

White-tailed Deer Population at Valley Forge

Objective: Students will be able to define key terms related to white-tailed deer populations and forest health and improve understanding of trends in the size of the deer population at Valley Forge National Historical Park, the factors influencing rate of population growth, and deer management in the park. Using actual park data, students will graph and interpret changes in the deer population over time and calculate deer density and rate of growth over two decades.

Subjects: Science, Math, Civics and Government

Skills: observation, calculation, analysis, graphing, synthesis, compare and contrast, research, scientific literacy

Materials: Writing materials, datasheets, calculator

Grades: 7-12

Keywords: Population, demographics, forest regeneration, growth rate, habitat, mortality, population dynamics, productivity, white-tailed deer, sex ratio, survival.

Teacher Background

Significant changes have occurred across Pennsylvania's landscape in recent decades, including the landscape in and around Valley Forge National Historical Park (NHP). Among the most dramatic of these changes is the increase of white-tailed deer (*Odocoileus virginianus*). Extremely rare at the turn of the 20th century, deer populations in Pennsylvania have not only rebounded, but are now higher than at any other point in time (NPS 2009).

The white-tailed deer is an adaptable animal that has favorably exploited changes in habitat and hunting pressure brought about by changes in land use patterns (e.g. increased development resulting in loss of habitat) and a decrease in areas available to hunters associated with suburban development. The arrival of people also has often signaled the elimination of natural predators from the environment, such as wolves, cougars, and coyotes.

"The last wolf was discovered and killed in the dense woods at Valley Forge in 1780."

Samuel Pennypacker,
1872

In national park units in the eastern U. S., such as Valley Forge NHP, landscapes have traditionally

been managed to allow for the preservation and rehabilitation of scenic and historic landscapes. The result is a mixture of forest and field, which constitutes ideal habitat for white-tailed deer.

At Valley Forge NHP, a combination of environmental factors including lack of natural predators and recreational hunting, loss of habitat due to urbanization in areas surrounding the park, and the availability of ideal habitat within the park resulted in a significant increase in the number of deer over two decades. The deer population at Valley Forge NHP increased from 165-185 deer in 1985 to 1,277 deer in 2009. At its peak, the size of the deer population was estimated at over 1,600 individuals (in 2008) (NPS 2009).



The mix of open fields and forest at Valley Forge represents ideal habitat for deer. (NPS Photo)

The dynamics of a population are determined by demographic factors and factors such as productivity, survival, mortality/harvest rate, and rate of population growth. Data on demographic factors such as sex ratio, age structure, and abundance are easily collected by natural resource managers and are used in modeling wildlife population dynamics. Many of these



Photo by Bill Moses

factors are directly influenced by the condition or health of deer which is largely determined by the quality of available habitat. For example, in areas where habitat quality is poor and food resources are scarce, deer may be less healthy and thus experience a higher rate of mortality and lower productivity (See Supplement 1 for Glossary of Terms).

Suburban deer populations often exhibit different characteristics compared to rural deer populations due to differences in environment (e.g. hunted vs. protected population, presence of predators, habitat). Understanding the dynamics of deer populations (how and why populations grow and shrink over time) is considered critical baseline information for park managers and is important in determining appropriate management strategies.

Characteristics of Suburban and Rural Deer Populations

At Valley Forge NHP prior to 2010, annual survival was estimated to be 83% and conversely, annual mortality was 17%. This means that each year, out of 100 deer, 83 would be expected to survive to the next year and 17 would be expected to die. Outside the park, annual survival of deer across Pennsylvania ranges from 27% (adult bucks) to 60% (adult does) and annual mortality ranges from 40% (adult does) to 73% (adult bucks). High survival rate at Valley Forge also means that deer in the park may live longer — up to 10 years. This compares to an average age of 2-4 years in rural deer populations (NPS 2009).

Since deer live longer and male deer often disperse to new environments, suburban deer populations tend to have a higher proportion of older animals and a greater number of female than male deer. At Valley Forge, 60% of deer are over 2.5 years old. This compares to rural deer populations where the majority of deer are less than 2.5 years old. At Valley Forge NHP the ratio of female to male deer in the population (sex ratio) is 2:1. Rural populations often exhibit an even higher ratio of female to male deer (3:1 to 6:1) due to hunter preference for bucks (DeNicola, Etter, and Almendinger 2008).

Reproductive rate has been selected by the park and Pennsylvania Game Commission as the primary measure of deer health. As habitat quality declines deer population health also declines, which leads to a lowered rate of reproduction and higher mortality rate, particularly in young animals.



Photo by Bill Moses

Preliminary park data and state estimates of reproductive rates in areas surrounding the park indicate low reproduction in yearlings (0.4 fawns per doe) and relatively high reproduction in adult females (1.8 fawns per doe). Statewide, reproduction is higher in yearlings (1.2 fawns per doe) and the same for adult does (1.8 fawns per doe) compared to deer at Valley Forge.

In suburban deer populations, access to ideal habitat, high survival rates, and a greater number of older female deer (usually have twins and triplets) contributes to high productivity and faster population growth rates compared to rural deer populations. As populations approach or exceed biological carrying capacity and competition for resources increases, productivity decreases and the population growth rate slows. Suburban deer populations may exhibit significant fluctuations in size at this point in response to factors such as severe weather events (e.g. heavy snow).

Population Management

Although the National Park Service generally relies on natural processes such as predation to manage native species, direct management of deer is authorized when a population occurs in an unnaturally high or low concentration as a result of human influences (e.g. loss of habitat, the extirpation of predators). Valley Forge NHP completed development of a White-tailed Deer Management Plan in 2009. The purpose of the plan is to provide an effective deer management strategy that supports long-term protection, preservation, and restoration of native vegetation, wildlife, and other natural and cultural resources in the park.



In order to effectively control populations, management actions must focus on female rather than male deer.

Photo by Bill Moses

Action to manage the deer population at Valley Forge NHP is considered necessary because the increasing number of deer over the past two decades has prevented the ability of native forests to grow and mature. Failure of trees to regenerate and complete elimination of the forest understory (removal of native shrubs and herbaceous plants) has degraded habitat for native wildlife species such as ground and shrub nesting birds (NPS 2009).

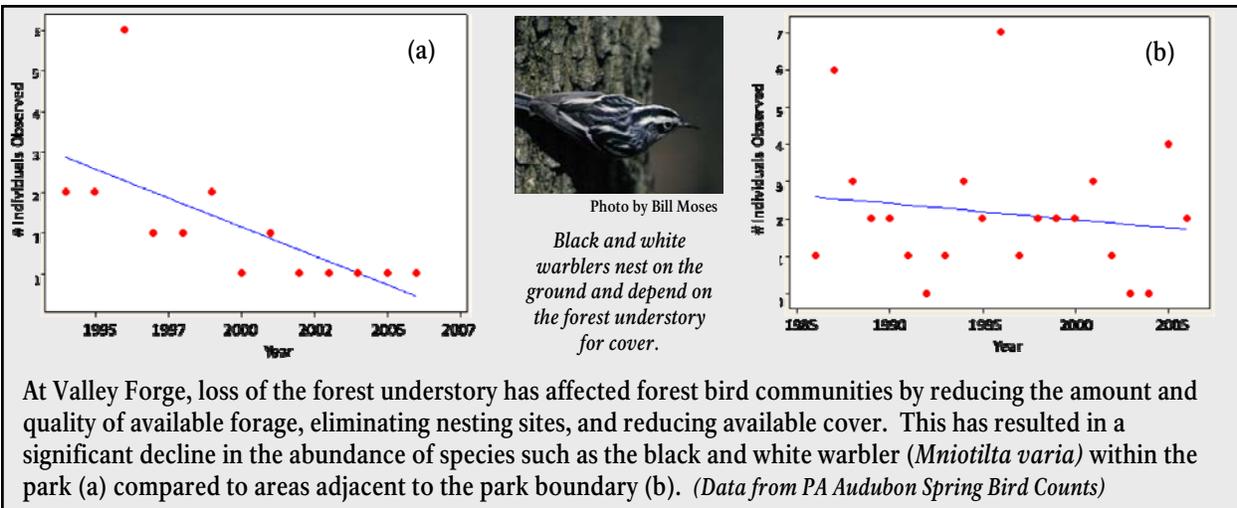
In determining the best way to manage the deer population, the NPS evaluated a full range of

Successful management of the deer population at Valley Forge is based on the level of successful forest regeneration achieved NOT the number of deer in the park.

reasonable management alternatives using the best available science. These actions were evaluated based on their ability to achieve park management objectives and their impacts on the human environment. The alternative that best achieved management objectives and minimized damage to the human environment is the one that was selected for implementation. This decision-making process is outlined by the National Environmental Policy Act of 1969 (NEPA) and ensures decisions made by federal agencies are informed (See Supplement 2).

The primary management objective of the White-tailed Deer Management Plan at Valley Forge NHP is to protect and promote restoration of native plant communities, including tree and shrub regeneration and a diverse herbaceous plant community. A secondary objective is to maintain a white-tailed deer population in the park. In other words, the park wants to maintain the deer population at a level that will also allow for sustainable, healthy forests to develop.

The “right” number of deer for Valley Forge was determined based on the ability of forests to regenerate. The initial target deer density has been identified as 31 to 35 deer/square mile (165 to 185 individuals). This is the number of deer that were



present in the park in 1985 when the health of forest plant communities was described as “excellent.” Across Pennsylvania, a deer density ranging from 10 to 40 deer per square mile is recommended to ensure adequate forest regeneration (NPS 2009).

At Valley Forge, the following deer management *actions* were considered:

- Existing management
- Sharpshooting by professionals
- Fencing of targeted plant communities
- Reproductive control (chemical)
- Fencing the entire park
- Surgical sterilization
- Reintroduction of predators
- Capture and relocation
- Repellents
- Supplemental feeding
- Poisons
- Public hunting

Four deer management *alternatives*, representing either individual actions or a combination of actions, were fully described and evaluated using the best available science. These alternatives are:

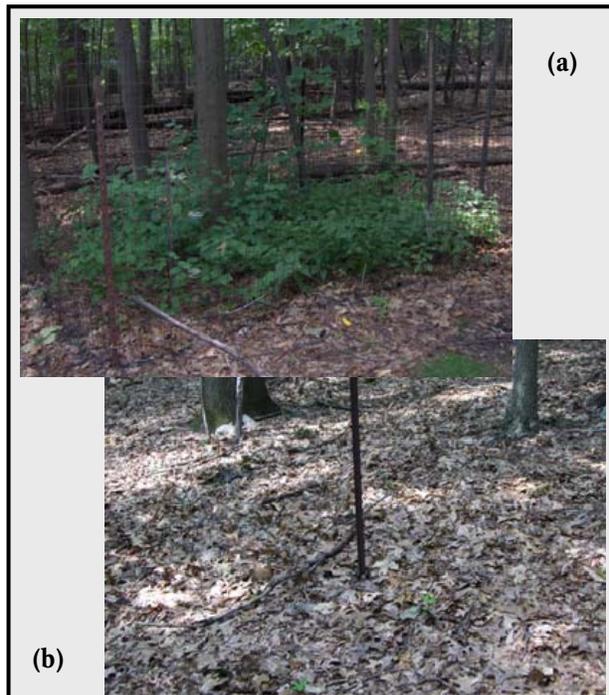
- A. Existing Management** (no-action)
- B. Combined Non-Lethal Actions** (includes fencing of targeted plant communities and reproductive control)
- C. Combined Lethal Actions** (includes sharpshooting by professionals and capture and euthanasia)
- D. Combined Lethal and Non-Lethal Actions** (includes sharpshooting by professionals and chemical reproductive control)

After extensive public involvement, including four public meetings, over 90 briefings, and review of over 4,000 comments from the public, Alternative D-Combined Lethal and Nonlethal Actions was selected to manage the deer population at Valley Forge NHP (See Supplement 3).

The selected alternative calls for rapid reduction of the deer population to the target deer density of 31-35 deer per square mile (165-185 deer) using sharpshooting and capture and euthanasia. Once

the target density is achieved, the park will use reproductive control to maintain the population at desired levels (NPS 2009). The park began implementation of lethal actions to reduce the size of the deer herd in November 2010.

Long-term monitoring of forest plant communities and deer population size will allow the park to determine whether they have been successful in achieving the goals and objectives of the deer management plan. Forest regeneration has been selected by the park as the primary measure of plan success. Adequate tree regeneration is defined as 8,000 tree seedlings per acre, the standard adopted by Pennsylvania Bureau of Forestry for forests across the state (NPS 2009). The target deer density may change (up or down) based on the level of tree regeneration observed in the park.



NPS Photos

Paired, fenced and unfenced, long-term monitoring plots were established in 1992 to evaluate changes in forest plant communities over time. Although in close proximity to each other, fenced and unfenced plots are significantly different after 15 years. Fenced plots (a) are characterized by higher plant species diversity, fewer non-native plants, and increased tree regeneration compared to unfenced plots. Unfenced plots (b) have not exhibited adequate tree regeneration since 1995.

Activity Overview

Using real information and data on the white-tailed deer population at Valley Forge National Historical Park and across Pennsylvania, students will discuss the terms and concepts associated with deer populations, population dynamics, and the relationship between deer populations (e.g. deer condition) and habitat (e.g. available forage).

Using information from Valley Forge NHP students will: (1) Graph and describe long-term trends in deer abundance; (2) Calculate deer density and annual growth rate between 1987 and 2008; and (3) calculate average annual growth rate over two ten year periods and describe potential changes in habitat quality and forest health occurring in the park over the same period. Using both park data and data representative of the statewide deer population students will: (1) Compare and contrast demographic and other factors that determine population dynamics in suburban versus rural deer populations and discuss how differences are related to environment and what they may indicate regarding deer health. Classes are encouraged to visit the park and take a walk through the woods to observe the forest understory and draw their own conclusions on the health of park forests.

Upon completion of all activities, students will discuss whether they believe a reduction in the size of the deer population is needed and why or why not, research potential deer management actions, and create their own alternative (including a no action alternative for those who don't believe action is needed). As would be required by the National Environmental Policy Act, students will present their approach to the 'public' (in class) and describe why they feel it is the best approach for managing the deer herd.

This activity encourages scientific literacy related to a current ecological issue—the overabundance of white-tailed deer—and provides a real world example to teach and reinforce core biological concepts related to populations while developing skills in mathematics, civics and government, and research (See Supplement 4 for related curriculum standards.).

Student Procedure

These activities may be completed in the classroom prior to visiting the park or while you are here. They can be completed individually or in groups.

1. To begin, have students conduct an on-line search on “Deer and Valley Forge” and read at least one news or opinion article on the issue of deer management at the park. Also have them read the list of frequently asked questions developed for the public by Valley Forge NHP and/or the article “Deer, Communities, and Quality of Life” (See Supplement 5).

2. Using Student Worksheet 1, students will graph and describe trends in deer population size over time and calculate deer density at Valley Forge NHP. Students will define forest regeneration and speculate on the level of regeneration occurring in park forests in 1985 compared to 2009.

3. Using Student Worksheet 2, students will calculate annual growth rate and average annual growth rate of the deer population at Valley Forge NHP between 1987 and 2008. Then students will calculate and compare average annual growth rate between 1987-1997 and 1998-2008. Based on this comparison students will draw conclusions about changes in deer condition and habitat quality over these same time periods.

4. Using Student Worksheet 3, students should fill in needed information based on previous calculations (deer density, annual average growth rate) and compare factors determining the dynamics of deer populations in suburban versus rural environments. Students will provide an example of how environmental differences may influence population dynamics and interpret what differences in key parameters may indicate regarding differences in deer condition and habitat quality. Lastly, students will define productivity and speculate on how key population parameters may influence deer productivity at Valley Forge NHP (See Supplement 6 for Teacher Answer Key).

5. Visit the park and take a walk through the woods of Mount Joy (See Supplement 7). Stop to observe one of the fenced monitoring plots



As native trees, shrubs, and wildflowers have been removed by overbrowsing, they have been replaced by non-native, highly invasive plant species such as Japanese stiltgrass (*Microstegium vimineum*) (above) further degrading habitat for native wildlife (NPS Photo).

near a trail and have the students observe the forest around them and within the fenced plot. Based on their observations investigate answers to the following questions:

- A. Has browsing by deer affected the diversity of plants outside fenced areas?
- B. Has browsing by deer affected the ability of trees and shrubs to grow and mature?
- C. What other factors may affect forest regeneration?
- D. Do you think deer that are primarily responsible for the differences in plant communities observed inside and outside fenced areas? Why or why not?
- E. How does removal of the forest understory affect the availability of food, cover, nesting sites, etc. for other types of wildlife in the park?
- F. Outside of causing damage to forest plant communities, what other impacts might abundant deer populations have on park resources (e.g. trampling of archeological resources) and visitor safety?

As you hike through Valley Forge, stay alert for signs of deer such as the presence of a browse line, buck rubs, deer scat, and visual sightings of deer themselves.

6. Upon return to the classroom, discuss with students whether they believe a reduction in the size of the deer herd is needed including why (or why not) they feel action is necessary. Have students locate at least one newspaper article that describes why deer management was considered necessary at Valley Forge National Historical Park.

7. Using materials provided in Supplement 3, have students review three management alternatives considered by Valley Forge NHP and research other types of deer management actions, if desired, to develop their own solution or alternative to managing the deer population at the park (this may be a single action or actions in combination with each other). Proposed alternatives must be considered “reasonable” indicating they are both technically and economically feasible, address the reason(s) management is considered necessary (the management objectives), and display common sense. Public input is a key element of government decision-making, therefore, students will describe and support their deer management approach to the ‘public’ (in class) and allow the ‘public’ an opportunity to comment (pro or con).

Special Note: During your visit to the park students must stay on or near established trails. Choose a fenced area to visit on Mount Joy that is visible from or near a trail and do not trample vegetation around fenced areas. Students should enjoy the park but should not put anything in their mouths and may not collect or remove anything (e.g. rocks, plants, animals, etc.) from the environment.

Data used to describe demographic and other factors that determine deer population dynamics are representative of the population at Valley Forge NHP prior to implementation of the deer reduction program. The number of deer in the park is expected to decrease rapidly over the next several years and this change will alter facts presented in this lesson plan including mortality rate, survival rate, and reproductive rate in the future.

Literature Cited

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Extensions

1. Consider conducting this activity in groups based on use of lethal versus non-lethal deer management actions. Have students develop arguments (pro and con) then present and debate their positions on whether to use lethal or non-lethal methods to manage wildlife populations. Use materials provided in Supplement 3)
2. Discuss the 10 steps of the decision-making process outlined by the National Environmental Policy of 1969 within the context of development of the Final White-tailed Deer Management Plan and Environmental Impact Statement for Valley Forge National Historical Park (See Supplement 2). Highlight steps that require public involvement and discuss with students what role they think the public should play in government decision-making.
3. Ask students what factors, other than white-tailed deer, may contribute to the failure of forest regeneration and decline in forest health at Valley Forge (e.g. spread of non-native plants, climate change, canopy closure, fragmentation). Reinforcing the scientific method, have students design an experiment or methodology to determine whether deer are the primary factor affecting tree regeneration. Based on their observations of forests at Valley Forge, students should clearly define their question and state their hypothesis. In describing their experiment students should identify the treatment, independent and dependent variable(s), and how the design will allow determination that the primary cause of failed regeneration is browsing by deer and not another factor.

4. Review the history of deer populations across Pennsylvania and have students research changes in land use statewide over time (particularly the area forested). Discuss how changes in habitat have influenced deer populations at a broad scale. Do these trends mirror what happened within Valley Forge? (See PGC 2003 and Latham et al. 2005 in Literature Cited for information related to this topic.)

Supplemental Reading

Obtain a full version of the Record of Decision and/or Final White-tailed Deer Management Plan and Environmental Impact Statement for Valley Forge National Historical Park at <http://www.nps.gov/vafo/parkmgmt/index.htm> OR request a hard copy or CD from vafo_superintendent@nps.gov

Latham et. al. 2005. Managing White-tailed Deer in Forest Habitat from an Ecosystem Perspective: Pennsylvania Case Study at http://pa.audubon.org/deer_report.html

Pennsylvania Game Commission. Pennsylvania White-tailed Deer and Wildlife Notes at <http://www.portal.state.pa.us/portal/server.pt/community/deer/11949>

Pennsylvania Game Commission. Management Plan for White-tailed Deer in Pennsylvania (2003-2007) at http://www.wpconline.org/dailyphotos/pa_game_commission_deer_mgt.pdf

White-tailed Deer Lesson Plans from Penn State University at <http://sfr.psu.edu/youth/sfrc/deer>



Experience Your America

Historical Perspective of Changes in Deer Population Size

Prior to European Settlement

North American white-tailed deer populations are estimated to have been present at a density of about 8-11 deer per square mile (McCabe and McCabe 1984).

1800s

Deer in Pennsylvania were described as scarce by 1895 due to unregulated deer harvests, including subsistence and market hunting, and the extensive logging of forests across the state in the 19th and early 20th centuries (PGC 2003; Latham et al. 2005). The Pennsylvania Game Commission was created to protect and preserve game species in 1896.

Early 1900s

To restore the state's deer population, over 1,200 deer were released into Pennsylvania between 1905-1925, and hunting laws were established and enforced (PGC 2003).

In 1939, the Superintendent of Valley Forge noted that "Deer in small numbers are making extended stays in the park" (Valley Forge Park Commission 1939).

Early successional vegetation (e.g. shrubs) that provided excellent deer habitat became abundant throughout Pennsylvania due to logging practices that occurred during the late 1800s and early 1900s. Deer populations rebounded.

Mid-1900s

Concern over escalating deer densities and alteration of forest plant communities was noted by state biologists as early as the mid-1940s (Latham et al. 2005).

Late 1900s

Deer population size at Valley Forge between 1983 and 1985 was estimated to be 165-185 deer and the quality of forested habitat described as "excellent" (Cypher et al. 1985).

2000s

Population density across Pennsylvania estimated between 20-25 deer per square mile (range 11 to >30 excluding suburban environments surround Philadelphia)(PGC 2003).

Deer population size at Valley Forge NHP in 2009 estimated to be 1,277 deer and the quality of forested habitat considered poor. Forests now characterized by the presence of non-native plant species, loss of the forest understory, and failed forest regeneration (NPS 2009).

White-tailed Deer Population Size: Student Worksheet 1

1. Using the actual data below on deer population size in the park, create a graph that illustrates changes in deer population size over time.

Year	Population Size
1985	185
1997	772
1998	907
1999	1011
2000	1122
2001	1092
2002	1147
2003	1389
2004	1388
2005	1241
2006	1218
2007	1023
2008	1647
2009	1277

A. Interpret your graph and describe trends in deer population size over time. What might cause fluctuations in deer population size at the park?

2. Deer density refers to the number of deer per unit of area. The park is 5.3 square miles in area. Calculate the density of deer for each of the years provided above. Based on your results, complete A and B below.

A. The deer density at Valley Forge NHP increased from _____ deer per square mile to _____ deer per square mile between 1985 and 2009.

B. Define forest regeneration. The recommended deer density to allow for adequate forest regeneration ranges from 10 to 40 deer per square mile. Based on this information and the results above, how much tree regeneration do you think was occurring in the forests at Valley Forge NHP in 2009 compared to 1985?

White-tailed Deer Population Growth: Student Worksheet 2

1. Growth rate describes how quickly or slowly a population is growing in size. Rate of growth is an indirect measure of reproduction. Rapid growth rates reflect high productivity, good habitat conditions, and a generally healthy deer population. Below are data from fall spotlight counts conducted between 1986 and 2008 at Valley Forge. Using the formula below, calculate annual growth for the deer population at Valley Forge NHP for each year and write it in the space provided. What conclusion can be drawn about changes in habitat quality based on these results?

Year	# deer obs.	Growth Rate (%)
1986	97.8	Leave Blank
1987	85.6	
1988	133.8	
1989	161.4	
1990	169.6	
1991	155.8	
1992	229.4	
1993	251.6	
1994	338.4	
1995	437.4	
1996	380.6	
1997	381.0	
Year	# deer obs.	Growth Rate (%)
1997	381.0	Leave Blank
1998	447.4	
1999	419.8	
2000	414.2	
2001	577.6	
2002	599.8	
2003	599.5	
2004	439.5	
2005	533.3	
2006	464.0	
2007	365.0	
2008	343.2	

$$\text{Annual Growth (\%)} = (\text{YR2} - \text{YR1}) / \text{YR1} * 100 \%$$

A. Calculate the overall average annual growth rate.

Average annual growth rate (1987-2008): _____

B. Calculate the average annual growth rate between 1987 and 1997 and between 1998 and 2008.

Average annual growth rate (1987-1997): _____

Average annual growth rate (1998-2008): _____

C. What conclusions might be drawn about habitat quality and deer condition in the park based on differences in average annual growth rate between 1987-1997 and 1998-2008?

Suburban Versus Rural Deer Populations: Student Worksheet 3

1. Fill in results for deer density and average annual population growth rate for Valley Forge NHP from worksheets 1 and 2. Compare and contrast the demographic and other factors that determine the population dynamics of suburban and rural white-tailed deer populations.

Population Parameter	Suburban (Valley Forge NHP)	Rural (Statewide)
Sex ratio (female:male)	2:1	3:1 to 6:1
Age structure	Skewed toward older animals	Skewed toward younger animals
Abundance* (= density expressed as number of deer per square mile)		20-25
Annual Survival (%)	83%	27% (bucks)-60% (does)
Annual Mortality (%)	17%	40% (does)-73% (bucks)
Average annual rate of population growth (%)		Unknown
Reproductive rate (fawns per doe)	0.4 (yearlings) - 1.8 (adults)	1.2 (yearlings) - 1.8 (adult)

* Use 2009 estimated deer density from Valley Forge NHP

A. Discuss how differences in population characteristics are related to differences in suburban and rural environments (e.g. hunting pressure, amount of forested habitat, presence of predators). Describe an example below.

B. Reproductive rate has been selected by Valley Forge NHP and Pennsylvania Game Commission as the primary indicator of deer health or condition. Based on this, provide an explanation for lowered reproductive rate in younger deer at Valley Forge compared to other deer populations statewide.

C. Define productivity. Describe how annual survival and age structure of suburban deer populations may affect productivity at Valley Forge NHP.

Space for Calculations

Supplement 1: Glossary of Terms

Student will be able to define key terms and use them correctly during discussion of populations and ecosystem health prior to completing this activity.

Abundance: Number of individuals (of the same species) in a given area or population.

Biological Carrying Capacity: The maximum number of individuals of a species that the resources of a given area can support, usually through the most unfavorable period of the year, without detrimental impacts to other species in that habitat. Factors such as available food, water, cover, prey and predator species will affect biological carrying capacity.

Demographic: A characteristic used to describe some aspect of a population that can be measured such as growth rate, sex ratio, age structure, lifespan, and birth rate. Referring to the intrinsic factors that contribute to a population's growth or decline: birth, death, immigration, and emigration.

Density: Number of individuals per unit area (e.g number of deer per square mile).

Dispersal: One-way and permanent movement of animals from an area of birth to another.

Forest regeneration: Defined for this activity as the regrowth of forest species and renewal of forest tree cover such that the natural forest sustains itself without human intervention. At Valley Forge NHP adequate forest regeneration is considered to be 8,000 tree seedlings per acre.

Growth rate: See Rate of population growth.

Habitat: The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors). The four critical elements of habitat are food, water, shelter/cover, and space to move about to find their daily requirements.

Herbaceous plants: Non-woody plants; includes grasses, wildflowers, and sedges and rushes (grass-like plants).

Human environment: As defined by the National Environmental Policy Act of 1969, this term is defined broadly to include the natural and physical environment and the relationship of people with that environment.

Mortality: Death rate. Mortality rate is a measure of the number of deaths in a population per unit time. Calculated based on the number of deaths in the population after a specified time interval, divided by the initial number of individuals in the population. Usually expressed on an yearly or annual basis. Often expressed as a percentage of the population that dies from one year to the next.

Population: A group of individuals belonging to the same species that live in the same region at the same time. Populations, like individuals, have unique characteristics such as growth rate, age structure, sex ratio, and mortality rate.

Productivity: Number of fawns born minus those killed through all sources of mortality at a given population size, during a specified time interval. Usually expressed on a yearly basis.

Population dynamics: Population dynamics is the branch of life sciences that studies short- and long-term changes in the size and age composition of populations, and the biological and environmental processes influencing those changes. Population dynamics deals with the ways populations are affected (grow and shrink over time) by birth and death rates, and by immigration and emigration.

Rate of population growth (growth rate): The rate at which a population is increasing (or decreasing) in a given year, expressed as a percentage of the base population. Calculated based on the total increase or decrease in a population during a given time period divided by the initial number of individuals in the population.

$(\text{Population size in YR1} - \text{Population size in YR2}) / \text{Population size in YR1} * 100$

Sex ratio: The proportion of males to females (or vice versa) in a population. A sex ratio of 1:1 would mean an equal number of does and bucks in a deer population.

Survival rate: Survival rate is a measure of the number of individuals alive in a population per unit time. Calculated based on the number of individuals in the population alive after a specified time interval, divided by the initial number of individuals in the population. Usually expressed on an yearly or annual basis. Often expressed as a percentage of the population that survives from one year to the next.

Supplement 2: National Environmental Policy Act and Public Involvement

This document was made available to the public during development of the White-tailed Deer Management Plan for Valley Forge National Historical Park in 2006 and has been updated to reflect more specific information related to public involvement. This supplement links to Step 7 of the Student Procedure and Extension 2.

National Environmental Policy Act (NEPA) and Public Involvement

10-Step Environmental Planning Process: Development of a White-tailed Deer Management Plan at Valley Forge NHP

The National Environmental Policy Act (NEPA) outlines the required environmental planning process that the National Park Service (NPS) must follow to ensure informed decision-making. *Any federal action* or federal decision being considered that would, if implemented, have an impact on the human environment require NEPA planning. This law has been described as the most important and far reaching environmental and conservation measure ever enacted by Congress. NEPA also requires that the public be involved and informed in a diligent way throughout the planning process. The Council on Environmental Quality provides regulations for the implementation of NEPA. The NPS has specific guidelines on how these regulations apply to NPS units through Director's Order 12: Conservation Planning, Environmental Impact Analysis and Decision Making. Opportunities for public involvement are highlighted in italics.

1. Identify Purpose, Need, and Objectives: Purpose describes what the NPS must accomplish to consider a management strategy a success. Need describes the condition or problem that must be addressed by the plan and answers the question "Why must we take action?" Objectives are specific statements of the plan purpose.
2. Identify Issues: Issues are environmental, social, and economic problems or effects that may occur if the deer management alternatives are implemented or if current management continues (no action).
3. Determine the Appropriate Path for Plan Development: The NPS has determined that an Environmental Impact Statement (EIS) is the appropriate pathway for development of a White-tailed Deer Management Plan at Valley Forge NHP based on criteria established through NEPA.
4. Identify Alternatives for Management and Conduct Public Scoping: The NPS must create a full range of deer management alternatives that resolve purpose and need for taking action and meet the specific objectives of the plan. Alternatives are considered the "heart" of NEPA's environmental planning process. *Scoping provides the public an opportunity to express their views on the purpose, need, context, and preliminary management alternatives related to deer management.*
 - A 90-day public scoping period was held between September 7, 2006 and December 8, 2006. Two public scoping meetings were held in November 2006, to facilitate the public involvement process early in the planning stage and to obtain community feedback on the initial concepts for deer management at Valley Forge NHP. During the comment period, 165 pieces of correspondence were received, with 365 comments. These comments were considered during development of the Draft White-tailed Deer Management Plan/EIS.

5. Bound the Analysis: For each park resource potentially affected by deer management alternatives, a boundary in time and space will be identified. The impacts of management alternatives on each resource will be analyzed within the context of these boundaries.

6. Describe the Affected Environment: Affected environment refers to the various resources (e.g. vegetation, wildlife) that are expected to experience environmental effects from implementation of deer management alternatives.

7. Analyze the Impacts of Alternatives: Impact analysis predicts the degree to which resources will be affected by each deer management alternative.

8. Revise Alternatives: Based on the results of impact analysis, deer management alternatives may be eliminated, added, or revised to better meet objectives and resolve resource issues and concerns.

9. Document Review and Revision: *The Draft White-tailed Deer Management Plan/EIS will be released for internal and public review.* The plan will be revised and finalized based on comments received.

- A 60-day public and agency review of the Draft White-tailed Deer Management Plan/EIS for Valley Forge NHP was held from December 19, 2008 through February 17, 2009. Public meetings were held in January 2009 where the NPS presented the alternatives analyzed in the Draft plan/EIS and identified the preferred alternative and requested feedback on the proposed alternatives. During the comment period 1,168 pieces of correspondence were received, with 3,884 comments. These comments were considered during development of the Final plan/EIS.

10. Decision: The decision on a preferred deer management alternative to be implemented at Valley Forge NHP is made by the NPS Regional Director.

- The Final White-tailed Deer Management Plan/EIS for Valley Forge NHP was released in August 2009. The Record of Decision for the Final White-tailed Deer Management Plan/EIS for Valley Forge NHP, documenting selection and approval of a deer management alternative, was signed by the NPS Northeast Regional Director on October 1, 2009.

Congress, “recognizing the profound impact of man’s activity on the interrelations of all components of the natural environment...” created a comprehensive national policy and set forth clear goals for Federal agencies so that the Nation may:

“Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice.”

NEPA 1969

Visit: <http://ceq.hss.doe.gov/nepa/regs/nepa/nepaeqia.htm>

Supplement 3: Excerpts from the 2009 Final White-tailed Deer Management Plan and Environmental Impact Statement for Valley Forge National Historical Park

Purpose, Need, Objectives, and Measure of Success for the White-tailed Deer Management Plan at Valley Forge NHP

Actions Considered But Dismissed (Pages 2-51 to 2-55)
Overview of Alternatives (Pages 2-3 to 2-5)

Activity: Selecting An Alternative For Managing White-tailed Deer



Purpose, Need, Objectives, and Measure of Success for the White-tailed Deer Management Plan at Valley Forge NHP

Purpose

The purpose of the White-tailed Deer Management Plan and EIS is to develop a deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources.

Need

- An increasing number of deer over the past two decades has resulted in undesirable changes in the species composition, structure, abundance, and distribution of native plant communities and associated wildlife.
- Browsing of tree and shrub seedlings by deer will prevent the ability of forests to regenerate.



Within fenced areas, a diverse plant community has developed, dominated by native plant species.

Objectives

Vegetation

- Protect and promote restoration of the natural abundance, distribution, structure, and composition of native plant communities by reducing deer browsing.
- Reduce deer browsing pressure enough to promote tree and shrub regeneration that results in a diverse forest structure dominated by native species.
- Promote a mix of native herbaceous plant species and reduce the competitive advantage of invasive non-native plant species.

Wildlife and Wildlife Habitat

- Maintain a white-tailed deer population within the park that allows for protection and restoration of native plant communities.
- Protect and preserve other native wildlife species by promoting the restoration of native plant communities.
- Promote early detection of and reduce the probability of occurrence and spread of chronic wasting disease.

Natural Resources

Threatened, Endangered, and Species of Special Concern

- Protect and promote special status plant and animal species and their habitats.

Cultural Resources

- Protect the integrity of the cultural landscape, including the patterns of open versus wooded land, commemorative plantings, and vegetative screening.

How Is Success Measured?

- Forest regeneration is the primary measure of success for the deer management plan.
Monitoring will indicate at least 8,000 tree seedlings per acre.
- Number of deer needed to achieve the desired level of tree of tree regeneration is called the initial deer density goal.
Initial deer density goal = 31-35 deer per square mile or 165-185 individual deer.

Please visit the park website for additional information on development and implementation of the White-tailed Deer Management Plan/EIS at Valley Forge National Historical Park.

<http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm>

2.10 Options Considered but Rejected

The following options were considered but rejected as explained below.

2.10.1 Public Hunting

Public hunting was considered but not carried forward for further analysis because it is inconsistent with existing laws, policies, regulations, and case law regarding hunts in units of the national park system.

NPS for the most part has maintained a strict policy of prohibiting hunting in units of the national park system. In the 1970s, Congress passed the General Authorities Act and the Redwood Amendment, which clarified and reiterated that the single purpose of the NPS Organic Act is conservation. While the Organic Act gives the secretary of the interior the authority to destroy plants or animals for the purposes of preventing detriment to park resources, it does not give the secretary authority to permit the destruction of animals for recreational purposes.

In 1984, after careful consideration of congressional intent with respect to hunting in national parks, the NPS adopted a policy that allows public hunting in national park areas only where “specifically mandated by Federal statutory law” (36 CFR 2.2). The NPS reaffirmed this approach in its *Management Policies 2006*.

Congress has not authorized hunting in any legislation for Valley Forge NHP. The likelihood that the law would be changed by Congress, or that NPS would change its long-standing service-wide policies and regulations regarding hunting in parks is remote and speculative.

In addition to legal and policy-related concerns, public hunting was evaluated based on cost, efficiency, safety, and the likelihood of achieving long-term management goals. A public hunt has not been shown to be more cost-effective or efficient than other reduction methods, such as sharpshooting by agency personnel, which is currently allowed under NPS laws and policies. Cost comparison studies in which differences in effects were considered show that the range of costs for sharpshooting substantially overlaps the range of costs reported for public hunts, suggesting that there is minimal to no cost saving by using citizen hunters. Net and average deer removal costs are as follows (Doerr, McAnnich, and Wiggers 2001; Warren 1997):

- Public hunts - net cost ranges from \$83 to \$237 per deer removed, with an average of \$117/deer
- Sharpshooting - net cost ranges \$72 to 260 per deer removed, with an average of \$121/deer.

In addition, sharpshooters are found to be more successful than hunters in meeting ungulate reduction goals (0.55 deer/hour for sharpshooting over bait vs. a hunter success rate of 0.03 deer/hour) (Doerr, McAnnich, and Wiggers 2001). This is at least in part because sharpshooters are encouraged to kill several animals, while hunters are only allowed to shoot up to their tag limit. Local experience also indicates that during public hunts the use of firearms is more efficient than the use of archery as a tool for lethal removal. Efficiency is defined as the number of hunter hours required to harvest a single deer (Prusack, pers. comm. 2007). During controlled public hunts within nearby Chester County parks between 2002 and 2007, firearm efficiency was 23 hunter hours per deer compared to 97 hunter hours per deer for archers (Prusack, pers. comm. 2007). As indicated above, sharpshooting with firearms is the most efficient.

Public hunting was considered but not carried forward for further analysis because it is inconsistent with existing laws, policies, regulations, and case law regarding hunts in units of the national park system.

At Gettysburg National Military Park, in 2006, a team of three sharpshooters spent 20 nine-hour days in the park. During this time they removed 115 deer. This equates to 5 hours per deer (Bolitho, pers. comm. 2007).

In addition, it is suggested that sharpshooting offers safety features that a typical public hunt does not. For example, sharpshooting over predetermined bait sites can establish shooting lanes and backstops. Sharpshooting also can take place when park visitation is low or absent, reducing or eliminating public safety concerns. The extensive planning and oversight that would be required to ensure a level of safety comparable to wildlife professionals engaged in sharpshooting activities would likely make a public hunt less feasible.

At Valley Forge NHP, safety of park visitors and security in developed areas would reduce the area and thus feasibility of public hunting. For example, due to existing developed areas and necessary buffer zones around roads and parking areas, more than 20% of the park would be off limits to public hunting. The topography of the park would further limit public hunter access to more remote areas of the park and may cause difficult line of sight issues and unsafe judgment calls. These necessary safety and security restrictions, as well as the landscape of the park, would make it difficult to meet the purpose, need, and objectives of this planning effort.

Finally, a number of studies have shown that retaining adequate hunter numbers is difficult, especially as ungulate densities drop and management enters the maintenance phase. Hansen and Beringer (1997) and Kilpatrick and Walter (1999) both documented a significant decrease in hunter applications for managed firearm hunts lasting more than two consecutive days and a hunt conducted in the same area for a consecutive year. Without consistent annual hunter effort, long-term management through public hunting would likely be unsuccessful.

In conclusion, the NPS considered and rejected a public hunt as a reasonable alternative for this plan as other alternatives could be implemented without changing current laws and policies; would better meet the purpose, need, and objectives of the plan; would raise fewer safety and cost concerns; and are more effective management tools

2.10.2 Fencing the Entire Park

This option would involve fencing the entire park to prevent deer from entering or leaving Valley Forge NHP. The minimum fence height would need to be approximately 8 feet to prevent deer from jumping over the barrier. Fencing would prevent deer from being pushed into Valley Forge NHP from surrounding areas during hunting season, and it also would prevent deer entering the adjacent neighborhoods from the park. However, vegetation within Valley Forge NHP would continue to suffer the effects of deer browse, the deer population within the fenced area would continue to increase, and the health of the contained population would eventually suffer. Therefore, all deer within the fence either would need to be removed or the deer population within the fence would need to be managed with other methods to meet the objectives of the plan/EIS.

Seven state roads run through the park and must remain open. The Schuylkill River flows through the park and cannot be fenced. Therefore, fencing the entire park is not practicable. Fencing would reduce visitor access and adversely affect the cultural landscape at Valley Forge NHP, and fencing options would be further limited by the extent of archeological resources.

Furthermore, if deer were pushed out of the park and the park was fenced, the impact on the surrounding environment would be unacceptable. The increased deer browse in the surrounding community would result in substantial property damage, the potential for increased deer-vehicle collisions, and the loss of forest communities throughout the immediate area. For these reasons, fencing the entire park was dismissed as a management option.

2.10.3 Surgical Reproductive Control

This option would involve a tranquilizing agent administered to female deer via a dart by qualified personnel. Once the tranquilizing agent had taken effect, surgery in the field would be performed by a qualified veterinarian to remove or disconnect select reproductive organs, effecting permanent infertility. The majority of existing research on surgical reproductive control as a deer management tool has focused on computer modeling or implementation in relation to small, isolated, low density deer populations and is not considered directly applicable to the large, free-ranging, high density deer population at Valley Forge NHP. In Highland Park, Illinois a deer sterilization program was implemented to test the efficacy of the technique to control the towns deer population (Mathews et al. 2005). The technique had shown promise at the Milwaukee City Zoo as a means to control deer populations in a small area (Mathews et al. 2005). Overall deer density at Highland Park was relatively low, with 31 deer per square mile of forested habitat being the highest density reported – significantly lower than the deer density at Valley Forge NHP. Mathews et al. (2005) also concluded that sterilized deer in Highland Park, IL died at a significantly higher rate than control [unsterilized] deer and moved more than fertile deer. Overall, this option would take a great deal of time per deer, when compared to the alternatives considered in this document and the number of deer that would need to be treated makes it technically unfeasible as a stand alone alternative. Finally, the mortality rate associated with the procedure (6%) is greater than the acceptable level of mortality for this proposal (5%) (Mathews, Paul-Murphy, and Frank 2005). Based on these reasons, surgical reproductive control was dismissed as a management option.

In March 2009, the internal scoping team met with veterinary staff with the NPS Biological Resource Management Division to discuss the potential use of surgical sterilization in combination with lethal actions. Discussion focused on the potential number of deer that would require treatment, the length of time required to achieve the deer density goal if implemented in combination with lethal actions, mortality of treated females, available science on population level effects particularly for large, free-ranging deer populations, baseline data on park deer required to fully develop a combined alternative involving surgical sterilization, and potential implications of using a non-reversible management action given the risk of CWD. Surgical reproductive control was dismissed as an element of a combined alternative because (1) the mortality rate associated with the procedure (6%) is greater than the acceptable level of mortality for this proposal (5%) (Mathews, Paul-Murphy, and Frank 2005); (2) there is little available science on population level effects; and (3) existing scientific data suggests sterilization may only be successfully applied in largely closed deer populations where there is little net movement of deer into the area and precise control can be exercised over the capture process (Miller, Cooch, and Curtis 2006). It was also noted that other population parameters upon which accurate population models would rely, such as mortality/survival, and for which relatively accurate data currently exists could potentially change significantly in the future should CWD be introduced. Therefore, the use of an irreversible management action based on population parameters that could potentially change significantly in the future was not recommended.

2.10.4 Reintroduction of Predators

Relationships between predators and prey are complex, and the impact of predators on herbivore populations is variable (McCullough 1979). Reintroduction of large predators, such as gray wolves (*Canis lupus*) or cougars (*Puma concolor*) would not be feasible as a management option at Valley Forge NHP due to the lack of suitable habitat. Wolves have home ranges averaging 30 square miles when deer are the primary prey (Mech 1990) which is much larger than Valley Forge NHP's 5.3 square miles.

Moreover, the park is surrounded by developed areas and the proximity to humans is not appropriate for reintroduction of large predators. Coyotes (*Canis latrans*) are present in the park and bobcats (*Lynx rufus*) potentially could be supported by habitats within the park. However, these predators have been shown not to exert effective control on white-tailed deer populations (Coffey and Johnston 1997). Based on these reasons, the reintroduction of predators was dismissed as a management option.

2.10.5 Capture and Relocation

Live-capture and relocation as an alternative may have limited success in controlling a small, isolated population, or in removing animals from one area to augment populations in other areas where the deer population is below desired levels (Coffey and Johnston 1997). Live-capture and relocation can be stressful (DeNicola and Swihart 1997b) and result in high mortality rates in the relocated deer (Ishmael et al. 1995; Porter 1991). In Pennsylvania, the PGC does not support capture and relocation of white-tailed deer populations, and the deer population would be subject to state purview once removed (Cottrell 2008a).

Additionally, recent NPS guidance related to CWD, reflected in the Valley Forge CWD Response Plan, prohibits all translocations of deer in or out of NPS units without extensive CWD surveillance (NPS 2002b). Pennsylvania's CWD Response Plan also establishes strict importation requirements including participation in a recognized CWD herd certification program for at least three years. Therefore, capture and relocation was dismissed as a management option.

2.10.6 Repellents, Plantings, and Other Deterrents

Chemical repellents and the selection of plants that are not palatable to deer are good options for individual homeowners to discourage deer from destroying residential yards and gardens. These repellents can be sprayed on or attached to nearby vegetation, thus protecting individual plants or larger areas (Coffey and Johnston 1997). Repellents are removed by rainfall, requiring repeated applications. At high deer densities, repellents may be totally ineffective (Maryland DNR 2002). Therefore, it would be impractical to effectively manage deer using repellents in a large park setting. Visual and sound deterrents also are available to scare deer away from areas (API 2000). Again, visual and sound deterrents and planting of unpalatable plants would be impractical in a large park setting and could have impacts on visitor experience. Therefore, using repellents, select plantings, and other deterrents was dismissed as a management option.

2.10.7 Supplemental Feedings

Providing supplemental food to deer is often suggested as a way of reducing damage to natural or ornamental vegetation. Much of the information available involving supplemental feeding practices relates to emergency feeding of deer during winter or on private lands often for recreational purposes. Providing alternative food sources may provide temporary relief from browsing on plants needing protection but would not provide a long-term solution. Few studies have evaluated foraging behavior of deer relative to a supplemental food source (Doenier et al. 1997). Existing research indicates the deer continue to rely on standing browse regardless of the amount/availability of supplemental food. Additionally, impacts of browsing may be more significant in areas where deer concentrate around food sources provided as supplements to natural forage (Doenier et al. 1997). Overall, no scientific evidence could be found to suggest that in large, free-ranging deer populations supplemental feeding could reasonably be expected to allow the park to achieve its target level of tree regeneration. In addition, supplemental feeding on a park-wide basis would be logistically and economically impractical (Maryland DNR 2002). For these reasons, supplemental feeding was dismissed as a management option.

2.10.8 Poisons

Currently, there are no toxicants, poisons, or lethal baits registered for deer control. While quick-acting lethal chemicals are available, there are no safe methods for delivering lethal dosages to free-ranging deer. The use of toxicants carries many hidden risks that may be socially unacceptable and is not considered a humane alternative. These include potential human health risks, particularly if poisoned free-roaming deer occur in areas open to legal hunting, as well as risks to untargeted animals, including pets that might eat baits or scavenge carcasses of poisoned deer (Bishop et al. 1999). For these reasons, the use of poisons was dismissed as a management option.

2.10.9 Use the Deer Population as a Research Model

During public scoping, a research alternative was suggested that was based on the premise that Valley Forge NHP would “serve a more valuable role in determining the long-term consequences of having an ‘overabundant’ deer population if it were left without a proactive management scheme in place.” Such an alternative would closely evaluate the potential utility of a coordinated effort to link different experimental “treatments” with a “control” that would allow for research questions as yet unanswered to be better addressed. As stated in the research proposal, however, “the scale of the study is small, the proposed treatments would not and could not control deer populations at VAFO” (Rutberg, Kirkpatrick, and Fraker 2002).

NPS staff at Valley Forge NHP have monitored forest health and impacts from deer browsing for nearly 25 years, and evidence shows that the forest is no longer naturally regenerating due in large part to browsing impacts. To continue following a purely research-oriented path would not meet the plan/EIS objectives. For these reasons, this research-only alternative was dismissed as a management option. Research proposals, including those involving deer, would be evaluated through procedures and guidelines provided by the NPS Research Permit and Reporting System.

The deer density goal at Valley Forge NHP refers to an appropriate density of deer that would allow for natural forest regeneration. This density would be used as a goal under any of the action alternatives that include deer population control. In 1983, based on the definitions above, deer density at Valley Forge NHP was moderate (31-35 deer per square mile) and habitat was considered in good condition (Cypher, Yahner, and Cypher 1985). The science team agreed that, based on the quality of vegetation, the 1983 deer density of 31-35 deer per square mile would be an appropriate target density for this plan. This range is an initial goal, meaning that it could be adjusted during the life of the plan (up or down) based on the level of successful tree regeneration and deer population monitoring to ensure that the goals are met, as described in Section 2.9: Adaptive Management Approaches Included in the Alternatives.

2.3 Overview of Alternatives

The alternatives selected for detailed analysis are summarized below. NEPA requires federal agencies to explore a range of reasonable alternatives and to analyze what impacts the alternatives could have on the human environment, which the act defines as the natural and physical environment and the relationship of people with that environment. The analysis of impacts is presented in Chapter 4: Environmental Consequences and is summarized in Table 8 at the end of this chapter.

The alternatives under consideration must include a no-action alternative, as prescribed by NEPA regulations at 40 CFR 1502.14. The no-action alternative (Alternative A) in this document is the continuation of the park's current deer management activities, including continuation of limited CWD surveillance. The three action alternatives (Alternatives B, C, and D) contain actions to support forest regeneration and to protect, conserve, and restore native plant communities and other natural and cultural resources.

These alternatives also include the full implementation of the park's CWD Response² Plan (Appendix C). CWD response actions include disease surveillance (for detection), as well as actions to assess disease prevalence and distribution, minimize the likelihood of spread to surrounding communities and amplification within local deer populations, and if possible, promote elimination of CWD. All actions would be closely coordinated with the PGC and Pennsylvania Department of Agriculture (PDA) due to the scale identified as necessary to address CWD (minimum 79 square miles) relative to park size (5.3 square miles).

Action alternatives were developed by the interdisciplinary planning team, with feedback from the public and the science teams during the planning process. These alternatives meet, to varying degrees, the management objectives for Valley Forge NHP and also the purpose of and need for action, as expressed in Chapter 1: Purpose of and Need for Action. Because these action alternatives would meet the park's objectives and would be technically and economically feasible, they are considered "reasonable."

² Response to CWD includes disease surveillance (detection) actions as well as short-term actions to assess disease prevalence and distribution, minimize the likelihood of spread to surrounding communities and amplification within local deer populations, and if possible, promote elimination of CWD.

2.3.1 No-action Alternative

Under **Alternative A, No-Action**, existing deer management and monitoring efforts would continue. These actions include continued deer population and vegetation monitoring, maintaining small fenced areas to protect selected vegetation, roadkill removal, public education, coordination with the PGC, and continuation of limited CWD surveillance as described in the CWD Response Plan. No new actions would occur to reduce the effects of deer overbrowsing or to address CWD. A detailed description of Alternative A is provided in Section 2.4.

2.3.2 Action Alternatives

Alternative B, Combined Nonlethal Actions: In addition to the actions included under Alternative A, Alternative B would incorporate nonlethal actions to protect native plant communities, promote forest regeneration, gradually reduce the deer population in the park, and enhance CWD surveillance. This would include rotational fencing of selected forest areas of the park. The location of fenced areas would be selected based on the availability of forested areas of appropriate size (e.g., where a 10-acre enclosure could be rotated four times to cover 40 acres of forest), to be inclusive of the different forest types in the park, to promote park-wide distribution, and facilitate easy maintenance. The fencing would be rotated as forests within fenced areas reached acceptable levels of regeneration. The rotational fencing would be implemented in conjunction with reproductive control to gradually reduce and then maintain the deer population at an appropriate density. Reproductive controls would be implemented via a chemical reproductive control agent, when an acceptable agent becomes available. Until such an agent is available, the rotational fencing would be the sole means of promoting regeneration of the park's vegetation. It is expected that both actions would occur throughout the life of this plan (15 years). When the initial deer density goal is achieved and acceptable levels of tree seedling recruitment have been reached it may be possible to eliminate or reduce rotational fencing. This would be assessed using adaptive management.

If a confirmed case of CWD were detected within 5 miles of the park boundary or the park fell within a state-established CWD containment zone, then surveillance would be enhanced using tonsillar biopsy to test deer and remove CWD-positive members of the population. A detailed description of Alternative B is provided in Section 2.6.

Alternative C, Combined Lethal Actions: In addition to the actions included under Alternative A, Alternative C would incorporate lethal actions to protect native plant communities, promote forest regeneration, and quickly reduce the deer population in the park. The additional actions would include direct reduction of the deer population and maintenance at an appropriate deer density. Population reduction and maintenance would be implemented through sharpshooting and capture and euthanasia of individual deer in certain circumstances where sharpshooting would not be appropriate.

If a confirmed case of CWD were detected within 5 miles of the park boundary or the park fell within a state-established CWD containment zone, then lethal reduction actions already being taken would be accelerated to achieve the target deer density more quickly. Additionally, a one-time population reduction action, to a density of not less than 10 deer per square mile, may be considered for the purposes of disease detection and monitoring. This action would be based on the state's success in reducing deer populations within the containment zone outside the park boundary. A detailed description of Alternative C is provided in Section 2.7.

Alternative D, Combined Lethal and Nonlethal Actions: In addition to the actions included under Alternative A, Alternative D would incorporate lethal and nonlethal actions to protect native plant communities, promote forest regeneration, and quickly reduce the deer population in the park. This would include all of the actions included under Alternative A, as well as the reproductive controls included in Alternative B, and the lethal actions included in Alternative C. Initially, this alternative would use lethal reduction via sharpshooting and capture/euthanasia to quickly reduce the deer population and achieve the initial deer density goal. Population maintenance would be conducted via reproductive control when an acceptable agent becomes available. Until an acceptable and effective reproductive control agent becomes available, population maintenance would be conducted using lethal methods.

If a confirmed case of CWD were detected within 5 miles of the park boundary or the park fell within a state-established CWD containment zone, then lethal reduction actions, if already being implemented, would be accelerated to achieve the target deer density more quickly. If reproductive control were already being implemented, then the park would return to lethal removal actions until CWD monitoring, conducted for a period of time consistent with current knowledge of the environmental persistence of CWD infectious agents, revealed no additional CWD-positive deer within the park. At that time, if an appropriate reproductive control agent were available, the park would implement reproductive control methods for population maintenance. Additionally, during the CWD response, a one-time population reduction action could be implemented to achieve a deer density of not less than 10 deer per square mile. This action would be based on the success of state agencies in lowering deer densities to less than 31-35 deer per square mile in areas surrounding the park for the purposes of disease management. A detailed description of Alternative D is provided in Section 2.8.

2.4 Alternative A: No-action (Existing Management Continued)

As a mandated alternative, the no-action alternative “sets a baseline of existing impact continued into the future against which to compare impacts of action alternatives” (Director’s Order 12, Section 2.7). Under the no-action alternative, Valley Forge NHP would continue to implement current management actions, policies, and monitoring efforts related to deer and their effects. Current actions within the park include monitoring to record deer impacts and deer population numbers within the park, vegetation and deer population monitoring, small fenced areas to protect selected vegetation, roadkill removal, public education, and coordination with the PGC. Limited CWD surveillance also would be continued under the no-action alternative. The actions included in this alternative would continue to be coordinated with actions taken by other agencies and landowners.

2.4.1 Current Actions

Vegetation Monitoring

Vegetation monitoring, described in Appendix A of this document, would continue. This monitoring comprises 30 paired plots (fenced and unfenced) on Mount Misery and Mount Joy (Figure 3). Vegetation monitoring would continue to detect changes in the abundance and species composition of the forest understory plant community over time. As noted in Chapter 1, the NPS Mid-Atlantic I&M Network established an additional 21 long-term forest monitoring plots between 2007 and 2009 as part of its Vital Signs Monitoring Program. An additional seven plots are scheduled to be established in 2010, and an overall



Selecting An Alternative For Managing White-tailed Deer

When making decisions that may impact the human environment, the National Park Service is required to identify a full range of “reasonable” management alternatives and to analyze their potential environmental impacts. A “reasonable” alternative is generally considered to one that resolves the purpose and need for taking action, demonstrates common sense, is both technically and economically feasible, and best meets the objectives of the plan. The public is the watch-dog of the government decision-making process and are involved and informed throughout the process, providing valuable input on all aspects of the management plan including why it is needed, the objectives of taking action, and potential management alternatives.

Alternative A: No-Action

Alternative Description: The National Park Service is required by law to consider a no-action management alternative. The no-action alternative serves as a baseline for comparing the impacts of taking no action to manage the deer population to the impacts of taking action. Under the no-action alternative, Valley Forge NHP would continue to implement current management actions, policies, and monitoring efforts related to deer and their effects on park resources. Current actions the park takes that would continue under the no-action alternative are:

1. Monitoring the impact that deer browsing has on plant communities in the park over time.
2. Monitoring the size and health of the deer population over time.
3. Erecting small fences to protect plants that are rare, threatened and endangered so they aren't completely eliminated from the park.
4. Removing deer hit by cars from park roadways.
5. Working with the Pennsylvania Game Commission to reduce poaching.
6. Conduct public education and outreach with the local community to increase awareness of issues related to abundant deer populations such as reduction in forest health, lyme disease, and deer-vehicle collisions.

NOTE: Under current National Park Service policy, the no-action alternative includes protection for predators that have recently reappeared in the park, such as coyotes.

Impacts of Alternative A: Under Alternative A, damage to forest vegetation, rare species, historic structures, and archeological resources at the park would continue as a result of excessive browsing and trampling by high numbers of deer. The balance between deer populations and park resources would not be maintained and cultural and natural resources would continue to be degraded. Impacts to vegetation (particularly the forest understory) from continued overbrowsing by deer could result in irreversible impacts to Valley Forge NHP's forests and the surrounding landscape. No tree regeneration will occur and as trees die they will not be replaced. Invasive, non-native plants that are not palatable to

deer would continue to expand. Habitat for wildlife that depend on ground and understory vegetation would continue to be lost and these animal species might not remain or return to Valley Forge NHP if the forest understory is unable to regenerate. Deer browsing has already resulted in the elimination or reduction of certain rare plant species at Valley Forge NHP, however limited protection would be provided through small fenced areas. Even if fencing were used to protect some of the sensitive species, it would be impossible to identify all individual plants, and overbrowsing of new plants located outside the fenced areas could occur.

What do you predict the impacts of the no-action alternative would be on the number of deer-vehicle collisions in the park and/or the probability of encountering a deer tick that may carry Lyme disease?

Relevant Quotes From the Public:

“Personally I don't understand all the worry about a few plants. Nature will find a way.”

“The only reason that we come to the Park is to see the beautiful natural area that has been preserved. THAT INCLUDES THE DEER.”

“There are alternatives that would not require violent or invasive actions. Although we support the ‘no-action’ alternative, the idea that the public must choose deer control [sharpshooting and/or reproductive control] or nothing is a false dilemma. Coyotes are beginning to re-establish themselves in the area. Should these natural predators gain a presence in the Park, they will remove some of the young, and also the sick, and thus check the deer numbers while promoting health in the deer. Unlike larger predators, coyotes could do well in the range Valley Forge Park provides. The coyote population will, of course, take time to rebound, but this means we should promote their role in the ecosystem of our region. These predators, rather than be considered vermin by local residents, must be encouraged to prosper and to keep the ecological balance intact. The park administrators could and should diligently publish information to promote safety and respect for coyotes.”

“Please leave the deer alone, they don't need to be managed.”

“The deer are already controlling themselves. They do NOT need the government killing them OR interfering with their sex lives. Let NATURE take its course.”

“This approach does not target the deer abundance problem. The current deer population is negatively impacting the Park's native vegetation and other wildlife species. An aggressive, active deer management program should be implemented to improve the health of the deer herd and minimize the negative impacts on other plant and animal species. This approach will not meet those objectives.”

“The park ecosystem will continue to deteriorate under a no-action management scenario. Clearly, the park must take action to avert further, permanent damage to the park's natural resources.”

Action Alternatives

(All actions described below are *in addition to* those described under the no-action alternative)

Alternative B: Combined Non-Lethal Actions - Rotational Fencing and Reproductive Control

Alternative B Description: Alternative B would incorporate nonlethal actions to protect native plant communities, promote forest regeneration, and gradually reduce the deer population in the park. This would include rotational fencing of selected forest areas, representing 10% to 15% of the total forested area of the park. The park would construct 9-15 fenced exclosures, each covering between 10-20 acres, or a total of 140-210 acres of forest. The rotational fences would be a minimum of 8-10 feet high and would consist of woven wire with 3- to 4-inch openings to allow most small animals to move freely through the fence. The location of fenced areas would be selected based on the availability of forested areas of appropriate size (e.g., where a 10-acre enclosure could be rotated four times to cover 40 acres of forest) and include all the different forest types across the park. The fencing would be rotated as forests within the fenced areas reached acceptable levels of forest regeneration which is expected to be every 10-15 years. Areas outside fenced sites would remain unprotected from deer browsing.

The rotational fencing would be implemented in conjunction with reproductive (“birth”) control to gradually reduce and then maintain the deer population at the desired deer density. In order for reproductive control agents to effectively reduce population size, treatment must effectively decrease the reproductive rate to less than the mortality rate. In urban deer populations, mortality rates are generally very low and, therefore, it would be necessary to treat 70-90% of the female deer, with a highly effective product, to successfully reduce or halt population growth. Reproductive controls would be implemented using a chemical reproductive control agent (versus surgical reproductive control), when an acceptable agent becomes available. Although a chemical reproductive control agent that meets the National Park Service criteria for use is currently **NOT** available, one is expected to be available in the next 6-10 years. Until such an agent is available, the rotational fencing would be the sole means of promoting regeneration of the park’s vegetation. Once implemented, reproductive control is expected to require up to 20 years to reduce the size of the deer herd to the park’s desired deer density goal. When the initial deer density goal is achieved and acceptable levels of tree seedling recruitment have been reached it may be possible to eliminate or reduce rotational fencing.

Impacts of Alternative B: Under Alternative B, damage to forest vegetation, rare species, historic structures, and archeological resources at the park would continue at least in the short-term as a result of excessive deer browsing and trampling. Rotational fencing would only protect part of the environment (only 10-15% of the forested area of the park) and unfenced areas (85-90% of the park) would continue to experience excessive deer browsing. As fences were rotated, areas that had been protected would also again experience heavy deer browsing until reproductive control slowly took effect (20 years). The lack of protection for a large percentage of the park, and the time it would take for any reproductive control to be effective, would mean that desired results would not be seen for some time. During this time there could be irreversible impacts to park vegetation and other resources, invasive, non-native plants that are not palatable to deer would continue to expand, and habitat for wildlife that

depend on ground and understory vegetation would continue to be lost. Over the long-term, this alternative may provide some protection for native plant communities and wildlife as fencing and reproductive controls took effect resulting in a future beneficial impact. The large-scale fences would detract from aesthetically pleasing surroundings and limit public access to some areas of the park. The installation and movement of fencing could result in damage and loss of resources (e.g., archeological resources). This alternative would minimally help by maintaining a balance between the deer population and park resources by reducing adverse browsing impacts in some areas immediately and ultimately across the entire park as the deer population was very gradually reduced.

What do you predict the impacts of the no-action alternative would be on the number of deer-vehicle collisions in the park and/or the probability of encountering a deer tick that may carry Lyme disease?

Relevant Quotes From the Public:

"I'm strongly in favor of using the 'contraceptive darts' as oppose to killing off the deer. Being an animal lover and rescuer, I've seen and learned by many years of working with stray cats/kittens, keeping the present population there and using a humane - safe alternative, such as the contraceptive darts, benefits all involved! This will also set a compassionate, positive example to the community instead of killing off these beautiful animals."

"I vigorously recommend the cutting-edge of science. Contraception, to deal with deer management. Contraception does work. It does not take out large numbers quickly. But rather creates a lower birth rate over time and keeps the numbers down long-term. Killing does not accomplish this due to providing excess food supply for surviving deer and compensatory reproduction-both of these factors increase births. On Fire Island deer numbers have been reduced by 60 percent over six years with contraception. Deer numbers have been reduced by more than one third after four years of contraception at the National Institute of Standards and Technology in Gaithersburg, Maryland. The contraceptive vaccine costs only \$20.00. Labor costs are additional. The development of a "one shot" vaccine that is effective for multiple years has simplified deer contraception. With a new one-shot dart that will last for years. Deer only need to be vaccinated once to achieve sterility."

"This approach involves using fertility control to limit or prevent new animals from being born in to the population but it does not address the current overabundance issue. Much research has been conducted over the past four decades to develop an effective contraceptive that can be used on free-ranging herds. Unfortunately much confusion surrounds the status of fertility control agents. The perception that overabundant deer herds can be controlled solely with fertility drugs is false. Successful fertility control may limit population growth but it does little to reduce the existing population. In small, isolated areas inaccessible to hunting or sharpshooting programs, this alternative may be useful at maintaining deer densities at acceptable levels following a herd reduction. However, this alternative does not reduce deer populations, it is expensive and retreatment of does is necessary. There also may be unknown long-term effects on deer behavior. This approach will not solve the Park's deer problem."

"A combination of reproductive control and fencing will solve this problem and will teach our young people that violence is not the answer to our difficulties."

"Fencing, while it may exclude deer from portions of the park, will not, in the long-term be of use as the cost of replacing fencing destroyed by deer or by weather or other causes, will tie up funding that could be used otherwise by a very funding-strapped agency. It will also detract from the enjoyment of visitors to the park as the fences must be high and sturdy and entry by visitors will be problematical."

Alternative C: Combined Lethal Actions – Sharpshooting and Capture and Euthanasia

Alternative C Description: Alternative C would incorporate lethal actions to protect native plant communities, promote forest regeneration, and quickly reduce the deer population in the park. These actions would include direct reduction of the deer population and maintenance at an appropriate deer density. Population reduction and maintenance would be implemented through sharpshooting and capture and euthanasia of individual deer in certain circumstances where sharpshooting would not be appropriate. Sharpshooting would be conducted by professional biologists/marksmen following extensive procedures to ensure public safety. It is expected to take up to four years to achieve the desired deer density goal.

Impacts of Alternative C: Alternative C would have beneficial impacts to park resources including forest vegetation, rare species, historic structures, and archeological resources. Although deer would be removed through lethal reduction, the deer population would continue at a sustainable level that represents a balance between the number of deer and park resources. Because the population would be reduced relatively rapidly, there would be little chance that park vegetation (including special status species) or other species that are dependent upon the forest understory and native ground cover would be irretrievably lost. Forest vegetation in the park would be able to regenerate for the benefit and enjoyment of future generations and result in more aesthetically pleasing conditions. Continuing damage to historic structures and archeological resources would cease relatively quickly. Alternative C would require closures of some areas of the park during reduction activities, which would limit their use by visitors. However, these closures would occur at times and places that were not high visitation periods and primarily at night when the park is closed.

What do you predict the impacts of the no-action alternative would be on the number of deer-vehicle collisions in the park and/or the probability of encountering a deer tick that may carry Lyme disease?

Relevant Quotes From the Public:

“Sharpshooting is considered the most humane method of reducing a deer herd by the American Veterinary Association. Sharpshooting programs have been successfully employed in many communities across the country by private consultants, local police authorities and federal agency personnel. This approach is proven to be successful at reducing deer populations and the meat can be donated to food banks. Deer populations can be reduced quickly and this is the preferred removal technique in areas inaccessible to hunting.”

“I was very pleased to read about Valley Forge Park’s deer management plan. I understand and sympathize with the feelings of those (and I fear there will be many) distraught over the idea of culling the herd. But having seen the change to our woodlands over the past 30 years wrought by overpopulation of deer, I see no alternative but an active culling program.”

“Alternative C, the Park will have the needed impact upon the deer population and the Park environment quickly and most efficiently. Alternative C will enjoy broad (but perhaps not vocal) citizen support, as objectively measurable, efficient and effective. Please select Alternative C as quickly as practicable.”

“As Hospital-Affiliated Licensed Psychologists who work with children, adolescents, and families, we see and treat disorders everyday that involve maladaptive patterns of anger and violence. By allowing and encouraging this indiscriminate and senseless murder of these timid and gentle co-habitants of our land because they are 'in the way' perpetuates a dangerous and pathological message: "If something is in your way.. .destroy it!" The choice is really between endorsing the infliction of pain, suffering and death or opposing the infliction of pain, suffering and death. This action is deeply disturbing to us especially in view of what this park symbolizes; a haven and sanctuary where families can experience the harmonious balance between human and non-human animals, but would be ever after remembered as a bloody slaughter ground.”

“Gunning down deer is a cruel way to manage deer populations. Many deer who are shot are merely wounded, and their deaths can be slow and painful. Mass killings tear apart families, leaving young and weak animals vulnerable to starvation, dehydration, and predators. Lethal methods for deer population control are also ineffective. As long as the areas of concern remain attractive and accessible to these animals, more will move in from surrounding areas to fill the newly vacant niche. In addition, an acute reduction in the deer herd will prompt remaining does to breed, causing the population to increase! I urge you to halt plans to kill deer at Valley Forge and instead push for long-term deer management methods that are more effective and humane.”

Selecting An Alternative For Managing White-tailed Deer: Student Worksheet 4

Please answer the following questions based on your reading and discussion.	Management Alternative			
	A	B	C	Create Your Own Alternative
1. Will selection of this alternative allow Valley Forge National Historical Park to achieve the desired deer density goal?				
1a. If you answered "yes" above, will the deer population be reduced quickly or gradually?				
2. Will selection of this alternative promote tree regeneration and the restoration of healthy forests at the park?				
3. Will selection of this alternative allow for deer to continue to exist at Valley Forge?				
4. Is this alternative technically feasible (does the technology exist to do it)?				
5. Is this alternative economically feasible?				
6. Does this alternative resolve the stated purpose and need for deer management?				
7. How well does this alternative meet the stated objectives of the park's deer management plan (does not meet, partially meets them, or fully meets them)?				
ADDITIONAL QUESTIONS:				
8. <i>Place an "X" next to YOUR preferred management alternative.</i>				

Supplement 4: Applicable PA Academic Standards (Applicable standards may vary based on extension activities included.)

Environment and Ecology

4.1 Ecology

- 4.1.10.A—Examine the effects of limiting factors on population dynamics
- 4.1.12.A—Analyze the significance of biological diversity in an ecosystem
- 4.1.10.B—Explain the consequences of interrupting natural cycles
- 4.1.12.B—Research solutions to problems caused by interrupting natural cycles
- 4.5.10.D—Research practices that impact biodiversity in specific ecosystems
- 4.1.10.E—Analyze how humans influence the pattern of natural changes (e.g. primary/secondary succession and desertification) in ecosystems over time
- 4.1.12.E—Research solutions addressing human impacts on ecosystems over time

4.5 Humans and the Environment

- 4.5.12 B—Evaluate pest management using methods such as cost/benefit analysis, cumulative effects analysis, environmental impact analysis, ethical analysis, and risk analysis

Civics and Government

5.2 Rights and Responsibilities

- 5.2.C.B—Analyze strategies used to resolve conflicts in society and government

5.3 How Government Works

- 5.3.C.B—Analyze the roles of local, state and national governments in policy-making
- 5.3.C.C—Explain how government agencies create, amend, and enforce policies in local, state, and national governments
- 5.3.12.C—Evaluate how government agencies create, amend and enforce regulations

Mathematics

2.1 Numbers, Number Systems and Number Relationships

- 2.1.8.A—Model and compare values of integers and rational numbers

2.2 Computation and Estimation

- 2.2.8.B—Add, subtract, multiply and divide different kinds and forms of rational numbers including integers, decimal fractions, percents, and proper and improper fractions

2.3 Measurement and Estimation

- 2.3.A2.C—Solve a formula for a given variable using algebraic processes

2.5 Mathematical Problem Solving and Communication

- 2.5.8.B—Use precise mathematical language, notation, and representations, including numerical tables and equations, simple algebraic equations and formulas, charts, graphs, and diagrams to explain and interpret results
- 2.5.A1.B—Use symbols, mathematical terminology, standard notation,, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.
- 2.5.G.B—Use symbols, mathematical terminology, standard notation,, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.

2.5.A2.B—Use symbols, mathematical terminology, standard notation,, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.

2.5.11.B—Use symbols, mathematical terminology, standard notation,, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.

2.6 Statistics and Data Analysis

2.6.A1.E—Make predictions based on lines of best fit or draw conclusions on the value of a variable in a population based on the results of a sample

2.6.A2.E—Make predictions based on lines of best fit or draw conclusions on the value of a variable in a population based on the results of a sample

2.6.11.E—Make predictions based on lines of best fit or draw conclusions on the value of a variable in a population based on the results of a sample

2.8 Algebra and Functions

2.8.8.B—Evaluate and simplify algebraic expressions and solve and graph linear equations and inequalities

2.8.8.F—Interpret the results of solving equations in one or two variables and inequalities in one variable in the context of the situation that motivated the model

2.8.A1.F—Intrepret the results of solving equations, inequalities, systems of equations, and systems of inequalities in the context of the situation that motivated the model

2.8.A2.F—Intrepret the results of solving equations, inequalities, systems of equations, and systems of inequalities in the context of the situation that motivated the model

2.8.11.F—Intrepret the results of solving equations, inequalities, systems of equations, and systems of inequalities in the context of the situation that motivated the model

Reading, Writing, Speaking and Listening

1.1 Reading Independently

1.1.9.B—Use context clues, knowledge of root words, and word origins as well as reference sources to decode and understand new words

1.1.10.B—Use context clues, knowledge of root words and word origins as well as reference sources to decode and understand new words

1.1.11.B—Use context clues, knowledge of root words, and word origins an well as reference sources to decode and understand new words

1.1.12.B—Use context clues, knowledge of root words, and word origins an well as reference sources to decode and understand new words

1.1.9.D– Demonstrate comprehension of grade level text using before reading, during reading and after reading strategies such as comparing and contrasting within and among texts, and evaluating an author’s purpose and position

1.1.10.D—Demonstrate comprehension/understanding before reading, during reading and after reading on a variety of literary works through strategies such as comparing and contrasting text elements, assessing validity of text based upon content, and evaluating author’s strategies.

1.2. Reading, Analyzing, and Interpreting Text

1.2.9.B—Differentiate fact from opinion using a variety of texts from public documents and all academic content areas by using accurate information and supporting arguments

1.2.10.B—Assess the accuracy of facts presented in different types of informational texts by using a variety of consumer, workplace and public documents

1.2.11.B—Distinguish among facts and opinions, evidence and inference across a variety of texts by using complete and accurate information, coherent arguments and points of view

1.2.12.B—Distinguish among facts and opinions, evidence and inference across a variety of texts by using complete and accurate information, coherent arguments and points of view

1.2.9.E—Read, understand and respond to essential content in a variety of informational texts and documents across all academic content areas

1.2.11.E—Examine and respond to essential content of text and documents in all academic areas

1.4 Types of Writing

1.4.C.B—Write complex pieces that use precise language, employ relevant graphics, use primary/secondary sources, as appropriate, and include a variety of methods to develop the main idea

1.4.C.C—Write persuasive pieces that include a clearly stated position, convincing and properly cited evidence that anticipates and counters reader arguments and a variety of methods to advance the writer's position

1.5 Quality of Writing

1.5.C.A Write with a clear focus, identifying topic, task, and audience

1.5.C.B—Develop content appropriate for the topic

1.5.C.C—Write with controlled and/or subtle organization

1.5.C.F—Use grade appropriate conventions of language when writing and editing

1.6 Speaking and Listening

1.6.A—Listen critically and respond to others in small and large group situations

1.6.B—Demonstrate awareness of audience using appropriate volume and clarity in formal and speaking presentations

1.8 Research

1.8.C—Formulate a clear research questions and design a methodology for gathering and evaluating information on the chosen topic

1.8.C.B—Conduct inquiry and research on self-selected or assigned topics, issues or problems using a wide variety of appropriate media sources and strategies

1.8.C.C—Analyze, synthesize, and integrate data, creating a reasoned product that supports and appropriately illustrates inferences and conclusions drawn from research

1.9. Information, Communication, and Technology Literacy

1.9.C.A—Use media and technology resources for research, information analysis, problem solving and decision making in content learning

Supplement 5: Student Background Reading

Valley Forge NHP Frequently Asked Questions Regarding Deer Management (11/29/2010)

Moyer, B., B. Shissler, and R. Latham. Deer, Communities & Quality of Life. The Ecosystem Management Project, State College, PA.

Valley Forge NHP Frequently Asked Questions Regarding Deer Management (11/29/2010)

What is the problem with deer in the park?

Browsing of tree and shrub seedlings by an increasing deer population over the last two decades has prevented the ability of native forests to grow and mature. In a self-sustaining forest of this age (about 80 years) you should see a mix of tree seedlings, sapling trees, young and mature trees - a range of ages and sizes. You would see an abundant and diverse herbaceous (or non-woody) plant layer, including a variety of ferns and wildflowers. You would see a dense understory of native shrubs. This layer of the forest, often called the forest understory, provides important habitat for a variety of animals. At Valley Forge, however, this vital mix of plants that makes up the forest understory is missing and the forests are in trouble. Deer now are so dominant in the environment that there is little or no habitat for a whole range of wildlife species that depend on the understory for survival.

How many deer are in the park?

In 2009, the deer population was estimated to be 241 deer per square mile (1,277 individual deer in the park). The number of deer in the park has steadily increased since the mid-1980s when the population size was estimated to be 31 to 35 deer per square mile (165 to 185 individual deer in the park).

What does the NPS think is the 'right' number of deer?

Plan success is not measured by the number of deer but on the success of forest regeneration. Therefore, the "right" number of deer will be determined based on the ability of forest to regenerate. The initial target deer density has been identified as 31 to 35 deer/square mile (165 to 185 individuals). This is the number of deer that were present in the park in 1983-1986 when the health of the park plant community was described as "excellent." Other agencies and researchers recommend a density ranging from 10 to 40 deer per square mile to ensure forest regeneration. The target deer density for the park may change (up or down) based on the results of vegetation monitoring in park forests.

When did the NPS begin development of the plan and has the public been involved in the decision-making process?

Many public agencies, federal, state, and local governments, nonprofit organizations, institutions, and individual citizens have an interest in deer management at Valley Forge NHP. Reaching out to these interested parties for their ideas and expertise and listening to their concerns was an important step in the development of the plan. A combination of activities, including internal workshops, four public meetings, a project web-site, brochure, and over 90 briefings to civic organizations, local elected officials, and others helped the NPS gain important guidance in developing alternatives for the deer management plan.

A Notice of Intent to prepare a White-tailed Deer Management Plan/Environmental Impact Statement (EIS) was published in the *Federal Register* on September 7, 2006, initiating a 90-day public scoping period between September 7, 2006 and December 8, 2006. Two public scoping meetings were held on November 8 and 9, 2006. A total of 365 public comments were received during the scoping period. These comments were taken into consideration during identification and development of the alternatives that then were presented in the Draft plan/EIS.

The Draft plan/EIS, containing four alternatives for management, was available for a 60-day public and agency review from December 19, 2008 through February 17, 2009. Two public meetings to present the plan and obtain comments were held on January 14 and 15, 2009. A total of 3,884 public comments were received on the Draft plan/EIS. Each comment was carefully evaluated and changes to the plan were made, if appropriate. Changes to the Draft plan/EIS as a result of public comment comprised factual updates to baseline data and clarifications added to the text. Appendix E: Review of White-tailed Deer Reproductive Control, was substantially updated to more accurately reflect the current state of the science and comments received through peer review. No substantive changes were made to the preferred alternative or other alternatives evaluated. A summary of public comments and NPS responses is contained in Appendix F of the Final plan/EIS.

What is the purpose of the plan?

The purpose of the plan/EIS is to provide an effective deer management strategy that supports long-term protection, preservation, and restoration of native vegetation, wildlife, and other natural and cultural resources in the park. The secondary purpose of this plan/EIS is to provide a chronic wasting disease (CWD) response strategy that is fully integrated with deer management and that will reduce the probability of occurrence, promote early detection, and reduce the probability of spread of CWD.

Has the NPS selected a deer management alternative yet and is the decision now final?

Yes, the NPS has selected a final deer management alternative and the decision is final. The Record of Decision documents NPS approval of the plan, selects the alternative to be implemented, and sets forth stipulations required for implementation. It was signed by the NPS Northeast Regional Director on October 1, 2009.

The NPS selected Alternative D, Combined Lethal and Nonlethal Actions, which was identified as the NPS preferred alternative in the Final plan/EIS

What management actions are included in the selected alternative?

The selected alternative continues current park deer management actions including vegetation and deer population monitoring, maintenance of small fenced areas, roadkill removal, public education, coordination with the Pennsylvania Game Commission (PGC), and CWD monitoring and response. In addition, the selected alternative incorporates lethal and nonlethal actions to quickly reduce and then maintain the deer population at a certain level in the park that protects native plant communities and promotes forest regeneration and habitat.

Initially, the selected alternative will use lethal reduction via sharpshooting and capture/euthanasia to quickly reduce the deer population and achieve the initial deer density goal. The NPS anticipates that this portion of the white-tailed deer management plan will take up to four years. When an acceptable reproductive control agent becomes available, maintenance of population levels will be conducted via reproductive control. Until an acceptable and effective reproductive control agent becomes available, however, population maintenance will be conducted using lethal methods.

Currently CWD does not occur in the park. If a confirmed case of CWD were detected within five miles of the park boundary or the park fell within a state-established CWD containment zone, however, then lethal reduction actions, if already being implemented, will be accelerated to achieve the target deer density more quickly. If use of a reproductive control agent is already being implemented, then the park will return to lethal removal actions. Lethal removal actions will continue until CWD monitoring, conducted for a period of time consistent with current knowledge of the environmental persistence of CWD infectious agents, reveals no additional CWD-positive deer within the park. At that time, if an appropriate reproductive control agent is available, the park will reinstitute reproductive control methods for population maintenance. Additionally, during the CWD response, a one-time population reduction action could be implemented to achieve a deer density of not fewer than 10 deer per square mile. This action will be based on the success of state agencies in lowering deer densities in areas surrounding the park for the purposes of disease management.

How did the NPS determine the level of adequate tree regeneration?

Adequate regeneration is considered to be reached when 70% of monitoring plots exhibit the equivalent of 8,079 tree seedlings per acre. This figure was adopted based on the Pennsylvania Regeneration Study being conducted by the U.S. Forest Service and PA Department of Conservation and Natural Resources. This figure is similar to that adopted across Pennsylvania to ensure adequate forest regeneration.

Why is chronic wasting disease (CWD) included as part of the deer management plan?

A recent risk assessment for CWD revealed that the park is at high risk for occurrence. This is because the disease, previously believed to be isolated in the west and mid-western regions of the U.S., jumped to West Virginia and New York in 2005. It has been detected approximately 200 miles from the park boundary. CWD is highly likely to occur where there are dense populations of deer. Although CWD doesn't occur yet in Pennsylvania or the park, the NPS has decided to be proactive in addressing this issue.

When will sharpshooting occur in the park?

All deer management actions will take place between November and March. The park will conduct the lethal reduction phase of the White-tailed Deer Management Plan/Environmental Impact Statement (plan) beginning from November 2010 through March 2011.

How will the NPS make sure that the public is safe? Who will conduct the action?

The safety of park visitors, park neighbors, park staff, motorists, and others is our top priority. Extensive safety measures are in place to ensure a safe, humane, and successful operation. One of the primary elements of ensuring operational and public safety is to use highly qualified and experienced marksmen that are familiar with the park and with conducting lethal activities in a highly suburbanized environment. Therefore, the NPS will work with professional biologists from the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA-WS). USDA-WS has a long history of conducting safe and effective actions to reduce wildlife populations, including the reduction of deer populations at multiple locations in Greater Philadelphia Area and other populated areas nationwide. Additional safety measures that will be employed include:

- Lethal reduction activities will be conducted during periods of low visitation and while the park is closed (after dark);
- Activities involving firearms will be conducted in compliance with all federal firearm laws administered by the Bureau of Alcohol, Tobacco, Firearms, and Explosives;
- Bait may be used to attract deer to safe removal locations that will be approved by NPS personnel and located away from public use areas;
- Lethal reduction activities will not take place within established safety zones along the park boundary, open roadways and occupied buildings;
- Shooting actions will be conducted from an elevated position (e.g. tree stand);
- Shooting actions will utilize specialized ammunition that is safe for use in urban areas (minimizes travel range of projectile) and the environment (non-lead);
- NPS personnel will patrol the park during removal actions to ensure compliance with park closures and public safety measures and accompany USDA-WS teams in the field.

Will the NPS provide more specific information on when these activities are taking place?

Public safety is our top priority and in order to make this action as safe as possible for park visitors, neighbors, staff, and motorists we will share specific information on reduction activities with local law enforcement and other state and local officials to ensure coordination. Details of implementation (e.g. what, when, and where actions on the ground will take place) will not be provided to the public. We are working closely with local and state officials to be sure we have a comprehensive communications strategy that ensures public safety.

Has the lawsuit filed against the NPS been resolved?

In November 2009, several groups filed a complaint in Federal District Court challenging the Record of Decision for the Valley Forge NHP White-Tailed Deer Management Plan / Environmental Impact Statement, asserting that in its planning process and decision the NPS had failed to comply with various federal statutes and regulations. On October 27, 2010, US District Judge Mitchell Goldberg issued a decision upholding the Record of Decision and stating that not only was the NPS decision neither arbitrary nor capricious but that, in fact it "exemplifies a fully informed decision." Injunctions filed in November 2010 have also been denied by the court.

Will the meat be donated?

As long as CWD is at least 60 miles away from the park, meat will be donated to organizations such as local food banks, consistent with guidance from the NPS Office of Public Health. If CWD were confirmed within 60 miles of the park boundary or the park fell within a state-established CWD containment zone, then disposal would follow guidelines provided in the PA Chronic Wasting Disease Management Plan. CWD-negative deer would be disposed of via landfill. CWD-positive deer would be disposed of via landfill, incineration, or digestion. The NPS cannot sell the meat. The disposition of any antlers and hides will be determined by the PGC.

What is the cost of implementing the selected alternative?

The estimated cost for this action in years 1-4, during population reduction, ranges from \$150,000 to \$180,000 annually, depending on how close CWD is to the park. Estimated cost per year for population maintenance (implementation of reproductive control) ranges from \$108,363 to \$194,517 annually.

There are many factors that affect forest regeneration - why is the NPS focusing on deer?

Long-term monitoring of fenced and unfenced areas in park forests clearly demonstrates that high deer density is the dominant force in the park limiting the growth and maturation of the park's forests, due to browsing of tree and shrub seedlings. Young trees and shrubs grow to only a few inches tall before being eaten by deer and other herbivores.

The bigger picture includes the need for increased management of non-native invasive plants, which already takes place in the park. Implementation of new silvicultural practices and restoration of the forests will take place when the browsing pressure is reduced to a point at which forests can regenerate.

Why not allow local hunters to reduce the deer population for free?

Under federal law, hunting isn't allowed at a national park unless it was specifically authorized in a park's enabling (or subsequent) legislation. The law establishing Valley Forge as a unit of the national park system was passed in 1976 and does not authorize hunting. Due to the number of comments from the public on this topic, public hunting was evaluated during the development of the plan, based on factors of cost, safety, efficiency, and ability to achieve management objectives. The cost of implementation of a public hunting option was similar to sharpshooting. Sharpshooting, however, provides significant advantages over a controlled public hunt in regard to public safety, efficiency, and the ability to achieve the target deer density.

Did you consider using a reproductive control agent?

The NPS fully evaluated the advantages, disadvantages, effectiveness, and costs of using reproductive control as part of two deer management alternatives. These were Alternative B (Combined Non-lethal Actions) and Alternative D (Combined Lethal and Non-lethal Actions), which is the alternative selected. Under the selected alternative, if an acceptable chemical reproductive control agent is available, reproductive control would be implemented once the initial target deer density has been achieved. If an acceptable reproductive control agent is not available or is ineffective, the park would return to sharpshooting to maintain the deer population at the target density.

Appendix E, in the Final plan/EIS, provides a comprehensive overview of the status of the science on reproductive control. At the request of animal preservation groups and others, this appendix was reviewed by experts in the field of reproductive science and the NPS revised and updated information on reproductive control in the Final plan/EIS based on expert comments. Expert review and comment was provided by Dr. Allen Rutberg and Dr. Jay Kirkpatrick.

Who decides that a reproductive control agent is “acceptable” - is it NPS or the Humane Society?

The NPS established the criteria for an acceptable reproductive control agent and makes this determination in consultation with technical experts. Our criteria for an acceptable reproductive control agent are that: (1) it is 85% to 100% effective for 3-5 years; (2) it can be delivered without having to handle the deer (remotely); (3) It would not leave hormonal residue in the meat, which would prevent the meat from being used for human consumption; and (4) it would not cause significant changes in deer behavior. The Humane Society of the United States was asked to comment on whether an agent that meets these criteria was expected to be available in the near future. Their representative, Dr. Allen Rutberg, indicated one would be available within at least the next 15 years.

Why isn't native PZP, developed by Dr. Jay Kirkpatrick, considered an acceptable reproductive control agent?

PZP is not considered an acceptable reproductive control agent because it does not meet two of our four criteria for an acceptable reproductive control agent. First, PZP is only currently effective for up to two years. Research is on-going to determine whether it will be effective for longer than two years. Second, the FDA/EPA has not determined whether vaccine components pose a human health risk. Therefore, the animals must be permanently marked so as not to enter the human food chain.

Once the deer population is reduced won't deer move into the park from surrounding areas and remaining deer simply reproduce more?

Park tracking data indicate that there is little movement across the park boundary – either deer coming in or deer going out. Female deer spend most of their time within the park and travel an average distance of 401 to 1400 feet from the park boundary. These data also suggest deer density in areas surrounding the park is similar to the target deer density of 31 to 35 deer per square mile. The home range of deer in the park is also very small – less than ½ a square mile. Although males may travel further during dispersal, we do not expect significant immigration/emigration (deer moving into or out of the park).

White-tailed deer have a high reproductive capacity and reproductive rate is considered a primary indicator of deer condition. Under the selected alternative the deer reproductive rate would be expected to remain high or to increase over time in adult females. The reproductive rate in fawns and yearlings would be expected to increase over time as deer density was reduced and habitat quality improved. This is considered a long-term beneficial impact, because it would indicate deer are in good or improved condition.

The plan/EIS is intended to guide long-term management of white-tailed deer in the park. While the reproductive rate of deer may increase in response to a decrease in the overall population and some deer may move into the park from the surrounding area, future deer removal actions would take into consideration any population growth and adjust management actions (e.g., number of individuals removed) as needed through the adaptive management process.

Many park visitors love seeing the deer. Will they still be able to see deer when they visit the park in the future?

Yes, there will continue to be deer in the park. Maintaining a deer population in the park is one of the objectives of the plan/EIS.

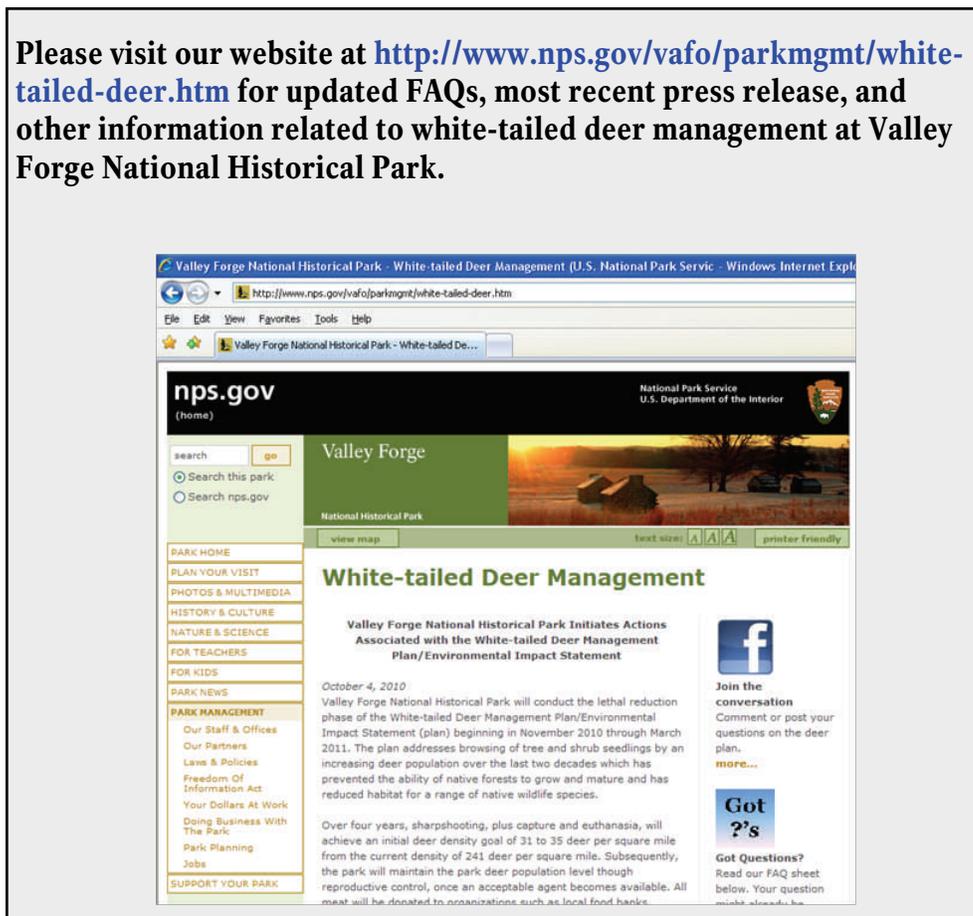
Will the number of deer-vehicle collisions go down as a result of this action?

An estimated 86 deer-vehicle collisions occur within the park annually. The NPS expects that as the deer population is reduced in size that the number of deer-vehicle collisions will also go down.

Who do I contact if I have questions or concerns?

Please contact our Natural Resource Manager, Kristina Heister, at 610-783-0252 or kristina_heister@nps.gov. Please contact your local law enforcement agency if you have concerns after park hours.

Please visit our website at <http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm> for updated FAQs, most recent press release, and other information related to white-tailed deer management at Valley Forge National Historical Park.



Deer, Communities & Quality of Life

A PUBLICATION OF THE ECOSYSTEM MANAGEMENT PROJECT by Ben Moyer, Bryon Shissler and Roger Latham

The woods next door: haven or hazard?

Pennsylvania offers many attractive residential communities for families seeking a high quality of life. Abundant natural beauty, healthful air, a generally mild but varying climate, fertile soils and the serenity of nearby woodlands and fields make these communities desirable places to live, raise children or retire. But in a growing number of neighborhoods across the state, overabundant and poorly managed deer herds are degrading that quality of life for increasing numbers of Pennsylvania residents.

Nearly everyone enjoys the occasional sighting of a deer near home. Increasingly, though, deer herds in residential areas are growing so large that the animals over-browse their woodland habitats, decimate gardens, create hazards on the highways, and even pose threats to human health. Residents and municipal officials in suburban and residential communities all across Pennsylvania are finding that overabundant deer are a serious, expensive and persistent problem.

For a long time in Pennsylvania, few people except deer hunters, farmers and foresters had reason to be

interested in the issue of deer abundance. Until recently abundant deer were mostly a rural problem, conflicting with farm and forestry interests but not the lives of people in residential communities. Within the past two decades, however, deer populations



CHRISTOPHER MILLETTE (COURTESY OF HARRISBURG PATRIOT-NEWS)

have surged state-wide and have spread into urban and suburban communities where they negatively affect the lives of motorists, gardeners and homeowners in every corner of the commonwealth. Few Pennsylvania drivers have not faced the unnerving

challenge posed by deer bounding suddenly onto the road. Pennsylvania motorists kill more deer by accident on our roads than are killed intentionally by hunters in many states. Too often, it is the driver that loses his or her life. One major insurance company

reported 18,000 deer-collision claims by Pennsylvania motorists from July 1, 2004, through June 30, 2005, the most of any state in the nation. According to the Pennsylvania Department of Transportation, the annual number of deer-vehicle crashes resulting in an injury or requiring towing has held steady at about 2,500 in recent years. From 2000 through 2004, 41 people died in deer-vehicle crashes in the state. Despite the highly publicized but very rare incidents involving wildlife such as bears or poisonous snakes, deer on the road are by far the most dangerous animal to humans. Police and transportation officials concede that hundreds of additional unex-

plained highway fatalities may also involve deer. In monetary terms alone, deer crashes cost Pennsylvania motorists, insurance companies, PennDOT and municipal governments hundreds of millions of dollars every year.

(continued on page 2)

In a growing number of neighborhoods across the state, overabundant and poorly managed deer herds degrade the quality of life for increasing numbers of residents.

(continued from page 1)

When not on the road, thousands of suburban Pennsylvanians look forward to gardening and ornamental landscaping as a way to enjoy their property and the outdoors. But as deer numbers mount, more gardeners are abandoning their flowers, ornamentals and vegetables because of the cost and frustration of dealing with deer. According to the Pennsylvania Landscape and Nursery Association, a professional trade group representing the horticulture industry, its members note declining sales in areas where deer have repeatedly stripped gardens and shrubs. "The average gardener will just give up," noted one PLNA member. Nursery owners deal with gardeners every day and say the deer crisis is rapidly becoming more urgent. In a survey, 80% of PLNA members said

Pennsylvania now leads the country in the number of new Lyme disease cases.

their deer problems had grown more severe over the past three years.

Unfortunately, the potential consequences of overabundant deer in residential communities reach far beyond frustrated gardeners. The incidence of Lyme disease is increasing rapidly in Pennsylvania, surging from two known cases in 1982 to more than 5,700 in 2003. Since 1994, Pennsylvania physicians have reported more than 28,000 cases of Lyme



A black-legged tick (deer tick) injects the spirochete that causes Lyme disease as it engorges with the blood of a human host.



CHRISTOPHER MILLETTE (COURTESY OF HARRISBURG PATRIOT-NEWS)

Pennsylvania motorists kill more deer by accident on our roads (80,000 to 100,000 annually) than are killed intentionally by hunters in many states.

disease, and Pennsylvania now leads the country in the number of new Lyme disease cases.

Named for the town of Lyme, Connecticut, where the illness was first described in 1977, Lyme disease results from a bacterial infection spread by the bite of the black-legged tick. White-tailed deer are the principal host for the adult form of this tick,

“Hardly anybody goes into the woods anymore. People just stay inside. They avoid the woods to avoid the ticks.”

and high tick densities occur only where deer densities are high. Lyme disease is seldom fatal but causes painful and debilitating symptoms, including chronic arthritis and neural damage if left untreated. More than 80% of all U. S. cases are reported from Pennsylvania, Maryland, Connecticut, New York, Rhode Island, Delaware, New Jersey, Massachusetts and Wisconsin. All these states contain areas of high deer density in developing regions with large and growing human populations.

Currently most Pennsylvania cases occur in the southeastern counties,

which exhibit some of the highest deer densities in the state. At a recent public forum on deer overabundance, Bucks County resident Debbie Plotnick said, “Seventy percent of the families in our community have been affected by Lyme disease, some more than once. Ours is a homestead community where diverse individuals live cooperatively with a shared intent to enjoy and interact with the outdoor environment. But this disease has changed the whole tenor of our community. Hardly anybody goes into the woods anymore. People just stay inside. They avoid the woods to avoid the ticks.”

Health departments and the medical community have issued preventive steps homeowners can take to reduce the risk of Lyme disease. But the recommendations often conflict with

In many Pennsylvania communities, the simple healthful pleasures of gardening, children’s outdoor play, and even casual walking represent risks people are no longer willing to take.

the values that originally drew homeowners to small towns and suburban communities. To reduce encounters with ticks, homeowners are warned to keep their children away from woodlands, and discouraged from allowing them to play in leaves and grass. Residents are advised to move swings and play equipment away from trees and brush, to locate firewood and bird feeders away from

the house, trim branches, widen paths, apply pesticides, and to keep areas used by the family away from Pennsylvania's natural landscape — the forest. But like Debbie Plotnick in Bucks County, many homeowners enjoy the wooded parts of their property, and value the outdoor exercise and satisfaction derived from gardening and landscaping. Removing such natural features diminishes their

enjoyment of their own outdoor environment, creating barriers that isolate people from nature and maroons them indoors or confines them to parking lots, driveways and streets. In many Pennsylvania communities, the simple healthful pleasures of gardening, children's outdoor play, and even casual walking represent risks people are no longer willing to take. Fear of Lyme disease would no longer dominate the lives of people who enjoy the outdoors if deer numbers could be kept below thresholds that promote the spread of disease-carrying ticks.

Long thought of as a creature of the backwoods, the adaptable white-tailed deer is now a familiar, abundant and not always welcome resident of small towns, cities and suburban communities across the state. Hunting is the traditional means of managing deer, but it is not always effective or appropriate in residential communities. Managing deer in community settings requires a range of strategies and the cooperation of residents and state and local government. It is possible to balance deer numbers with the health, safety and objectives of



U.S. FOREST SERVICE



ANN FOWLER RHOADS



ROGER EARL LATHAM

Hobblebush (above) and many other native shrubs once provided food and cover for birds and other wildlife living in the forest understory. Hearts Content, an old-growth stand of northern hardwoods in the Allegheny National Forest, had a typical rich understory of hobblebush and other native plants as recently as the 1940s (above left). Decades of chronic overbrowsing have since turned this and many other forest understories in Pennsylvania into a carpet of hay-scented and New York ferns (left) with no shrub layer and a complete failure of tree regeneration.

communities if a full range of deer management options are made available. ■

Deer impacts on our forests

The damage caused by abundant deer over longer periods of time can be clearly seen in Pennsylvania's forests. Throughout much of the twentieth century, large areas of Pennsylvania woodland harbored as many as 80 deer per square mile, exceeding by 10 times our best scientific estimates of deer densities in North America before the arrival of the first European explorers. Today, many parts of Pennsylvania still have deer populations of 50 or more per square mile.

At such high numbers, deer can gradually destroy the forest, reducing the diversity of plants and wildlife and threatening its future. Scientific research published in respected journals documents that the destruction is well underway in Pennsylvania's woodlands. Dr. Gary Alt, former supervisor of the Game Commission's Deer Management Section, described the situation

Today, thousands of square miles of Pennsylvania forests have mature oak trees but no young oak seedlings.

It is possible to balance deer numbers with the health, safety and objectives of communities if a full range of deer management options are made available.

involving deer and forests this way: "If the deer population is not controlled, we will lose the composition of forests; we'll lose the ability to grow wildlife, and we'll grossly change the commonwealth and be poorer because of it."

The most immediate impact of high deer numbers is the over-browsing of ecologically and economically important tree seedlings, such as Pennsylvania's 17 native species of oak. Oaks are the ecological cornerstone of our forests. Many species of wildlife, including deer, bears, turkeys, grouse, squirrels, wood ducks, mice, woodrats and numerous birds depend on the acorns that fall from oak trees each autumn. In turn, the predators of these animals — for instance, fishers, foxes, bobcats, hawks, owls and human hunters — reap the acorns' benefits indirectly. Acorns are a vital source of calories and other nutrients for woodland wildlife. But oak forests, like human civilizations, must produce younger generations to replace the old.

Today, thousands of square miles of Pennsylvania forests have mature oak trees but no young oak seedlings. As the mature oaks die off in future years, there will be no young seedlings to take their place. Scientists refer to this condition as failed regeneration. Unless oak regeneration can be restored and protected, Pennsylvania forests will lose these vital trees that support so much of our wildlife heritage and our rural economy.

In many of our forests, plants that deer avoid because of their undesirable taste, texture or other characteristics are replacing oaks and other desirable species. Eventually the less-preferred species avoided by deer, such as hay-scented and New York ferns, striped maple, black birch and American beech, become dominant, and impede

The destruction of the understory by deer is having a serious impact on forest wildlife.

the germination and growth of other species, even if deer densities are reduced.

These species are rapidly increasing their abundance in Pennsylvania, while many desirable species that were historically present are in decline.

Overabundant deer have not only changed the makeup of tree species within our forests, they have altered



AJ HAND (COURTESY OF CONN. ORNITHOLOGICAL ASSN.)



J. HEIDCKER (COURTESY OF VIREO)



R. & N. BOWERS (COURTESY OF VIREO)

Overbrowsing in Pennsylvania's forests is a serious threat to native bird species that nest, feed or take cover in the forest understory, including (from left) ovenbird, eastern wood-pewee and indigo bunting.

the physical structure of forests as well, with documented impacts on other wildlife. Healthy hardwood forests have four major structural “layers.” The canopy is the highest level, formed by the interlocking network of crowns of mature trees. Below the canopy is the subcanopy, smaller trees that will eventually take the place of taller ones in the canopy. Under the subcanopy are tree saplings and low-growing, shade-tolerant species such as dogwood, mountain-laurel, viburnum, hazel and rhododendron, which form the shrub layer. And growing at or near ground-level is the herbaceous layer, consisting of familiar grasses, wildflowers, ferns, tree seedlings, mosses and fungi. Scientists refer to the subcanopy, shrub and

herbaceous layers collectively as the “understory.”

Deer have completely removed the shrub layer and tree seedlings in huge expanses of Pennsylvania forests, and most forests today exhibit an unmistakable “browse line” about five feet above the ground, which is the height to which adult deer can easily browse. In forests across northern Pennsylvania, where deer numbers were extremely high for many decades, it is possible to see through the woods for hundreds of yards in any direction. Such a view would not be possible if a healthy understory were intact.

Hobblebush provides an example of the devastation that high deer populations have visited on Pennsylvania forests. Hobblebush is a flowering

Scientific research published in respected journals documents that the destruction is well underway in Pennsylvania’s woodlands.

shrub that was once abundant across the northern half of the state and southward at higher elevations in the Allegheny Mountains. It was especially plentiful on the Allegheny Plateau in northwestern Pennsylvania, a region that has long held high numbers of deer. In 1929 researchers surveyed parts of the Allegheny National Forest and recorded hobblebush on 50% of sampled plots. A later survey of the same forests in 1995 failed to find hobblebush on any of the plots, and researchers found a 59 to 80% loss of shrubs and herbaceous plant species compared to the 1929 data. American yew, fly-honeysuckle, pinxter-flower and mountain maple are other native shrubs that have all but disappeared from many
(continued on page 6)

Many of Pennsylvania’s most popular wildflowers are also preferred deer foods and have disappeared entirely from large parts of the state.



VIRGINIA KLINE (COURTESY OF UNIV. OF WISCONSIN)



ROGER EARL LATHAM



ALLEN CHARTIER



ROGER EARL LATHAM

Species that are endangered or threatened in Pennsylvania partly due to deer overbrowsing include showy lady’s-slipper (top), golden puccoon (left), yellow-fringed orchid (center) and glade spurge (right).

(continued from page 5)

areas of the state where deer numbers have been high for a long time.

The 1995 study found that hay-scented and New York ferns, which deer avoid, had increased in abundance on the survey plots from 3 to 21%. These ferns grow in a dense network, blocking out wildflowers, shrub and tree seedlings, and other plants that once graced the colorful and diverse web of life on the forest floor.

The destruction of the understory is having a serious impact on forest wildlife. More than 40 species of Pennsylvania birds nest within the shrub layer or on the ground, sheltered by low-growing plants. Careful experiments have shown that the abundance of many of these bird species drops as deer populations increase.

Abundant deer even affect woodland amphibians, insects and other life that depends on a moist environment. As deer strip away the understory, increased sunlight and wind movement dry out the leaf litter and soil, rendering the forest less hospitable to

mals and other wildlife. When abundant deer destroy insects' host plants, the effects ripple throughout the food web, cutting the food base for many wildlife species.

Besides their ecological and economic benefits, forests provide

many Pennsylvania residents with the pleasure of viewing wildflowers. But many of our most popular wildflowers are also preferred deer foods and have disappeared entirely from large parts of the state. Well-known

wildflowers that deer graze heavily include large white trillium, Canada mayflower, turtlehead, and numerous wild lilies and orchids. Defoliation and the loss of their flowers to deer browsing can kill these plants outright or cause reproductive failure. Some rare plants such as showy lady's-

Deer have completely removed the shrub layer and tree seedlings in huge expanses of forest, which exhibit an unmistakable "browse line" at the height that adult deer can reach.

salamanders, frogs, snails and soil insects that need damp conditions to survive.

Many insects have highly restricted diets, depending on particular understory plant species for survival. Insects, in turn, are essential items in the diets of many birds, small mam-



GARY ALT

The differences in species diversity, tree regeneration and wildlife habitat quality are dramatic between the outside and inside of deer enclosure fences all across the state. High deer populations are not the only problem facing Pennsylvania's forests, but experimental enclosures make it clear that overbrowsing has a devastating impact.

slipper and yellow fringed-orchid are especially threatened by deer because they now exist only in small, scattered locations, and their showy flowers attract deer in the same way they draw the attention of human admirers.

Though many factors, including plant diseases, insect outbreaks and acid precipitation can affect forest health, deer have been proven to be the overwhelming influence in numerous experiments using deer “enclosures.” Experimental enclosures are fences erected around plots of forest to keep deer out. Scientists

When allowed to become too abundant for too long, white-tailed deer can transform vibrant, productive and self-sustaining forests into degraded environments.

study the vegetation inside and outside the fence to determine its response in the absence of deer.

Since insects, disease and acid rain have the same impact on both sides of the fence, the influence of deer can be studied in isolation. Wherever enclosures are erected in Pennsylvania, they show remarkable recovery in the growth and diversity of plant species inside compared with outside the fence.

It is increasingly clear that deer, though valued and important, can be a destructive influence in the forests that support them. When allowed to become too abundant for too long, deer can transform vibrant, productive and self-sustaining forests into degraded environments that support only a fraction of their former diversity. Unfortunately, this is the condition today of much of Pennsylvania’s forestland, including the Department of Conservation and

Natural Resources’ 2.1 million acres of State Forest, which even though certified by the Forest Stewardship Council as “well managed” remain seriously degraded by deer. The FSC report itself acknowledges that overbrowsing by deer has decimated the diversity and sustainability of State Forests’ flora and fauna. These forests can recover their vitality. But that recovery depends upon a commitment to managing our forests as total ecosystems, not as deer habitat alone. In simplest terms, that means managing for fewer deer for the foreseeable future. ■

What you can do

The Pennsylvania Game Commission (PGC) is responsible for deer management throughout the Commonwealth. The Commission is staffed, funded and administered almost exclusively by hunters, 94% of which hunt deer. Vocal and powerful hunting organizations have long used their influence to demand that the Commission keep deer populations high to facilitate recreational hunting. Meanwhile, the agency devotes less than 5% of its budget to the conservation of endangered species and wildlife not pursued by hunters (non-game) and it has failed to develop an effective urban deer program. Dependent upon the sale of hunting licenses for its funding, the PGC has never been able to complement its traditional role of

The Game Commission is staffed, funded and administered by hunters, 94% of which hunt deer. Vocal and powerful hunting organizations have long used their influence to demand that the Commission keep deer populations high to facilitate recreational hunting.

supporting and facilitating sport hunting with a true, comprehensive wildlife conservation program that strives to maintain balanced wildlife populations within healthy ecosystems. ■

The 2.1 million acres of State Forest, even though certified by the Forest Stewardship Council as “well managed,” remain seriously degraded. Overbrowsing by deer has decimated the diversity and sustainability of State Forests’ flora and fauna.

It is particularly difficult for the PGC to effectively address deer challenges in residential communities, since recreational hunting is often not a workable option near homes and businesses.

To successfully address the complexities of wildlife management in modern Pennsylvania, the state will need to broaden the representation on the eight-member Game Commission board to include not just hunting interests, but the views and needs of other stakeholders such as farmers, forest landowners, residential communities and environmental organizations. And Pennsylvania urgently needs new public funding sources for wildlife conservation and management that do not rely solely on hunting license sales. To make this happen the Governor, General Assembly, PGC and citizen stakeholders will need to work together.

You can encourage positive change by writing to Governor Rendell, your state Senator and Representative, and the PGC (see contact information on next page). In your letters, tell your story about how overabundant deer affect your quality of life and ask

for a fresh approach to deer management that protects Pennsylvania’s forests, receives the broad-based funding it deserves, and involves all the diverse stakeholders affected by deer. ■

Write to Governor Rendell:

Governor Edward G. Rendell's Office
225 Main Capitol Building
Harrisburg, PA 17120

Or telephone: (717) 787-2500

Write to your state Senator and Representative:

To contact your state Senator and Representative on-line, go to www.state.pa.us and click on *Contacting Your Legislator*.

Write to the Pennsylvania Game Commission:

Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Or telephone: (717) 787-4250

On-line: www.pgc.state.pa.us

The Ecosystem Management Project

The Ecosystem Management Project, in care of the Community Foundation for the Alleghenies, is an education initiative created to increase public awareness regarding the values of managing white-tailed deer from an ecosystem/habitat-based perspective and to supply the public with information about this issue. It is our goal to assist state agencies, landowners, hunters and communities towards that end and to publicize opportunities to be involved. We welcome your input and involvement.

For additional copies of this publication, contact:

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Deer, Communities & Quality of Life

THE ECOSYSTEM MANAGEMENT PROJECT

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Supplement 6: Teacher Answer Keys for Student Worksheets

Did Soldiers at Valley Forge During the 1777-1778 Winter Encampment Eat Venison?

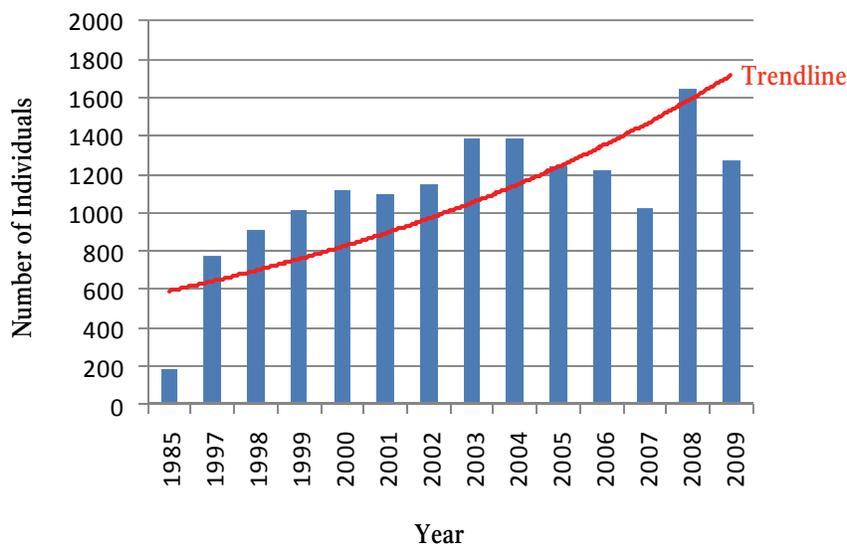
At Valley Forge NHP, “there is no evidence that the soldiers supplemented their diet by hunting...it is unlikely that there were many deer and other wild animals in the vicinity of the camps during the winter of 1777-78.

The construction of the soldiers’ cabins or “huts” in December of 1777 would have eliminated nearly all the tree cover in the area of the encampment and thereby eliminated the habitat for deer and other forest animals” (Steele et al. 2006).

White-tailed Deer Population Size: Teacher Key

1. Using the actual data below on deer population size in the park, create a graph that illustrates changes in deer population size over time.

Year	Population Size
1985	185
1997	772
1998	907
1999	1011
2000	1122
2001	1092
2002	1147
2003	1389
2004	1388
2005	1241
2006	1218
2007	1023
2008	1647
2009	1277



A. Interpret your graph and describe trends in deer population size over time. What might cause fluctuations in deer population size at the park?

The deer population at Valley Forge increased steadily over time with the greatest number of deer observed in 2008. Significant fluctuations in population size are observed after 2004. Fluctuations in population size at Valley Forge are primarily caused by severe weather events and change in the amount of available forage.

2. Deer density refers to the number of deer per unit of area. The park is 5.3 square miles in area. Calculate the density of deer for each of the years provided above. Based on your results, complete A and B below.

A. The deer density at Valley Forge NHP increased from 35 deer per square mile to 241 deer per square mile between 1985 and 2009.

B. Define forest regeneration. The recommended deer density to allow for adequate forest regeneration ranges from 10 to 40 deer per square mile. Based on this information and the results above, how much regeneration do you think was occurring in the forests at Valley Forge NHP in 2009 compared to 1985?

Forest regeneration: The regrowth of forest species and renewal of forest tree cover such that the natural forest sustains itself without human intervention. Significantly more regeneration would have been occurring in 1985 when deer density was within that recommended to allow for adequate forest regeneration.

White-tailed Deer Population Growth: Teacher Key

1. Growth rate describes how quickly or slowly a population is growing in size. Rate of growth is an indirect measure of reproduction. Rapid growth rates reflect high productivity, good habitat conditions, and a generally healthy deer population. Below are data from fall spotlight counts conducted between 1986 and 2008 at Valley Forge. Using the formula below, calculate annual growth for the deer population at Valley Forge NHP for each year and write it in the space provided. What conclusion can be drawn about changes in habitat quality based on these results?

Year	# deer obs.	Growth Rate (%)
1986	97.8	Leave Blank
1987	85.6	-12.47
1988	133.8	56.31
1989	161.4	20.63
1990	169.6	5.08
1991	155.8	-8.14
1992	229.4	47.24
1993	251.6	9.68
1994	338.4	34.50
1995	437.4	29.26
1996	380.6	-12.99
1997	381.0	0.11
Year	# deer obs.	Growth Rate (%)
1997	381.0	Leave Blank
1998	447.4	17.43
1999	419.8	-6.17
2000	414.2	-1.38
2001	577.6	39.61
2002	599.8	3.84
2003	599.5	-0.05
2004	439.5	-26.69
2005	533.3	21.33
2006	464.0	-12.99
2007	365.0	-21.34
2008	343.2	-5.97

Annual Growth (%) =
 $(\text{YR2} - \text{YR1}) / \text{YR1} * 100 \%$

A. Calculate the overall average annual growth rate.

Average annual growth rate (1987-2008): **8%**

B. Calculate the average annual growth rate between 1987 and 1997 and between 1998 and 2008.

Average annual growth rate (1987-1997): **15.38%**

Average annual growth rate (1998-2008): **0.69%**

C. What conclusions might be drawn about habitat quality and deer condition in the park based on differences in average annual growth rate between 1987-1997 and 1998-2008?

Between 1987 and 1997, habitat quality in the park was sufficient to maintain deer in good condition leading to high productivity and a rapid rate of population growth.

Between 1998 and 2008, overbrowsing by deer had degraded available habitat and increased competition for resources. This may have led to a decrease in deer condition, particularly in young animals, and decreased productivity leading to a lower rate of population growth.

Suburban Versus Rural Deer Populations: Teacher Key

1. Fill in results for deer density and average annual population growth rate for Valley Forge NHP from worksheets 1 and 2. Compare and contrast the demographic and other factors that determine the population dynamics of suburban and rural white-tailed deer populations.

Population Parameter	Suburban (Valley Forge NHP)	Rural (Statewide)
Sex ratio (female:male)	2:1	3:1 to 6:1
Age structure	Skewed toward older animals	Skewed toward younger animals
Abundance* (= density expressed as number of deer per square mile)	241	20-25 (*1998-2003 data)
Annual Survival (%)	83%	27% (bucks)-60% (does)
Annual Mortality (%)	17%	40% (does)-73% (bucks)
Average annual rate of population growth (%)	8%	Unknown
Reproductive rate (fawns per doe)	0.4 (yearlings) - 1.8 (adults)	1.2 (yearlings) - 1.8 (adult)

* Use 2009 estimated deer density from Valley Forge NHP

A. Discuss how differences in population characteristics are related to differences in suburban and rural environments (e.g. hunting pressure, amount of forested habitat, presence of predators). Describe an example below.

Suburban areas are characterized by lower hunting pressure and fewer predators compared to rural environments contributing directly to high survival and low mortality.

B. Reproductive rate has been selected by Valley Forge NHP and Pennsylvania Game Commission as the primary indicator of deer health or condition. Based on this, provide an explanation for lowered reproductive rate in younger deer at Valley Forge compared to other deer populations statewide.

Lowered reproductive rate in young deer at Valley Forge is a reflection of reduced habitat quality and increased competition for available resources which directly impacts deer condition. Change in deer condition or health is often first observed in younger animals that don't have the same level of fat reserves compared to older animals.

C. Define productivity. Describe how annual survival and age structure of suburban deer populations may affect productivity at Valley Forge NHP.

Productivity: Number of fawns born minus those killed through all sources of mortality at a given population size, during a specified time interval. Usually expressed on a yearly basis.

In suburban deer populations, a survival rate of 83% leads to populations with a higher proportion of older individuals (age structure). Adult female deer have a higher rate of reproduction compared to younger animals and often produce twins or triplets compared to single fawns. As more fawns are born that continue to experience low mortality (high survival), productivity increases (given adequate habitat quality).

Selecting An Alternative For Managing White-tailed Deer: Student Worksheet 4 Teacher Key

Please answer the following questions based on your reading and discussion.	Management Alternative			
	A	B	C	Create Your Own Alternative
1. Will selection of this alternative allow Valley Forge National Historical Park to achieve the desired deer density goal?	No	Yes	Yes	
1a. If you answered "yes" above, will the deer population be reduced quickly or gradually?		Gradually (20 yrs)	Quickly (4 yrs)	
2. Will selection of this alternative promote tree regeneration and the restoration of healthy forests at the park?	No	Yes (in time)	Yes	
3. Will selection of this alternative allow for deer to continue to exist at Valley Forge?	Yes	Yes	Yes	
4. Is this alternative technically feasible (does the technology exist to do it)?	Yes	Yes	Yes	
5. Is this alternative economically feasible?	Yes	Yes	Yes	
6. Does this alternative resolve the stated purpose and need for deer management?	No	Yes (in time)	Yes	
7. How well does this alternative meet the stated objectives of the park's deer management plan (does not meet, partially meets them, or fully meets them)?	Does Not Meet	Partially	Fully	
ADDITIONAL QUESTIONS:				
8. Place an "X" next to YOUR preferred management alternative.				



Supplement 7: Mount Joy Trails Map Showing Location of Accessible Fenced Areas for Observation

