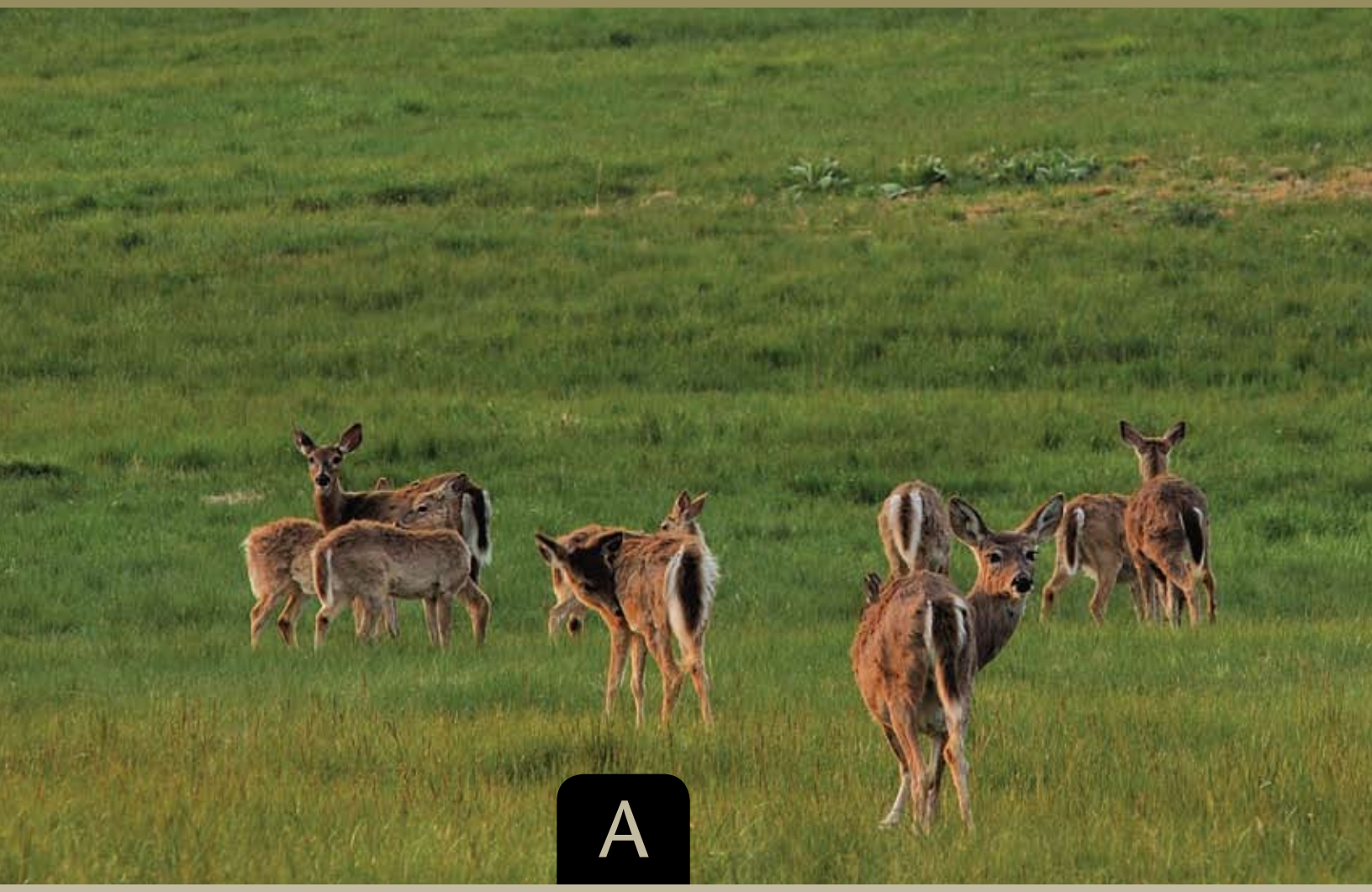


A

Appendixes

A: Deer and Vegetation Monitoring Protocol
B: Relevant Correspondence
C: CWD Response Plan for Valley Forge NHP
D: Detailed Cost Estimates
E: Review of White-tailed Deer Reproductive Control

Appendix A: Deer and Vegetation Monitoring Protocol

Introduction

The following appendix describes the protocols for deer and vegetation monitoring related to implementation of the White-tailed Deer Management Plan at Valley Forge National Historical Park (NHP). These protocols do not include monitoring associated with the park's Chronic Wasting Disease (CWD) Response Plan. See Appendix C for a description of monitoring associated with the CWD Response Plan.

Deer Monitoring Protocol

Fall Spotlight Counts

Fall spotlight counts have been conducted by park staff since 1986 and represent the data with the longest period of record. The counts provide an assessment of trends in deer population size over time. Methods used in assessing these trends follow those recommended by Cypher, Yahner, and Cypher (1985). Due to the fact that there is no estimate of the number of deer observed during spotlight counts, this method does not provide an accurate estimate of deer population size. The following factors are taken into consideration when conducting spotlight counts.

Timing: Five spotlight counts would be conducted annually during a 2-week period in October. Historically, counts have been conducted as early as October 10 and as late as November 1. Counts have typically been conducted successfully during the last 2 weeks of October. Conducting these counts later than November is not recommended, due to the change in deer movement patterns associated with the breeding season.

Weather: Ambient weather conditions should meet minimum standards (wind – less than 15 miles per hour [mph)]; rain – less than heavy and not steady; visibility – greater than 1 mile) as reported by the local weather service and measurement at the Valley Forge NHP weather station. Should conditions fail to meet minimum standards, the spotlight count would be postponed.

Vehicle Type: A vehicle that sits high above ground level, such as a pickup truck, should be used to conduct counts to facilitate deer observation. A National Park Service (NPS) pickup truck is recommended for safety purposes, as it is equipped with flashing warning lights. A flashing light has no detectable effect on spotlighted deer (Cypher, Yahner, and Cypher 1985).

Data Collection Period: Counts should begin 1 hour after official sunset and require approximately 2 hours to complete.

Driving Route: The spotlight-count route should remain the same as in previous years. This route covers approximately 15.5 miles of roadway located south of the Schuylkill River, within the park. Roadways or portions of roadways included on the route are Inner Line Drive, Outer Line Drive, County Line Road, Route 23, Route 252, and Yellow Springs Road. The majority of parking areas along the spotlight

route also are included during the count. The route should be driven at 5-10 mph. Since 1998, one section of the driving route along Route 23 east and west has become hazardous due to high traffic volume. Therefore, this section of the route should be driven along the Joseph Plumb Martin trail wherever possible.

Observers: As least two observers are required to conduct the count - one responsible for counting deer and one to drive and assist with spotting deer, when possible.

Data Collection: Ambient weather conditions should be recorded at the start and end of each count using a Kestrel pocket weather meter. Start time and end time, date, observer names, spotlight candlepower, and vehicle type also should be recorded prior to initiating each count.

Observers would use handheld spotlights for each survey. Spotlight candlepower has changed over the years, ranging from 200,000 candlepower to 400,000 candlepower due to changes in technology. It is recommended that a similar candlepower spotlight be used as long as possible (e.g., 200,000 candlepower spotlights are no longer available). When deer are located, the vehicle should be stopped (as necessary) to allow the observer to count deer as accurately as possible. Observers may use binoculars to count the number of deer. The number of deer observed is recorded and the count continued. The total number of deer observed during all five counts combined should be divided by five to yield an annual population index. These indices can be compared among years to determine whether deer population size is increasing, decreasing, or stable. Observers should be careful to avoid double counting animals.

Spring Compartment Counts

Spring compartment counts have been conducted by park staff since 2000. This survey is based on a mark-capture study conducted between 1997 and 1999. The study developed a sighting index, expressed as the proportion of the number of marked deer seen to the number of marked deer known to occur. The number of deer observed during spring compartment counts is multiplied by the sighting index to generate an estimate of the deer population size within the park. Methods for recording this data follow those developed by Lovallo and Tzilkowski (2003). While this is a standard method for estimating population size (Conroy and Nichols 1996), it will become less accurate over time as park vegetation changes and there are changes in deer mortality, etc. Therefore, in the long-term, spring compartment counts should be used as a park-wide abundance index (Lovallo and Tzilkowski 2003). The following factors are taken into consideration when conducting spring compartment counts.

Timing: Three compartment counts should be conducted annually during the spring – usually the last two weeks of April extending into the first week of May depending on timing of spring "green-up." Historically, spring counts have been conducted as early as April 18 and as late as May 8.

Weather: Ambient weather conditions should meet minimum standards (wind – less than 15 mph; rain – less than heavy and not steady; visibility – greater than 1 mile) as reported by the local weather service and measurement at the Valley Forge NHP weather station. Should conditions fail to meet minimum standards, the survey would be postponed.

Vehicle: A vehicle that sits high above ground level, such as a pickup truck, is recommended to facilitate deer observation. An NPS pickup truck is recommended for safety purposes because it is equipped with flashing warning lights. However, type of vehicle for most routes is not as important as in spotlight counts because observers may get out of the vehicle and walk to areas to more easily observe deer. Compartment 1 requires use of a 4-wheel-drive vehicle due to the nature of the survey route. Use of flashers for all vehicle types is recommended.

Data Collection Period: Counts should be conducted during a 60-minute survey period beginning one hour before sunset (6:45-7:00 pm) and ending just after sunset (7:45-8:00 pm).

Compartments and Driving Routes: Five compartments, established as geographic sampling units for vehicle-based spring deer counts by Lovallo and Tzilkowski (2003), should be surveyed using established survey routes (see Figure 11). Compartments vary in area from approximately 1.0 to 1.3 square miles. Compartment boundaries are based on roads, streams, forest boundaries, and topography and were designed to minimize deer movement among compartments during counts. Driving routes follow all accessible roadways within a designated compartment. All roadways should be traversed slowly, at least once during each survey period. An observer may leave the vehicle and traverse a compartment on foot when terrain features obstruct viewing opportunities from roadways.

Compartments located south of the Schuylkill River should be surveyed simultaneously by multiple observers to prevent duplicate counts if deer traverse from one compartment to another.

Observers: At least two observers are required to conduct the survey - one with primary responsibility for counting deer and one to drive and assist with counting deer.

Data Collection: Ambient weather conditions should be recorded at the start and end of each count using a Kestrel pocket weather meter. Start time and end time, date, observer names, and compartment number should also be recorded prior to initiating each survey.

Observers should be provided with an aerial photograph of each compartment, with compartment boundaries and driving route indicated, as well as binoculars. All deer observed should be counted and recorded on a data sheet and on the aerial photograph where the deer were actually seen. Locations where deer are counted are indicated by using consecutive letters (A, B, etc.) on the aerial photograph and data sheet. Observers should indicate in the comments section of the data sheet if a "marked" deer is observed during the survey. A marked deer is any deer with a radio-collar or vinyl collar. Observers also should indicate whether deer are observed on private or park land.

Total number of deer observed on park land should be summed across all compartments and multiplied by the sighting index (0.58) to yield an annual population index. These indices can be compared among years to determine whether deer population size is increasing, decreasing, or stable. Because park vegetation communities have retained their open character and other factors affecting deer populations (e.g., mortality rate) are not believed to have changed significantly since 1999, park managers believe this method may still be accurate in estimating deer population size also.

Reproductive Control Monitoring

The ability to achieve target levels of infertility in the deer population would require knowledge of the fertility status of individual deer that had been treated (Hobbs, Bowden, and Baker 2000). To monitor treated animals, the park would continue its fall spotlight surveys and spring compartment surveys, at which time observations would indicate if population growth had occurred. Additional observations would be made through the collection of data from all deer carcasses related to the number of fetuses present, which would indicate if reproduction occurred. Using protocols being implemented by the Pennsylvania Game Commission (PGC) to estimate deer reproductive rates state-wide, reproductive tracts from dead female deer would be removed and each uterus examined. The number and sex of fetuses present would be recorded. Age of fetuses would be determined based on measurement of crown-to-rump length and be used to calculate conception dates. Pregnancy rate would be defined as the percentage of does sampled that were pregnant. Reproductive rate would be defined as the average number of fetuses per doe.

Forest Health Monitoring Through the NPS Inventory and Monitoring Program

Overview

Knowing the condition of natural resources in national parks is fundamental to the service's ability to manage park resources. The intent of the NPS monitoring program is to track a subset of physical, chemical, and biological elements, as well as processes of park ecosystems that are selected to represent the overall health or condition of park resources. The monitoring program also includes known or hypothesized effects of stressors, or elements that have important human values, known as "vital signs." To implement this program, the NPS grouped parks into 32 inventory and monitoring networks linked by geography and shared natural resource characteristics.

Valley Forge NHP is included in the Mid-Atlantic Inventory and Monitoring Network (MIDN). The MIDN consists of 10 parks distributed from southern Pennsylvania to southern Virginia, and extending from the piedmont to the coastal plain. The parks range in size from 224 acres (Booker T. Washington National Monument) to 197,411 acres (Shenandoah National Park), and include many sites of historical and cultural interest as well as diverse natural resources.

Forest health is one of the vital signs selected for monitoring by the MIDN in 2006. Network staff have developed a forest vegetation monitoring protocol that will be implemented in all parks in the network, including Valley Forge NHP in 2007. The goal of the forest vegetation monitoring protocol is to provide scientific data that will increase an understanding of the status and trends in forest resources, inform park management, and are compatible with other monitoring protocols to facilitate regional analyses. Specifically for Valley Forge NHP, the forest vegetation monitoring should be capable of addressing questions related to the effectiveness of deer management on the health of forest resources in the park.

Specific Monitoring Objectives

- Determine status and trends in forest structure, composition, and dynamics of canopy and understory woody species.
- Determine status and trends in the density and composition of tree seedlings and selected herbaceous species that are indicators of deer browse.
- Detect and monitor presence of invasive nonnative plants, nonnative plant diseases and pathogens, and forest pests.
- Determine status and trends in forest coarse woody debris and the availability of snags.
- Determine status and trends in soil Calcium:Aluminum and Carbon:Nitrogen ratios to assess the extent of base cation depletion, increased aluminum availability, and/or nitrogen saturation impacting MIDN forest soils.

Basic Approach

The MIDN forest monitoring protocol is derived from the Forest Inventory and Analysis (FIA) approach used by the U.S. Forest Service. Not only is this protocol similar to the FIA approach, it also is directly compatible with other networks and parks in the northeast, national capital, and southeast regions. The protocol consists of permanent plots (20 by 20 meters [m] or approximately 66 by 66 feet) established in forested areas at each of the network parks. Trees and shrubs with diameters greater than or equal to 10 centimeters (cm) (approximately 4 inches) will be identified, measured, mapped, and permanently tagged and marked to ensure their accurate relocation and measurement in subsequent years. Tree condition and canopy health also will be evaluated. Saplings and small shrubs will be monitored in microplots, and twelve 1-square-meter quadrats (approximately 11 square feet) will track changes in seedling regeneration, invasive nonnative plants, and indicator herbaceous cover. Coarse woody debris will be measured along three transects originating in the plot, and a soil sample will be collected to evaluate changes in basic chemistry that can result from acid deposition.

Plots will be randomly located within forested areas at each park to ensure that inferences can be made regarding the condition of the park forested habitat with a high degree of statistical confidence. The number of plots at each park will be related to total forest area represented. Plots will be sampled on a 4-year rotating panel design, with one panel sampled each year at each park. Therefore, one quarter of the plots at a park will be monitored each year so as to detect possible inter-annual variation.

Integration with Current Monitoring

Valley Forge NHP is currently monitoring vegetation in 30 permanent paired plots (fenced and unfenced). Vegetation in the fenced plots (deer exclosures) provides valuable information on the potential forest structure and composition in the absence of deer. Unfenced plots represent forest conditions in the presence of deer. Achieving target values for a variety of metrics that are linked to these plots seems reasonable. Data from these plots will indicate when the structure and composition of the forest reaches a predefined proportion of what is found in the fenced plots. Therefore, the new plots established by MIDN should collect information that allows for comparative analyses, or data collected in the current plots should be modified to meet the standards established by the new plot network. Adjustments appear to be minor based on the current and proposed methods.

Issues Considered for New Plots

Given time and budget considerations, the MIDN estimates that it can complete 75 plots per year throughout the network to reach a total of 300 plots monitored. Allocation across parks in the network will be based on extent of forest to be sampled. Therefore, it is estimated that Valley Forge NHP will have about 28 plots. The ability to detect change will be increased by having more plots across the landscape than fewer, more intensively monitored plots.

Metrics Relevant to Deer Management Success

Deer are directly reducing the regeneration capacity of the forests at Valley Forge NHP through intensive grazing. The forest monitoring should be capable of detecting whether the target deer densities are having a desired effect through forest recovery. Two important components of the forest monitoring plan include measures of seedling and sapling regeneration and cover of herbaceous plants, including invasive nonnative species.

Seedling and Saplings

Stocking rates established by McWilliams et al. (2004) and metrics for determining these rates will be used in the new monitoring plots. MIDN will sample seedlings greater than 5 cm (approximately 2 inches) in height but less than 1 cm (approximately 0.4 inches) diameter breast height (dbh) in twelve 1 square-meter (approximately 11 square feet) quadrats that are spread throughout the plot. MIDN will record the number of live, established tree seedlings by species within the height classes (Table A-1). Weighting factors are applied according to the height class; therefore, one seedling that is greater than 1.5 m (approximately 5 feet) in height is equivalent to 50 seedlings that are 0.05-0.3 m (approximately 0.2-1 foot) in height. The forest will be considered adequately stocked if there is an average of 24 seedlings in the twelve 1-square-meter quadrats (approximately 11 square feet), or about 2 seedlings per 1 square meter. It is likely that natural stocking rates may vary across forest communities. Therefore, the original deer exclosures will be maintained as a measure of the potential seedling density possible, bearing in mind that these exclosures are located only on Mount Misery and Mount Joy.

Table A-1 Height Class Categories for Enumeration of Seedlings

Height Class	Weighting Factor
0.05-0.3 m	1
0.3-1 m	2
1-1.5 m	20
>1.5 m	50

Source: Tierney and Faber-Langendoen 2006, modified from McWilliams et al. 2004.

Herbaceous Vegetation

Sampling of herbaceous vegetation will also be included in the twelve 1-square-meter quadrats. Herbaceous cover, especially nonnative invasive species, will influence the regeneration capacity of tree seedlings. Therefore, being able to directly correlate herbaceous cover to seedling density is an important metric, especially when regeneration rates are low even at low deer densities. Monitoring will focus on indicator species rather than a complete enumeration of herbaceous plants within the quadrats, including invasive nonnative plants, species that are considered to be highly preferred by deer as browse, and those species that are actively avoided by deer (Table A-2). Total herbaceous cover will be included as a metric for each quadrat. Percent cover classes will be assigned as follows: 0, <1, 1-2, 2-5, 5-10, 10-25, 25-50, 50-75, 75-95, and 95-100%.

Table A-2 Preliminary Herbaceous Target Species to be Measured in Twelve 1-square-meter Quadrats

Species	Common Name	Exotic (E) or Native (N)	Comments
Akebia quinata	Five-leaved akebia	E	
Alliaria petiolata	Garlic mustard	E	
Ampelopsis brevipedunculata	Porcelain berry	E	
Berberis thunbergii	Japanese barberry	E	
Celastrus orbiculatus	Oriental bittersweet	E	
Centaurea biebersteinii	Spotted knapweed	E	
Cirsium arvense	Canada thistle	E	
Clematis terniflora	Yam-leaf clematis	E	
Duchesnea indica	Indian strawberry	E	
Euonymus fortunei	Creeping euonumous	E	
Glechoma hederacea	Ground ivy	E	
Hedera helix	English ivy	E	
Hemerocallis fulva	Common daylily	E	
Lespedeza cuneata	Chinese lespedeza	E	Sericea lespedeza
Lonicera japonica	Japanese honeysuckle	E	
Lonicera spp.	Bush honeysuckles	E	
Microstegium vimineum	Japanese stiltgrass	E	
Polygonum cuspidatum	Japanese knotweed	E	
Polygonum perfoliatum	Mile-a-minute	E	
Pueraria montana	Kudzu	E	
Ranunculus ficaria	Lesser celandine	E	
Rosa multiflora	Multi-flora rose	E	
Rubus phoenicolasius	Wineberry	E	
Vinca minor	Periwinkle	E	
*Arisaema triphyllum**	Jack in the pulpit	N	
*Aralia nudicaulis**	Wild sarsaparilla	N	

Table A-2 Preliminary Herbaceous Target Species to be Measured in Twelve 1-square-meter Quadrats (continued)

Species	Common Name	Exotic (E) or Native (N)	Comments
*Eurybia divaricata**	White wood aster	N	
Ferns (not including those below)		N	As a group
Grasses		N	As a group
*Impatiens capensis**	Jewelweed	N	
Lilies		N	As a group
*Medeola virginiana**	Indian cucumber	N	
Orchids		N	As a group
Podophyllum peltatum	Mayapple	N	
Polystichum acrostichoides	Christmas fern	N	
Sedges		N	As a group
Thelypteris noveboracensis	New York fern	N	
Trillium spp.		N	By species
Vaccinium spp.		N	By species
Smilacina racemosa	False Solomon's seal	N	

Source: Schmit and Chojnacky 2007

Monitoring of Forest Understory Vegetation in Fenced and Unfenced Plots

In 1992, staff at Valley Forge NHP implemented a fixed plot monitoring system to evaluate changes in vegetation over time in two large forested areas at Valley Forge NHP. The objectives of this monitoring system are to: 1) describe the existing understory plant community on Mount Misery and Mount Joy in terms of species richness and abundance; and 2) determine changes in abundance and species composition of understory plant communities in fenced and unfenced plots over time.

Thirty vegetation sample sites were randomly located on Mount Misery and Mount Joy (15 in each area). At each sample site, paired plots were established where one plot was fenced to exclude deer, but no other herbivores. The control, or unfenced, plots were located 36.5 m (approximately 120 feet) from the center of the fenced plot in a random direction (except 3 plots were located 10-27.4 m away [approximately 33-90 feet]). Each plot was 2 by 2 meters in size (approximately 7 by 7 feet). Data was collected from fenced and unfenced plots in 1993, 1995, 1998, and 2003 and will continue to be collected approximately every 5 years. Data collected within each vegetation sample plot allows comparison of species diversity, herbaceous cover, and tree seedling density between fenced and unfenced plots. It also promotes identification of trends over time. Most tree, shrub, vine, and herbaceous vegetation were identified to species, although few only to genera. The number of tree seedlings by species was enumerated in all plots. The collection of data related to tree seedlings is currently being modified to be consistent with the FIA and MIDN Forest Health monitoring protocol by including only those seedlings greater than 5 cm (approximately 2 inches) but less than 1 cm dbh (approximately 0.4 inches).

Although monitoring conducted by the MIDN will serve as the primary means of monitoring success of forest regeneration and general recovery of forested plant communities, it is expected that monitoring of the 30 fixed plots will also continue for an undetermined amount of time to facilitate overall data interpretation (See Integration with Current Monitoring above).

Selected Bibliography

Comiskey, J. A., K. K. Callahan, and C. M. Davis
2005 *Mid-Atlantic Network Vitals Signs Monitoring Plan: Phase One. Inventory and Monitoring Program*. National Park Service: Fredericksburg, Virginia.

Conroy, M. J., and J. D. Nichols
1996 "Designing a Study to Assess Mammalian Diversity." In *Measuring and Monitoring Biological Diversity Standard Methods for Mammals*. Washington, DC: Smithsonian Institution Press.

Cypher, B. L., R. H. Yahner, and E. A. Cypher
1985 *Ecology and Management of White-tailed Deer at Valley Forge National Historical* Park. U. S. Dept. of the Interior, National Park Service, Valley Forge National Historical Park. NPS Contract No: 14-16-0009-1548.

Hobbs, N. T., D. C. Bowden, and D. L. Baker
2000 "Effects of Fertility Control on Populations of Ungulates: General, Stage-Structured Models." *Journal of Wildlife Management* 64 (2): 473-91.

Lovallo, M. J., and W. M. Tzilkowski
2003 *Abundance and Movements of White-tailed Deer (Odocoileus Virginianus) within Valley Forge National Historical Park and Surrounding Private Lands.*

McWilliams, W. H., C. A. Alerich, D. A. Devlin, A. J. Lister, T. W. Lister, S. L. Sterner, and J. A. Westfall
2004 *Annual Inventory Report for Pennsylvania's Forests: Results from the First Three Years*. Resource Bulletin NE-159. U.S.D.A. Forest Service, Newtown Square, Pennsylvania.

Schmit, J. P., and D. C. Chojnacky
2007 *National Capital Region Long-Term Forest Monitoring Protocol in the National Capital Region of the National Park Service* (in draft form). National Capital Region Network, National Park Service, Washington, D.C.

Tierney, G., and D. Faber-Langendoen
2006 "Northeast Temperate Network Forest Monitoring Protocols (Version 1.0)." *Northeast Temperate Network*. Philadelphia, PA: National Park Service.

This page intentionally left blank.

Appendix B: Relevant Correspondence

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry

Apr. 18, 2007

Michael A. Caldwell
US Department of the Interior
National Park Service
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

Pennsylvania Natural Diversity Inventory Review, PNDI Number **19036**
White-Tailed Deer Management Plan/Environmental Impact Statement
Valley Forge National Historical Park; Chester & Montgomery Counties

Dear Mr. Caldwell,

This responds to your request for information on species of special concern within the area under evaluation for this project. We screened this project for potential impacts to species and resources of special concern under the Department of Conservation and Natural Resources' responsibility, which includes plants, natural communities, terrestrial invertebrates and geologic features only.

PNDI records indicate that species and communities of special concern under DCNR's jurisdiction are known to occur in the vicinity of the above-mentioned project. **Please see the attached list for species found in the project area. If any earth disturbance is planned or more detailed project information becomes available, please submit this project to our office for further review of potential impacts to the attached species list.**

This response represents the most up-to-date summary of the PNDI data files and is good for one (1) year from the date of this letter. An absence of recorded information does not necessarily imply actual conditions on-site. A field survey of any site may reveal previously unreported populations. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered.

This finding applies to impacts to plants, natural communities, terrestrial invertebrates and geologic features only. To complete your review of state and federally-listed species of special concern, please be sure the U.S. Fish and Wildlife Service, the PA Game Commission and the Fish and Boat Commission has been contacted regarding this project either directly or by performing a search with the online PNDI ER Tool found at www.naturalheritage.state.pa.us.

Rebecca H. Bowen

Rebecca H. Bowen, Environmental Review Specialist, PNHP
DCNR/BOF/PNDI, PO Box 8552, Harrisburg, PA 17105 ~ Ph: 717-772-0258 ~ F: 717-772-0271 ~ c-rbowen@state.pa.us

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry

April 18, 2007

Scientific Name	Common Name	Current Status	Proposed Status	Habitat	Management Suggestions
Andropogon gyrans	Elliott's Beardgrass	Not protected	Rare	Dry or moist fields or open woods	
Cuscuta campestris	Dodder	Not protected	Tentatively undetermined	Thickets and waste ground, parasitic on various hosts	Succession is a threat. Control invasives and reduce deer browse.
Desmodium laevigatum	Smooth Tick-trefoil	Not protected	Tentatively undetermined	Dry, sandy woods and roadsides	
Hypericum hypericoides	St Andrew's-cross	Not protected	Tentatively undetermined	Open woods, banks, thickets and serpentine barrens, in dry sandy soil	Deer browse is a threat.
Lupinus perennis	Lupine	Rare	Rare	Alluvial sand and gravel bars, open fields, woods edges and roadsides in sandy soils	No herbicides or mowing/brush clearing between March and August. Railroad clearance may be beneficial to Lupinus but timing is crucial.
Phaseolus polystachios	Wild Kidney Bean	Not protected	Tentatively undetermined	Woods, roadside banks and waste grounds	Invasives, deer browse and frequent mowing are potential threats.
Rotala ramosior	Tooth-cup	Rare	Rare	Wet, sandy shores and other swampy, open ground	Recommended restriction of basin area to foot trail only. Also control invasives and reduce deer density.

Stewardship Partnership Service

An Equal Opportunity Employer www.dcnr.state.pa.us Printed on Recycled Paper

Stockbridge-Munsee Tribal Historic Preservation Office

Sherry White - Tribal Historic Preservation Officer
N8510 MohHeConNuck Road
P.O. Box 70
Bowler, WI 54416

January 17, 2007

National Park Service
Michael Caldwell
Superintendent
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

RE: White-tailed Deer Management Plan

Dear Mr. Caldwell:

Thank you for contacting the Stockbridge-Munsee Tribe regarding the above referenced project. The Tribe is committed to protecting archaeological sites that are important to tribal heritage, culture and religion. Furthermore, the Tribe is particularly concerned with archaeological sites that may contain human burial remains and associated funerary objects.

As described in your correspondence, the proposed ground disturbing activity of this project does not appear to endanger archaeological sites of interest to the Stockbridge-Munsee Tribe, therefore, the tribe will refer you to your State Archaeologist and your state's Office of Historical Preservation regarding the need for archaeological surveys of further investigation. Should either of these agencies recommend an archaeological survey of the proposed construction site, we ask that the Stockbridge-Munsee Tribe be informed of the results of the survey, including copies of site forms and reports. Also, any changes to the above referenced project should be resubmitted to the Tribal Historical Preservation Officer.

Should this project inadvertently uncover an archaeological site, even after an archaeological survey, we request that you immediately contact the appropriate state agencies, as well as the Stockbridge-Munsee Tribe. Also, we ask that you halt all construction and ground disturbing activities until the Tribe and these state agencies are consulted.

We appreciate your cooperation in contacting the Historic Preservation Office. Should you have any questions, feel free to contact me.

Sincerely,

Sherry White, gi

Sherry White,
Tribal Historic Preservation Officer

(715) 793-3970

Email: sherry.white@mohican-nsn.gov

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, Pennsylvania 16801-4850

January 11, 2007

Michael Caldwell
National Park Service
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

RE: USFWS Project #2007-0613

Dear Mr. Caldwell:

This responds to your letter of December 12, 2006, requesting information about federally listed and proposed endangered and threatened species within the area affected by the proposed White-Tailed Deer Management Plan/Environmental Impact Statement in Chester and Montgomery Counties, Pennsylvania. The following comments are provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species.

The proposed project is within the known range of the bog turtle (*Clemmys muhlenbergii*), a species that is federally listed as threatened. However, based on the information provided and the project scope, project activities are not likely to adversely affect the bog turtle.

This response relates only to endangered and threatened species under our jurisdiction, based on an office and/or field review of the proposed project. Consequently, this letter is not to be construed as addressing potential Service concerns under the Fish and Wildlife Coordination Act or other authorities. A compilation of certain federal status species in Pennsylvania is enclosed for your information.

To avoid potential delays in reviewing your project, please use the above-referenced USFWS project tracking number in any future correspondence regarding this project.

Please contact Pam Shellenberger of my staff at 814-234-4090 if you have any questions regarding this matter.

Sincerely,

David Densmore
Supervisor

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

L76 VAFO(P)

DEC 12 2006

Mr. Justin Newell
Pennsylvania Natural Heritage Program
Pennsylvania Natural Diversity Index
208 Airport Drive
Middletown, PA 17057

Re: White-tailed Deer Management Plan/Environmental Impact Statement
Valley Forge National Historical Park
List of Federally-Listed Rare, Threatened, and Endangered Species

Dear Mr. Newell:

The National Park Service (NPS) proposes to prepare and implement a white-tailed deer management plan/environmental impact statement (EIS) at Valley Forge National Historical Park, in Chester and Montgomery Counties, Pennsylvania. The plan will develop an informed, scientifically based deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources.

This letter serves as notification that we have begun the National Environmental Policy Act (NEPA) compliance process and are proposing to have a Draft EIS available for public and regulatory review late next year. This letter also serves as a record that the NPS is initiating informal consultation with your agency pursuant to the requirements of the 1973 Endangered Species Act, as amended, and *NPS Management Policies 2006*. As part of the scoping for this project, we request any information regarding listed or proposed threatened or endangered species or critical habitats that might occur in the project vicinity, and any special management considerations for such species. The project area includes the entire park and extends 1,325 feet from its borders. It is approximated on the enclosed section of the U.S. Geological Survey topographic map for the vicinity (Valley Forge, Pennsylvania quadrangle).

Additional information on the purpose, need, objectives, and preliminary management alternatives of the plan may be obtained at http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm. If you have any questions, please do not hesitate to contact Kris Heister, Natural

Resource Manager, at the above address, by telephone at (610) 783-1008, or by email at kristina_heister@nps.gov. Your participation in the scoping process for this project is important to us, and we look forward to hearing from you.

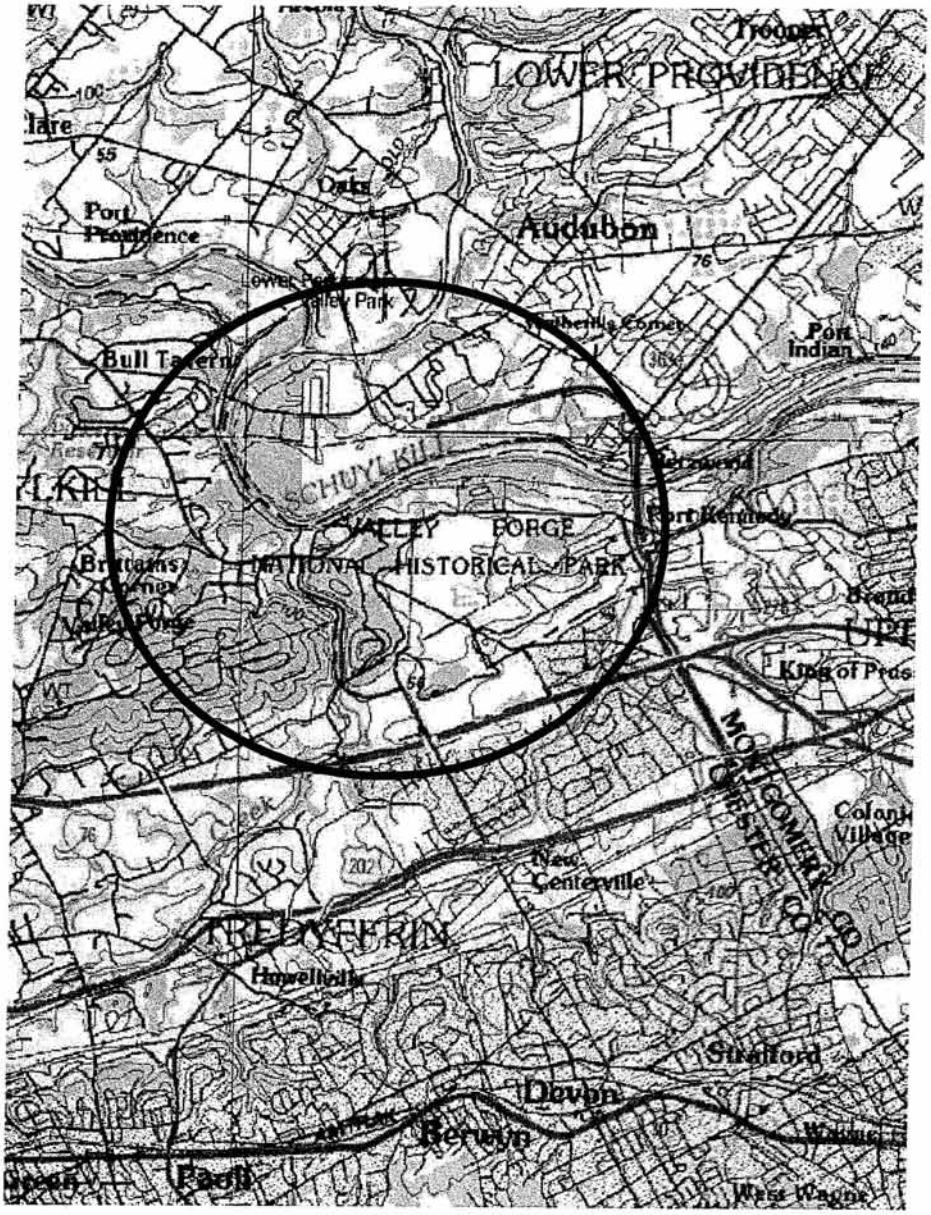
Sincerely,

Michael A Caldwell
Superintendent

Enclosure

cc: Deirdre Gibson, NPS-VAFO
Kris Heister, NPS-VAFO
Tricia Wingard, VHB

Valley Forge, Pennsylvania USGS Quadrangle



United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

L76 VAFO(P)

DEC 12 2006

Ms. Pam Shellenberger
U.S. Fish and Wildlife Service
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, PA 16801-4850

Re: White-tailed Deer Management Plan/Environmental Impact Statement
Valley Forge National Historical Park
List of Federally-Listed Rare, Threatened, and Endangered Species

Dear Ms. Shellenberger:

The National Park Service (NPS) proposes to prepare and implement a white-tailed deer management plan/environmental impact statement (EIS) at Valley Forge National Historical Park, in Chester and Montgomery Counties, Pennsylvania. The plan will develop an informed, scientifically based deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources.

This letter serves as notification that we have begun the National Environmental Policy Act (NEPA) compliance process and are proposing to have a Draft EIS available for public and regulatory review late next year. This letter also serves as a record that the NPS is initiating informal consultation with your agency pursuant to the requirements of the 1973 Endangered Species Act, as amended, and *NPS Management Policies 2006*. As part of the scoping for this project, we request any information regarding listed or proposed threatened or endangered species or critical habitats that might occur in the project vicinity, and any special management considerations for such species. The project area includes the entire park and extends 1,325 feet from its borders. It is approximated on the enclosed section of the U.S. Geological Survey topographic map for the vicinity (Valley Forge, Pennsylvania quadrangle).

Additional information on the purpose, need, objectives, and preliminary management alternatives of the plan may be obtained at http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm. If you have any questions, please do not hesitate to contact Kris Heister, Natural

Resource Manager, at the above address, by telephone at (610) 783-1008, or by email at kristina_heister@nps.gov. Your participation in the scoping process for this project is important to us, and we look forward to hearing from you.

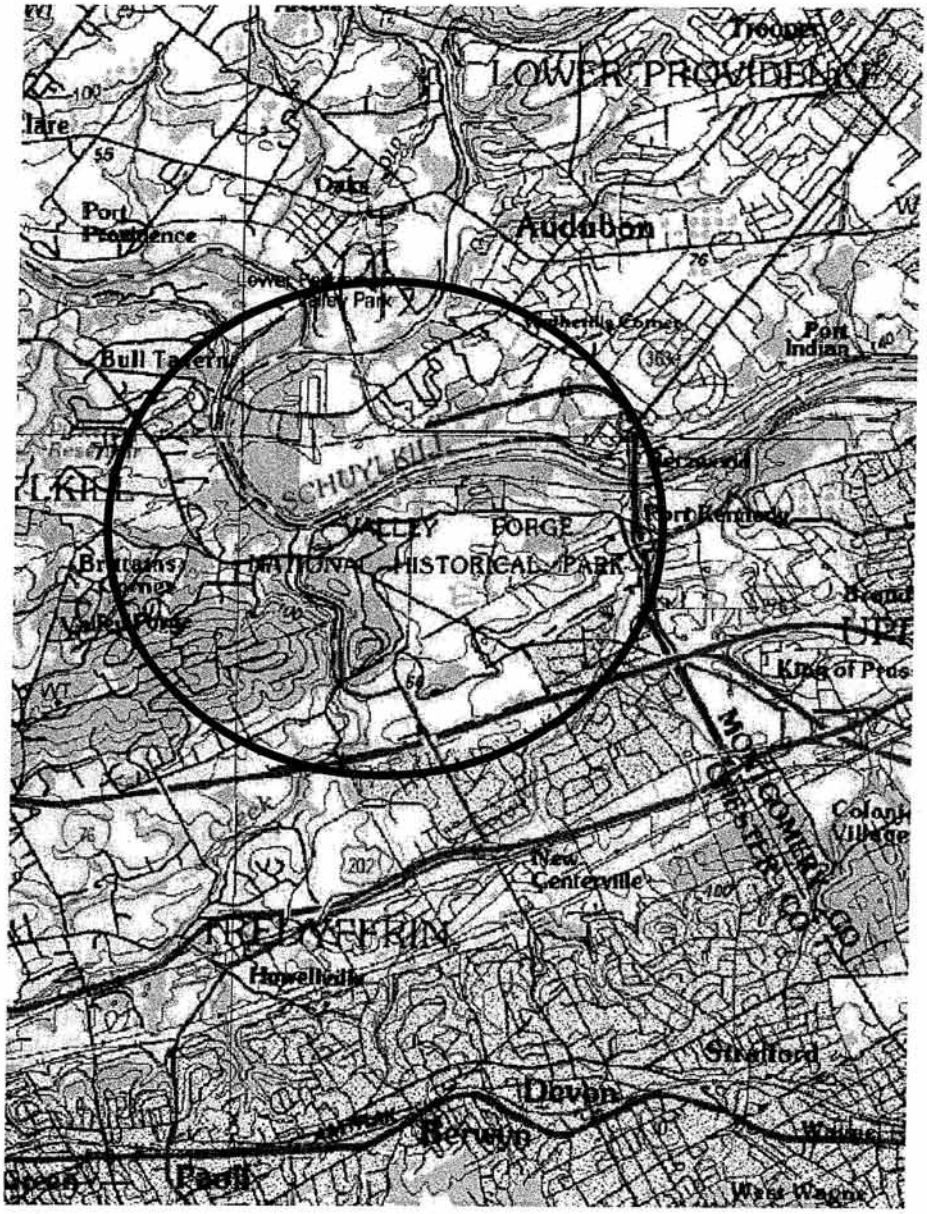
Sincerely,

Michael A. Caldwell
Superintendent

Enclosure

cc: Deirdre Gibson, NPS-VAFO
Kris Heister, NPS-VAFO
Tricia Wingard, VHB

Valley Forge, Pennsylvania USGS Quadrangle



United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

L76 VAFO(P)

DEC 12 2006

Mr. John Fowler
Executive Director
Advisory Council on Historic Preservation
809 Old Post Office Building
1100 Pennsylvania Avenue, NW
Washington, DC 2004

Re: White-tailed Deer Management Plan/Environmental Impact Statement
Valley Forge National Historical Park
Notification of Combination NEPA/Section 106 Compliance

Dear Mr. Fowler:

The National Park Service (NPS) proposes to prepare and implement a white-tailed deer management plan/environmental impact statement (EIS) at Valley Forge National Historical Park, in Chester and Montgomery Counties, Pennsylvania. The plan will develop an informed, scientifically based deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources.

At this stage in the planning process, we are ready to initiate consultation as set forth in 36 CFR 800 and the Programmatic Agreement among the Advisory Council for Historic Preservation, the National Conference of State Historic Preservation Officers, and the NPS. This letter serves as notification that the process and documentation required for compliance with the National Environmental Policy Act (NEPA) will be used to comply with Section 106 of the National Historical Preservation Act of 1966, as amended. We are proposing to have a Draft EIS available for public and regulatory review late next year. The Draft EIS will contain an assessment of effect for all cultural resources potentially affected by the plan.

We appreciate the long and positive working relationship the park has enjoyed with your office and look forward to your participation in this new planning process. Additional information on the purpose, need, objectives, and preliminary management alternatives of the plan may be obtained at http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm. If you have any questions

please contact Kristina Heister, Natural Resource Manager, at the above address, by telephone at 610-783-1008, or by email at kristina_heister@nps.gov. Your participation in the scoping process for this project is important to us, and we look forward to hearing from you.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Deirdre Gibson, NPS-VAFO
Kris Heister, NPS-VAFO
Tricia Wingard, VHB
Barbara Franco, Pennsylvania Historical and Museum Commission

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

L76 VAFO(P)

DEC 12 2006

Ms. Barbara Franco
Executive Director
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North St.
Harrisburg, PA 17120-0093

Re: White-tailed Deer Management Plan/Environmental Impact Statement
Valley Forge National Historical Park
Notification of Combination NEPA/Section 106 Compliance

Dear Ms. Franco:

The National Park Service (NPS) proposes to prepare and implement a white-tailed deer management plan/environmental impact statement (EIS) at Valley Forge National Historical Park, in Chester and Montgomery Counties, Pennsylvania. The plan will develop an informed, scientifically based deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources.

At this stage in the planning process, we are ready to initiate consultation as set forth in 36 CFR 800 and the Programmatic Agreement among the Advisory Council for Historic Preservation, the National Conference of State Historic Preservation Officers, and the NPS. This letter serves as notification that the process and documentation required for compliance with the National Environmental Policy Act (NEPA) will be used to comply with Section 106 of the National Historical Preservation Act of 1966, as amended. We are proposing to have a Draft EIS available for public and regulatory review late next year. The Draft EIS will contain an assessment of effect for all cultural resources potentially affected by the plan.

We appreciate the long and positive working relationship the park has enjoyed with your office and look forward to your participation in this new planning process. Additional information on the purpose, need, objectives, and preliminary management alternatives of the plan may be obtained at http://www.nps.gov/vafo/parkmgmt/white-tailed-deer.htm. If you have any questions

please contact Kristina Heister, Natural Resource Manager, at the above address, by telephone at 610-783-1008, or by email at kristina_heister@nps.gov. Your participation in the scoping process for this project is important to us, and we look forward to hearing from you.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Deirdre Gibson, NPS-VAFO
Kris Heister, NPS-VAFO
Tricia Wingard, VHB
John Fowler, Advisory Council on Historic Preservation

ONEIDA INDIAN NATION

ONEIDA NATION HOMELANDS

November 27, 2006

Deirdre Gibson
Chief of Planning and Natural Resources
U.S. Department of the Interior
National Park Service
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

Dear Ms. Gibson,

Thank you for soliciting Oneida Indian Nation involvement in your White-tailed Deer Management Plan (letter of Nov. 2). The proposed project does not impact anything we know to be culturally or religiously significant and does not threaten any bonds Oneidas feel toward Valley Forge.

We appreciate your courtesy of the invitation and in acknowledging Oneida associations with the park.

Sincerely,

Anthony Wonderley

Anthony Wonderley, Ph.D.
Historian
Oneida Indian Nation
Legal Department
1256 Union Street PO Box 662
Oneida, NY 13421-0662

221 Union Street
PO Box 662 • Oneida, NY 13421-0662
(315) 829-8461 • Fax (315) 829-8473

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

H2217 VAFO(S)

NOV 2 2006

Anthony Wonderley, Ph.D., Nation Historian
Oneida Indian Nation
221 Union Street
Oneida, NY 13421-0662

Dear Dr. Wonderley:

The National Park Service is currently evaluating alternatives for a White-tailed Deer Management Plan for Valley Forge National Historical Park (NHP), and in conjunction, conducting an Environmental Impact Study (EIS) of the proposed alternatives. Valley Forge NHP encompasses 3,452 acres in southeastern Pennsylvania, in a rapidly growing suburban region 18 miles northwest of Philadelphia. The park was established in 1976, with the explicit purpose "to preserve the cultural and natural resources that embody and commemorate the Valley Forge experience and the American Revolution ...". Major issues to be addressed include preservation of native plant and wildlife communities, threatened and endangered species, and significant elements of the cultural landscape.

In recognition of the fact that the Oneida Nation has a traditional association with the park, we would like to initiate the Section 106 process of the National Historic Preservation Act (36 CFR 800.2 (c)(2)(B) (ii)). We are interested in any information you may wish to provide or concerns you may have and whether you are aware of sacred sites within the park.

This letter serves as an invitation to the Oneida Nation to inform us of any features of Valley Forge NHP that may hold cultural or religious significance, and, if so, to initiate consultation regarding the White-tailed Deer Management Plan/EIS. My staff and I here at Valley Forge NHP would like to discuss the management alternatives with the Oneida Nation, if the tribe is interested, so that we may adequately integrate tribal comments, perspectives, concerns, and recommendations into the proposed plan.

We look forward to hearing any thoughts your tribe may have regarding the future planning for management of white-tailed deer and preservation of natural and cultural resources in the park.

If you have any questions or would like additional information, please contact Deirdre Gibson, Chief of Planning and Resource Management, Valley Forge National Historical Park, at 610-783-1047.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Tricia Wingard, VHB

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

H2217 VAFO(S)

NOV 2 2006

Corina Williams, THPO
Oneida Nation of Wisconsin
Cultural Heritage
P.O. Box 365
Oneida, WI 54155

Dear Ms. Williams:

The National Park Service is currently evaluating alternatives for a White-tailed Deer Management Plan for Valley Forge National Historical Park (NHP), and in conjunction, conducting an Environmental Impact Study (EIS) of the proposed alternatives. Valley Forge NHP encompasses 3,452 acres in southeastern Pennsylvania, in a rapidly growing suburban region 18 miles northwest of Philadelphia. The park was established in 1976, with the explicit purpose "to preserve the cultural and natural resources that embody and commemorate the Valley Forge experience and the American Revolution ...". Major issues to be addressed include preservation of native plant and wildlife communities, threatened and endangered species, and significant elements of the cultural landscape.

In recognition of the fact that the Oneida Nation has a traditional association with the park, we would like to initiate the Section 106 process of the National Historic Preservation Act (36 CFR 800.2 (c)(2)(B) (ii)). We are interested in any information you may wish to provide or concerns you may have and whether you are aware of sacred sites within the park.

This letter serves as an invitation to the Oneida Nation to inform us of any features of Valley Forge NHP that may hold cultural or religious significance, and, if so, to initiate consultation regarding the White-tailed Deer Management Plan/EIS. My staff and I here at Valley Forge NHP would like to discuss the management alternatives with the Oneida Nation, if the tribe is interested, so that we may adequately integrate tribal comments, perspectives, concerns, and recommendations into the proposed plan.

We look forward to hearing any thoughts your tribe may have regarding the future planning for management of white-tailed deer and preservation of natural and cultural resources in the park.

If you have any questions or would like additional information, please contact Deirdre Gibson, Chief of Planning and Resource Management, Valley Forge National Historical Park, at 610-783-1047.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Tricia Wingard, VHB

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

H2217 VAFO(S)

NOV 2 2006

Tamara Francis, NAGPRA Director
Delaware Nation, NAGPRA Office
P.O. Box 825
Anadarko, OK 73004

Dear Ms. Francis:

The National Park Service is currently evaluating alternatives for a White-tailed Deer Management Plan for Valley Forge National Historical Park (NHP), and in conjunction, conducting an Environmental Impact Study (EIS) of the proposed alternatives. Valley Forge NHP encompasses 3,452 acres in southeastern Pennsylvania, in a rapidly growing suburban region 18 miles northwest of Philadelphia. The park was established in 1976, with the explicit purpose "to preserve the cultural and natural resources that embody and commemorate the Valley Forge experience and the American Revolution ...". Major issues to be addressed include preservation of native plant and wildlife communities, threatened and endangered species, and significant elements of the cultural landscape.

In recognition of the fact that the park is located within Delaware Nation ancestral homelands, we would like to initiate the Section 106 process of the National Historic Preservation Act (36 CFR 800.2 (c)(2)(B) (ii)). We are interested in any information you may wish to provide or concerns you may have and whether you are aware of sacred sites within the park.

This letter serves as an invitation to the Delaware Nation to inform us of any features of Valley Forge NHP that may hold cultural or religious significance, and, if so, to initiate consultation regarding the White-tailed Deer Management Plan/EIS. My staff and I here at Valley Forge NHP would like to discuss the management alternatives with the Delaware Nation, if the tribe is interested, so that we may adequately integrate tribal comments, perspectives, concerns, and recommendations into the proposed plan.

We look forward to hearing any thoughts your tribe may have regarding the future planning for management of white-tailed deer and preservation of natural and cultural resources in the park.

If you have any questions or would like additional information, please contact Deirdre Gibson, Chief of Planning and Resource Management, Valley Forge National Historical Park, at 610-783-1047.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Tricia Wingard, VHB

United States Department of the Interior

NATIONAL PARK SERVICE
Valley Forge National Historical Park
1400 North Outer Line Drive
King of Prussia, PA 19406-1009

IN REPLY REFER TO:

H2217 VAFO(S)

NOV 2 2006

Sherry White, THPO
Stockbridge-Munsee Community
Historic Preservation Office
N8476 Mo He Con Nuck Rd
Bowler, WI 54416

Dear Ms. White:

The National Park Service is currently evaluating alternatives for a White-tailed Deer Management Plan for Valley Forge National Historical Park (NHP), and in conjunction, conducting an Environmental Impact Study (EIS) of the proposed alternatives. Valley Forge NHP encompasses 3,452 acres in southeastern Pennsylvania, in a rapidly growing suburban region 18 miles northwest of Philadelphia. The park was established in 1976, with the explicit purpose "to preserve the cultural and natural resources that embody and commemorate the Valley Forge experience and the American Revolution ...". Major issues to be addressed include preservation of native plant and wildlife communities, threatened and endangered species, and significant elements of the cultural landscape.

In recognition of the fact that the park is located within Delaware Nation ancestral homelands, we would like to initiate the Section 106 process of the National Historic Preservation Act (36 CFR 800.2 (c)(2)(B) (ii)). We are interested in any information you may wish to provide or concerns you may have and whether you are aware of sacred sites within the park.

This letter serves as an invitation to the Delaware Nation to inform us of any features of Valley Forge NHP that may hold cultural or religious significance, and, if so, to initiate consultation regarding the White-tailed Deer Management Plan/EIS. My staff and I here at Valley Forge NHP would like to discuss the management alternatives with the Delaware Nation, if the tribe is interested, so that we may adequately integrate tribal comments, perspectives, concerns, and recommendations into the proposed plan.

We look forward to hearing any thoughts your tribe may have regarding the future planning for management of white-tailed deer and preservation of natural and cultural resources in the park.

NOV 0 7 2006

If you have any questions or would like additional information, please contact Deirdre Gibson, Chief of Planning and Resource Management, Valley Forge National Historical Park, at 610-783-1047.

Sincerely,

Michael A. Caldwell
Superintendent

cc: Tricia Wingard, VHB

Appendix C: CWD Response Plan for Valley Forge NHP

Introduction

As deer populations increase, risks related to transmission of contagious diseases within these higher density populations are a concern (Joly et al. 2006; Samuel et al. 2003). Chronic wasting disease (CWD) is a fatal, neurological disease that has been identified in free-ranging and captive mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and most recently moose (*Alces alces*). CWD is in the family of diseases known as the transmissible spongiform encephalopathies (TSEs) or prion diseases. Other TSEs include scrapie in sheep, bovine spongiform encephalopathy (BSE) or mad cow disease, and Creutzfeldt-Jakob disease (CJD) in humans. CWD causes brain lesions that result in progressive weight loss, behavioral changes, and eventually death in affected individuals. While much is still unknown about the way this disease spreads among natural hosts, there are indications of the potential for long-term, population-level effects.

Signs of CWD in deer include changes in behavior and body condition. Affected animals can lose their fear of humans, show repetitive movements, or appear depressed but quickly become alert if startled. CWD also results in rapid loss of body condition despite having an appetite. This can lead to affected animals becoming emaciated in the end stages of the disease (NPS 2007c). Once signs of CWD appear, it can vary from a few days to nearly a year until death. In wild populations, however, it is likely that animals late in the clinical stages of the disease live only days. Although the precise origin of CWD will probably never be determined, it is strongly suspected that CWD is a nonnative disease among cervids (NPS 2007c, 2002).

CWD was thought to be isolated to the west and midwest regions of the United States until 2005, when it was confirmed in both New York and West Virginia. Since that time, staff at Valley Forge National Historical Park (NHP) have been tracking the occurrence and detection efforts within Pennsylvania and surrounding states. Natural Resource Management staff also have remained up-to-date on the biology of CWD, management issues surrounding CWD, and development of the Pennsylvania's CWD Response Plan (PCWDTF 2007, 2008). Valley Forge NHP staff also have received training on CWD sampling/testing. In 2007, activities associated with opportunistic and targeted surveillance for CWD were categorically excluded using the appropriate planning process as directed by the National Environmental Policy Act (NEPA) (NPS Director's Order 12, 3.4 E (3) and 3.3 M). This process allowed Valley Forge NHP and other parks to take quick action to initiate CWD surveillance. In 2008, the National Park Service's (NPS) Biological Resource Management Division (BRMD) provided funding to purchase CWD testing supplies to initiate opportunistic and targeted surveillance, as appropriate.

There is currently no evidence that the disease is contagious to humans or domestic livestock; however, significant concerns remain primarily related to the following:

- Ongoing surveillance programs are expensive and draw resources from other wildlife management needs.
- Impacts of CWD on population dynamics of deer and elk are presently unknown. Computer modeling suggests that CWD could substantially reduce infected cervid populations by lowering adult survival rates and destabilizing long-term population dynamics.
- In some areas where it occurs, CWD has already begun to alter the management of wild deer and elk populations.
- Public and agency concerns and perceptions about human health risks associated with all TSE's may erode hunter confidence and their willingness to hunt in areas where CWD occurs (CWD Alliance 2008). In Pennsylvania, deer and deer hunting represent an industry contributing 4.8 billion dollars to the commonwealth's economy (PCWDTF 2007).

Due to the uncertainty associated with the disease, as well as social, economic, and biological threats to the community and the affected species, there is much concern among both the public and scientific communities regarding CWD. To address these concerns, in 2002, the director of the NPS provided a memorandum with the following guidance:

- NPS units should cooperate and coordinate with state agencies regarding CWD response.
- NPS units within 60 miles of where CWD has been detected should initiate targeted and opportunistic surveillance by removing deer with clinical signs of CWD, as well as submitting samples from all deer found dead.
- All translocations of deer in or out of NPS units would be prohibited without extensive CWD surveillance.
- Public outreach should be conducted.
- NEPA should be used as a decision-making tool if other actions for CWD detection or response are being considered (NPS 2002).

One of the objectives of the White-tailed Deer Management Plan/Environmental Impact Statement (plan/EIS) for Valley Forge NHP is to reduce the probability of occurrence, promote early detection, and reduce the probability of spread of CWD. Action is needed at this time to address the elevated risk of CWD, as identified through a CWD risk assessment for Valley Forge NHP, and because of the efficiencies and cost savings associated with incorporating a CWD response plan into the deer management plan. The direct relationship between the plan/EIS objectives, alternatives, and impact analysis and CWD Response Plan goals, response strategies, and environmental impacts make integration both feasible and cost-effective.

Role of the CWD Science Team

As part of the preparation of the park's CWD Response Plan, a team of technical experts was engaged in the discussion of CWD and potential detection and initial response options available to the NPS. The purpose of these discussions was to provide science-based input to the park on issues relevant to CWD detection and response, as well as incorporation of CWD detection and response actions into the

plan/EIS. The team convened via conference calls, meeting three times in June 2008. Topics of discussion included existing conditions surrounding the park; CWD response goals; definitions of terms; approach to establishing implementation thresholds for detection and response; disease transmission; issues related to implementation of various actions; and costs associated with implementation.

The participants in these discussions were limited to persons with scientific background in CWD, deer management and research, and NPS staff. Table C-1 lists the CWD science team participants.

Table C-1 CWD Science Team Members

Name	Title	Organization/Agency
Kristina Heister	Natural Resource Manager	Valley Forge NHP
Madelyn Carpenter	Environmental Quality Specialist	NPS - Environmental Quality Division
Jenny Powers	Wildlife Veterinarian	NPS - BRMD
Mark Graham	Wildlife Biologist	NPS - BRMD
John Karish	Regional Chief Scientist	NPS - Northeast Region
Christopher Rosenberry	Deer Management Section Supervisor	Pennsylvania Game Commission (PGC)
Walter Cottrell	Wildlife Veterinarian	PGC

Definitions

The following terminology was used during the discussion of CWD response for Valley Forge NHP.

Active lethal surveillance. Lethal removal of deer within the park for the purposes of assessing disease prevalence. This action also may minimize the likelihood of CWD becoming established, minimize the likelihood of amplification and spread if the disease is introduced, and may promote elimination of CWD.

Amplification. Increased prevalence of disease within a target population or a region (modified from Samuel et al. 2003).

Cervids. All members of the Cervidae family and hybrids (PCWDTF 2007) including deer, elk, and moose.

Confirmed. Two positive official tests are needed for a confirmed CWD diagnosis (USDA 2006).

Containment. To keep CWD from spreading outside of an area (Samuel et al. 2003).

Containment zone. Defined by the Commonwealth of Pennsylvania as a buffer zone around the 5-mile radius surveillance area established when two or more CWD-positive cases are documented. The buffer area would have a radius at least as large as the surveillance zone radius. State priorities within the containment zone are to contain the disease and reduce the prevalence rate (PCWDTF 2007).

Elimination (aka Eradication). To remove CWD from a target area or population and prevent its reintroduction (Multi-agency Task Force 2002).

Enhanced targeted surveillance. Actions that improve the probability of detecting animals exhibiting clinical signs consistent with CWD and subsequently taking samples for CWD testing from these animals.

Established. When the disease becomes enzootic or when the disease is sustained in a population over a period of time. (Multi-agency Task Force 2002).

Exposure. Contact between the target population and the disease agent. For purposes of this plan, the target population is white-tailed deer.

Opportunistic surveillance. Taking diagnostic samples for CWD testing from cervids found dead or removed through a lethal management action. Cause of death may be culling, disease, trauma (hit by car), or undetermined (NPS 2007c).

Prevalence. The number of disease cases in a population at a designated time without distinction between old and new cases. It is represented by the number of diseased animals divided by the number of susceptible animals (target population) (Powers, pers. comm. 2008) or the total number of cases of a disease in a given location at a specific time (PCWDTF 2007).

Prevention. To maintain a population or an area free from CWD (generally approached by minimizing the risk factors for disease exposure or amplification) (Multi-agency Task Force 2002).

Response. 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.

Spreading. When the 5-mile radius surveillance areas established around individual positive CWD cases expand beyond 10 miles from the index or first case.

Surveillance. Activities related to the detection and monitoring of a disease.

Surveillance area. Defined by the Commonwealth of Pennsylvania as a 5-mile radius established around the first CWD-positive case within which intensive CWD surveillance occurs (PCWDTF 2007).

Target population. For the purposes of this plan, white-tailed deer.

Targeted surveillance. Lethal removal of deer which exhibit clinical signs consistent with CWD (NPS 2007c).

Risk Assessment

As of 2008, the nearest confirmed case of CWD in free-ranging deer was in West Virginia, over 200 miles from Valley Forge NHP. Other states with confirmed CWD cases in free-ranging cervids are Colorado, Illinois, Kansas, Nebraska, New Mexico, New York, South Dakota, Wisconsin, Utah, and Wyoming (PCWDTF 2007). Additionally, the nearest confirmed case of CWD in captive populations was in New

York. No cases of CWD have been confirmed in Pennsylvania; however, the entire state is considered to be at high risk due to the presence of CWD in an adjacent state (PCWDTF 2007).

Risk factors are attributes of the landscape, environment, or host animals that increase the probability of CWD occurring in a given region or cervid population. By evaluating risk factors, wildlife managers can attempt to predict the population(s) most likely to be affected by CWD. There are two categories of risk factors:

- Exposure – the likelihood that the CWD agent will be introduced into a given population
- Amplification – the risk of increasing the prevalence of the disease once a population has been exposed (NPS 2007c)

Based on the risk factors described in Table C-2, Valley Forge NHP is considered to be at high risk for exposure to and amplification of CWD. If these risk factors could be adequately minimized, the probability of disease introduction into the park's deer population, disease spread within the park or to deer outside the park boundary, and increased prevalence of the disease should it become established, may be lowered. However, many of these risk factors, particularly those related to exposure, are outside the control of the park. The Valley Forge NHP CWD response relies on the policies and actions of the PGC and the Pennsylvania Department of Agriculture (PDA) to minimize the risk of exposure to CWD. Current policy and actions by the PGC and PDA to minimize exposure of deer to CWD include:

- Establishment of an interagency CWD task force to implement a communication/education strategy for state employees, the public, and other stakeholders (e.g., taxidermists, hunters, landfill operators) providing up-to-date information about CWD (risk, symptoms, biosecurity, scientifically acceptable waste disposal methods, feeding of wild cervids).
- Initiation of mandatory CWD herd certification and monitoring programs for the farmed cervid industry.
- Establishment of importation requirements for live cervids, including participation in a recognized CWD herd certification program for at least three years if from a CWD-free state or province, and at least five years if from a state or province known to have CWD.
- Establishment of importation prohibitions for high-risk cervid parts to reduce the likelihood of CWD contaminated materials ending up in the environment of free-ranging or farmed cervids.
- Implementation of opportunistic surveillance for CWD. Opportunistic surveillance requires testing of representative samples of apparently healthy cervids acquired through normal hunting seasons or as a result of deer-vehicle collisions. As of May 2008, approximately 18,070 deer and 260 elk have been tested by the PGC. No cervids tested positive for CWD (Cottrell, pers. comm. 2008a).

Table C-2 Known or Suspected CWD Risk Factors Identified for Valley Forge NHP

Type of Risk	Risk Factor	Source[a]	Valley Forge NHP
Exposure	Areas adjacent to CWD-positive wildlife	PA	Since 2005, CWD has spread from the Midwest to New York and West Virginia, states adjacent to Pennsylvania. The nearest known case is 200 miles from the park.
	Areas adjacent to land on which CWD-positive animals have lived; Distance to nearest CWD-positive free-ranging deer and/or captive deer or elk facility	PA/NPS	Pennsylvania borders two states (NY, WV) with a history of CWD. The Pennsylvania farmed cervid industry has expanded significantly in recent years. Within Chester and Montgomery Counties (counties which include portions of the park), there are 22 captive cervid facilities. Neighboring Lancaster County contains the greatest number of captive deer facilities in the state (101 facilities) (PCWDTF 2007). None have tested CWD-positive.
	Areas that have received translocated deer or elk from CWD-affected regions; Nearest area with translocated deer or elk, both captive and free-ranging	PA/NPS	The Pennsylvania farmed cervid industry has expanded significantly in recent years. Within Chester and Montgomery Counties (counties which include portions of the park), there are 22 captive cervid facilities. Neighboring Lancaster County contains the greatest number of captive deer facilities in the state (101 facilities) (PCWDTF 2007). It is known that in 2007, at least 9 deer were imported from CWD-affected areas of Wisconsin into Lancaster County captive deer herds (Cottrell, pers. comm. 2008a).
	Areas permitting transport of hunter-killed elk or deer carcasses from areas infected with CWD	PA	Not applicable; PGC has established importation prohibitions for high-risk cervid parts to reduce the likelihood of CWD-contaminated materials ending up in the environment of free-ranging or farmed cervids.
	Rate of immigration/emigration of deer in the area	NPS	Although rates of immigration and emigration at Valley Forge NHP are unknown, assessment of home range and movement relative to the park boundary provides insight. The majority (80%) of female deer at Valley Forge NHP spend more than 50% of their time within the park boundary. They travel, on average, 401 feet from the park boundary. Deer that spend less than 50% of their time in the park travel, on average, 1,325 feet from the boundary. Boundary crossings by deer are most frequent along the southeastern, southwestern, and northwestern park boundaries (Lovallo and Tzilkowski 2003).
Amplification	Areas with high elk or deer population density	PA/NPS	Deer density at Valley Forge NHP was 193 deer per square mile in 2007. The best available data on deer density in areas surrounding the park indicates an average deer density of 29 deer per square mile between 2001 and 2008 (ranging from 8 to 45 deer per square mile).
	Areas with a history of CWD animals or CWD-contaminated environments	PA/NPS	Not applicable.
	Areas with low abundance of large predators	PA/NPS	There are no large predators or recreational hunting within Valley Forge NHP.
	Areas where free-ranging elk or deer are artificially concentrated (baiting, feeding, water development, refuge, and other human related habitat modifications)	PA/NPS	Deer at Valley Forge NHP are concentrated due to human related habitat modifications outside the park, lack of natural predators, and creation of ideal deer habitat within the park.

a Source refers to risk factors identified and defined by *Pennsylvania's Chronic Wasting Disease Response Plan* (PCWDTF 2007) and the *NPS Reference Notebook to Understanding Chronic Wasting Disease* (2007c).

CWD Response Goals

The goals of the CWD Response Plan at Valley Forge NHP are:

- Determine the ongoing risk of CWD infection in the white-tailed deer population at Valley Forge NHP based on known disease risk factors.
- Develop adaptive management protocols for the detection of CWD presence, prevalence, and distribution, as well as response to the disease based on the proximity of a confirmed case of CWD to the park boundary and proximity of the park to a state-established CWD containment zone.
- Cooperate and coordinate with state wildlife and agricultural agencies to promote 99% confidence of detecting the disease if it is present in the area at a prevalence of at least 1% and respond to positive or confirmed cases. It is assumed that data from both state and federal lands would be pooled to achieve a sample size sufficient to ensure a high level of confidence in detection of CWD, if it is present, and assess prevalence if CWD is confirmed.
- Minimize the likelihood of CWD becoming established within the park's deer population, and if CWD becomes established, minimize the likelihood of amplification and spread and promote elimination of CWD, if possible, from the park or state-established CWD containment zone.
- Promote communication with state wildlife and agricultural agencies, other stakeholders, and the public to ensure timely distribution of accurate information related to CWD and associated management actions.

Thresholds for Response

CWD response includes disease surveillance (detection) actions, actions to assess disease prevalence and distribution, actions to minimize the likelihood of spread to surrounding communities and amplification within local deer populations, and if possible, actions to promote elimination of CWD. Response to a confirmed case of CWD would be defined by the distance of the case from the park boundary and location of the park relative to a state-established CWD containment zone. Three implementation zones have been established, reflecting established thresholds for increasing CWD response (Figure C-1). Although thresholds are based on confirmation of CWD outside the park boundary, CWD response actions associated with each implementation zone would only occur within the park boundary. The three CWD response thresholds for the park are:

Zone 3 Closest confirmed case of CWD is more than 60 miles from the park boundary

Zone 2 Closest confirmed case of CWD is less than or equal to 60 miles but more than 5 miles from the park boundary and the park is not within a state-established CWD containment zone

Zone 1 Closest confirmed case of CWD is less than or equal to 5 miles from the park boundary or the park falls within a state-established CWD containment zone



Figure C-1 CWD Implementation Zones at Valley Forge NHP

Note: Not to scale

Implementation Zones 3 and 2 were determined based on current NPS guidance (NPS 2002, 2007c). Implementation Zone 1 is based on the maximum distance female deer within the park are known to travel (Lovallo and Tzilkowski 2003), the average male dispersal distance within the Ridge and Valley Province of Pennsylvania, and is consistent with the 5-mile radius surveillance and containment zones established in the PA CWD Response Plan (PCWDTF 2007). Evaluation of deer movements relative to the park boundary between 1997 and 1999 indicated the maximum distance female deer traveled from the park boundary was 1.23 miles (6,512 feet), and 5 miles is expected to contain most doe movements. The PGC also evaluated dispersal distance and dispersal rate for male deer across the state between 2002 and 2003. Average dispersal distance of young males, in areas similar to Valley Forge NHP, was 4.35 miles (Long et al. 2005). Therefore, a 5-mile boundary was selected for Zone 1. All actions would be closely coordinated with the PGC and PDA due to the scale of the area identified as necessary to address CWD (minimum of 79 square miles) relative to park size (5.3 square miles). A summary of response actions associated with the implementation zones is provided in Table C-3.

Table C-3 Actions Associated with CWD Response Based on Established Implementation Zones at Valley Forge NHP

Implementation Zone	Opportunistic Surveillance	Targeted Surveillance	Enhanced Targeted Surveillance	Test and Cull[a]	Active Lethal Surveillance[b]	Coordination with PGC and PDA
Zone 3	X					X
Zone 2	X	X				X
Zone 1	X	X	X	X	X	X

a To be implemented only under the combined nonlethal deer management alternative (Alternative B) described in the plan/EIS.

b To be implemented only under deer management alternatives that include lethal actions (Alternatives C and D), as described in the plan/EIS.

Inclusion of the park (or portions thereof) within a state-established containment zone as an element of the response threshold for Zone 1 is based on the CWD science team recommendation that the park become part of the state's actions once a containment area has been established, regardless of proximity of the confirmed case to the park boundary. Overall, CWD response within the park would represent one component of the broad-scale, long-term CWD management effort by the state. This plan also assumes that CWD is likely present within the park if the Zone 1 threshold is reached.

Implementation Zone 3

If a case of CWD was confirmed more than 60 miles from the park boundary (i.e., within a state bordering Pennsylvania), the park would follow NPS recommendations (NPS 2002, 2007c) and continue to conduct opportunistic surveillance for the presence of CWD within the park. Opportunistic surveillance involves taking diagnostic samples for testing from deer found dead or removed through a park management activity. Opportunistic surveillance has little, if any, adverse impact on current populations. This action is consistent with "active surveillance" described in *Pennsylvania's Chronic Wasting Disease Management Plan* (PCWDTF 2007).

A standard operating procedure for identifying and removing appropriate tissue samples for testing would be developed along with training of park staff to implement this action. This protocol would follow CWD surveillance guidance for Valley Forge NHP (i.e., sample collection, storage, and submission; safe handling procedures; shipping; etc.) and training provided by the NPS-BRMD (NPS 2007c). Tissue samples would be tested by the NPS-BRMD or at the New Bolton Center, University of Pennsylvania's veterinary diagnostics laboratory. The only other laboratory certified by the U.S. Department of Agriculture (USDA) to test deer and elk tissues for the presence of CWD in Pennsylvania is the Pennsylvania Veterinary Laboratory in Harrisburg, Pennsylvania. It is estimated that up to three weeks may be required to complete CWD testing regardless of the service provider.

It is assumed that animals killed in collisions with vehicles may be a biased sample that is likely to be a more sensitive measure for identifying animals carrying the disease. Based on an average of 87 deer-vehicle collisions reported annually between 1997 and 2007, it is estimated that a minimum of 51 deer (5% of total park deer population estimate of 1,023 individuals) would be tested annually. The number of deer tested may be limited by use of a contractor to remove dead deer from park

roadways, need to euthanize some animals due to injury (possible head shots), and condition of some road-killed deer. Sample size also may vary depending on selection of the preferred deer management strategy. The park also would continue to coordinate with the PGC and/or agricultural agencies regarding surveillance methods and results.

Activities included in Zone 3 were categorically excluded using the appropriate NEPA process in 2007, and therefore are included under all deer management alternatives, including the no-action alternative (Alternative A) in the plan/EIS.

Implementation Zone 2

If a case of CWD was confirmed between 5 and 60 miles of the park boundary and the park did not fall within a state-established CWD containment zone, Valley Forge NHP would continue to implement opportunistic surveillance, as described above. Additional actions would include training of NPS employees, volunteers, and others to recognize and report deer exhibiting clinical signs of CWD, monitoring for deer exhibiting clinical signs, and implementing targeted surveillance consistent with NPS guidance (NPS 2007c). Monitoring would consist of visual surveys for deer exhibiting clinical signs of CWD conducted by park staff and volunteers during their daily work activities, which often involve travel throughout the park or direct interaction with deer (e.g., deer counts, deer-vehicle collision response). Targeted surveillance has negligible adverse effects on the entire population, removes a potential source of CWD infection, and is an efficient means of detecting new centers of infection (Miller et al. 2000). One limitation to targeted surveillance is that clinically affected animals presumably shed infectious prions before they are visibly ill. Thus, environmental contamination and direct transmission may occur before the animal is removed (NPS 2007c). The park would develop standard operating procedures to implement these actions. This action is consistent with "targeted surveillance" described in Pennsylvania's CWD management plan (PCWDTF 2007).

Increased coordination with the PGC and PDA would be initiated to pool samples to reach the desired detection level and to monitor and evaluate changes in CWD risk to the park. The desired detection level established in the state CWD management plan is 99% confidence in detecting CWD if it is present at a prevalence of at least 1%. Targeted surveillance may reduce the sample size required to achieve the desired level of detection as evidenced by the fact that nearly half of the CWD-positive populations in Colorado have been detected using this method (Conner, Krumm, and Miller 2005). It is estimated that the number of deer tested through targeted surveillance would vary depending on the number of deer exhibiting clinical signs of CWD and selection of the preferred deer management strategy in the plan/EIS.

Implementation Zone 1

If a confirmed CWD case occurs within 5 miles of the park boundary or the park (or a portion of the park) falls within a state-established containment zone, activities described under Zones 2 and 3 above would continue within the park. Once this threshold is reached, it is assumed that CWD is likely within the park.

Under all deer management alternatives in the plan/EIS, including Alternative A (no-action), additional actions triggered by Zone 1 would include enhanced targeted surveillance in the form of dedicated staff and volunteer time to monitor the park

deer population for clinical signs of CWD on a regular basis. Under Alternative B (combined nonlethal actions), live testing and culling of CWD-positive deer would be implemented. Under deer management alternatives that include lethal actions (Alternatives C and D), the park would initiate a rapid reduction of the deer population to quickly achieve the target deer density. This may include a one-time reduction of the population for the purposes of disease response. All actions would be conducted in cooperation with the state to ensure a coordinated response. The NPS would contribute all deer obtained through surveillance and response activities to the state sampling effort to assess prevalence and distribution.

Test and Cull

Under the combined nonlethal deer management alternative (Alternative B) in the plan/EIS, a test and cull approach would be used to enhance CWD detection and monitoring efforts. The technique requires capture, general anesthesia, training in biopsy techniques, and the ability to test large proportions of the population (NPS 2007c). Tonsillar biopsy has been used in limited situations to test deer and cull CWD-positive members of the population (NPS 2007c; Wolfe, Miller, and Williams 2004). Initial treatment of deer with a reproductive control agent, under Alternative B in the plan/EIS, requires capture for the purpose of marking individuals as "treated." Therefore, a test and cull approach is considered reasonable with minimal additional effort. Training on tonsillar biopsy techniques and appropriate handling and storage of tissue samples would be provided by the NPS BRMD.

Animals would be individually marked to ensure CWD-positive animals could be relocated, and radio collars may be used to facilitate relocation of individuals that have moved outside the park. CWD-positive animals would be removed from the population by qualified federal or state employees or contractors. The number of animals to be tested annually would be expected to be the same as the number initially treated with a reproductive control agent under Alternative B in the plan/EIS.

Limitations of this approach include the fact that animals initially captured and marked as "treated" with a reproductive control agent would not be anesthetized and handled for subsequent reproductive control treatments (delivered remotely). These individuals would be excluded from CWD testing after the first year, which may result in large variations in sample size over time. Additionally, reproductive control, as described under Alternative B in the plan/EIS, excludes male deer from the surveillance effort. Dispersal of male deer may be one of the primary means of CWD spread. Variation in sample size and exclusion of male deer from the sampling effort may increase the potential of failing to detect the disease if it is present.

Active Lethal Surveillance

The term active lethal surveillance refers to lethal removal of deer within the park for the purposes of assessing disease presence, prevalence, and distribution. These actions may also minimize the likelihood of CWD becoming established, minimize the likelihood of amplification and spread if the disease is introduced, and promote elimination of CWD, if possible. Specific actions associated with active lethal surveillance are rapid reduction of the deer population to achieve the initial target deer density (31-35 deer per square mile) and a one-time reduction in population to a density consistent with the surrounding environment but not less than 10 deer per square mile.

NPS guidance suggests reducing population numbers as an appropriate management tool when population density is above that identified in park management plans and/or the need to know CWD prevalence with a high degree of accuracy is necessary (NPS 2007c). Use of population reduction as a method for controlling disease in wildlife is based on the premise that infectious disease is a density-dependent process (Wobeser 1994). In captive situations, where animal density is high, the prevalence of CWD can be substantially elevated compared to that seen in free-ranging situations. The rate of disease transmission depends on factors such as contact rate among deer, total number of deer, and the number of infected deer (WDNR 2003). Thus it is hypothesized that increased animal density and increased animal-to-animal contact enhances the transmission and spread of CWD. Decreasing animal densities may decrease the transmission and incidence of the disease (NPS 2007c). The success of using population reduction, as a method for controlling disease, is directly related to early detection, response time, and the intensity, consistency, and duration of the control effort (WDNR 2003). This method may be more effective in managing isolated areas of disease than when disease is widely distributed. Therefore, removal efforts are considered most appropriate in situations focused on intensive control of smaller areas.

Rapid Reduction to Initial Target Deer Density

Alternative C (combined lethal actions) and Alternative D (combined lethal and nonlethal actions) in the plan/EIS involve the lethal removal of deer within the park boundary. Under these alternatives, active lethal surveillance would allow for a more rapid reduction of the deer population to achieve the initial deer density goal of 31-35 individuals per square mile. It is expected that this action would result in achieving this density twice as fast as population reduction would occur as described under Alternatives C and D in the plan/EIS. Achieving the initial deer density goal more quickly would minimize the probability of amplification within local deer populations and reduce the probability of spread to other deer populations. Data collected by NPS staff during spring deer counts indicate that the average deer density outside the park boundary between 2001 and 2008 was 29 deer per square mile. A deer density of 31-35 deer per square mile is considered appropriate as an initial target related to CWD, as well as in the plan/EIS, because it is consistent with deer density in the surrounding community and therefore, is not likely to create a refuge for deer or their associated diseases. This number also is consistent with recommendations in the scientific literature related to appropriate deer density to ensure adequate forest regeneration, which range from 10-40 deer per square mile.

Rapid reduction actions would be carried out as described under Alternative C (combined lethal actions) of the plan/EIS. However, testing for CWD would necessitate targeting the body rather than the head for removal efforts. With training, head shots may be taken and still preserve tissues needed for CWD testing (Cottrell, pers. comm. 2008b). Sharpshooting activities would initially target areas immediately surrounding the positive case to ensure removal of animals that have been in contact with CWD animals and potentially decrease local prevalence of CWD. Areas where deer movements across the park boundary into surrounding communities are frequent (southeastern, southwestern, and northwestern boundaries) and areas with high concentrations of deer (central and southwestern areas) may also be targeted for removal activities to reduce the probability of spread and promote elimination of the disease, if possible. During initial removal efforts, both male and female adult deer would be targeted due to the increased probability of infection in older animals and the spread potential posed by males. Additional removals in the first two years of the action would be based on available staffing and resources. This action is consistent with the Level 1 response described in Pennsylvania's CWD response plan (PCWDTF 2007).

To achieve the initial deer density goal of 31-35 deer per square mile in half the time proposed under Alternatives C and D, it is estimated that 550 deer would need to be removed in year 1 and 475 deer would need to be removed in year 2. This assumes the 2007 population size of 1,023 deer. The planned removals are outlined below.

- Years One and Two -- The population model estimated that between 475 and 550 deer would need to be removed annually for the first two years. This would reduce the deer population to an estimated 170 by the end of the second year (32 deer per square mile). This would result in the deer density goal being achieved.
- Subsequent Years - The population model estimated removal of 35-40 animals on an annual basis to maintain a population density of 31-35 deer per square mile.

One-time Reduction Action

In addition to the rapid reduction of the park's deer population to the target deer density, Zone 1 response could include a one-time reduction action to not less than 10 deer per square mile. Implementation of a one-time reduction of the deer population to not less than 10 deer per square mile would be based on the state's success in reducing deer populations within the CWD containment zone outside the park boundary. The NPS would not want to reduce the number of deer within the park to a density far below that outside the park because it may increase the likelihood of potentially infected deer repopulating the park from surrounding areas. However, the NPS also would not maintain a deer density significantly higher than that in surrounding communities, because that may increase the likelihood of disease amplification and spread into the park. To ensure that neither of these situations occurred, the park would work cooperatively with the state to address CWD as the state works to achieve a population density lower than 31-35 deer per square mile in areas surrounding the park. The one-time reduction action promotes the park's ability to provide CWD response commensurate with state actions in the areas surrounding the park and to contribute to CWD management efforts taking place at a broader scale. A deer density of 10 deer per square mile is considered appropriate as a lower limit for this action because it is consistent with recommendations in the scientific literature related to appropriate deer density to ensure adequate forest regeneration, which range from 10-40 deer per square mile. It is also consistent with the stated objective of the plan/EIS to maintain a deer population in the park. The action would be carried out as described above under rapid reduction to initial target deer density. Additional removals that are part of the one-time reduction would be based on available staffing and resources and may take more than one year to achieve.

All deer removed in the one-time reduction action would be tested for the presence of CWD, and samples from both the NPS and state would be pooled. It is assumed that an adequate number of samples would be available when samples collected within the park are combined with state samples to reach the state's desired detection/prevalence level without having a significant impact on the park deer population. If additional positive cases were not found within the CWD containment zone, the park would continue the monitoring described for Zone 2 above for a period of time consistent with current knowledge of the environmental persistence of CWD infectious agents and continue to contribute to the CWD monitoring efforts of the state.

If additional positive cases are detected, assuming the park has achieved its initial deer density goal or successfully implemented a one-time reduction for the purposes of disease response, the NPS would continue to contribute all deer obtained through opportunistic, targeted, and enhanced targeted surveillance, as well as those obtained

through deer management actions, to the state sampling effort. If Alternative B in the plan/EIS was implemented, live testing and culling of CWD-positive deer from the park would continue.

Relationship to White-tailed Deer Management Plan Alternatives

All deer management alternatives (A, B, C, and D) described in the plan/EIS include opportunistic, targeted, and enhanced targeted CWD surveillance. Surveillance actions described for Implementation Zones 2 and 3 would be implemented under any of the deer management alternatives, based on proximity of the nearest confirmed case of CWD to the park boundary and proximity of the park to a state-established containment zone. Live testing and culling of CWD-positive animals is included as a surveillance technique within Implementation Zone 1 under Alternative B (combined nonlethal actions) in the plan/EIS. Active lethal surveillance is included as a surveillance and response technique within Implementation Zone 1 under Alternative C (combined lethal actions) and Alternative D (combined lethal and nonlethal actions).

Active lethal CWD surveillance is only included in alternatives in the plan/EIS that include lethal reduction methods (Alternatives C and D). Alternative A (no-action) and Alternative B (combined nonlethal actions) described in the plan/EIS do not allow for lethal surveillance methods. Excluding active lethal surveillance may be an appropriate action if the threat of CWD was low and there were very limited resources to dedicate to disease recognition. The consequences of excluding active lethal surveillance under Alternative B include potentially failing to detect the disease if it is present, and the inability to work with neighboring land management agencies in assessing, understanding, and controlling the disease (NPS 2007c). However, to maintain consistency with public input, park staff felt it was important to provide one completely nonlethal management alternative outside of the no-action alternative.

Active lethal surveillance would be implemented in Zone 1 only if the combined lethal action (Alternative C) or combined lethal and nonlethal actions (Alternative D) is selected as the NPS preferred management alternative in the plan/EIS. If one of the lethal alternatives proposed in this plan/EIS is implemented (Alternative C or D) and CWD is detected within the park, the same lethal removal methods described in the alternative would be used to address CWD management. Details of implementation could change slightly as described above under Zone 1. If Alternative C is the preferred alternative, then population maintenance at the target deer density would continue to be implemented using lethal reduction methods such as sharpshooting and capture and euthanasia (if appropriate). If Alternative D is the preferred alternative, then population maintenance would be implemented using lethal reduction methods until CWD surveillance, 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 is available, the park would implement reproductive control methods for population maintenance as described in the alternative.

Predator reintroduction (wolf predation as a stewardship tool) and depopulation were the only management options provided by NPS guidance (NPS 2007c) that were not considered in development of the CWD management approach at Valley Forge NHP. Predator reintroduction was considered but dismissed as a deer management strategy in the plan/EIS and thus was not considered an appropriate

tool for CWD management. Depopulation was dismissed because it is inconsistent with the stated objective of the plan/EIS to maintain a white-tailed deer population within the park. A summary of CWD management actions associated with deer management alternatives described in the plan/EIS is provided in Table C-4.

Table C-4 Relationship between CWD Surveillance and Response Actions and Deer Management Strategies Described in the Plan/EIS

Alternative	Opportunistic Surveillance[a]	Targeted Surveillance[a]	Enhanced Targeted Surveillance	Test and Cull	Active Lethal Surveillance	Coordination with State Agencies
Alternative A (No Action)	X	X	X			X
Alternative B (Combined Nonlethal Actions)	X	X	X	X		X
Alternative C (Combined Lethal Actions)	X	X	X		X	X
Alternative D (Combined Lethal and Nonlethal Actions)	X	X	X		X	X
Implementation Zone	Zone 3	Zone 2	Zone 1			All actions, across implementation zones, would be closely coordinated with the PGC and PDA due to the scale of management identified as necessary to address CWD (minimum 79 square miles) relative to park size (5.3 square miles)
Implementation Threshold Description	Confirmed case of CWD more than 60 miles from park boundary	Confirmed case of CWD within 60 miles but greater than 5 miles from park boundary; park does not fall within a state containment zone	Confirmed case of CWD within 5 miles of park boundary or park falls within a state-established CWD containment zone			

a Actions are cumulative. Therefore, once opportunistic sampling is initiated in Zone 3, it continues to be implemented in Zones 2 and 1. Once targeted surveillance is implemented in Zone 2, it continues to be implemented in Zone 3.

Disposal

Recommendations for disposal of CWD-infected deer are based upon guidance provided through the NPS Public Health Program (NPS 2006), the Pennsylvania CWD response plan (PCWDTF 2008a), and recommendations provided by the CWD science team. Currently, no scientific evidence exists linking the consumption of meat from deer or elk in areas with historic CWD to human disease. However, due to the lack of knowledge surrounding CWD disease ecology, proposed disposal options preclude donation of CWD-positive deer for human consumption.

Implementation Zone 3

As long as there were no confirmed cases of CWD within a 60-mile radius of the park, carcass disposal would continue as described under all deer management alternatives in the plan/EIS. These methods include landfilling, surface disposal, and donation of meat to food pantries.

Implementation Zones 2 and 1

If the presence of CWD is confirmed within Implementation Zones 2 or 1, then carcass disposal would occur in accordance with NPS Public Health Program guidelines for donation of meat from an "Area Affected by CWD" for the purpose of human consumption (NPS 2006). These guidelines require that those persons actually consuming the meat be fully informed and take full responsibility for any long-term unanticipated effects of eating meat from animals coming from a CWD-affected area. Donation of meat to food pantries would likely prohibit the park from being able to obtain informed consent from final consumers. This precludes the park from considering this as a disposal option within Implementation Zone 2. If a CWD-positive deer is confirmed within Zone 1, these guidelines clearly preclude the donation of meat to food pantries, soup kitchens, or any entity that intends to redistribute the meat (NPS 2006).

Within Implementation Zones 2 and 1, disposal of carcasses would follow guidelines provided by the Pennsylvania CWD response plan (PCWDTF 2007). It is acknowledged that guidelines provided by the commonwealth's plan are considered preliminary and are expected to be more fully developed over time. Developing science is expected to dictate the disposal of CWD-positive deer in Pennsylvania. Park staff would remain in close contact with appropriate state agencies regarding disposal of CWD-positive deer and integration of the park and state approach to carcass disposal.

Landfilling

The Pennsylvania CWD response plan (PCWDTF 2007) identifies three disposal methods appropriate for CWD-positive carcasses: landfilling, incineration, and tissue digestion. These methods are consistent with recommendations provided by the CWD science team. Disposal of carcasses at a landfill is preferred, with landfilling occurring at a site which meets modern sanitary landfill standards, such as engineered liners, caps, and leachate and gas collection systems. This disposal option is suggested as the most cost effective and most capable of handling large numbers of animals. A disadvantage to landfilling is while it is generally considered effective at containing the prions, this method of disposal does not immediately destroy the prion. It is expected that the prions in the landfill would degrade over time, but it is not known how long it would take to completely inactivate all prions (PCWDTF 2007).

A standard operating procedure would be developed to address procedures such as delivery, covering, and placement in relation to the leachate collection system. Currently, the state has not initiated discussions with landfill operators regarding disposal of CWD-positive deer. If landfills are unwilling to accept CWD-positive deer, then it would be necessary to store carcasses until test results were available. Only carcasses that test negative for CWD would be disposed of via landfilling.

Storage of carcasses would occur through use of a refrigerated box car or truck, capable of storing at least 100 deer for up to 3 months. The box car or truck would be located within a secured area at the park maintenance yard. Under all

management alternatives in the plan/EIS, deer carcasses would be tagged with a unique identifying mark to facilitate tracking of test results. Under alternatives that include lethal removal (Alternatives C and D), deer would be processed and stored in identified lots (e.g., 10 deer per lot) to maximize efficiency. If test results revealed a CWD-positive animal, the entire lot to which it belonged would be disposed of in an approved manner. Processing areas and tools would be decontaminated between lots to prevent potential CWD contamination among lots. Under other alternatives, where large numbers of carcasses would not be expected, processing areas and tools would be decontaminated as appropriate.

Incineration

Carcasses that test positive for CWD may be disposed of by incineration through the Pennsylvania Animal Diagnostic Laboratory System (PADLS). The European Union recommends temperatures of at least 1,562 degrees Fahrenheit (850 Celsius) be maintained for at least two seconds to denature the CWD prion and incinerate carcasses (PCWDTF 2007). The PADLS incineration facility uses a controlled furnace, which is equipped with a primary and secondary combustion chamber. This equipment is similar to that found in other pathological incinerators and animal crematories. The only potential disadvantages of incineration are that this method is relatively expensive and may have a limited surge capacity. However, it can meet the temperature criteria described above (PCWDTF 2007). Should additional incineration capacity be needed, the Pennsylvania Department of Environmental Protection and the PGC would be consulted for additional incineration sites. Ashes associated with incineration would be disposed of by PADLS or via landfilling.

Alkaline Digestion

The use of tissue digestion as a disposal method for CWD-positive deer may be considered in the future. Although commonly called a digester, this method of carcass disposal is based on alkaline hydrolysis. The basis of this technology is the use of sodium or potassium hydroxide solutions under pressure and at elevated temperatures (approximately 150 degrees Celsius) to hydrolyze proteins into peptides and amino acids. As TSEs are believed to be caused by an abnormal prion protein, this technology is ideally suited for inactivation and disposal of infected animals and tissues derived from them. Currently, an approved digestion facility does not exist within the Commonwealth of Pennsylvania, although construction of one is being considered at PADLS, New Bolton Center.

Minimizing Environmental Contamination

It is unlikely that CWD prions can be completely removed from the landscape once introduced. However, actions to minimize environmental contamination can be taken. At Valley Forge NHP, these activities would remain consistent with the constantly improving state of knowledge on this subject. Within Zone 1, the following additional activities would occur under all deer management alternatives in the plan/EIS to minimize environmental contamination during carcass handling and disposal:

- Surface disposal would be eliminated as a carcass disposal method.
- Temporary storage areas for carcasses would be impervious.

- Deer carcasses obtained through lethal removal actions (Alternatives C and D in the plan/EIS) would not be gutted and would be removed from the landscape immediately.
- Deer carcasses obtained through other means (e.g., deer-vehicle collisions) would be removed from the landscape as soon as possible (many are unreported and thus may not be noticed immediately).
- Baiting as a tool for facilitating delivery of reproductive control agents under Alternative B or lethal removal actions under Alternatives C and D in the plan/EIS would be limited (reducing fecal concentration on the landscape).
- Handling of deer for the purpose of obtaining samples for CWD testing would occur on plastic tarps or other impervious surface to minimize the transfer of body fluids onto the ground.

Implementation Costs

The following tables (C-5, C-6, C-7, and C-8) summarize the costs associated with implementation of the CWD response plan for Valley Forge NHP. The costs are broken down by implementation zone under each deer management alternative.

Table C-5 Alternative A: CWD Response Costs by CWD Implementation Zones

Action	Implementation Zone 3		Implementation Zone 2		Implementation Zone 1	
Opportunistic Surveillance	NPS Staff Time to Obtain Tissue Samples; 51 deer per year x 1hr/deer x $20/hr	$1,020	NPS Staff Time to Obtain Tissue Samples; 75 deer per year x 1hr/deer x $20/hr	$1,500	NPS Staff Time to Obtain Tissue Samples; 75 deer per year x 1hr/deer x $20/hr	$1,500
Targeted Surveillance			NPS Staff Time: Conduct Annual Training; 16 hrs @ $35/hr	$560	NPS Staff Time: Conduct Annual Training; 16 hrs @ $35/hr	$560
			NPS Staff Time: Lethal Removal of Deer Exhibiting Clinical Signs of CWD and Obtaining Tissue Samples; 15 deer per year @ 3 hrs/deer x $35/hr	$1,575	NPS Staff Time: Lethal Removal of Deer Exhibiting Clinical Signs of CWD and Obtaining Tissue Samples; 25 deer per year @ 3 hrs/deer x $35/hr	$2,625
			Equipment: 20 pairs of binoculars @ $80 each; Likely purchased twice during life of plan (YR 1, YR 8)	$3,200 total cost (15 yrs)	Equipment: 20 pairs of binoculars @ $80 each; Likely purchased twice during life of plan (YR 1, YR 8)	$3,200 total cost (15 yrs)
			Set-up Cost YR 1: Rifle and Ammunition	$1,000	Set-up Cost YR 1: Rifle and Ammunition	$1,000
Enhanced Targeted Surveillance						
Dedicated NPS staff time					NPS Staff Time: 1 hr/day or 5 hrs/week x 26 weeks x $20/hr	$2,600
Dedicated volunteer time *Cost based on NPS staff time needed to organize and provide oversight of volunteer activities.					Volunteer Time: 1 hr/day or 5 hrs/week x 26 weeks (Cost based on NPS Staff Time to organize and provide oversight for volunteers @ 1 hr/week X 26 weeks x $20/hr)	$520
CWD Testing and Testing Supplies *It is assumed that NPS-BRMD will provide CWD testing at no charge throughout the life of this plan.	Testing conducted at no cost by NPS-BRMD for at least first 5 years; includes mailing costs	$0	Testing conducted at no cost by NPS-BRMD for at least first 5 years; includes mailing costs	$0	Testing conducted at no cost by NPS-BRMD for at least first 5 years; includes mailing costs	$0
	Purchase of testing supplies every 3 years (YR 3, YR 6, YR 9, and YR 12) @ $1500 to $3,000 per purchase	$6,000 total cost (15 yrs)	Purchase of testing supplies every 3 years (YR 3, YR 6, YR 9, and YR 12) @ $1500 to $3,000 per purchase	$12,000 total cost (15 yrs)	Purchase of testing supplies every 3 years (YR 3, YR 6, YR 9, and YR 12) @ $1500 to $3,000 per purchase	$12,000 total cost (15 yrs)
Disposal of CWD-positive Carcasses *Assumes relatively high prevalence (10%) and increased probability of detecting CWD in road-killed deer. *Assumes average weight of deer is 100 lbs. *Costs included under implementation Zone 3 only because it is at this point that CWD-positive deer are assumed to be in the park. *Due to uncertainties regarding landfilling of CWD-positive carcasses costs are based on incineration ($1-$2.50/lb).					10 carcasses per year @ 100 lbs/carcass X $1-$2.50/lb for incineration; $100-$250/carcass	$1,000 -$2,500
Alternative A Recurring Annual CWD Costs		**$1,020**		**$3,635**		**$8,805 - $10,305**
Alternative A 15-YR CWD Costs (includes one-time/set-up costs, periodic activities)		**$21,300**		**$70,725**		**$148,275 - $170,775**

Table C-6 Alternative B: CWD Response Costs by CWD Implementation Zones

Action	Implementation Zone 3		Implementation Zone 2		Implementation Zone 1	
CWD Costs Associated with Alternative A, plus:						
Test and Cull CWD-Positive Deer					NPS Staff Time to Obtain Tissue Samples via Tonsillar Biopsy; Handling and Shipping; Cost would depend on number of deer treated and current available technology. Assume 90% of does (460) treated each year, beginning at Year 1. 1 hr per deer x 460 deer x $35/hr	$16,100
CWD Testing and Testing Supplies *It is assumed that NPS-BRMD will provide CWD testing at no charge throughout the life of this plan.					Conducted at no cost by NPS-BRMD for at least first 5 years.	$0
					Additional $2,000 per purchase for CWD testing supplies every 3 years (YR 3, YR 6, YR 9, and YR 12)	$8,000 total (15 yrs)
Disposal of CWD-positive Carcasses *Assumes relatively high prevalence (10%) and increased probability of detecting CWD in road-killed deer. *Assumes average weight of deer is 100 lbs. *Costs included under implementation Zone 3 only because it is at this point that CWD-positive deer are assumed to be in the park. *Due to uncertainties regarding landfilling of CWD-positive carcasses costs are based on incineration ($1-$2.50/lb).					Additional 35 carcasses per year than proposed under Alternative A @ 100 lbs/carcass X $1-$2.50/lb for incineration; $100-$250/carcass	$3,500 -$8,750
Alternative A Recurring Annual Costs		$1,020		$3,635		$8,805 - $10,305
Additional Recurring Annual Costs Under Alternative B		$0		$0		$19,600 - $24,850
Alternative B Recurring Annual CWD Costs		**$1,020**		**$3,635**		**$28,405 - $35,155**
Alternative A 15-year Costs		**$21,300**		**$70,725**		**$148,275 - $170,775**
Alternative B 15-year CWD Costs (includes one-time/set-up costs, periodic activities)		**$21,300**		**$70,725**		**$450,275 - $551,525**

Table C-7 Alternative C: CWD Response Costs by CWD Implementation Zones

Action	Implementation Zone 3		Implementation Zone 2		Implementation Zone 1	
CWD Costs Associated with Alternative A, plus:						
Active Lethal CWD Surveillance						
Rapid Reduction to Target Deer Density: Sharpshooting					Years 1: 150 additional deer removed than proposed under Alt C ($200/deer)	$30,000
					Years 2: 75 additional deer removed than proposed under Alt C ($200/deer)	$15,000
					Years 3-15: 35-40 deer removed annually ($400/deer); No additional costs to those proposed under Alt C	
One-Time Reduction to Not Less Than 10 Deer Per Square Mile *Costs based on number of deer removed to go from 35 deer per square mile to 10 deer per square mile and represent costs in addition to those costs proposed under Alternative C. *Assumes initial target deer density has been achieved and initial population size is 185 deer. *Expected to take two years to achieve 10 deer per square mile.					Year 1: 40 additional deer removed than proposed under Alt C (Years 5+) ($400/deer)	$16,000
					Year 2: 30 additional deer removed than proposed under Alt C (Years 5+) ($400/deer)	$12,000
					Years 3-15: 10-20 deer removed annually ($400/deer); No additional costs to those proposed under Alt C	
Carcass Storage					Six month lease of 32-48 foot refrigerated storage trailer and gas; @$1,400 per month; Estimated for 5 years	$42,000
Disposal of CWD-positive Carcasses *Assumes relatively low prevalence (<1%). *Assumes average weight of deer is 100 lbs. *Costs included under implementation Zone 3 only because it is at this point that CWD-positive deer are assumed to be in the park. *Due to uncertainties regarding landfilling of CWD-positive carcasses costs are based on incineration ($1-$2.50/lb).					Additional 10 carcasses per year than proposed under Alternative A @ 100 lbs/carcass X $1-$2.50/lb for incineration; $100-$250/carcass	$1,000 – $2,500

Table C-7 Alternative C: CWD Response Costs by CWD Implementation Zones

Action	Implementation Zone 3		Implementation Zone 2		Implementation Zone 1	
CWD Testing and Testing Supplies *It is assumed that NPS-BRMD will provide CWD testing at no charge throughout the life of this plan.					No additional costs for supplies and equipment.	
					NPS Staff Time to Obtain CWD Samples; Mark individual animals; Handling and Shipping; Cost would depend on number of deer treated and current available technology. Cost based on 50 deer x 1 hr/deer x $35/hr	1,750
Alternative A Recurring Annual Costs		**$1,020**		**$3,635**		**$8,805 - $10,305**
Additional Recurring Annual Costs		**$0**		**$0**		**$2,750 - $4,250**
Alternative C Recurring Annual CWD Costs		**$1,020**		**$3,635**		**$11,555 - $14,555**
Alternative A 15-YR Costs		**$21,300**		**$70,725**		**$148,275 - $170,775**
Alternative C 15-Yr CWD Costs (includes one-time/set-up costs, periodic activities)		**$21,300**		**$70,725**		**$436,600 - $504,100**

Table C-8 Alternative D: CWD Response Costs by CWD Implementation Zones

Actions	Implementation Zone 3		Implementation Zone 2		Implementation Zone 3	
Same as CWD Costs Associated with Alternative C						
Alternative D Recurring Annual CWD Costs		**$1,020**		**$3,635**		**$11,555-$14,555**
Alternative D 15-Yr Costs (includes one-time/set-up costs, periodic activities)		**$21,300**		**$70,725**		**$436,600 - $504,100**

Selected Bibliography

Alaimo Group
2007 *Chester County Municipal Waste Management Plan, Chester County, Pennsylvania*. Prepared by the Alaimo Group for the County of Chester, The Chester County Health Department, and Bureau of Environmental Health Protection. Chester County, Pennsylvania.

Conner, M. M., C. E. Krumm, and M. W. Miller
2005 "Increasing the Efficacy of Chronic Wasting Disease Detection Via Selective and Targeted Sampling." Paper presented at the Second InternationalChronic Wasting Disease Symposium, Madison, WI, July 12–14, 2005.

Cottrell, W.
2008a E-mail message from Walter Cottrell, Wildlife Veterinarian, PGC to Kristina Heister, Valley Forge NHP Natural Resource Manager, May 15, 2008, regarding deer imported from CWD affected areas.

2008b E-mail message from Walter Cottrell, Wildlife Veterinarian, PGC to Kristina Heister, Valley Forge NHP Natural Resource Manager, August 22, 2008, regarding comments on version 4 of the CWD Response Plan.

CWD Alliance
2008 *Why Are We Concerned About CWD?* Available on the Internet at <http://www.cwd-info.org/index.php>. Accessed on May 6, 2008.

Joly, D. O., C. A. Ribic, J. A. Langenberg, K. Beheler, C. A. Batha, B. J. Dhuey, R. E. Rolley, G. Bartelt, T. R. Van Deelen, and M. D. Samuel
2003 "Chronic Wasting Disease in Free-ranging Wisconsin White-tailed Deer." *Emerging Infectious Diseases* 9:599–601.

Joly, D. O., M. D. Samuel, J. A. Langenberg, J. A. Blanchong, C. A. Batha, R. E. Rolley, D. P. Keane, and C. A. Ribic
2006 "Spatial Epidemiology of Chronic Wasting Disease in Wisconsin White-tailed Deer." *Journal of Wildlife Diseases* 42(3): 578-88.

Long, E. S., D. R. Diefenbach, C. S. Rosenberry, B. D. Wallingford, and M. D. Grund
2005 "Forest Cover Influences Dispersal Distance of White-tailed Deer." *Journal of Mammalogy* 86 (3): 623-29.

Lovallo, M. J., and W. M. Tzilkowski
2003 *Abundance of White-tailed Deer (Odocoileus Virginianus) within Valley Forge National Historical Park and Movements Related to Surrounding Private Lands.* U.S. Department of the Interior, National Park Service, Technical Report NPS/NERCHAL/NRTR-03/091.

Miller, M. W., E. S. Williams, C. W. McCarty, T. R. Spraker, T. J. Kreeger, C. T. Larsen, and E.T. Thorne
2000 "Epizootiology of Chronic Wasting Disease in Free-ranging Cervids in Colorado and Wyoming." *Journal of Wildlife Diseases* 36:676-90.

Multi-agency Task Force
2002 *Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids*. Available on the Internet at <http://www.cwd-info.org/docs/CWD_National_CWD_Plan.doc>.

National Park Service (NPS)
2002 "Director's CWD Guidance Memorandum." July 26.

2006 *Elk and Deer Meat from Areas Affected by Chronic Wasting Disease: A Guide to Donation for Human Consumption*. Washington, DC: National Park Service Public Health Program.

2007a *Antietam and Monocacy National Battlefields Chronic Wasting Disease/Detection and Initial Response Plan and Environmental Assessment*: *Science Team Summary, Final Report*.

2007b *Chronic Wasting Disease Surveillance Guidance for Valley Forge National Historical Park, PA*. Valley Forge National Historical Park, King of Prussia, PA. In draft form.

2007c *A National Park Service Manager's Reference Notebook to Understanding Chronic Wasting Disease. Version 4*. Available on the Internet at <http://www1.nrintra.nps.gov/brmd/nativespecies/wildlifehealth/Chronic_Wasting/CWD_notebook_version%204%20_7_27_07_.pdf>.

2008 "CWD Science Team Recommendations." Summary Memorandum for Valley Forge National Historical Park. July 7, 2008.

Pennsylvania Chronic Wasting Disease Task Force (PCWDTF)
2007 *Pennsylvania's Chronic Wasting Disease Response Plan*. May 2007. Harrisburg, PA.

2008 *Chronic Wasting Disease Update, 8/14/2008*. Available on the Internet at <http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=458&q=163873>.

Powers, J.
2008 E-mail message from Jenny Powers, Wildlife Veterinarian, Biological Resource Management Division, National Park Service to Kristina Heister, Valley Forge NHP Natural Resource Manager, June 27, 2008, regarding CWD response.

Samuel, M. D., D. O. Joly, M. A. Wild, S. D. Wright, D. L. Otis, R. W. Werge, and M. W. Miller
2003 *Surveillance Strategies for Detecting Chronic Wasting Disease in Free-ranging Deer and Elk*. National Wildlife Health Center, United States Geological Survey, Madison, Wisconsin, USA. 41pp.

U.S. Department of Agriculture (USDA)
2006 *Final Ruling on Chronic Wasting Disease*. Animal and Plant Health Inspection Service (APHIS), U.S. Department of Agriculture.

Wisconsin Department of Natural Resources (WDNR)
2003 *Environmental Impact Statement on Rules to Eradicate Chronic Wasting Disease from Wisconsin's Free-Ranging White-tailed Deer Herd*. Available on the Internet at <http://www.dnr.state.wi.us/org/land/wildlife/Health/issues/Cwd/doc/eis.htm>.

Wobeser, G. A.
1994 *Investigation and management of disease in wild animals*. New York: Plenum Press.

Wolfe, L. L., M. W. Miller, and E. S. Williams
2004 "Feasibility of "test-and-cull" for managing chronic wasting disease in urban mule deer." *Wildlife Society Bulletin* 32:500-505.

Wolfe, L. L., T. R. Spraker, L. Gonzalez, M. P. Dagleish, T. M. Sirochman, J. C. Brown, M. Jeffrey, and M. W. Miller
2007 "PrPCWD in Rectal Lymphoid Tissue of Deer (*Odocoileus* spp.). *Journal of General Virology* 88:2078-82.

This page intentionally left blank.

Appendix D: Detailed Cost Estimates

Alternative A: No-action

The costs associated with Alternative A would primarily cover deer and vegetation monitoring, CWD surveillance (opportunistic, targeted, and enhanced targeted), maintenance of small fenced areas (e.g. riparian buffer fencing), and removal of deer from roadways. These estimates are considered minimum costs and do not include inflation over time. Costs assume knowledge of existing park activities and experience of park staff. Costs associated with CWD response vary significantly based on the distance of a confirmed case of CWD from the park boundary and location of the park relative to a state-established CWD containment zone. Recurring annual costs associated with Alternative A are estimated to total between $14,828 and $32,567. Costs over the life of the plan (15 years) are estimated to total between $253,782 and $403,257.

Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every three years) in addition to the sum of annual recurring costs over 15 years.

Table D-1 provides a detailed breakdown of the costs associated with Alternative A.

Table D-1 Cost Estimate for Alternative A: No-action

Action	Assumptions	Estimated Recurring Annual Cost	Estimated Cost for the 15-year Planning Period
Valley Forge NHP Vegetation Monitoring (Carried out every 5 years)		**$384 -8,838**	**$31,122**
	30 days field work at NPS salary of $3,454/month (3 times over life of plan)	$3,454 (once every 5 years)	10,362
	30 days field work for Botanist Assistant at $2,500/month (3 times over live of plan)	$2,500 (once every 5 years)	$7,500
	Data Analysis Report (3 times over life of plan)	$2,500 (once every 5 years)	$7,500
	Annual exclosure check consists of 32 hours of a volunteer‘s time at $12/hour	$384	$5,760

Table D-1 Cost Estimate for Alternative A: No-action (continued)

Action	Assumptions	Estimated Recurring Annual Cost	Estimated Cost for the 15-year Planning Period
NPS I&M Vegetation Monitoring[a]	Carried out every year. Only a select number of plots are monitored each year. Over a five year period, all of the plots are monitored. Costs and labor are covered by the I&M program.	**$0**	**$0**
Deer Population Monitoring		**$1,702**	**$25,530**
Fall Spotlight Counts	12 hours at NPS salary of $35.27/hour	$423	$6,350
	12 hours of a volunteer's time at $12/hour	$144	$2,160
Spring Compartment Counts	7.5 hours at NPS salary of $35.27/hour	$265	$3,970
	7.5 hours at NPS salary of $20/hour	$150	$2,250
	7.5 hours of 8 volunteers' time at $12/hour	$720	$10,800
Small Fenced Areas		**$6,000**	**$90,000**
	325 volunteer hours at $12/hour to annually maintain riparian buffer fencing	$3,900	$58,500
	80 hours of NPS staff time at $20/hour	$1,600	$24,000
	Supplies and equipment	$500	$7,500
	Viburnum nudum fencing is checked on during other tasks	$0	$0
Roadkill Removal		**$3,511**	**$52,665**
	40 hours of NPS staff time to pull deer off road and/or euthanize.	$1,411	$21,165
	Contractor removes and disposes of dead deer at $35/deer (via landfilling)	$2,100	$31,500

Table D-1 Cost Estimate for Alternative A: No-action (continued)

Action	Assumptions	Estimated Recurring Annual Cost	Estimated Cost for the 15-year Planning Period
Public Education		**$2,211**	**$33,165**
	40 hours of NPS staff time at $20/hour	$800	$12,000
	40 hours of NPS staff time at $35.27/hour	$1,411	$21,165
CWD Response[b]		**$1,020 - $10,305**	**$21,300 to $170,775**
Opportunistic Surveillance	Implementation Zone 3	$1,020	$21,300
Add Targeted Surveillance	Implementation Zone 2	$3,635	$70,725
Add Enhanced Targeted Surveillance	Implementation Zone 1	$8,805 - $10,305	$148,275 - $170,775
Total Costs		**$14,828 - $32,567[c]**	**$253,782 - $403,257 [c]**

Note: Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every five years) in addition to the sum of annual recurring costs over 15 years.

a The costs of the I&M monitoring are covered by the program budget and are not assumed by Valley Forge NHP.

b Refer to Appendix C: CWD Response Plan for a full explanation of costs associated with CWD surveillance. Costs associated with surveillance activities include supplies and equipment and disposal of CWD-positive carcasses under Implementation Zone 1.

c Upper range of total costs excludes $2,100 costs for contractor disposal of road-killed deer in Implementation Zones 2 and 1.

Alternative B: Combined Nonlethal Actions

Costs of implementing Alternative B would include the same costs described under Alternative A (vegetation and deer population monitoring, small fenced areas, roadkill removal, public education, and CWD response), plus costs of constructing, monitoring, and maintaining rotational fencing, implementing reproductive controls and fertility monitoring, and initiating testing and culling of CWD-positive deer, if CWD is confirmed within five miles of the park boundary or the park falls within a state-established CWD containment zone. The overall cost of implementing Alternative B would depend on factors such as the number of deer treated, methods used, number of personnel, monitoring costs, and the distance of a confirmed case of CWD from the park boundary (Implementation Zone 3, 2, or 1). Recurring annual costs associated with Alternative B are estimated between $514,113 and $943,317. Costs over the life of the plan (15 years) are estimated between $12,614,807 and $13,417,832.

Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every three years) in addition to the sum of annual recurring costs over 15 years.

The following text provides an explanation des of the costs included in Alternative B, and Table D-2 provides a summary of the detailed costs.

Rotational Fencing

Rotational fencing would be a minimum of 8-10 feet tall and comprise woven wire. It is estimated that it would take up to 150 working days to construct all fenced areas. Details related to fence installation are expected to vary widely based on factors such as topography, geologic substrate, access, and presence of archeological resources. A cost estimate for fencing was generated using the standardized government Cost Estimating Software System CESS (NPS 2008b) program and is considered to be a Class C estimate. Class C indicates a conceptual cost estimate based on square foot cost (or unit cost) of similar construction. The NPS CESS software calculates labor and materials costs based on the local area and the average difficulty to install wire mesh in southeastern Pennsylvania based on 2008 pricing. The following cost factors are accounted for in the estimate: park location, design contingency, historic preservation factor, general and administrative costs, overhead, and profit. Fence design and installation cost is estimated between $30 (materials and labor only) and $45 per linear foot. Total cost to install rotational fencing across 10%-15% of the forested area of the park would range from $1,403,550 to $2,105,325.

Most likely, fenced areas would be relocated every 15 to 20 years. Therefore, relocation costs are not included in this plan. However, it is estimated that future costs to relocate up to 15 fenced areas are 75% of the original cost. Maintenance costs could be substantial due to the remoteness of some fenced sites and the presence of very rocky soils.

Labor to inspect and maintain fencing is estimated at approximately one person per day for each exclosure annually, assuming four scheduled visits per year. Using an average rate of $160 per day and 15 days to cover all of the exclosures, the annual maintenance cost would be $2,400 for labor. An additional $8,000 per year would be needed for maintenance materials and additional visits due to inclement weather. The additional vegetation monitoring cost for three exclosures per year would be approximately $1,500 (based on annual monitoring costs used in Alternative A).

Reproductive Control

A study in New York, one of the few conducted on a suburban, free-ranging deer population, estimated that the minimal annual time commitment per deer for reproductive control (using PZP) was approximately 20 hours, costing in the range of $450 to $1,000 per deer (Rudolph et al. 2000). At Cleveland Metro Parks, labor cost approximately $450 per deer, and vaccines and equipment were approximately $450 per deer (DeNicola, pers. comm. 2004). Vaccine trials in Connecticut cost $1,128 per deer for 30 deer over 2 years, with 64% of the cost going to labor (Latham et al. 2005).

At Valley Forge NHP, costs per deer would include the reproductive control and anesthetic agents, labor and equipment, and potentially bait piles. The estimated cost is $200 per dose of Leuprolide. Additional handling and processing costs associated with delivering the treatment also would apply. Based on the high number of deer that would need to be treated and potential difficulties working within a suburban setting (visitation, restrictions on timing) at Valley Forge NHP, the expected costs for implementing reproductive controls would range from $1,000 to $1,900 per deer. Costs could vary based on the number of deer that need to be treated, improved technology, market demand, and/or changes in pricing (APHIS, pers. comm. 2008).

Current monitoring carried out in the spring and fall would continue to be the primary method of measuring the success of this alternative. Additional monitoring to document reproductive control success (pregnancy rate, reproductive rate) would be implemented and would require approximately 30 minutes of additional handling for each female deer carcass documented within the park. It would be expected that as the number of does treated with a reproductive control agent increased over time the percent of pregnant does would decrease. Data on reproductive rates also would be used to define the existing population.

CWD Response Plan

Costs associated with CWD response would only be incurred if a confirmed case of CWD were documented within 5 miles of the park boundary or the park fell within a state-established CWD containment zone (Implementation Zone 1). Costs would vary primarily based on when this CWD response threshold is reached and how many deer had already been treated with a reproductive control agent and marked initially at the time of the response.

Tonsillar biopsy would be conducted during initial treatment of a reproductive control agent and permanent marking of deer. No additional costs associated with capture and anesthesia are expected. For the purposes of this plan costs are estimated based on tonsillar biopsy of 460 deer and assumes implementation simultaneously with reproductive control.

CWD testing would be conducted by the NPS-BRMD at no cost for at least the first five years. It is assumed that this service would continue to be provided through the life of the plan. If NPS-BRMD is no longer able to provide testing services free of charge, an additional $5 per test would be incurred. An additional hour of labor per deer would be required to obtain, process, and mail tissue samples. Most materials required to conduct tissue biopsies were purchased for the park by NPS-BRMD in 2008. Additional materials may be required for processing tonsillar biopsy samples and would be purchased approximately every three years throughout the life of this plan (e.g. disinfectant, plastic tarps).

Disposal costs for CWD-positive deer represent cost per pound for incineration ($1 to $2.50 per pound). These costs would only be incurred under Implementation Zone 1, where it is assumed that CWD is in the park. Costs were based on incineration due to the uncertainties surrounding the use of landfills for disposal of CWD-positive deer. Estimates assume an average weight of 100 pounds per deer.

Table D-2 Cost Estimate for Alternative B: Combined Nonlethal Actions

Action	Assumptions	Estimated Recurring Annual Cost	Estimated Cost for the 15-Year Planning Period
Same actions as Alternative A (excluding CWD response)	See Alternative A	**$13,808 - $22,262**	**$232,482**
Rotational Fencing		**$10,400**	**$1,559,550 - $2,261,325**
Construction	10-15 fenced areas (estimated 46,700 linear feet @ $30-$45/linear foot)	$0	$1,403,550 - $2,105,325 (first year only)
Maintenance	Equipment and materials for repairs	$8,000	$120,000
Labor	1 person-day/ exclosure/year, with up to 4 visits per year for maintenance actions.	$2,400	$36,000
Vegetation Monitoring	Data collection and analysis of 3 plots within fenced areas each year, completing all 15 plots in 5 years.	**$1,500**	**$22,500**
Reproductive Control	Cost would depend on number of deer treated and current available technology. Assume 90% of does (460) treated each year, beginning at Year 1; $1,000-$1,900/deer x 460 does	**$460,000-$874,000**	**$10,350,000**
CWD Response[a]		**$28,405-$35,155**	**$450,275-$551,525**
Test and Cull CWD-Positive Deer	Labor, Carcass Disposal	$19,600 - $24,850	$294,000 - $372,750
	Supplies and Equipment		$8,000
Total Costs		**$514,113 - $943,317**	**$12,614,807 - $13,417,832**

Note: Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every five years) in addition to the sum of annual recurring costs over 15 years.

a Refer to Appendix C: CWD Response Plan for a full explanation of costs associated with CWD surveillance. CWD Response costs represent the sum of costs incurred under Alternative A and additional costs incurred under Alternative B.

Alternative C: Combined Lethal Actions

Costs of implementing Alternative C would include the costs described under Alternative A (vegetation and deer population monitoring, small fenced areas, roadkill removal, public education, and CWD response), plus the cost of sharpshooting, capture/euthanasia, and initiation of active lethal CWD surveillance if CWD were confirmed within five miles of the park boundary or the park fell within a state-established CWD containment zone. The overall cost of implementing Alternative C would depend on factors such as the number of deer removed, methods used, personnel or contractor costs, and the distance of a confirmed case of CWD from the park boundary (Implementation Zone 3, 2, or 1). Recurring annual costs associated with Alternative C are estimated between $56,113 and $150,317. Costs over the life of the plan (15 years) are estimated between $1,381,832 and $1,449,332.

Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every three years) in addition to the sum of annual recurring costs over 15 years.

Estimated costs for Alternative C are discussed below and summarized in Table D-3.

Sharpshooting

Factors affecting the final cost of implementing this alternative include deer density, number of deer to be removed, ease of access to deer, number, location, and success of bait stations, equipment availability, amount of data to be collected from deer, and processing requirements. The greatest costs would generally be incurred when the deer and bait stations were difficult to access, when deer were wary of humans, the removal area was large, and when deer densities were lower (requiring more time to find each deer). Conversely, lower costs could be expected when the removal area was smaller, deer density was high (less time to find each deer), and deer were not wary of human activities. For this alternative, it is assumed that a qualified federal employee or contractor would conduct the lethal removal activities and collect biological data. NPS staff would collect samples for CWD testing and arrange for transport, processing, and appropriate disposal of deer carcasses (if needed).

Costs and efficiencies of sharpshooting programs have been assessed in the literature. One study documented that costs ranged from $72 to $260 per deer harvested (Warren 1997). A study in Minnesota compared methods to reduce deer abundance, and sharpshooting averaged $121 per deer harvested (Doerr, McAnnich, and Wiggers 2001). Gettysburg National Military Park reported that costs averaged $128 per deer, with 355 deer removed (Frost et al. 1997). In a suburban area near Minneapolis, the cost for a contractor to remove 36 deer in 2004 was $400 per deer based on several bait station locations, difficult access to removal locations, and a lower deer density (NPS 2008a). A recent estimate from APHIS to conduct sharpshooting activities within the park indicated a range of costs between $195 and $209 per deer in years 1 and 2, depending on level of processing (gutting or ungutted).

It is estimated that this alternative would cost $200 per deer for the first four years and would increase to $400 per deer as the population decreased and deer became more wary of human activities. However, with a smaller population, even though the cost per deer might increase because of the additional time needed to locate deer, the overall removal costs could decrease, because fewer deer would have to be removed.

Capture and Euthanasia

Factors affecting the final cost of implementing this element of Alternative C include the number of deer removed via this method, location of the removal, accessibility, type of trap or immobilization drug used, and the type of euthanasia used. Based on the experience of NPS personnel and the range of costs identified for capturing deer under the reproductive control action, costs could range from $100 to $1,000 per deer. An experienced contractor estimates that the minimum cost for capture and euthanasia would be $400 per animal (White Buffalo, Inc. 2005); therefore, actual costs for this method would likely be closer to the middle of the range ($500).

CWD Response Plan

Costs in addition to those under Alternative A would be incurred only if a confirmed case of CWD was documented within 5 miles of the park boundary or the park fell within a state-established CWD containment zone (Implementation Zone 1). Costs would vary based on when the CWD response threshold is reached, how many deer have been removed, and the success of the state's actions to reduce deer density in areas surrounding the park for the purpose of disease management. For example, if a confirmed case of CWD were documented within 5 miles of the park boundary and the park had already achieved the target deer density of 31-35 deer per square mile, and deer density in the surrounding environment were at least 31-35 deer per square mile, then no additional costs for CWD response would be incurred.

Costs for implementation of a rapid reduction to the deer density goal assume that deer density in the park is still high and that CWD is confirmed near the park early in the life of the plan. This expenditure would be unnecessary once the deer density goal has been achieved. Costs for implementation of a one-time reduction action to no less than 10 deer per square mile were based on the assumption that the initial deer density goal (31-35 deer per square mile) had been achieved. This estimate represents the number of additional deer that need to be removed over two years to achieve 10 deer per square mile. Implementation and number of deer removed is based on the success of the state in reducing deer density in surrounding communities for the purposes of disease management and therefore, costs associated with this action would vary.

CWD testing would be conducted by the NPS-BRMD at no cost for at least the first five years and it is assumed that this service would continue to be provided through the life of the plan. If NPS-BRMD is no longer able to provide testing services free of charge, an additional $5 per test would be incurred. An additional hour of labor per deer would be required to obtain CWD samples from deer carcasses resulting from management actions, and to process and mail tissue samples. Labor costs are based on 50 deer per year and assume CWD would not be confirmed near the park for at least four years. Most materials required to conduct tissue biopsies were purchased for the park by NPS-BRMD in 2008. Additional materials would be required throughout the life of the plan and would be purchased approximately every three years throughout the life of this plan (e.g. disinfectant, plastic tarps).

If carcasses need to be stored until CWD test results are returned a refrigerated storage trailer would be leased. Costs associated with leasing of a 32-48 foot refrigerated storage trailer assumes that it would be needed for 6 months annually for a period of five years (minimally). Cost of leasing a refrigerated storage trailer is estimated to be $8,400 ($1,400 per month) annually including vehicle lease ($950/mo) and diesel fuel ($450/mo).

Disposal costs for CWD-positive deer represent cost per pound for incineration ($1 to $2.50 per pound). These costs only appear under Implementation Zone 1 where it is assumed that CWD is in the park. Costs were based on incineration due to the uncertainties surrounding the use of landfills for disposal of CWD-positive deer. Estimates assume an average weight of 100 pounds per deer.

Table D-3 Cost Estimate for Alternative C: Combined Lethal Actions

Action	Assumptions	Estimated Recurring Annual Cost	Estimated Cost for the 15-year Planning Period
Same actions as described for Alternative A (excluding CWD response)	See Alternative A	**$13,808-$22,262**	**$232,482**
Lethal Reduction Actions		**$44,558 - $135,762**	**$945,232**
Sharpshooting	Years 1-2: 400 deer removed annually ($200/deer) Years 3-4: 200-250 deer removed annually ($200/deer) Years 5+: 20-50 deer removed annually ($400 /deer) [a]	Years 1-2: $80,000 Years 3-4: $50,000 Years 5+: $20,000	$480,000 [b]
Carcass Processing	$65 per deer for meat processing (meat donation)	Years 1-2: $26,000 Years 3-4: $16,250 Year 5+: $3,250	$120,250
Capture and euthanasia	15 deer maximum/year (estimated $500/deer)	$7,500	$112,500
CWD Response[c]		**$11,555 - $14,555**	**$436,600 - $504,100**
Active Lethal CWD Surveillance	Rapid Reduction to Target Deer Density	**$0**	$45,000
	One-Time Reduction	**$0**	$28,000
	Carcass Storage	**$0**	$42,000
	Carcass Disposal (CWD-positive)	$1,000 – $2,500	$15,000-$37,500
CWD Testing	Additional labor to obtain CWD samples	$1,750	$26,250
Total Costs		**$56,113 - $150,317**	**$1,381,832 - $1,449,332**

Note: Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every five years) in addition to the sum of annual recurring costs over 15 years.

a Cost increase after year four is due to additional time needed to locate deer at a lower deer density.

b This cost would increase if the deer density goal was not reached by the fourth year.

c Refer to Appendix C: CWD Response Plan for a full explanation of costs associated with CWD surveillance.

Alternative D: Combined Lethal and Nonlethal Actions

Costs of implementing Alternative D would include the costs described under Alternative A (vegetation and deer population monitoring, small fenced areas, roadkill removal, public education, coordination with PGC, and initiating CWD monitoring), plus the costs of implementing lethal reduction to achieve the target deer density and reproductive control to maintain the population, as described under Alternatives B and C. If CWD were confirmed within 5 miles of the park boundary, or the park fell within a state-established CWD containment zone, costs associated with implementing active lethal CWD surveillance would be the same as described under Alternative C. The overall cost of implementing Alternative D would depend on the number of deer removed and/or treated, methods used, personnel/contractor costs, and the distance of a confirmed case of CWD from the park boundary (Implementation Zone 3, 2, or 1). Recurring annual costs associated with Alternative D are estimated between $99,113 and $150,317 in years 1-4 (lethal actions) and between $183,063 and $194,517 during years 5-15 (reproductive control). Costs over the life of the plan (15 years) are estimated between $2,778,282 and $2,845,782.

Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every three years) in addition to the sum of annual recurring costs over 15 years.

Estimated costs for Alternative D are discussed below and summarized in Table D-4.

Sharpshooting

Factors affecting the final cost of implementing this alternative include deer density, number of deer to be removed, ease of access to deer, number and location of bait stations, equipment availability, amount of data to be collected from deer, and processing and disposal requirements. The greatest costs would generally be incurred when the deer and bait stations were difficult to access, when deer were wary of humans, the removal area was large, and when deer densities were lower (requiring more time to find each deer). Conversely, lower costs could be expected when the removal area was smaller, deer density was high (less time to find each deer), and deer were not wary of human activities. For this alternative, it is assumed that a qualified federal employee or contractor would conduct the lethal removal activities, process the deer, and collect biological data. NPS staff would arrange for processing and disposal of deer carcasses (if needed) and the transfer of meat to a local food bank (as appropriate).

Costs and efficiencies of sharpshooting programs have been assessed in the literature. One study documented that costs ranged from $72 to $260 per deer harvested (Warren 1997). A study in Minnesota compared methods to reduce deer abundance, and sharpshooting averaged $121 per deer harvested (Doerr, McAnnich, and Wiggers 2001). Gettysburg National Military Park reported that costs averaged $128 per deer, with 355 deer removed (Frost et al. 1997). In a suburban area near Minneapolis, the cost for a contractor to remove 36 deer in 2004 was $400 per deer based on several bait station locations, difficult access to removal locations, and a lower deer density (NPS 2008a).

It is estimated that this alternative would cost $200 per deer for the first four years and would increase to $400 per deer as the population decreased. However, with a smaller population, even though the cost per deer might increase because of more time needed to locate deer, the overall removal costs could decrease, because fewer deer would have to be removed.

Capture and Euthanasia

The costs for capturing deer would likely vary. Factors would include the location of the removal, accessibility, type of trap or immobilization drug used, the means of deer disposal, and the type of euthanasia used. Based on the experience of NPS personnel and the range of costs identified for capturing deer under the reproductive control action, costs could range from $100 to $1,000 per deer. An experienced contractor estimates that the minimum cost for capture and euthanasia would be $400 per animal (White Buffalo, Inc. 2005); therefore, actual costs for this method would likely be closer to the middle of the range ($500).

Reproductive Control

The costs of implementing reproductive controls on a population that has undergone reduction efforts for several years would vary depending on advances in reproductive control technology, sensitivity of the deer population to humans, methods used by the qualified federal employees or contractors, changes in immigration with reduced deer density, and general deer movement behavior (Porter et al. 2004; Naugle et al. 2002). A recent estimate from the USDA-APHIS (APHIS, pers. comm. 2008) to implement reproductive control after reduction of the deer population to 31-35 deer per square mile indicates a cost of $1,900 per deer. Compared to Alternative B, there would be fewer deer to treat, and those deer are more wary of humans. Therefore, it would be more difficult (i.e., take longer) to find and treat the necessary number of deer.

CWD Response Plan

Assumptions made in estimating the cost for the CWD Response Plan are the same as those described under Alternative A and C.

Table D-4 Cost Estimate for Alternative D: Combined Lethal and Nonlethal Actions

Action	Assumptions	Estimated Recurring Annual Cost	Cost for the 15-Year Planning Period
Same actions as Alternative A (excluding CWD response)	See Alternative A	**$13,808 - $22,262**	**$232,482**
Lethal Reduction			
Sharpshooting	Years 1-2: 400 deer removed annually ($200/deer) Years 3-4: 200-250 deer removed annually ($200)	Years 1-2: $80,000 Years 3-4: $50,000	$260,000 [a]
Capture and Euthanasia	Years 1-4: 15 deer maximum/year (estimated $500/year)	$7,500	$30,000 [a]
Carcass Processing	$65 per deer for meat processing (meat donation)	Years 1-2: $26,000 Years 3-4: $16,250	$84,500
Reproductive Control	Assume starting in Year 5. $1,900/deer x 83 does - See Alternative B	$157,700	$1,734,700 [a]
CWD Response[b]		**$11,555 - $14,555**	**$436,600 - $504,100**
Active Lethal CWD Surveillance	Rapid Reduction to Target Deer Density	$0	$45,000
	One-Time Reduction	$0	$28,000
	Carcass Storage	$0	$42,000
	Carcass Disposal (CWD-positive)	$1,000 – $2,500	$15,000-$37,500
CWD Testing	Additional labor to obtain CWD samples	$1,750	$26,250
Total Costs		**Lethal Actions: $99,113 – $150,317** **Reproductive Control: $183,063 – $194,517**	**$2,778,282 – $2,845,782 (Combined lethal and nonlethal actions)**

Note: Cost over the life of the plan includes one-time and periodic costs (e.g., start-up costs, costs incurred every five years) in addition to the sum of annual recurring costs over 15 years.

a This cost would increase if the deer density goal was not reached by the fourth year.

b Refer to Appendix C: CWD Response Plan for a full explanation of costs associated with CWD surveillance.

Appendix E: Review of White-tailed Deer Reproductive Control

Introduction

Managing the overabundance of certain wildlife species has become a topic of public concern (Rutberg et al. 2004). Species such as Canada geese (*Branta canadensis*), coyotes (*Canis latrans*), and white-tailed deer (*Odocoileus virginianus)* have become either locally or regionally overabundant throughout the United States (Fagerstone et al. 2002). In addition, traditional wildlife management techniques such as hunting and trapping are infeasible in many parks and suburban areas, forcing wildlife managers to seek alternative management methods.

The use of reproductive control in wildlife management has been assessed for several decades. Its use has gained more attention, as the public has become more involved in wildlife management decisions. Interest in reproductive control as an innovative alternative to traditional management methods, has led to the current state of the science (Baker et al. 2004). Often, the use of reproductive control is promoted in urban and suburban areas where traditional management tools, such as hunting, are publicly unacceptable or illegal due to firearm restrictions (Kilpatrick and Walter 1997; Muller, Warrnen, and Evans 1997).

The following describes the state of reproductive control as of 2008, as it relates to white-tailed deer management. In addition to describing the current technology available, it also covers population management challenges, regulatory issues, logistics, and consumption issues. It should be noted that since technology is changing rapidly in this field of research, this appendix is meant to be a description of the types of technology available and is not all-inclusive.

Current Technology

The area of wildlife contraception is constantly evolving as new technologies are developed and tested. For the sake of brevity, this appendix will only discuss reproductive control as it applies to female deer. There is a general understanding in white-tailed deer biology that managing the female component of the population is more important than managing the male component. Based on the polygamous breeding behavior of white-tailed deer, treating males with reproductive control would be ineffective if the overall goal is population management (Warren 2000).

There are three basic categories of reproductive control technology: (1) immunocontraceptives (vaccines), (2) non-immunological methods (pharmaceuticals), and (3) physical or chemical sterilization.

Immunocontraceptives

It is suggested that immunocontraceptive vaccines offer significant promise for future wildlife management (Rutberg et al. 2004). Immunocontraceptive treatment involves injecting an animal with a vaccine that "stimulates its immune system to produce antibodies against a protein (i.e., antigen) involved in reproduction"

(Warren 2000). In order to provide for sufficient antibody production, an adjuvant is combined with the vaccine. An adjuvant is a product that increases the intensity and duration of the immune system's reaction to the vaccine. There are two primary types of antigens used in reproductive control vaccines in deer: porcine zona pellucida (PZP) and gonadotropin releasing hormone (GnRH). Neither PZP nor GnRH vaccines are 100% effective in preventing pregnancy. Decreases in pregnancy rates can usually be expected for 1-2 years from immunocontraceptive vaccines. However, efficacy generally decreases as antibody production wanes.

Porcine Zona Pellucida (PZP)

The majority of immunocontraceptive research in wildlife has been conducted using PZP vaccines, which in 1992, Turner, Kirkpatrick, and Liu successfully used on white-tailed deer (1992). This type of vaccine stimulates an immune response to the egg coat proteins and is therefore only effective in female deer. Until recently there were two PZP vaccine products being developed, one is simply called PZP and the other SpayVac™. However, the company producing SpayVac™ has stated that it will no longer begin new research projects involving SpayVac™ in white-tailed deer (Fraker, pers. comm. 2006). The other PZP vaccine has been used extensively in white-tailed deer in the course of investigating its effectiveness (Kirkpatrick et al. 1997; Turner, Kirkpatrick, and Liu 1992, 1996; Walter et al. 2002a, 2002b).

The currently available PZP vaccine formulation is effective for two years (Turner et al. 2007), though longer multiyear applications are also being studied. There are several limitations to the PZP based vaccines. First, the PZP based vaccines often cause abnormal out of season breeding behavior in treated deer populations (Fraker et al. 2002; McShea and Rappole 1997), as treatment with PZP causes repeated estrous cycling in females, which can result in late pregnancies and behavioral changes. Additionally, at this time, PZP vaccines require periodic boosters in order to maintain infertility, which requires hands-on access on a moderately regular basis. Finally, the Food and Drug Administration (FDA), the current regulatory agency, 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.

Gonadotropin Releasing Hormone (GnRH) Vaccines

GnRH is a small neuropeptide (a protein-like molecule made in the brain) that plays a necessary role in reproduction. It is naturally secreted by the hypothalamus (a region of the brain that regulates hormone production), which directs the pituitary gland to release hormones that control the proper functioning of reproductive organs (Hazum and Conn 1998). In an attempt to interrupt this process, research has focused on eliminating the ability of GnRH to trigger the release of reproductive hormones. One solution that has been investigated is a vaccine that, when combined with an adjuvant, stimulates the production of antibodies to GnRH. These antibodies likely attach to GnRH in the hypothalamic region and prevent the hormone from binding to receptors in the pituitary gland, thus suppressing the secretion of reproductive hormones.

The use of GnRH vaccines has been investigated in a variety of both wild and domestic ungulates (hoofed mammals) (Curtis et al. 2002; Miller et al. 2000; Miller, Rhyan, and Drew 2004). In recent years, a great deal of research has been done on their effectiveness. One such GnRH vaccine being researched and developed is GonaCon™. In addition to developing an adjuvant with fewer unwanted side effects, researchers also are studying ways to develop a multiyear dose of the vaccine

(USDA 2004). Potential benefits of this vaccine include the longer-lasting contraceptive effect and possibly the lack of repeated estrous cycles. At this time, however, there are many uncertainties about this vaccine. First, like PZP vaccines, there is little information regarding the theoretical human and nontarget species health risks. At this time, treated animals must be permanently marked, so as not to enter the human food chain. Second, there is little information regarding vaccination of pregnant animals. Third, the vaccine can cause antibody development to not only the GnRH antigen but also a component of the adjuvant. This may cause difficulties with a population of treated deer when determining the Johne's disease status (a gastrointestinal disease of potential regulatory importance for domestic livestock). Finally, there is limited published data using this vaccine in free-ranging animals. More work is necessary to establish population and herd level effects.

Non-immunological Reproductive Control Methods

This group of reproductive control agents includes GnRH agonists, GnRH toxins, steroid hormones, and contragestives.

GnRH Agonists

GnRH agonists are similar in structure and action to GnRH. These agonists attach to receptors in the pituitary gland. By attaching to the receptors, these agonists reduce the number of binding sites available and thereby temporarily suppress the effect of the GnRH. As a result of this suppression, reproductive hormones are not released (Aspden et al. 1996; D'Occhio, Aspden, and Whyte 1996). However, not all agonists have the same effects in all species. In fact, some can have an effect that is the opposite of what is intended. However, it is important to fully understand the effects of a product on a given species. GnRH agonists have been tested in mule deer and shown to both suppress reproductive hormones and prevent pregnancy (Baker et al. 2004). Researchers believe this may be a useful tool for preventing pregnancy in white-tailed deer as well.

Leuprolide Acetate

Leuprolide is one GnRH agonist that has been studied. Tests reveal that when it is administered as a controlled-release formulation, it results in 100% pregnancy prevention in treated female elk and mule deer (Baker et al. 2002, 2004). In addition, the treatment is reversible, and the effects last only for a specific period of time (90-120 days) (Baker et al. 2004; Trigg et al. 2001). This means that, should a female be treated in one year, before the breeding season, it will not become pregnant in that year, but if the female is not retreated the following year, then she has the same chances of becoming pregnant as an animal that was never treated. This means that female deer must be treated on an annual basis and within a very short timeframe prior to the breeding season. Treatment using Leuprolide differs from GnRH vaccines in that it does not require an adjuvant and does not induce an antibody reaction. It does, however, require a slow release implant that remains under the skin or in the muscle for the duration of the treatment effectiveness.

Leuprolide is not likely to pose a threat to the environment or nontarget species (including humans) (Baker et al. 2004); however, this hypothesis has not been extensively researched. In contrast with some of the immunocontraceptive vaccines, leuprolide does not result in physiological side effects and short term behavioral effects are minimal.

Histrelin Acetate

Histrelin acetate has been found to be effective in suppressing a key reproductive hormone in white-tailed deer (Becker and Katz 1995). However, testing was administered using a mini-pump that was surgically implanted under the animal's skin. This is an infeasible route of administration in free-ranging animals. In the future, a delivery system with slow release characteristics may help to make this a more feasible option for free-ranging wildlife. It is likely that histrelin acetate will also suppress ovulation and pregnancy in white-tailed deer, although this remains to be tested.

GnRH Toxins

GnRH toxins consist of a cellular toxin that is combined with a GnRH analog. The toxin is then carried to the receptors in the pituitary gland and is internalized. Once absorbed, the toxin disrupts cellular function and can lead to cellular death. When this occurs, the production of reproductive hormones is affected. This process has been studied in female mule deer (Baker et al. 1999), and the technology is still being developed.

Steroid Hormones

The field of wildlife contraception began with research examining the manipulation of reproductive steroid hormones. Treatments using steroids can include administering high doses of naturally occurring hormones, such as estrogen or progesterone. However, the treatment usually entails the application of synthetic hormones, such as norgestomet, levangesterol, and melangestrol acetate. Most products that are available are used in domestic animal or zoological veterinary medicine and have not been used widely in free-ranging wildlife. Some issues related to using steroids include difficulties in treating large numbers of animals for extended periods of time, negative side effects experienced by the treated animals, and concerns over the consumption of treated animals by nontarget species, including humans.

Contragestives

Contragestives are products that terminate pregnancy. Progesterone is the primary gestational hormone for maintaining pregnancy in mammals. Many contragestives act by preventing progesterone production or blocking its effect, thereby affecting pregnancy. The primary contragestive that has been researched for use in domestic animals and white-tailed deer is an analog of Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) (Becker and Katz 1994; DeNicola, Kesler, and Swilhart 1997; Waddell et al. 2001). Lutalyse® is a commercially available form of $PGF_{2\alpha}$. Unlike many of the other alternatives, there are no issues related to consumption of the meat when it has been previously treated with this product. Difficulties with contragestives include timing of administration, efficacy, potential to rebreed if breeding season is not finished, and the potential for aborted fetuses on the landscape.

Sterilization

Sterilization can be either a surgical or chemical treatment process. Surgical sterilization is an invasive procedure that requires a veterinarian. This method is common in managing domestic animal fertility but is generally considered too labor and cost intensive for widescale use in free-ranging wildlife. Chemical sterilization, disrupting reproductive organs using tissue irritating agents, is typically performed on males as a contraceptive measure. Both types of sterilizations are typically permanent.

Regulatory Issues

The application of reproductive control agents in free-ranging wildlife is fairly new, and regulation will soon be shared between the FDA and the U.S. Environmental Protection Agency (EPA). Pharmaceuticals and some immunocontraceptive applications will continue to be regulated by FDA; however, at least one immunocontraceptive (GonaCon™) will likely be regulated by the EPA. As of March 2008, none of the agents discussed here are licensed or labeled for use as reproductive control agents in wildlife species. However, some can be used in a research setting under an Investigational New Animal Drug (INAD) exemption. This exemption is granted by the FDA for the purpose of allowing research to facilitate the gathering of information pertaining to the agent prior to the FDA granting full approval for its use. The EPA has a similar research exemption process.

Alternatively, some of the agents discussed above, specifically several of the pharmaceuticals, have FDA approval for therapeutic use in humans (e.g., Leuprolide) or other nonwildlife species (e.g., $PGF_{2\alpha}$). As a safety precaution, each approved agent is labeled indicating how it is to be used. In order to use the agent in a manner other than that indicated on the label, a licensed veterinarian must prescribe the agent and it must be used in accordance with the Animal Medicinal Drug Use Clarification Act of 1994. The prescribing veterinarian is accountable for prescribing and labeling a product when it is to be used in an extra-label manner. The owner (in this case, the National Park Service unit manager) is responsible for using the agent in the prescribed manner. In addition, the veterinarian must establish a meat residue withdrawal period (the time it takes for the animal to metabolize and clear the drug from its tissue) for any animals that may enter the human food chain. A treated animal may not be killed and enter the human food chain before the meat residue withdrawal period is over. All animals treated with pharmaceuticals used in an extra-label manner or experimental drugs/vaccines must be permanently marked for accurate identification.

Population Management Challenges

Managing local populations of wildlife using reproductive control can be difficult. The difficulty relates to the number of animals that need to be treated, their behavior (e.g., solitary, herd, diurnal, nocturnal), the topography of the habitat in which they are found, as well as treatment protocol logistics. In species like elk, animal roundups can occur making treatment easier than in cases where the populations are more dispersed (e.g., deer).

In order for reproductive control agents to effectively reduce population size, treatment with an agent must decrease the reproductive rate to less than the mortality rate. In urban deer populations, mortality rates are generally very low (approximately 10%). Therefore, it would be necessary to treat 70-90% of the female deer, with a highly efficacious product, to effectively reduce or halt population growth (Rudolph, Porter, and Underwood 2000). Additionally, a significant amount of population data is necessary to effectively monitor the effects of long-term population changes due to the use of contraceptives (Rudolph, Porter, and Underwood 2000; Hobbs, Bowden, and Baker 2000; Porter Underwood, and Woodward 2004).

Reproductive control agents generally decrease population levels slowly. At best, with 90% of the female deer treated, a 5% decline in the population could be expected after several years of treatment. Hobbs, Bowden, and Baker (2000) described a model that

suggests deer density will remain constant if 90% of the initial females are treated with a long-term reproductive control agent. Subsequently, 90% of female fawns would require treatment. This would stabilize the population if the average mortality rate is 10%. However, this result does not hold for short-duration agents (1 year duration). In this case, the 90% of reproductively mature females would require treatment each year in order to maintain constant herd numbers (Hobbs, Bowden, and Baker 2000). Both of these scenarios assume 100% efficacy. It has been suggested that reproductive control techniques are best suited to localized populations where the number of breeding females to be treated is small (e.g., less than 100 deer) and managers are trying to maintain the population between 30% and 70% of carrying capacity (Rudolph, Porter, and Underwood 2000).

Administering the Treatment

There are two basic approaches to administering reproductive control agents: capture and treat and remotely treat. Capture and treat requires physically and/or chemically restraining the animal and using a syringe or other delivery device to treat the animal. One benefit of this approach is that it allows for marking the deer, which facilitates subsequent treatments and meets current requirements. This method is also helpful in collecting valuable biological data, and it provides notice of meat residue withdrawal times. However, this approach is often more time intensive and can be more expensive than using a remote delivery system, especially as treated animals tend to be more difficult to recapture. In addition, capture-related mortality also can be a concern.

A remote delivery system uses an adapted firearm (i.e., dart gun) and some form of projectile that contains the reproductive control agent. These projectiles can be darts or another form of delivery system (e.g., biobullet) that can be used at a distance without needing to capture the animal first. One shortcoming of remote treatment is that it does not allow for permanently marking the treated animals. In addition, previously treated animals can be more difficult to re-treat. Under current regulation, there are few products which can be used in a remote delivery system.

Potential Impacts to Deer Behavior and Health

There have been few studies designed to intensively assess the effects of reproductive control on deer behavior and health. For many agents, additional research is needed to fully understand the behavioral and social consequences of reproductive control use. Because each group of reproductive control agents operates differently, the effects to the individual deer or population can vary widely. PZP immunocontraceptive agents have been documented to cause the continued cycling of females, which can extend the breeding season or rut (Fraker et al. 2002; McShea et al. 1997). In addition, if the contraceptive actions of the vaccine fail late during the breeding season and females get pregnant later in the year, there are changes to fawning dates and survival rates, as they are born later in the season (DeNicola and Swihart 1997). Other immunocontraceptives such as the GnRH vaccine, when applied to males, have resulted in depressed antler development and lack of interest in breeding. When this vaccine is applied to females, it may prolong or eliminate breeding behaviors. If enough females in the population are treated, it may result in a disruption to natural male/female social and reproductive interactions. More research is needed to investigate these questions.

The group of reproductive control agents categorized as non-immunocontraceptive methods also can have varying effects to deer behavior and health. For example, GnRH agonists have not been documented as causing behavioral changes when applied to female deer (Baker et al. 2004). GnRH agonists have had variable behavioral effects when applied to male elk. Steroids such as progestins can result in females being unreceptive to males, resulting in breeding behavioral changes (Matschke 1977). Contragestives pose a different kind of problem depending on when the treatment is applied. If applied too early in the breeding season, then the female could potentially breed again later in the year, extending the rut and resulting in fawn-related health issues such as those described for some immunocontraceptive agents above. If applied too late in the season, contragestives can result in abortion-related health implications for the female (DeNicola and Swihart 1997).

Depending on the method of sterilization, this procedure may have behavior effects on both male and female deer. If gonads are removed, then the source of important reproductive hormones will be removed. This is likely to change deer social interactions. If gonads are not removed, females will continue to ovulate and show behavioral signs of estrus and consequently may extend the breeding season.

As described above, any effect that could extend the rut has the potential for secondary effects to the individual deer. Increased attempts to breed, especially if unwelcomed, can result in increased aggression and movements. This may be problematic in areas with high vehicle use, as there could be increases in deer-vehicle collisions or other negative interactions with the public. However, as stated above, the effects of reproductive control agents still need more research in order to more fully understand the variations in deer behavior and health.

Potential Impacts for Consumption

As described above, some of the reproductive control agents can result in issues related to human consumption of meat. These issues can be avoided by: 1) using an agent that does not pose a risk to humans, 2) marking treated animals and providing meat residue withdrawal times (if possible), 3) providing educational materials to the local public that may consume hunted animals in the general area of treated animals, and 4) increasing research efforts to determine true human consumption risks.

Table E-1 provides a summary of the perceived advantages and disadvantages of different reproductive control agents for deer.

Table E-1 Summary of the Perceived Advantages and Disadvantages of Different Reproductive Control Agents for Deer

Reproductive Control Agent	Mechanism	Advantages	Disadvantages
PZP Vaccine	Immunization - antibodies directed at the ovum (egg)	▪ No hormonal residues ▪ Effective for at least 1-2 years ▪ Antibodies not harmful to humans ▪ Apply any time of year ▪ Remote delivery possible ▪ No apparent adverse health effects ▪ Reversible ▪ Available for use as an INAD	▪ Requires periodic booster vaccinations ▪ Only useful in females ▪ Females continue to cycle out of natural breeding season ▪ Not 100% effective ▪ Potential adjuvant problems ▪ Animals must be permanently marked
GnRH Vaccine	Immunization - antibodies directed at a protein hormone that is needed for reproduction	Same as above plus: ▪ Stops hormonal cycling ▪ Applicable to both males and females	▪ May remove primary and secondary sexual characteristics ▪ Animals must be permanently marked ▪ Incompletely tested in free-ranging populations
GnRH Agonists: Leuprolide/ Histrelin	Overwhelming GnRH receptors on anterior pituitary suppress release of reproductive hormones	▪ No hormonal meat residues ▪ No effect on reproductive behaviors ▪ FDA approved for therapeutic use in humans ▪ Slow-release formula available ▪ Remote delivery possible ▪ Continuous release micro-pump (surgically implanted) available	▪ Annual treatment prior to breeding season ▪ Drug meat residue withdrawal period not well established ▪ Animals must be permanently marked

Table E-1 Summary of the Perceived Advantages and Disadvantages of Different Reproductive Control Agents for Deer (continued)

Reproductive Control Agent	Mechanism	Advantages	Disadvantages
GnRH Toxin	Linking a GnRH analog to a cellular toxin which targets and kills GnRH receptors preventing release of reproductive hormones	▪ May cause permanent sterility	▪ More research is needed before using this product in free-ranging populations
Steroid Hormones: Progestins/ Estrogens	Controlling the reproductive cycle by administering steroid hormones or their analogues	▪ Variable efficacy ▪ Variable duration	▪ Some formulations can accumulate in tissues and may pose a health risk to scavengers or humans ▪ Some steroids can be harmful to the target species ▪ Animals must be marked ▪ Administered by slow release implants or repeated feeding
Contragestion: $PGF_{2\alpha}$	Pre-term pregnancy termination	▪ Administered by biobullet or hand injection ▪ FDA approved for use in domestic large animals ▪ No meat withdrawal period in domestic cattle	▪ Administered when the animal is pregnant ▪ Re-breeding may occur if given early ▪ Increased health complications if given late

Selected Bibliography

Aspden, W. J., A. Rao, P. T. Scott, I. J. Clark, T. E. Trigg, J. Walsh, and M. J. D'Occhio

1996 "Direct Actions of the Luteinizing Hormone-releasing Hormone Agonist, Deslorelin, on Anterior Pituitary Contents of Luteinizing Hormone (LH) and Follicle-Stimulating Hormone (FSH), LH and FSH Subunit Messenger Ribonucleic Acid, and Plasma Concentrations of LH and FSH in Castrated Male Cattle." *Biology of Reproduction* 55:386–92. Available on the Internet at <http://www.biolreprod.org/cgi/reprint/55/2/386>.

Baker, D. L., M. A. Wild, M. M. Connor, H. B. Ravivarapu, R. L. Dunn, and T. M. Nett

2002 "Effects of GnRH Agonist (Leuprolide) on Reproduction and Behavior in Female Wapiti (*Cervus elaphus nelsoni*)." *Reproductive Supplement* 60:155-67.

2004 "Gonadotropin-Releasing Hormone Agonist: A New Approach to Reversible Contraception in Female Deer." *Journal of Wildlife Diseases* 40:713-24.

Baker, D. L., T. M. Nett, N. T. Hobbs, R. B. Gill, and M. M. Miller

1999 "Evaluation of GnRH-toxin Conjugate as an Irreversible Contraceptive in Female Mule Deer." The Wildlife Society 6th Annual Conference, Austin, Texas, USA.

Becker, S. E., and L. S. Katz

1994 "Effects of Exogenous Prostaglandin-F2α (PGF2α) on Pregnancy Status in White-tailed Deer." *Zoo Biology* 13:315-23.

1995 "Effects of a Gonadotropin-Releasing Hormone Agonist on Serum Luteinizing Hormone Concentrations in Female White-tailed Deer." *Small Ruminant Research* 18:145-50.

Curtis, P. D., R. L. Pooler, M. E. Richmond, L. A. Miller, G. F. Mattfeld, and F. W. Quimby

2002 "Comparative Effects of GnRH and Porcine Zona Pellucida (PZP) Immunocontraceptive Vaccines for Controlling Reproduction in White-tailed Deer (*Odocoileus virginianus*)." *Reproduction Supplement* 60:131–41.

DeNicola, A. J., D. J. Kesler, and R. K. Swilhart

1997 "Remotely Delivered Prostaglandin $F_{2\alpha}$ Implants Terminate Pregnancy in White-tailed Deer." *Wildlife Society Bulletin* 25:527-31.

DeNicola, A. J., and R. K. Swihart

1997 "Capture-induced Stress in White-tailed Deer." *Wildlife Society Bulletin* 25(2):500-3.

D'Occhio, M. J., W. J. Aspden, and T. R. Whyte

1996 "Controlled, Reversible Suppression of Oestrous Cycles in Beef Heifers and Cows Using Agonists of Luteinizing Hormone Gonadotropin-Releasing Hormone." *Journal of Animal Science* 74:218–25.

Fagerstone, K. A., M. A. Coffey, P. D. Curtis, R. A. Dolbeer, G. J. Killian, L. A. Miller, and L. M. Wilmot
2002 "Wildlife Fertility Control." *Wildlife Society Technical Review* 02-2, 29 pp.

Fraker, M. A.
2006 Personal communication between M. A. Fraker and Jenny Powers, Wildlife Veterinarian, Biological Resource Management Division, National Park Service, regarding SpayVac™ use in white-tailed deer.

Fraker, M. A., R. G. Brown, G. E. Gaunt, J. A. Kerr, and B. Pohajdak
2002 "Long Lasting Single Dose Immunocontraception of Feral Fallow Deer in British Columbia." *Journal of Wildlife Management* 66(4):1141-47.

Hazum, E., and P. M. Conn
1988 "Molecular Mechanisms of Gonadotropin Releasing Hormone (GnRH) Action: I. The GnRH Receptor." *Endocrine Review* 9 (4): 379–86.

Hobbs, N. T., D. C. Bowden, and D. L. Baker
2000 "Effects of Fertility Control on Populations of Ungulates: General, Stage-Structured Models." *Journal of Wildlife Management* 64 (2): 473-91.

Kilpatrick ,J. F., I. K. M. Liu, J. W. Turner, R. Naugle, and R. Keiper
1992 "Long term Effects of Porcine Zona Pellucidae Immunocontraception on Ovarian Function in Feral Horses (*Equus caballus*)." *Journal of Reproduction and Fertility* 94:437–44.

Kilpatrick, H. J., S. M. Spohr, and A. J. DeNicola
1997 "Darting Urban Deer: Techniques and Technology." *Wildlife Society Bulletin* 25 (2): 542-46.

Kilpatrick, H. J., and W. D. Walter
1997 "Urban Deer Management: A Community Vote." *Wildlife Society Bulletin* 25:388–91.

Kirkpatrick, J. F., J. W. Turner, Jr., I. K. M. Liu, R. Fayer-Hosken, and A. T. Rutberg
1997 "Case Studies in Wildlife Immunocontraception: Wild and Feral Equids and White-tailed Deer." *Reproductive Fertility and Development* 9:105–10.

Knox, W. M., K. V. Miller, and R. L. Marchinton
1988 "Recurrent Estrous Cycles in White-tailed Deer." *Journal of Mammalogy* 69:384-86.

Matschke, G. H.
1977 "Antifertility Action of Two Synthetic Progestins in Female White-tailed Deer." *Journal of Wildlife Management* 41:194-6.

McShea, W. J., and J. H. Rappole
1997 "Herbivores and the Ecology of Forest Understory Birds." Pp. 298-309 in W. J. McShea, H. B. Underwood and J. H. Rappole (eds.), *The Science of Overabundance, Deer Ecology and Population Management*. Washington, D.C.: Smithsonian Institution Press.

McShea, W. J., S. L. Monfort, S. Hakim, J. Kirkpatrick, I. Liu, J. W. Turner, Jr., L. Chassy, and L. Munson
1997 "The Effect of Immunocontraception on the Behavior and Reproduction of White-tailed Deer." *Journal of Wildlife Management* 61:560-9.

Miller, L. A., J. C. Rhyan, and M. Drew
2004 "Contraception of Bison by GnRH Vaccine: A Possible Means of Decreasing Transmission of Brucellosis in Bison." *Journal of Wildlife Diseases* 40:725-30.

Miller, L. A., K. Crane, S. Gaddis, and G. J. Killian
2000 "Immunocontraception of White-tailed Deer with GnRH Vaccine." *American Journal of Reproductive Immunology* 44:266-74.

2001 "Porcine Zona Pellucida Immunocontraception: Long-term Health Effects on White-tailed Deer." *Journal of Wildlife Management* 65 (4): 941-5.

Muller, L. I., R. J. Warrnen, and D. L. Evans
1997 "Theory and Practice of Immunocontraception in Wild Animals." *Journal of Wildlife Management* 25 (2): 504–14.

Porter, W. F., H. B. Underwood, and J. L. Woodward
2004 "Movement Behavior, Dispersal, and the Potential for Localized Management of Deer in Suburban Environments." *Journal of Wildlife Management* 68 (2): 2223-34.

Rudolph, B. A., W. F. Porter, and B. H. Underwood
2000 "Evaluating Immunocontraception for Managing Suburban White-tailed Deer in Irondequoit, New York." *Journal of Wildlife Management* 64:463-73.

Rutberg, A. T., R. E. Naugle, L. A. Thiele, and I. K. M. Liu
2004 "Effects of Immunocontraception on a Suburban Population of White-tailed Deer *Odocoileus virginianus*." *Biological Conservation* 116:243-50.

Trigg, T. E., P. J. Wright, A. F. Armour, P. E. Williamson, A. Junaidi, G. B. Martin, A. G. Doyle, and J. Walsh
2001 "Use of a GnRH Analogue Implant to Produce Reversible Long-term Suppression of Reproductive Function in Male and Female Domestic Dogs." *Journal of Reproduction and Fertility Supplement* 57:255-61.

Turner, J. W., Jr., I. K. M. Liu, D. R. Flanagan, A. T. Rutberg, and J. F. Kirkpatrick
2007 "Immunocontraception in Wild Horses: One Inoculation Provides Two Years of Infertility." *The Journal of Wildlife Management* 71:662-7.

Turner, J. W., Jr., J. F. Kirkpatrick, and I. K. M. Liu
1992 "Remotely Delivered Immunocontraception in Captive White-tailed Deer." *Journal of Wildlife Management* 56 (1): 154-7.

1996 "Effectiveness, Reversibility and Serum Antibody Titers Associated with Immunocontraception in Captive White-tailed Deer." *Journal of Wildlife Management* 60:45-51.

U.S. Department of Agriculture (USDA)
2004 *GnRH: Deer Population Control*. Wildlife Services. Animal and Plant Health Inspection Service. Available on the Internet at http://www.aphis.usda.gov/ws/nwrc/ research/reproductive_control.

Waddell, R. B., D. A. Osborn, R. J. Warren, J. C. Griffin, and D. J. Kesler
2001 "Prostaglandin F2α – Mediated Fertility Control in Captive White-tailed Deer." *Wildlife Society Bulletin* 29:1067-74.

Walter, W. D., P. J. Perkins, A. T. Rutberg, and H. J. Kilpatrick
2002a "Evaluation of Immunocontraception in a Free-ranging Suburban White-tailed Deer Herd." *Wildlife Society Bulletin* 30:186-92.

2002b "Evaluation of Immunocontraceptive Adjuvants, Titers, and Fecal Pregnancy Indicators in Free-ranging White-tailed deer." *Wildlife Society Bulletin* 30:908-14.

Warren, R. J.
2000 "Overview of Fertility Control in Urban Deer Management." In *Proceedings of the 2000 Annual Conference for the Society of Theriogenology, 2 December 2000, San Antonio, Texas*, 237–46. Nashville, TN: Society for Theriogenology.

This page intentionally left blank.