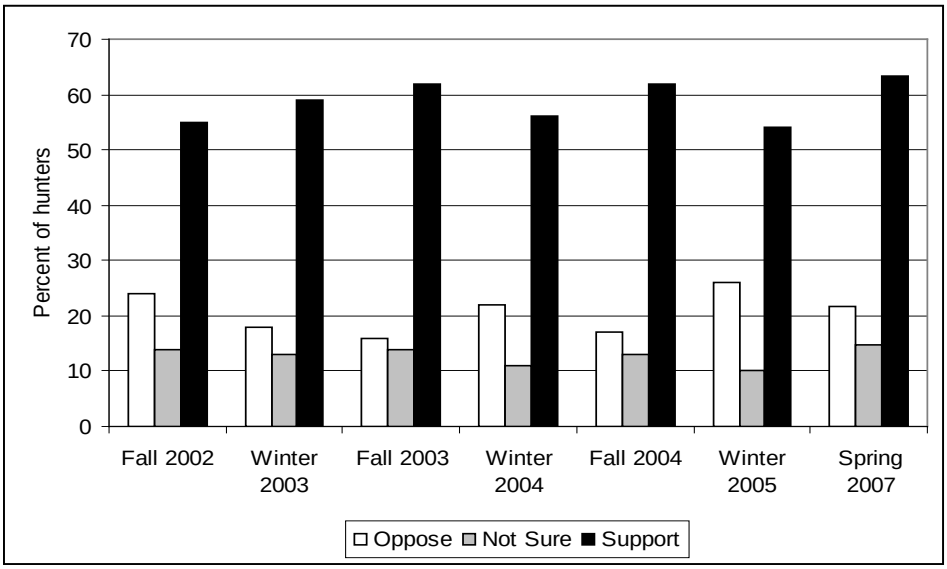
Properly conducted surveys provide a means to gather representative information on hunter attitudes, opinions, and behavior. Consequently, they form an important part of a responsive deer management program.

Citizen Advisory Committees

Deer management has traditionally been formulated by the state wildlife agency and applied across the landscape. The purpose of a Citizen Advisory Committee (CAC) is to gain involvement from diverse stakeholders at the local level to formulate deer management objectives for a specific area (Decker et al. 2004). Citizen Advisory Committees have the ability to increase knowledge of the resource, improve agency image, and increase support for controversial management strategies (Stout et al. 1996, Curtis and Hauber 1997, Lafon et al.

2004). In addition, 65% of Pennsylvania hunters supported the use of CACs in a hunter survey conducted in the spring of 2006 (Librandi Mumma 2006).

Figure 19. Levels of support for antler restrictions in the area where hunters hunted based on random surveys of Pennsylvania hunters from 2002 to 2007. Results may not add up to 100 because of rounding and no responses to question.



The Game Commission began implementing Citizen Advisory Committees as a way to gauge the level of deer-human conflict or tolerance for deer populations in a WMU in 2006. Objectives of CACs are (1) to provide an opportunity to inform stakeholders on the mission of the Game Commission, complexities of deer management, and the importance of proper management; (2) to provide an opportunity for the Game Commission to understand stakeholder values regarding deer management; (3) to provide an opportunity for stakeholders to interact with one another and increase understanding of different stakeholder values and concerns; and (4) to provide an opportunity for stakeholders to have direct input concerning deer population objectives for a WMU.

With the aid of trained facilitators, CAC members work together to recommend a deer population trend objective to the Bureau of Wildlife Management's Deer and Elk Section. The Deer and Elk Section considers the CAC's population recommendation when making deer management recommendations for the WMU in question.

Each member represents a group of stakeholders and is vested with the decision-making power of that group. Members present values and concerns of their stakeholder group and not their own individual viewpoint. Members are encouraged to consider all relevant biological and social data as it pertains to their constituents. Input is sought from all members equally. Members work towards consensus on a recommendation for a deer population trend objective. Recommendations are made by consensus, defined as all but one member in agreement, and not the majority. The CAC is disbanded following completion of the assigned tasks.

Biologists work with the committee as advisory members. Biologists provide technical information on deer management including biological and social data, as well as background material. Staff has no voting or vetoing power within the meetings.

Participants representing stakeholder groups are drawn from a variety of sources. Each July, the Game Commission sends out a news release and makes information available on its website for interested individuals to volunteer to serve on a CAC. In addition, the Game Commission solicits nominations from regional personnel, county extension offices, county conservation districts, various wildlife and conservation organizations, and other government agencies. By using all of these methods of identifying potential stakeholder representatives, the Game Commission tries to ensure every citizen of Pennsylvania has an equal opportunity to participate.

Independent, third-party, facilitators interview and select members to the advisory committee and organize and conduct committee meetings. Facilitators are the main point of contact for committee members and lead meetings. Facilitators are responsible for focusing advisory committee interaction in a positive manner.

If the committee reaches consensus, the recommendation forms the basis of the public input recommendation for the deer population trend objective for the WMU in question for the next 5 years. Biologists consider the recommendation as one of the measures (i.e., deer health, forest habitat health, and CAC recommendation) used to formulate its recommendation to the Board of Commissioners. If consensus is not reached, the Deer & Elk Section considers input of all members when formulating its recommendation to the Board of Commissioners.

DEER POPULATION MONITORING

White-tailed deer are secretive, well camouflaged, and notoriously difficult to count (Rice and Harder 1977, Ludwig 1981, Stoll et al. 1991, Beringer et al. 1998). Thus, most wildlife agencies monitor deer population trends by analyzing deer harvest data (Creed et al. 1984, Roseberry and Woolf 1991). In Pennsylvania, harvest data represents the primary source of population trend information.

For decades, the Pennsylvania Game Commission based its deer management objectives on deer densities, specifically, the number of deer per forested square mile. Beginning with the deer management plan in 2003, deer densities no longer defined deer management goals. Rather than setting targets based on the number of deer in an area, indicators of deer health, forest habitat health, and deer-human conflicts became the basis for deer management recommendations. Despite these changes, the ability to monitor deer population trends remains important to deer management.

The following quote accurately captures the conflict surrounding and use of deer population information in Pennsylvania's deer program:

> *"Estimates of whitetail population size interest the public and appeal to the media. Often, however, the importance of knowing the population size is overestimated as a tool for*

deer management. It is more important to know the relative abundance of deer – whether the population is increasing or decreasing, and whether it is above, below or nearly in balance with carrying capacity of the environment." (Hayne 1984).

Population estimates certainly appeal to the public and media. Courage of the Game Commission's deer program has been called into question because it does not release a deer population estimate (Mulhollem 2007). And in 2008, an audit was approved by the Legislative Budget and Finance Committee to determine Pennsylvania's deer herd in absolute numbers and percentages for the past 12 years. Despite difficulties associated with estimating deer populations in state wildlife management programs (Millspaugh et al. 2006), the public and media continue to focus on them.

Instead of using the number of deer as a management measure, the Game Commission monitors relative abundance of deer and whether the trend is increasing, decreasing or stable. In addition, the relationship of deer populations to available nutrition, forest sustainability, and human tolerances are monitored using reproductive data, regeneration data, and citizen input, respectively. In other words, instead of focusing on whether there are 20 or 30 deer per forested square mile, the Game Commission now monitors trends and makes deer management decisions based on the impacts of deer on themselves, the forest, and the people.

There are 3 primary methods used to assess deer population trends; two relatively simple indices based on hunter success and one more complex index that incorporates a larger data set. We use multiple methods to monitor deer population trends including; 1) an antlered harvest index (i.e., estimated antlered harvest for a WMU), 2) antlerless hunter success index (i.e., estimated antlerless harvest divided by the number of antlerless licenses), and 3) a modified Sex-Age-Kill (SAK) deer population monitoring procedure.

We use the SAK method of population reconstruction (Eberhardt 1960, Creed et al. 1984, Skalski and Millspaugh 2002) with modifications for Pennsylvania's antler restrictions (Long et al. 2008) to monitor deer population trends. Population trend monitoring relies on research data from Pennsylvania (e.g., Long et al. 2005), harvest estimates, and deer aging data. Population monitoring begins with adult males (males 1.5 years of age and older) and progresses to females and fawns.

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 ongoing internal and external evaluations, refinements to this procedure will occur.

TREND ASSESSMENT PROCEDURES

Population trends are identified as increasing, decreasing, or stable based on graphical and statistical methods, including the Mann-Kendall Test for Trend (Mann 1945, Kendall and Gibbons 1990). This test 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: 1) statistically appropriate, 2) utilizes information available to the public (e.g., a graph of estimates over time), and 3) is easy to explain.

DECISION RULES FOR DEER MANAGEMENT RECOMMENDATIONS

The following rules describe the process for setting a deer population trend objective (see also Table 21).

Rule 1. Forest habitat health must be good and deer health at least at target to increase deer population.

Justification: Below the levels indicated in Rule 1, forest habitat health and deer health are fair and below target, respectively. It is not justifiable to allow a deer herd increase when forest habitat and the deer resource itself are fair at best.

Rule 2. If forest habitat health is good and deer health is at least at target, follow CAC recommendation.

Justification: Under this situation, the two biological measures support a socially driven management decision. If a CAC does not exist, the Executive Director serve as a surrogate because the residing director will have the most comprehensive understanding of social issues (Rule 7)

Rule 3. If forest habitat health is fair, take 6-year deer population and forest habitat trends into account

a. If forest habitat health is fair and 6-year deer population trend has been increasing, decrease deer population
b. If forest habitat health is fair but improving, and 6-year deer population trend has remained the same, stabilize deer population
c. If forest habitat health is fair but stable, and 6-year deer population trend has remained the same, decrease deer population
d. If forest habitat health is fair but declining, and 6-year deer population trend has remained the same, decrease deer population
e. If forest habitat health is fair and 6-year deer population trend has been decreasing, stabilize deer population

Justification: In some cases it is necessary to examine trends and incorporate additional data. When forest habitat health is fair, it would be inappropriate to recommend a standard deer population reduction without deer population and forest habitat trends.

For example, forest habitat health measures will properly correspond to deer population levels using a 6-year stable deer population trend following a deer population reduction. The reason is that only established, or 2-year old, seedlings are counted in the PRS. By using a 6-year stable deer population and the most recent forest habitat measure (a 5-year sample), this ensures the forest habitat measure accurately reflects the impact of the stable deer population.

Rule 4. If forest habitat health is fair or poor or deer health is below target and CAC desires fewer deer, decrease herd

Justification: The social parameter and an important biological parameter both support a decision to decrease the herd

Rule 5. If forest habitat health is poor, take 6-year deer population trend into account

a. If forest habitat health is poor and 6-year deer population trend has been increasing, decrease deer population
b. If forest habitat health is poor and 6-year deer population trend has remained the same, decrease deer population
c. If forest habitat health is poor and 6-year deer population trend has been decreasing, stabilize deer population

Justification: Similar to Rule 3, it is inappropriate to recommend a standard herd reduction without additional information. In (a) and (b) above, it is apparent that habitat cannot support deer at current levels. In (c) above, we allow for a time lag in habitat response rather than continuing to reduce a herd that is in a downward trend.

Rule 6. If forest habitat health is good and deer health is below target, stabilize deer population

Justification: Here, we would expect deer health to catch up with forest habitat health. Because forest habitat generally shows a greater time lag than deer health, this is an unlikely scenario, but accounted for nonetheless.

Rule 7. When a Citizen Advisory Committee does not exist, the Executive Director serves as a surrogate, as he will have the most comprehensive understanding of social issues

Table 21. Possible combinations of primary measures with associated herd recommendations and relevant decision rule numbers, Pennsylvania Deer Management Program.

Habitat Health	Deer Health	CAC	Herd Recommendation	Rule #
Good	At target	Increase	Increase	1,2
Good	Above target	Increase	Increase	1,2
Good	At target	Stabilize	Stabilize	2
Good	Above target	Stabilize	Stabilize	2
Good	Below target	Stabilize	Stabilize	6
Good	Below target	Increase	Stabilize	6
Fair	At target	Stabilize	Stabilize or decrease	3
Fair	At target	Increase	Stabilize or decrease	3
Fair	Above target	Stabilize	Stabilize or decrease	3
Fair	Above target	Increase	Stabilize or decrease	3
Fair	Below target	Stabilize	Stabilize or decrease	3
Fair	Below target	Increase	Stabilize or decrease	3
Poor	At target	Stabilize	Stabilize or decrease	5
Poor	At target	Increase	Stabilize or decrease	5
Poor	Above target	Stabilize	Stabilize or decrease	5
Poor	Above target	Increase	Stabilize or decrease	5
Poor	Below target	Stabilize	Stabilize or decrease	5
Poor	Below target	Increase	Stabilize or decrease	5
Good	At target	Decrease	Decrease	2
Good	Above target	Decrease	Decrease	2
Good	Below target	Decrease	Decrease	4
Fair	At target	Decrease	Decrease	4
Fair	Above target	Decrease	Decrease	4
Fair	Below target	Decrease	Decrease	4
Poor	At target	Decrease	Decrease	4
Poor	Above target	Decrease	Decrease	4
Poor	Below target	Decrease	Decrease	4

RESEARCH PROGRAM

Research supports deer management. Since 2000, the Game Commission has supported an active deer research program in cooperation with the Pennsylvania Cooperative Fish and Wildlife Research Unit at Pennsylvania State University. A number of research studies have been

conducted to address management and scientific needs (Table 22). Research results are presented to the public via a number of outlets including news releases, annual reports, graduate theses and dissertations, and scientific publications (Table 23).

Table 22. Deer research conducted in Pennsylvania from 2000 to 2008.

Years	Study[1]
2000-2001	Fawn survival
2001-2005	Evaluation of biological effects and social acceptance of new antler restrictions for white-tailed deer hunting season in Pennsylvania
2005-2006	Survival and response to hunting activity of female white-tailed deer
2007-2008	Survival, mortality causes, and antlered harvest rates of white-tailed deer in Pennsylvania
2008-present	Biological and social implications of a 7-day concurrent firearms season

[1] – Annual reports are available on the Game Commission's website, www.pgc.state.pa.us

Table 23. Scientific publications resulting from research conducted by the Pennsylvania Game Commission, 2000 to 2009.

Year	Reference
2004	Vreeland, J. K., D. R. Diefenbach, and B. D. Wallingford. Survival rates, mortality causes, and habitats of Pennsylvania white-tailed deer fawns. *Wildlife Society Bulletin 32:542-553.*
2004	Rosenberry, C. S., D. R. Diefenbach, and B. D. Wallingford. Reporting rate variability and precision of white-tailed deer harvest estimates in Pennsylvania. *Journal of Wildlife Management 68:858-867*.
2004	Diefenbach, D. R., C. S. Rosenberry, and R. C. Boyd. 2004. Efficacy of detecting chronic wasting disease via sampling hunter-killed white-tailed deer. *Wildlife Society Bulletin:32:267-272*.
2005	Long, E. S., D. R. Diefenbach, C. S. Rosenberry, B. D. Wallingford, and M. D. Grund. 2005. Landscape structure influences dispersal distances of a habitat generalist, the white-tailed deer. *Journal of Mammalogy* 86:623-629.
2008	Diefenbach, D. R., E. S. Long, C. S. Rosenberry, B. D. Wallingford, and D. R. Smith. 2008. Modeling the distribution of dispersal distances in male white-tailed deer. *Journal of Wildlife Management* 72:1296-1303.
2008	Long, E. S. D. R. Diefenbach, C. S. Rosenberry, B. D. Wallingford. 2008. Multiple proximate and ultimate causes of natal dispersal in white-tailed deer. *Behavioral Ecology 19:1235-1242*.
2009	Rosenberry, C. S., E. S. Long, B. D. Wallingford, H. M. Hassel, V. P. Bunaccorsi, D. R. Diefenbach, and B. D. Wallingford. 2009. Lack of mother-offspring relationship in white-tailed deer capture groups. *Journal of Wildlife Management 73:357-361.*

DEER MANAGEMENT IN DEVELOPED AREAS (Urban deer management)

"Various means were discussed as to how to reduce the excess deer herd in Chester, Delaware and Montgomery counties. No action was taken but it was the general opinion of the Commission that the landowners in those counties should open their land to public hunting to solve the problem." -- Aug. 16, 1955 Meeting Minutes

In 2006, the Game Commission created its first comprehensive plan to address deer management in developed areas. The goals, objectives, and strategies of the 2006 plan have been incorporated into this deer management plan.

Deer-human conflicts in developed areas are not new (Forbes et al. 1971). As human populations continue to expand into rural areas and make traditional hunting difficult through regulations and safety concerns, deer populations benefit. Developed areas often provide ideal conditions for deer population growth. There is ample food supply in the edge environment created by development and low risk of mortality except for vehicles. As a result, deer populations can thrive in these human-altered landscapes.

Common deer-human conflicts in developed areas include increased deer-vehicle collisions; increased exposure to Lyme disease; and increased damage to gardens, ornamentals, and landscaping. However, metropolitan residents still view deer favorably and are interested in wildlife (Conover 1995, Conover 1997b). As stewards of all wildlife in the Commonwealth, the Pennsylvania Game Commission is challenged to minimize negative effects of deer in developed areas while maintaining positive benefits they provide to residents.

The Game Commission first addressed issues of deer management in developed areas in the 1980s. It extended the 2-day antlerless season to 3 days and implemented the "bonus" tag system that permitted hunters to buy unsold antlerless licenses in select counties in southeastern and southwestern Pennsylvania (Kosack 1995). Since then, the Game Commission has further increased hunting opportunities in more developed Wildlife Management Units (WMUs) by extending the antlerless season to 30 days or more (including the 2-week concurrent antlered-antlerless season), increasing the antlerless license allocation, reducing the 150-yard safety zone for archers to 50 yards, and legalizing the use of crossbows. Municipal deer control permits also have been added as a way for communities to remove deer by professional means.

The Game Commission is directed by law to use hunting as a method of management for white-tailed deer. Where safe and appropriate, this approach will be used to manage deer populations in developed areas. The Game Commission will support and encourage hunting as a means of managing deer populations by annually making hunting opportunities available, increasing hunting opportunities in developed areas, and providing deer hunters with tools to increase their success.

Enacting these types of regulations is part of the Game Commission's normal procedures and does not require direct community involvement. It is a service provided by the Game

Commission to residents and hunters in developed areas. Communities not experiencing enough relief through traditional deer management may request additional aid from the Game Commission to address their urban deer problems.

While traditional hunting is the most economical and effective way to manage deer populations, its application may be limited in some developed areas because of real or perceived safety concerns, social values, and legal constraints (DeNicola et al. 1997, DeNicola et al. 2000). Some non-traditional management approaches may be needed to address deer problems. Upon receiving a written request for assistance, the Game Commission will work with a community to find a solution to its deer problems. For non-traditional management techniques to be utilized, the affected community must develop a deer management plan, which must be approved by the Game Commission. Examples of nontraditional deer management techniques include controlled hunts and sharpshooting.

A key component to managing deer in developed areas is information and education. Residents of urban deer environments must be informed on deer biology, ecology, and management. Equipping residents with this knowledge will aid in resolution of deer-human conflicts and acceptance of management techniques.

Wildlife management requires sustained effort. Managing deer in developed areas is no different. There is no quick fix, one-time solution to reducing deer-human conflicts in developed areas. Once deer have integrated themselves into a community, the community must integrate a long-term plan to manage them.

POSITION ON DEER MANAGEMENT IN DEVELOPED AREAS

Deer-human conflicts in developed areas are not easy to solve, nor do they appear overnight. Resolving deer-human conflicts requires a long-term commitment from residents and public officials to effectively apply available deer management tools. The Game Commission cannot solve deer-human conflicts in developed areas. Rather, residents and public officials must accept long-term responsibility to resolve deer-human conflicts in their community. If residents and public officials are willing, the Game Commission will provide technical assistance to resolve deer-human conflicts in developed areas.

SUMMARY OF PUBLIC COMMENT ON 2006 PLAN

On August 11, 2005, the Pennsylvania Game Commission distributed a news release seeking public input for the 2006 management plan for deer in developed areas. The month-long comment period yielded more than 500 individual comments (Table 24). Deer prove to be a part of everyone's life in Pennsylvania. Comments were received from hunters young and old, once rural residents who now find themselves living in suburbia, farmers who provide a tasty green oasis among a patchwork of houses, and urban residents with barely a patch of grass.

Among the suggested solutions to address overabundant urban deer, there were many stories of concern, frustration, and anger. One farmer wrote, "…being the last farmer in Doylestown Township, my corn and soybeans are ruined by deer." He goes on to say that the communities

surrounding his farm do not allow hunting. Another urban resident wrote, “Although I am not a hunter, I am not anti-hunting…..Try to find a 200-yard safety zone edge to hunt. Woodlots are surrounded by homes and highways. I urge you to stop thinking of urban deer in terms of ‘sport’ and start thinking in terms of resource needing to be harvested.”

Table 24. Summary of public comments and suggestions regarding deer in developed areas, Pennsylvania 2005.

Comment or Suggestion	Count
Baiting	45
Longer seasons	54
Special urban deer archery season (early, late, youth, Christmas/New Year's Day)	19
Special urban deer sporting arm season (handgun, atlatl)	2
Earn a Buck program	17
Controlled hunts	30
Open county parks/publicly-owned land to hunting	29
Sunday hunting	28
Unlimited antlerless tags	29
Eliminate antler restrictions in urban WMUs	11
Hunt after hours	6
Reduce safety zone <50 yards	10
Extend hunting hours 1/2 hour after sunset	2
Start rifle season on Saturday	1
Sharpshooters	10
Translocation	41
Bait & poison	1
Sterilization/contraception	15
DMAP urban properties/townships	16
Relax Red Tag/Crop Damage program	1
Alter crop damage restrictions	1
Ban deer feeding/sale of deer feed	6
Proficiency test/urban hunter education/certification	54
Resident education program	66
Hunter/Landowner registration database	48
Sponsor community deer task force/committee	4
Tax breaks/incentives for hunting access	18
Increase trespass penalties	2
Market urban deer hunting	6
Fight municipal hunting ordinances	3
Fencing	7
Deterrents	3

INFORMATIONAL RESOURCES

Pennsylvania Game Commission's Deer Program Website
http://www.pgc.state.pa.us/pgc/cwp/browse.asp?a=465&bc=0&c=70124

A Guide to Deer Management in Developed Areas of Pennsylvania (PGC)
http://www.pgc.state.pa.us/pgc/lib/pgc/deer/pdf/Urban_Deer_Guide.pdf

Pennsylvania Chronic Wasting Disease Response Plan
http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=458&q=163873

An Evaluation of Deer Management Options
http://www.pgc.state.pa.us/pgc/lib/pgc/deer/deermgmtoptions.pdf

Managing White-tailed Deer in Suburban Environments: A Technical Guide
http://wildlifecontrol.info/pubs/Documents/Deer/Deer_management_mechs.pdf

Human-Wildlife Conflict Management: A Practitioners' Guide
http://wildlifecontrol.info/pubs/Documents/Human-Wildlife/H-W%20Guide.pdf

Community-Based Deer Management: A Practitioners' Guide
http://wildlifecontrol.info/pubs/Documents/Deer/DeerGuide.pdf

Learning by Doing: Deer Management in Urban and Suburban Communitities
http://www.dnr.cornell.edu/hdru/PUBS/HDRUReport04-2.pdf

Pennsylvania Chronic Wasting Disease Response Plan
http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=458&q=163873

Case Studies in Controlled Deer Hunting
Contact the Game Commission at 717-787-5529 for copies.

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APPENDIX 1: Implementation Schedule

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1.1. Maintain reproduction at or above 1.50 embryos per adult doe	*1.1.1. Annually collect reproductive data*	•	•	•	•	•	•	•	•	•	•
	1.1.2. Maintain adequate sample sizes of road-killed deer for a 3-year sample	•	•	•	•	•	•	•	•	•	•
	1.1.3. Increase sample sizes to permit annual estimation of embryos per adult doe			•							
1.2. Monitor deer population trends	*1.2.1. Annually collect sex, age, and harvest information from field-checked deer*	•	•	•	•	•	•	•	•	•	•
	1.2.2. Maintain 95% efficiency for trained deer agers	•	•	•	•	•	•	•	•	•	•
	1.2.3. Annually collect deer harvest information via report cards, telephone, and Internet	•	•	•	•	•	•	•	•	•	•
	1.2.4. Annually estimate antlered and antlerless harvest	•	•	•	•	•	•	•	•	•	•
	1.2.5. Annually estimate antlerless hunter success	•	•	•	•	•	•	•	•	•	•
	1.2.6. Annually calculate deer population indices	•	•	•	•	•	•	•	•	•	•
	1.2.7. Propose seasons, bag limits, and antlerless allocations by April of each year that affect deer populations to maintain, and where appropriate, promote improvement in deer reproduction, forest health, and deer-human conflicts	•	•	•	•	•	•	•	•	•	•
	1.2.8. Complete current field studies to evaluate population monitoring techniques					•					
	1.2.9. Review scientific literature and other state deer programs for deer population monitoring techniques										•
	1.2.10. Conduct experiments to evaluate population monitoring techniques	A	A	A	A	A	A	A	A	A	A

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1.3. Identify and implement additional measures of deer health as needed to improve effectiveness of deer management program	*1.3.1. Evaluate collecting antler beam diameter data from road-killed deer*			•							
	1.3.2. Review scientific literature and other state deer programs for deer health measures						•				
	1.3.3. Conduct research to evaluate potential deer health measures	A	A	A	A	A	A	A	A	A	A
1.4. Monitor disease risks that could effect deer populations	*1.4.1. Annually collect samples from deer for CWD testing*	•	•	•	•	•	•	•	•	•	•
	1.4.2. Monitor other disease risks in white-tailed deer	A	A	A	A	A	A	A	A	A	A
1.5. Reduce disease risk factors	*1.5.1. Collect and test deer exhibiting visible symptoms of illness, as needed*	A	A	A	A	A	A	A	A	A	A
	1.5.2. Collect and test captive deer escapees for diseases, as needed	A	A	A	A	A	A	A	A	A	A
	1.5.3. In cooperation with the Pennsylvania Department of Agriculture, strengthen regulations to minimize risk to wild deer from captive cervid operators	•	•	•	•	•	•	•	•	•	•
	1.5.4. In cooperation with the Pennsylvania Department of Agriculture, encourage compliance with cervid herd monitoring programs	•	•	•	•	•	•	•	•	•	•
	1.5.5. Review and update information and education materials explaining rationale for local deer feeding ban and post on website				•			•			•
	1.5.6. Implement educational program to activities that facilitate transmission of disease	A	A	A	A	A	A	A	A	A	A

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1.6. Increase citizens' awareness and understanding of deer-related diseases	*1.6.1. Annually review and update information and educational materials explaining Chronic Wasting Disease and post on website*	•	•	•	•	•	•	•	•	•	•
	1.6.2. Review and update information and educational materials explaining Lyme disease and the role of deer populations and post on website		•			•			•		
	1.6.3. Review and update information and educational materials explaining Epizootic Hemorrhagic Disease and post on website			•			•			•	
	1.6.4. Develop information and educational materials on other important diseases affecting deer and people and post on website	A	A	A	A	A	A	A	A	A	A
2.1. Maintain deer-human conflicts at levels where Citizen Advisory Committees recommend deer populations remain the same or increase	*2.1.1. Annually conduct 3 to 5 Citizen Advisory Committees according to established protocols so that each WMU is visited every 5 years*	•	•	•	•	•	•	•	•	•	•
	2.1.2. Annually review Citizen Advisory Committee process	•	•	•	•	•	•	•	•	•	•
	2.1.3. Review Citizen Advisory Committee process and recommend changes			•							
	2.1.4. Review literature and other state programs to identify potential deer-human conflict measures			•					•		
	2.1.5. Conduct research to test and evaluate potential deer-human conflict measures	A	A	A	A	A	A	A	A	A	A
	2.1.6. Develop Wildlife Complaint Database					•					

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.2. Provide opportunities for landowners to achieve deer management objectives	*2.2.1. Continue the Deer Management Assistance Program (DMAP) through 2018*	•	•	•	•	•	•	•	•	•	•
	2.2.2. Continue the Agricultural Deer Depredation Permit program (Red Tag) through 2018	•	•	•	•	•	•	•	•	•	•
	2.2.3. Work with public land DMAP participants (i.e., State Forest, State Parks, National Forest, and Army Corps of Engineers) to standardize deer management assessment protocols	•	•	•	•	•	•	•	•	•	•
	2.2.4. Hold annual meetings with public agencies to increase communication and understanding of deer management and how it affects their management activities.	•	•	•	•	•	•	•	•	•	•
	2.2.5. Conduct survey of participating landowners to assess effectiveness and administration of DMAP						•				
	2.2.6. Conduct survey of participating landowners to assess effectiveness and administration of Red Tag								•		
	2.2.7. Modify the Deer Management Assistance and Agricultural Deer Depredation Permit programs	A	A	A	A	A	A	A	A	A	A
2.3. Improve effectiveness of hunting in developed areas	*2.3.1. Classify existing WMUs as "developed" based on level of development and/or rate of development*						•				
	2.3.2. Maintain special antlerless-only seasons in developed WMUs	•	•	•	•	•	•	•	•	•	•
	2.3.3. Maintain an archery safety zone of 50 yards	•	•	•	•	•	•	•	•	•	•
	2.3.4. Allow use of crossbows during all archery seasons in developed WMUs	•	•	•	•	•	•	•	•	•	•
	2.3.5. Annually recommend WMU antlerless allocations to ensure adequate antlerless hunting opportunities in developed WMUs	•	•	•	•	•	•	•	•	•	•

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.3. Improve effectiveness of hunting in developed areas	*2.3.6. Publish a guide, "Planning and Implementing a Controlled Deer Hunt" and distribute to communities in developed areas*			•							
	2.3.7. Support and encourage expansion of Hunters Sharing the Harvest program and increase funding	•	•	•	•	•	•	•	•	•	•
	2.3.8. Evaluate baiting regulation in WMUs 5C and 5D using hunter surveys, deer harvests, and field study	•									
	2.3.9. Determine deer movement patterns in response to hunting activity in developed areas							•			
	2.3.10. Conduct hunter survey and harvest data analysis to evaluate impact of crossbows during archery seasons and antlerless only seasons in developed WMUs								•		
	2.3.11. Conduct survey of developed area landowners to evaluate effectiveness of hunting to reduce deer-human conflicts										•
	2.3.12. Conduct research to test and evaluate potential hunting-related deer management tools	A	A	A	A	A	A	A	A	A	A
2.4. In addition to hunting, provide options to reduce deer impacts in developed areas	*2.4.1. Discourage deer feeding and support local ordinances that prohibit deer feeding in developed areas*	•	•	•	•	•	•	•	•	•	•
	2.4.2. Annually provide permits on a request basis to communities to lethally remove deer in accordance with Deer Control Permits	•	•	•	•	•	•	•	•	•	•
	2.4.3. Develop a written policy on deer fertility control agents	•									
	2.4.4. Review and revise, if needed, Deer Control Permits	A	A	A	A	A	A	A	A	A	A

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.4. In addition to hunting, provide options to reduce deer impacts in developed areas	*2.4.5. Investigate potential non-hunting deer management tools via review of scientific literature and field study*				•						
	2.4.6. Develop a standard operating procedure for issuing permits in accordance with Deer Control Permit				•						
	2.4.7. Identify approved management options that reduce deer impacts						•				
	2.4.8. Develop regulations to permit use of approved management options on developed properties in all WMUs							•			
	2.4.9. Develop an Urban Deer Control Program to allow the taking of deer outside regular hunting seasons in developed areas							•			
	2.4.10. Conduct survey of landowners in developed areas to evaluate effectiveness of options to reduce deer-human conflicts in developed areas										•
	2.4.11. Conduct research to test and evaluate current and potential management tools	A	A	A	A	A	A	A	A	A	A
2.5. Inform political and community leaders, residents, and hunters about deer management options and opportunities in developed areas	*2.5.1. Conduct survey to identify educational needs of communities, community leaders, landowners, and hunters in developed areas*		•								
	2.5.2. Develop an urban deer webpage as part of a PGC urban wildlife webpage		•								
	2.5.3. Develop a module on deer biology and management options in developed areas to be part of "Living with Wildlife" workshop series			•							
	2.5.4. Develop displays with information and educational materials for shows and fairs			•							
	2.5.5. Train PGC staff and/or community leaders to conduct deer module of "Living with Wildlife" workshop series				•						

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.5. Inform leadership, residents, and hunters about deer management options and opportunities in developed areas	*2.5.6. Review and update guidelines for writing a community deer management plan*					•					•
	2.5.7. Develop recommendations for using approved, management options and publish management options guide						•				
	2.5.8. Develop urban deer hunting guide to encourage and inform hunters of deer hunting opportunities in urban areas						•				
	2.5.9. Conduct seminars/workshops for leaders (county commissioners, township supervisors, borough and town managers, police departments, mayors, conservation organizations) in developed areas informing them about deer management options and opportunities as requested	A	A	A	A	A	A	A	A	A	A
2.6. Encourage positive relationships between hunters and communities in developed areas	*2.6.1. Identify characteristics that landowners and communities consider when determining qualifications needed for hunters to hunt in their community*		•								
	2.6.2. Create a landowner/hunter database template to be used by communities and municipalities. Provide supporting documentation explaining how landowner/hunter databases can be used by communities to identify hunters for controlled hunts				•						
	2.6.3. Incorporate qualifying characteristics into hunter education materials					•					
	2.6.4. Develop an advanced hunter education seminar for those interested in hunting in developed areas						•				
	2.6.5. Provide advanced hunter education seminar as needed and requested							•			

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.6. Encourage positive relationships between hunters and communities in developed areas	*2.6.6. Maintain record of hunters completing advance hunter education seminar and make available to communities and landowners*							•			
3.1. Maintain deer impacts on forested areas at levels that support sustainable forest habitats	*3.1.1 Annually request advance tree-seedling and sapling regeneration (ATSSR) data from the USDA Forest Service, Northeastern Forest Inventory and Analysis Unit to monitor forest habitat health for each WMU*	•	•	•	•	•	•	•	•	•	•
	3.1.2. Secure funding to increase data collection if ATSSR data do not provide good precision (CV ~ 13%) of regeneration estimates based on the 5-year sampling period	A	A	A	A	A	A	A	A	A	A
	3.1.3. Adapt sampling protocols based on data trends and information gaps	A	A	A	A	A	A	A	A	A	A
	3.1.4. Conduct field studies to evaluate additional forest health and deer impact measures							•			
	3.1.5. Conduct evaluation of the first 10 years of forest habitat health and deer impact data in relation to deer population management									•	
	3.1.6. Promote habitat manipulations that improve the sustainable threshold of forested lands					•					
3.2. Identify, evaluate, and implement measures of deer impacts on forest habitat as needed to improve effectiveness of deer management program	*3.2.1. Conduct review of scientific literature and other state deer programs to identify potential forest health and deer impact measures*						•				
	3.2.2. Conduct research to investigate roles of habitat availability and interspersion on deer-forest interactions								•		
	3.2.3. Conduct research to evaluate effectiveness of DMAP as an alternative to deer deterrent fencing										•

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3.2. Identify, evaluate, and implement measures of deer impacts on forest habitat as needed to improve effectiveness of deer management program	*3.2.4. Incorporate research results into deer management recommendations and programs where needed*	A	A	A	A	A	A	A	A	A	A
3.3. Promote habitat management that is compatible with needs of deer, diverse native wildlife species, and citizens	*3.3.1. Develop educational materials encourage manipulation of natural vegetation (e.g., burning, disking, timber management)*			•							
	3.3.2. Identify, test, and demonstrate sustainable, cost-effective deer habitat management techniques							•			
	3.3.3. Provide public land managers with information necessary to manage deer and their habitats									•	
	3.3.4. Incorporate and support use of prescribed fire to manage habitat on public and private lands										•
3.4. Increase understanding of the role of deer and other factors on forested habitats	*3.4.1. Develop educational materials explaining deer-forest relationships*			•							
	3.4.2. Develop website with links to PGC Habitat Management Manual					•					
	3.4.3. *Develop handouts using photo points from FIA*							•			

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4.1. Provide deer hunting opportunities	*4.1.1. Annually provide a concurrent firearms season for antlered and antlerless deer following Thanksgiving*	•	•	•	•	•	•	•	•	•	•
	4.1.2. Annually provide fall and post-Christmas archery seasons	•	•	•	•	•	•	•	•	•	•
	4.1.3. Annually provide a fall muzzleloader season for antlerless deer	•	•	•	•	•	•	•	•	•	•
	4.1.4. Annually provide a fall rifle season for antlerless deer for junior, senior, disabled permit holders, and active military license holders	•	•	•	•	•	•	•	•	•	•
	4.1.5. Annually provide a post-Christmas flintlock-only season	•	•	•	•	•	•	•	•	•	•
	4.1.6. Annually allocate antlerless licenses based on deer management objectives in each WMU	•	•	•	•	•	•	•	•	•	•
	4.1.7. Support legislation to allow Mentored Youth to take antlerless deer with a mentor's antlerless license or DMAP permit	•	•	•	•	•	•	•	•	•	•
4.2. Establish deer hunting seasons to achieve deer management objectives	*4.2.1. Annually propose seasons and bag limits to achieve deer management objectives*	•	•	•	•	•	•	•	•	•	•
	4.2.2. Annually evaluate ability of hunting seasons and opportunities to achieve deer management objectives	•	•	•	•	•	•	•	•	•	•
	4.2.3. Evaluate hunting season and opportunity needs of deer hunters		•			•			•		
	4.2.4. Evaluate the effect of the October firearms seasons on antlered and antlerless deer movements		•								
	4.2.5. Evaluate traveling behavior of deer hunters beyond their local county or WMU				•						
4.3. Use antler restrictions to increase adult male harvest	*4.3.1. Annually monitor age structure of the antlered harvest*	•	•	•	•	•	•	•	•	•	•
	4.3.2. Annually monitor antlered deer hunter success rates	•	•	•	•	•	•	•	•	•	•

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4.3. Use antler restrictions to increase adult male harvest	*4.3.3. Complete report on biological and social effects of antler restrictions*	•									
	4.3.4. Monitor deer hunter satisfaction with antler restrictions		•			•			•		
	4.3.5. Adjust antler restrictions as needed to meet biological (e.g., protection of at least 50% of yearling males), deer management, and hunter satisfaction (e.g., majority support) objectives	A	A	A	A	A	A	A	A	A	A
4.4. Provide alternative deer hunting opportunities on State Game Lands, where appropriate	*4.4.1. Determine hunter interest in alternative deer hunting opportunities on State Game Lands*		•								
	4.4.2. Evaluate deer response to hunting pressure on State Game Lands			•							
	4.4.3. Identify alternative deer hunting opportunities and specific management objectives on State Game Lands			•							
	4.4.4. Conduct feasibility analysis of alternative deer hunting opportunities on State Game Lands to meet deer, habitat, and hunting objectives				•						
	4.4.5. Recommend alternative deer hunting opportunities that meet deer, habitat, and hunting objectives					•					
4.5. Increase awareness and promote other recreational opportunities besides hunting	*4.5.1. Continue to discourage deer-related recreational opportunities that create potential for deer-human conflicts, such as deer feeding*	•	•	•	•	•	•	•	•	•	•
	4.5.2. Conduct a statewide survey of Pennsylvania residents to identify deer-related recreational demands			•							
	4.5.3. Develop quantifiable objectives for deer-related recreational activities						•				
	4.5.4. Inform public about deer-related recreational opportunities								•		

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5.1. Solicit public input and suggestions regarding deer program	*5.1.1. Conduct an ongoing public request for input from interested groups and individuals on ideas for suggestions regarding deer management practices*			•	•	•	•	•	•	•	•
	5.1.2. Investigate each suggested deer management practice, complete review document, and make available to the public within 1 year				•	•	•	•	•	•	•
	5.1.3. Establish state-wide stakeholder advisory committee, modeled after Citizen Advisory Committees, to provide communication and discussion on the deer management program. The committee would meet at least once annually to discuss management plan implementation and other topics		•	•	•	•	•	•	•	•	•
5.2. Assess public knowledge and needs regarding deer and deer management	*5.2.1. Annually track letters and complaints to identify issues of importance*	•	•	•	•	•	•	•	•	•	•
	5.2.2. Use pop-up surveys on website to assess what information users are seeking and if their informational needs are met		•								
	5.2.3. Conduct surveys of deer hunters' opinions, knowledge, and understanding of deer and deer management		•								
	5.2.4. Conduct surveys of general public's opinion, knowledge, and understanding of deer and deer management				•					•	
	5.2.5. Use limited-term, issue-specific focus groups to assess public knowledge, needs, and support of deer management issues	A	A	A	A	A	A	A	A	A	A

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5.3. Provide information and educational materials regarding deer biology, management, recreational opportunities, and the impacts that deer have on landscapes and people to interested individuals and groups	*5.3.1. Publish an article as part of the series, "Life and Times of the Whitetail" in Game News each month*	•	•	•	•	•	•	•	•	•	•
	5.3.2. Annually distribute the "Deer Chronicle" each summer and fall	•	•	•	•	•	•	•	•	•	•
	5.3.3. Periodically conduct a public open house in each region and Harrisburg between January and April Commission meetings varying locations each year	A	A	A	A	A	A	A	A	A	A
	5.3.4. Annually publish a special feature press release per field research project	•	•	•	•	•	•	•	•	•	•
	5.3.5. Bi-annually conduct a deer-habitat tour in each region		•		•		•		•		•
	5.3.6. Organize deer management web pages to make them user-friendly	•									
	5.3.7. Maintain a webpage titled, "Ask a deer biologist" for discussion of public questions and concerns	•	•	•	•	•	•	•	•	•	•
	5.3.8. Develop web-based informational and instructional presentations			•							
	5.3.9. Create visual tools for public to recognize differences in habitat quality			•							
	5.3.10. Develop multi-media presentations on deer and deer management	A	A	A	A	A	A	A	A	A	A
	5.3.11. Collaborate with broadcast media to feature aspects of deer program	A	A	A	A	A	A	A	A	A	A
	5.3.12. Develop materials for use in school programs	A	A	A	A	A	A	A	A	A	A
	5.3.13. Present deer and deer management programs to the public	A	A	A	A	A	A	A	A	A	A

Objective	Strategy	By End of Fiscal Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5.4. Assess Game Commission employee knowledge and provide information to assist them in achieving Objective 5.2	*5.4.1. Continue the Deer Communications Working Group through 2017*	•	•	•	•	•	•	•	•	•	•
	5.4.2. Annually, conduct at least one informational and instructional meeting for all Game Commission employees	•	•	•	•	•	•	•	•	•	•
	5.4.3. Bi-annually conduct employee surveys to assess understanding of deer and deer management program and to collect input on outreach needs			•		•		•		•	

• – Indicates fiscal year when strategies will be started

A – Indicates strategies that will be completed as needed or requested

APPENDIX 2: Agency distribution of responsibilities

Personnel who may be involved implementing objectives and strategies. List is intended to depict the scope of resources that may be required for each strategy. Other personnel groups or agencies may be required**.**

Objective	Strategy	Executive Office	Bureau of Wildlife Management	Bureau of Administrative Services	Bureau of Automated Technology Services	Bureau of Information and Education	Bureau of Wildlife Habitat Management	Bureau of Wildlife Protection	Region Offices
1.1	*1.1.1.*		•						•
	1.1.2.		•						•
	1.1.3.	•	•						•
1.2.	*1.2.1.*		•		•	•	•		•
	1.2.2.		•		•	•	•		•
	1.2.3.			•	•				
	1.2.4.		•		•				
	1.2.5.		•	•	•				
	1.2.6.		•						
	1.2.7.	•	•	•	•	•	•	•	•
	1.2.8.		•						
	1.2.9.		•						
	1.2.10.		•						
1.3.	*1.3.1.*		•						•
	1.3.2.		•						
	1.3.3.		•						
1.4.	*1.4.1.*		•		•	•	•		•
	1.4.2.		•						•
1.5.	*1.5.1.*		•						•
	1.5.2.		•					•	•
	1.5.3.	•	•					•	
	1.5.4.	•	•					•	
	1.5.5.		•		•	•			•
	1.5.6.		•		•	•			•

Objective	Strategy	Executive Office	Bureau of Wildlife Management	Bureau of Administrative Services	Bureau of Automated Technology Services	Bureau of Information and Education	Bureau of Wildlife Habitat Management	Bureau of Wildlife Protection	Region Offices
1.6.	*1.6.1.*		•		•	•			
	1.6.2.		•		•	•			
	1.6.3.		•		•	•			
	1.6.4.		•		•	•			
2.1.	*2.1.1.*		•						
	2.1.2.		•						
	2.1.3.		•						
	2.1.4.		•						
	2.1.5.		•						
	2.1.6.		•		•				•
2.2.	*2.2.1.*		•		•				•
	2.2.2.		•					•	•
	2.2.3.		•				•		
	2.2.4.		•				•		
	2.2.5.		•		•				
	2.2.6.		•		•				
	2.2.7.	•	•		•			•	•
2.3.	*2.3.1.*		•						
	2.3.2.	•	•						
	2.3.3.	•	•						
	2.3.4.	•	•						
	2.3.5.	•	•						
	2.3.6.		•		•	•			•
	2.3.7.	•	•			•			•
	2.3.8.		•		•				
	2.3.9.		•						
	2.3.10.		•	•	•				
	2.3.11.		•	•					
	2.3.12.		•						
2.4.	*2.4.1.*	•	•			•			•
	2.4.2.		•					•	•
	2.4.3.	•	•						
	2.4.4.	•	•					•	
	2.4.5.		•						

Objective	Strategy	Executive Office	Bureau of Wildlife Management	Bureau of Administrative Services	Bureau of Automated Technology Services	Bureau of Information and Education	Bureau of Wildlife Habitat Management	Bureau of Wildlife Protection	Region Offices
	2.4.6.	•	•					•	
	2.4.7.	•	•					•	
	2.4.8.	•	•					•	
	2.4.9.	•	•					•	
	2.4.10.		•	•					
	2.4.11.		•						
2.5.	*2.5.1.*		•	•					
	2.5.2.		•		•	•			
	2.5.3.		•		•	•			•
	2.5.4.		•			•			•
	2.5.5.		•			•			
	2.5.6.		•						
	2.5.7.		•						
	2.5.8.		•			•			•
	2.5.9.		•						
2.6.	*2.6.1.*		•	•					
	2.6.2.		•		•	•			
	2.6.3.		•			•			•
	2.6.4.		•			•			•
	2.6.5.					•			•
	2.6.6.				•	•			•
3.1.	*3.1.1.*		•						
	3.1.2.	•	•						
	3.1.3.		•				•		
	3.1.4.		•				•		
	3.1.5.		•				•		
	3.1.6.		•				•		
3.2.	*3.2.1.*		•				•		
	3.2.2.		•				•		
	3.2.3.		•				•		•
	3.2.4.		•				•		
3.3.	*3.3.1.*		•			•	•		•
	3.3.2.		•				•		
	3.3.3.		•			•	•		•

Objective	Strategy	Executive Office	Bureau of Wildlife Management	Bureau of Administrative Services	Bureau of Automated Technology Services	Bureau of Information and Education	Bureau of Wildlife Habitat Management	Bureau of Wildlife Protection	Region Offices
	3.3.4.	•	•			•	•		•
3.4.	*3.4.1.*		•			•	•		•
	3.4.2.		•		•	•	•		
	3.4.3.		•		•	•	•		
4.1.	*4.1.1.*	•	•						
	4.1.2.	•	•						
	4.1.3.	•	•						
	4.1.4.	•	•						
	4.1.5.	•	•						
	4.1.6.	•	•						
	4.1.7.	•							
4.2.	*4.2.1.*	•	•	•	•	•	•	•	•
	4.2.2.		•						
	4.2.3.		•	•	•	•			
	4.2.4.		•						
	4.2.5.		•		•				
4.3.	*4.3.1.*		•		•	•	•		•
	4.3.2.		•	•	•				
	4.3.3.		•						
	4.3.4.		•	•	•	•			
	4.3.5.		•						
4.4.	*4.4.1.*		•	•	•	•			
	4.4.2.		•						
	4.4.3.		•				•		•
	4.4.4.		•				•		•
	4.4.5.		•						
4.5.	*4.5.1.*	•	•			•			•
	4.5.2.		•	•	•	•			
	4.5.3.		•						
	4.5.4.				•	•			
5.1.	*5.1.1.*		•						
	5.1.2.		•						
	5.1.3.		•						
5.2.	*5.2.1.*					•			

Objective	Strategy	Executive Office	Bureau of Wildlife Management	Bureau of Administrative Services	Bureau of Automated Technology Services	Bureau of Information and Education	Bureau of Wildlife Habitat Management	Bureau of Wildlife Protection	Region Offices
	5.2.2.				•	•			
	5.2.3.		•	•	•	•			
	5.2.4.		•	•		•			
	5.2.5.		•			•			•
5.3.	*5.3.1.*		•			•			
	5.3.2.		•		•	•			
	5.3.3.		•			•			•
	5.3.4.		•			•			
	5.3.5.		•			•	•		•
	5.3.6.		•		•	•			•
	5.3.7.		•		•	•			
	5.3.8.		•		•	•			•
	5.3.9.		•		•	•	•		•
	5.3.10.		•			•			•
	5.3.11.		•			•			•
	5.3.12.		•			•			•
	5.3.13.		•						
5.4.	*5.4.1.*		•			•			•
	5.4.2.	•	•	•	•	•	•	•	•
	5.4.3.		•			•			•

APPENDIX 3: Identifying goals for the 2003-2007 Deer Management Plan

INTRODUCTION

The Pennsylvania Game Commission's Bureau of Wildlife Management uses internal and external stakeholders to gather input on management goals and objectives for all Wildlife Management Plans. Twenty-nine key stakeholders were invited to a meeting to identify goals and objectives for the 2003-2007 Deer Management Plan; eighteen were external stakeholders and eleven were internal stakeholders. External stakeholders represented interests of: Sportsmen, Agricultural, Forestry, Environmental-Conservation, Federal and State Agencies, and Urban-Suburban Municipalities. Two legislative and nine PGC representatives were invited as internal stakeholders. An invitational letter was sent to each participant and the educational portion of the plan was included so each member was provided with the same information about deer biology, ecology and management; and the positive and negative impacts deer have on Pennsylvania's economy, environment, and people.

The meeting was held at the C. Ted Lick Conference Center on the Wildwood Campus of the Harrisburg Area Community College on July 16, 2002, from 10:00 a.m. through 3:00 p.m. Participants for the legislative representatives did not attend, thus, twenty-seven participants were present at this meeting. Management consultants from the Bureau of Management Consulting in the Governor's Office of Administration facilitated the meeting. In large part, the facilitators developed the agenda for the meeting.

IDENTIFYING GOALS

After briefly defining and characterizing the term "goal," the facilitator also provided goal statements developed for other governmental agencies throughout the country. The group then identified categories for "goals" that should be developed to guide the PGC in managing white-tailed deer herds in Pennsylvania. The group then developed eight goals but agreed that two of the goals could serve as objectives for other goals; thus the group unanimously agreed to six goals:

1) To provide public and private landowners with the deer management tools they need to achieve their land use objectives
2) To increase recreational opportunities involving deer
3) To reduce human/deer conflicts
4) To improve the health and sustainability of the ecosystem
5) To increase citizen understanding of healthy ecosystems and deer herds
6) To improve and maintain a healthy deer herd

PRIORITIZING GOALS

The group was then asked to prioritize these six goals. Participants were provided three stickers and instructed to place their stickers next to the goal(s) they believed was most important to them and/or their interests. Eighty-one stickers were used by the twenty-seven participants. The priority of the goals were (highest priority to least priority): 4) To improve the health and sustainability of the ecosystem—36 stickers, 1) To provide public and private landowners with the deer management tools they need to achieve their land use objectives—21 stickers, 6) To improve and maintain a healthy deer herd—14 stickers, 2) To increase recreational opportunities involving deer—6 stickers, 5) To increase citizen understanding of healthy ecosystems and deer herds—4 stickers, and 3) To reduce human/deer conflicts—0 stickers.

ORGANIZATIONS INVITED TO ATTEND MEETING

Sportsmen Interests
Pennsylvania Federation of Sportsmen's Clubs
Unified Sportsmen of Pennsylvania
Pennsylvania Deer Association
United Bowhunters of Pennsylvania
Quality Deer Management Association
National Wild Turkey Federation

Agricultural Interests
Pennsylvania Farm Bureau
Pennsylvania Vegetable Growers Association

Commercial Forestry Interests
Keith Horn and Associates
Forest Investment Associates
Kane Hardwood

Environmental Conservation Interests
Audobon
Western Pennsylvania Conservancy
The Nature Conservancy

Federal and State Agencies
USDA – Forest Service
Pennsylvania Department of Agriculture
Pennsylvania Department of Conservation and Natural Resources

Urban-Suburban Municipalities
Montgomery County Parks
Lorimer Park

Legislature
House Game and Fisheries Committee Chairman
Senate Game and Fisheries Committee Chairman

Game Commission
Commissioner
Representatives from bureaus and regions

APPENDIX 4: Public support for goals of the 2009-2018 Deer Management Plan

During the fall of 2007, the Pennsylvania Game Commission held open houses at locations across the state. Open houses provided an opportunity for the public to review the deer management program, and to gather public input on proposed changes to deer management goals.

PROPOSED GOALS

1. Manage deer for a healthy and sustainable deer herd
2. Manage deer-human conflicts at levels considered safe and acceptable to Pennsylvania citizens
3. Manage deer for healthy forest habitat
4. Manage deer to provide recreational opportunities
5. Improve public's knowledge and understanding about deer and the deer management program

At each open house, the public was asked to complete a comment form in which they could indicate their level of support for each of the above goals, as well as provide comments. Public support for the above goals ranged from 78% to 90%.

PUBLIC COMMENTS ADDRESSED THE FOLLOWING TOPICS

1. Deer hunting seasons – 13 comments
2. Satisfied with deer program – 10 comments
3. Deer management goals – 7 comments
4. Public and private lands – 7 comments
5. Antler restrictions – 6 comments
6. Habitat management – 6 comments
7. Wildlife Management Units – 6 comments
8. Antlerless allocations – 4 comments
9. Deer health, forest health, and CACs – 3 comments
10. Information and Education – 2 comments
11. SGL roads – 2 comments
12. Dissatisfied with deer program – 2 comments
13. Youth hunting and participation – 2 comments
14. Seeing more deer – 2 comments
15. Harvest estimates – 2 comments
16. Too many deer – 1 comment
17. Baiting – 1 comment
18. Trap and Transfer – 1 comment
19. Crossbows – 1 comment

Open houses were be held in seven different locations, with six of the open houses set for a Sunday and Monday format to maximize the opportunity for those interested in attending. The scheduled days and hours for six of the open houses were Sundays from 11 a.m. to 7 p.m., and Mondays from 3 p.m. to 8 p.m. The seventh open house, which occurred at the State Capitol, was for one day only, from 9 a.m. to 1 p.m.

Open houses occurred at the following locations and dates:

Southeast Region: Sept. 9 and 10, at Berrier Hall at Lehigh Carbon Community College, Schnecksville, Lehigh County.

Northeast Region: Sept. 16 and 17, at Lehman Volunteer Fire Company Hall, Dallas, Luzerne County.

State Capitol, September 19, in the East Wing Rotunda, Harrisburg, Dauphin County.

Southwest Region: Sept. 30 and Oct. 1, at the Youngwood Volunteer Hose Co. #1 Building, Youngwood, Westmoreland County.

Southcentral Region: Oct. 14 and 15, at the Blair County Convention Center in Altoona.

Northwest Region: Oct. 21 and 22, at the Rocky Grove Fire Hall, Franklin, Venango County.

Northcentral Region: Oct. 28 and 29, at the Little League Recreation Room at Little League Headquarters, South Williamsport, Lycoming County.

APPENDIX 5: Public comment on 2009-2018 Deer Management Plan

On February 11, 2010, the Game Commission released a draft of the 2009-2018 deer management plan for public comment. The public comment period ended a month later on March 12, 2010. Two-hundred and nine comments were received electronically over the Internet. Twenty-seven written comments were received.

Comments were categorized according to their reference to a specific Goal, Objective, or Strategy. Comments that did not reference a specific goal, objective, or strategy were tabulated under 'General Comments'.

A majority of comments referenced increasing deer numbers and suggested methods to achieve increased deer numbers. Based on goals identified by the public, the Game Commission does not manage deer for a certain number of deer. The goals and objectives of the deer management program are based on deer impacts on themselves, habitat, other wildlife, and people. When goals of the deer program are met, deer population increases will be recommended. This has occurred in WMUs 4B, 4E, and 5A in recent years. However, despite the desire for more deer, the Game Commission cannot responsibly make recommendations to increase deer populations if management goals have not been achieved.

Number of Individual Public Comments by Deer Management Goal

1.	Goal – Recreation	98
2.	General comments or complaints	90
3.	Multiple Goals	31
4.	Goal – Conflict	10
5.	Goal – Deer Health	3
6.	Goal – Forest Health	2
7.	Goal – Information and Education	2

Comments that referenced a goal, objective, or strategy are presented below. Although, specific comments – such as 'go back to 2-week antlered season followed by 2 days antlerless' – are not included, this tally clearly identifies sections of the deer plan that received the most attention. Information gathered from specific comments will be used in the future to direct outreach efforts to more fully explain the reasons and justification for deer management recommendations. Strategies not appearing in this following table received no public comments. Number of comments in the table below will not equal the number of individual comments because individuals often commented on 2 or more parts of the deer plan.

Public Comments in Reference to Sections of Deer Management Plan

GOAL 1. MANAGE DEER FOR A HEALTHY AND SUSTAINABLE DEER HERD		Comments
Objective 1.1.	Maintain reproduction at or above 1.50 embryos per adult doe	2
Objective 1.2.	Monitor deer population trends	2
	1.2.3 Annually collect harvest report cards	7
	1.2.4 Annually estimate harvest by WMU	5
	1.2.6 Annually calculate deer population indices by WMU	6
Objective 1.3.	Identify and implement additional measures of deer health as needed	1
	1.3.1. Investigate antler beam diameter data	3
Objective 1.4.	Monitor disease risks that could affect wild and captive deer populations	1
Objective 1.5.	Reduce disease risk factors and increase public knowledge and compliance with the elimination of these risk factors	1
	1.5.5. Materials on feeding impacts	2
Objective 1.6.	Increase citizens' awareness and understanding of deer-related diseases	1

GOAL 2. MANAGE DEER-HUMAN CONFLICTS AT SAFE AND ACCEPTABLE LEVELS		Comments
Objective 2.1.	Maintain deer-human conflicts at acceptable levels to CACs	4
	2.1.1. Annually conduct CACs	4
	2.1.6 Develop a wildlife complaint DB	1
Objective 2.2.	Provide opportunities for landowners to achieve their deer management objectives	1
	2.2.1. Continue DMAP	8
	2.2.2. Continue Red Tag	1
	2.2.3. Standardize DMAP protocols in public lands	3
Objective 2.3.	Improve the effectiveness of hunting in developed areas	4
	2.3.2. Maintain special antlerless-only seasons	2
	2.3.6. Publish a guide on Controlled Deer Hunting	1
	2.3.8. Evaluate baiting regulation	5
	2.3.9. Conduct research	1
	2.3.10. Conduct hunter survey	1
	2.3.12. Conduct research	1
Objective 2.4.	Provide options to reduce deer impacts on landowners and communities	2
	2.4.1. Discourage deer feeding	1
	2.4.2. Deer Control Permits	1
	2.4.3. Policy on deer fertility control	3
Objective 2.5.	Inform community leaders, residents, and hunters about deer management	1
Objective 2.6.	Encourage positive relationships between hunters and communities in developed areas	3
	2.6.4. Develop an advanced hunter education	3
	2.6.5. Provide an advanced hunter education	1

GOAL 3. MANAGE DEER FOR HEALTHY AND SUSTAINABLE FOREST HABITAT		Comments
Objective 3.1.	Maintain deer impacts on forested areas at levels that support sustainable forest habitats	11
Objective 3.3.	Promote habitat management that is compatible with needs of deer, diverse native wildlife species, and citizens	5
Objective 3.4.	Increase public's understanding of the role of deer and other factors on forested habitats	2
General Comments		
	Include all plots not just 40-75% stocked	3
	Review list of species in regen measure (dominant/high canopy)	2

GOAL 4. MANAGE DEER TO PROVIDE RECREATIONAL OPPORTUNITIES		General Comments	Support	Oppose	Total
Objective 4.1.	Provide annual deer hunting opportunities	2			2
4.1.1.	*Concurrent firearms season*	16	5	39	60
4.1.2.	*Fall and post-Christmas archery seasons*	6		3	9
4.1.3.	*Fall muzzleloader season for antlerless deer*	5	2	5	12
4.1.4.	*Fall rifle season for antlerless deer*	5		1	6
4.1.5.	*Post-Christmas flintlock-only season*	3		1	4
4.1.6.	*Antlerless allocations*	17			17
4.1.7.	*Mentored Youth to take antlerless deer*	1	6	2	9
Objective 4.2.	Establish deer hunting seasons to achieve objectives				0
4.2.1.	*Propose seasons and bag limits*	10			10
4.2.2.	*Evaluate hunting seasons to achieve objectives*		1		1
4.2.3.	*Evaluate hunting season needs of deer hunters*				0
4.2.4.	*Evaluate October firearms seasons on deer behavior*				0
4.2.5	*Evaluate traveling behavior of deer hunters*		1		1
Objective 4.3.	Use antler restrictions to increase adult male harvest	25	23	19	67
4.3.1.	*Annually monitor age structure*	1			1
4.3.2.	*Annually monitor hunter success rates*				0
4.3.3.	*Publication on biological/social effects*				0
4.3.4.	*Monitor deer hunter satisfaction*	1			1
4.3.5.	*Adjust antler restrictions to meet objectives*	2			2
Objective 4.4.	Provide alternative deer hunting opportunities on SGLs	3	1		4
Objective 4.5.	Promote other recreational opportunities besides hunting	1			1
General Comments					
	Hunter satisfactions must be considered	3			3
	Sunday Hunting	0	8	1	9
	Out-of-state antlerless license opportunities	1			1
	WMUs too large/change	20	1		21
	Include antlerless tag with Junior license	1			1
	Change APR to height or spread requirement	1			1
	Simplify Hunting Regulations	3			3
	Junior hunters follow antler restrictions	1			1
	Earn a buck	1			1
	Limit buck tags/buck management	3			3
	Protect button bucks/tag with buck tag	1			1
	Saturday start to rifle season	1			1
	Posted or Leased Properties	3			3

GOAL 5. IMPROVE PUBLIC'S KNOWLEDGE AND UNDERSTANDING OF DEER AND THE DEER MANAGEMENT PROGRAM		Comments
Objective 5.1.	Solicit public input and suggestions regarding deer program	4
Objective 5.3.	Provide information and educational materials to interested individuals and groups	9
5.3.1.	*Publish an article in Game News each month*	2
5.3.5.	*Deer-habitat tour*	1
5.3.6.	*Organize deer management web pages*	2
Objective 5.4.	Assess Game Commission employee knowledge and provide information	3
General Comments		
	Include impact of commissioners' and legislative agendas	1
	Include material on deer management history	1
	Include "more info" or "update" links to plan strategies	1