Chesapeake and Ohio Canal and Harpers Ferry National Historical Parks
West Virginia, Maryland, Virginia

U.S. Department of the Interior
National Park Service

White-tailed Deer Management Plan and Environmental Assessment

CHESAPEAKE AND OHIO CANAL AND HARPERS FERRY NATIONAL HISTORICAL PARKS

April 2017

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

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PROJECT SUMMARY

The National Park Service (NPS) prepared this White-tailed Deer Management Plan and Environmental Assessment (plan/EA) to evaluate a range of alternatives for managing white-tailed deer (*Odocoileus virginianus*) at two parks, Chesapeake and Ohio Canal (C&O Canal) and Harpers Ferry National Historical Parks (NHP) (the parks), and to assess the impacts that could result from continuation of the current management framework (no action alternative) or implementation of any of the action alternatives. The plan is needed because:

- Deer have the potential to become the dominant force in the parks' ecosystems and adversely affect native vegetation and other wildlife.
- Browsing and other damage to native seedlings, saplings, and understory vegetation by deer in the parks has prevented successful forest regeneration, and resulted in undesirable changes to the forest.
- Attainment of the parks' cultural landscape preservation and restoration goals and mandates are compromised by the high density of deer.
- Opportunities exist to improve coordination with other nearby jurisdictional entities currently implementing deer management actions and other stakeholders.
- Chronic wasting disease (CWD) has been identified in deer near the parks and represents an imminent threat to park resources. Opportunities exist to evaluate and plan responses to threats from CWD over the long term and help maintain the overall health of the deer herds in the two parks.

The alternatives include various deer management actions as well as actions that address detection and response to CWD. Deer management alternatives include the following:

Alternative A: No Action—Continue current management actions, including deer and vegetation monitoring, research, use of protective caging and tree tubes as needed, education and interpretation, opportunistic and targeted sampling for CWD, and agency/interjurisdictional cooperation. No new actions would be taken to reduce the effects of deer overbrowsing.

The action alternatives include the following deer management options:

Alternative B: Nonlethal Deer Management—Includes all actions described under alternative A and several additional management techniques that could be used to prevent adverse deer impacts, such as changing crop configurations or crop selection at the parks, using repellents for short-term situations or over growing seasons, and using aversive conditioning in selected areas or at specific times. The main focus of deer management under alternative B would be the use of a combination of nonlethal actions, including the construction of large-scale deer exclosures for the purpose of vegetation restoration; the installation of fencing to protect gardens, restoration areas, or agricultural fields; and the use of nonsurgical reproductive control of does to restrict deer population growth in the implementation areas so vegetation can recover. Any reproductive control agent used must meet NPS-established criteria (these criteria are described in "Chapter 2, Alternative B: Nonlethal Deer Management").

Alternative C: Lethal Deer Management—Includes all actions described under alternative A and the additional management techniques described under alternative B. Instead of large-scale exclosures and reproductive control, alternative C adds a primary focus of using lethal deer management actions to reduce the herd size. Direct reduction of the deer herd would be accomplished mainly by controlled harvest programs in designated implementation areas through sharpshooting with firearms and/or selective use of archery by park staff or authorized agents. Use of capture and euthanasia of individual deer would be limited to those few circumstances where sharpshooting would not be considered appropriate due to safety concerns.

Alternative D: Combined Lethal and Nonlethal Deer Management—Is the same as alternative C, but adds the potential use of reproductive control to maintain deer populations after the initial population density has been reduced. Lethal actions (including sharpshooting, with very limited capture/euthanasia if necessary) would be taken initially in designated implementation areas to reduce the deer herd numbers quickly. Population maintenance could be conducted either by nonsurgical reproductive control methods, if these are available and meet NPS criteria, or by sharpshooting, both in implementation areas. Both of these population maintenance methods are retained as options under alternative D to maintain maximum flexibility for future management.

All three action alternatives include a long-term CWD management plan to address concerns about CWD and its proximity to the parks. This plan includes the use of sharpshooting to substantially reduce deer density once CWD is in close proximity to the parks because high deer population densities generally support greater rates of CWD transmission and have found to be positively correlated with the prevalence of CWD.

How to Comment

Agencies and the public are encouraged to review and comment on the contents of this plan/EA during the 30-day public review and comment period. We invite you to comment on this plan, and you may do so by any one of several methods. The preferred method of providing comments is through the NPS's Planning, Environment, and Public Comment (PEPC) website for the park at: http://parkplanning.nps.gov NHPdeermanagement. You may also submit written comments to

Superintendent
C&O Canal NHP
c/o White-tailed Deer Management Plan and Environmental Assessment
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740-6620

Or

Superintendent
Harpers Ferry NHP
c/o White-tailed Deer Management Plan and Environmental Assessment
P.O. Box 65
Harpers Ferry, WV 25425-0065

Only written comments will be accepted. Please submit your comments within 30 days of the posting of the notice of availability on the PEPC website. **Please be aware that your entire comment will become part of the public record. If you wish to remain anonymous, please clearly state that within your correspondence; however, NPS cannot guarantee that personal information, such as email address, phone number, etc., will be withheld.**

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CHAPTER 1: PURPOSE AND NEED

INTRODUCTION

The National Park Service (NPS) prepared this White-tailed Deer Management Plan and Environmental Assessment (plan/EA) to evaluate a range of alternatives for managing white-tailed deer (*Odocoileus virginianus*) at two parks, Chesapeake and Ohio Canal (C&O Canal) and Harpers Ferry National Historical Parks (NHP) (hereafter referred to as the parks), and to assess the impacts that could result from continuation of the current management framework (no action alternative) or implementation of any of the action alternatives. The white-tailed deer management plan that is selected will guide future actions for at least the next 15 to 20 years. The plan is being prepared for both parks at once because Harpers Ferry is adjacent to the C&O Canal NHP and shares similar concerns about deer density and forest regeneration.

An EA considers a range of alternatives and their potential impacts on the environment. This EA has been prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA), and implementing regulations, 40 Code of Federal Regulations (CFR) 1500–1508, and NPS *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision Making* (NPS 2011a) and the associated handbook (NPS 2001), as well as the new *NEPA Handbook* (NPS 2015a).[1] Compliance with section 106 of the National Historic Preservation Act (NHPA) of 1966 and with section 7 of the Endangered Species Act of 1973 has been conducted in conjunction with the NEPA process.

PURPOSE OF AND NEED FOR ACTION

The purpose of the plan/EA is to develop a white-tailed deer management strategy that supports long-term protection, preservation, and restoration of native vegetation and other natural and cultural resources and landscapes and provides for the management of chronic wasting disease (CWD) in the parks.

The plan is needed because:

- The potential exists for deer to become the dominant force in the park's ecosystem and adversely affect native vegetation and other wildlife.
- Browsing and other damage to native seedlings, saplings, and understory vegetation by deer in the parks has prevented successful forest regeneration and resulted in unacceptable changes to the forest.
- Attainment of the parks' cultural landscape preservation and restoration goals and mandates are compromised by the high density of deer.
- Opportunities exist to improve coordination with other nearby jurisdictional entities currently implementing deer management actions and other stakeholders.
- CWD has been identified in deer near the parks and represents an imminent threat to park resources. Opportunities exist to evaluate and plan responses to threats from CWD over the long term and help maintain the overall health of the deer herds in the two parks.

[1] This document represents a hybrid approach between old (NPS 2001) and new guidance (NPS 2015a) because the EA was in progress when the new guidance was issued. In such cases, NPS has the option to follow either guidance direction per the Assistant Director of Natural Resource Stewardship and Science.

PROJECT AREA

Both the C&O Canal and Harpers Ferry NHPs are located in the NPS National Capital Region (NCR) within approximately two hour's drive from Washington, DC (figure 1). The C&O Canal NHP parallels the Potomac River for 184.5 miles, extending from Washington, DC, to Cumberland, Maryland, through areas of rapid development and more rural areas.

Harpers Ferry NHP lies at the confluence of the Potomac and Shenandoah Rivers where the state lines for Maryland, Virginia, and West Virginia meet. The park is located in and around the town of Harpers Ferry, West Virginia, and includes land in Jefferson County, West Virginia; Washington County, Maryland; and Loudoun County, Virginia. It is an extremely dynamic area that consists of rivers, riparian areas, agricultural fields, historical towns, and forests, all within 50 miles of Washington, DC. The park contains 3,745 acres. Frederick, Maryland, a fast-growing city, is just northeast of Harpers Ferry NHP.

The planning area for this plan/EA includes all of C&O Canal NHP, excluding the portion of C&O Canal NHP that is in the District of Columbia, and Harpers Ferry NHP.

PARK BACKGROUNDS

CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

History of the Chesapeake and Ohio Canal National Historical Park

The C&O Canal NHP was established on January 8, 1971, by Public Law 91-664, which mandated NPS to "preserve and interpret the historic and scenic features of the Chesapeake and Ohio Canal, and to develop the potential of the canal for public recreation..." The mission statement of C&O Canal NHP is "to safely protect and preserve the park's cultural and natural resources, to educate the public about those resources, and to provide for public recreation and enjoyment."

Stretching along the Potomac River from Georgetown in Washington, DC, to Cumberland, Maryland, the canal served as a major transportation corridor operating as a conduit for coal, lumber, and agricultural products to propel western development and satisfy demands from eastern US markets (figure 1). Construction on the canal, which was intended to connect Chesapeake Bay to the Ohio River, began in 1828. Falling short of the original vision for the canal, construction ended in Cumberland in 1850, and the canal remained in operation until 1924.

Some of the park's historical significance stems from the canal's proximity to the Potomac River. The Potomac was a major dividing line between the Union and the Confederacy during the Civil War, causing the canal to be strategically significant to both sides. The canal was used by the Union for transportation of troops, coal, and war supplies. Confederates were known to attack the canal and boat traffic along it. When the war came to the state of Maryland, the towpath was a constantly travelled road used by both sides. In the 19th and early 20th century, the C&O Canal provided opportunities and employment to people throughout the Potomac River Valley. As improvements in technology and transportation occurred over the years, the canal became obsolete as a means of conducting business.

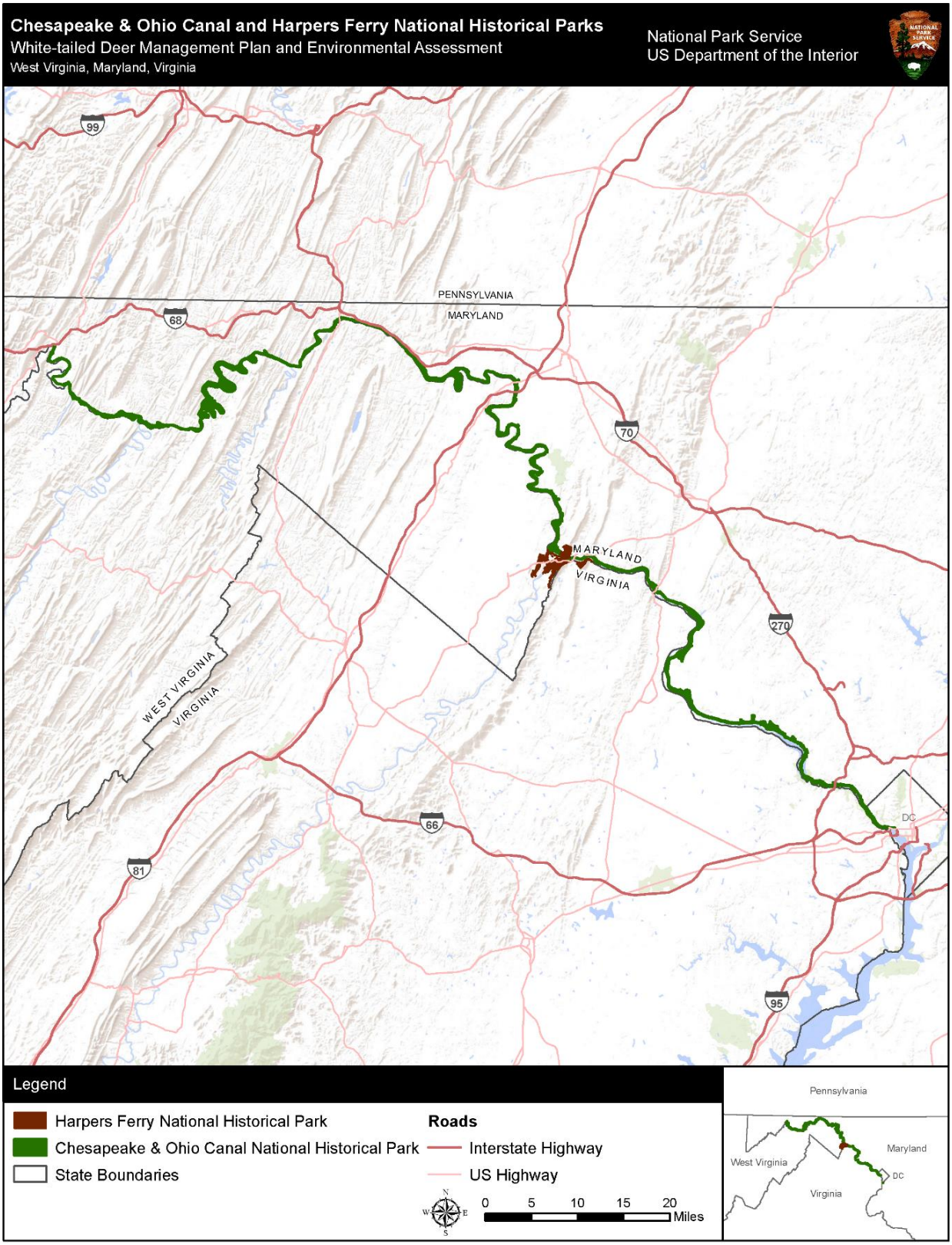

FIGURE 1. CHESAPEAKE AND OHIO CANAL AND HARPERS FERRY NATIONAL HISTORICAL PARKS

Purpose and Significance of the Chesapeake and Ohio Canal National Historical Park

The purpose of the C&O NHP is to preserve and interpret the 19th century transportation canal and its associated scenic, natural, and cultural resources, as well as provide opportunities for education and outdoor recreation.

The foundation document (NPS 2013) has identified several significance statements, two of which are pertinent to deer management efforts:

- The 15-mile-long Potomac Gorge, managed in part by C&O Canal NHP, is one of the most biologically diverse natural areas in the national park system.
- Paralleling the Potomac River for 184.5 miles and travelling through four physiographic provinces, C&O Canal NHP provides a natural buffer of forest, woodlands, prairies, and barrens and a wildlife corridor along the second-largest tributary to the Chesapeake Bay.

HARPERS FERRY NATIONAL HISTORICAL PARK

History of Harpers Ferry National Historical Park

Harpers Ferry NHP was established to commemorate historical events that occurred at or near Harpers Ferry, West Virginia (figure 2). Harpers Ferry witnessed the first successful application of interchangeable manufacture, John Brown's attack on slavery, the largest surrender of federal troops during the Civil War, and the education of former slaves in one of the earliest integrated schools in the United States. It was designated as the second Federal Armory in 1796 and served as the principal supply base for Union military operations in the Shenandoah Valley during campaigns in 1862, 1863, and 1864. In 1944, the area was originally designated as Harpers Ferry National Monument, but was named a National Historical Park by the US Congress on May 29, 1963.

Purpose and Significance of Harpers Ferry National Historical Park

The purpose of Harpers Ferry NHP as stated in the 1944 original enabling legislation is to "maintain and preserve [the park] for the benefit and enjoyment of the people of the United States." According to the legislation, acquired existing structures will be maintained while relics and records pertaining to historical events that took place at Harpers Ferry, or items of national or patriotic interest, shall be stored in a museum. Points of interest within Harpers Ferry shall have roadways, facilities, and markers associated with them.

The significance of the park originates from its geography, which made Harpers Ferry a key travel, trade, and communication crossroad from the time of early American Indians to the present, specifically the historic events described in the previous section.

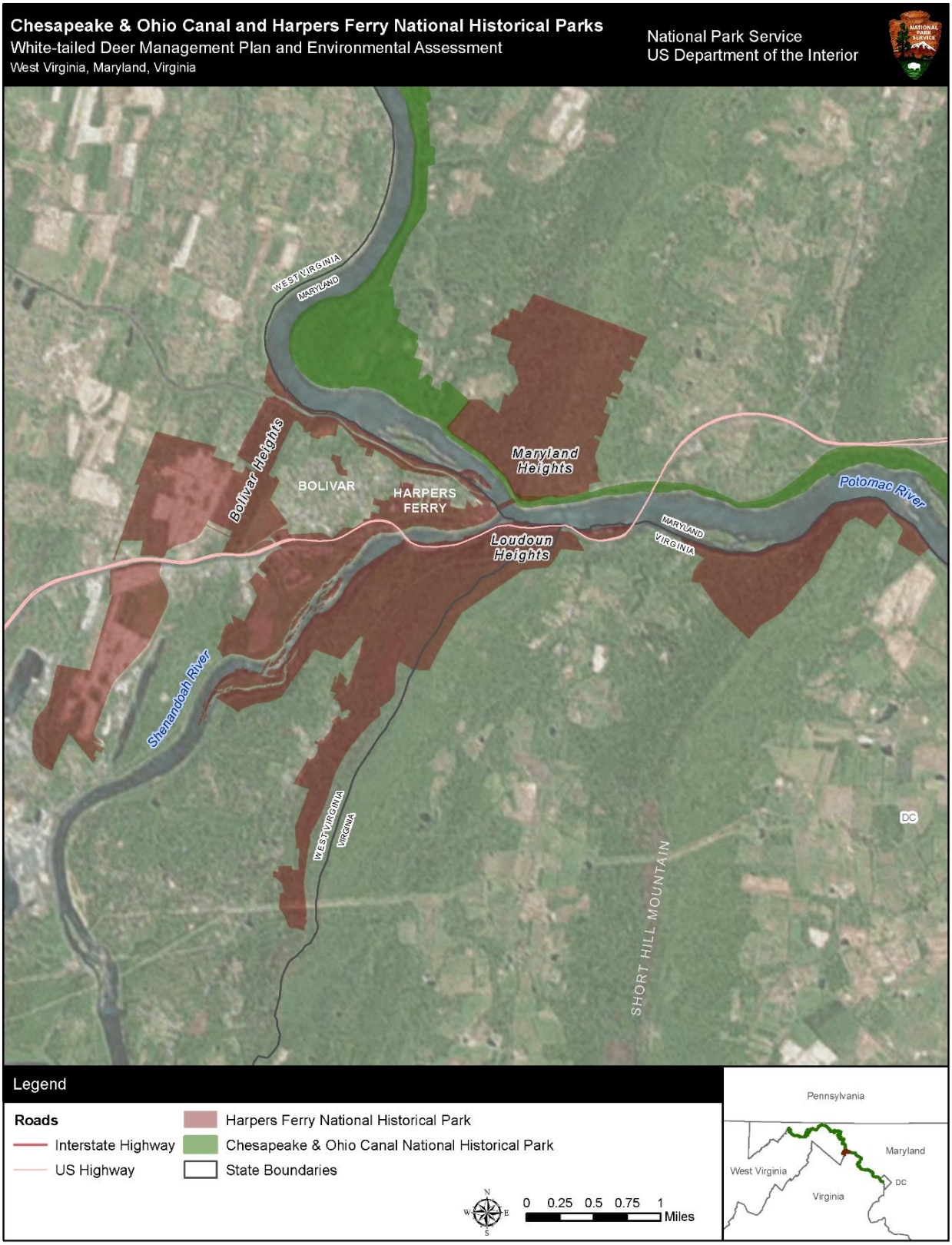

FIGURE 2. HARPERS FERRY NATIONAL HISTORICAL PARK

PROJECT BACKGROUND

DEER MANAGEMENT AT THE PARKS

Since 2000, C&O Canal NHP staff has conducted deer density surveys and maintained vegetation monitoring plots at the Gold Mine tract at Great Falls. Overall, NPS maintains 75 plots in the park, the majority of which are in the Washington and Montgomery County portions of the park (NPS, Schmit, pers. comm. 2016a). The park is implementing agricultural and wetland restoration plans for locations in which deer management activities could occur (e.g., Canal/Chick Farm). The park has also coordinated with its adjacent counties (Montgomery County and Washington County, Maryland) concerning deer management plans for these counties. Given the limited park resources available for surveying and the widely recognized importance of its vegetation communities, deer density surveys have been focused only at Potomac Gorge. Deer density at the Gold Mine tract was estimated at 142 deer per square mile in 2010, 67 deer per square mile in 2014, and 148 deer per square mile in 2015. Both parks have also assessed other related parameters such as herd health, vegetation conditions, and forest regeneration. Deer density at the parks where monitoring has occurred has varied from year to year but remains consistently high.

Harpers Ferry NHP staff has monitored all parts of the park, although monitoring has been focused on Maryland Heights. At Harpers Ferry, park staff began to notice effects from deer overabundance and overbrowsing in 1998 and installed 100 deer pellet plots on Maryland Heights in 1999. The plots were 4 meters by 22 meters but changed to 1-square-meter plots in 2004. In 2010, Harpers Ferry worked with the US Geological Survey to install 12 deer exclosures on Maryland Heights, 3 exclosures on Bolivar Heights, and 3 exclosures on Short Hill. In 2011, park staff conducted an infrared scan that confirmed the presence of large numbers of white-tailed deer, and later in 2013 another 18 deer exclosures were erected on Loudoun Heights. In addition, park staff has conducted deer surveys on Maryland Heights with digital trail cameras to estimate deer densities since 2012. Availability of personnel determines the number of cameras used—ten cameras were used in 2012; five in 2013, and nine in 2014. Staff from the US Department of Agriculture, Animal and Plant Health Inspection Service (APHIS)-Wildlife Services also has conducted a ground-based infrared survey at the Murphy Farm and counted approximately 260 deer per square mile (NPS, Nisbet, pers. comm. 2016b).

The parks also conduct occasional opportunistic sampling for CWD—a transmissible neurological disease of deer that produces small lesions in brains of infected animals—from deer found as road kill or that died naturally. CWD has been found in deer approximately 2 miles from C&O Canal NHP and 45 miles from Harpers Ferry NHP.

Vegetation monitoring via exclosure studies has been used to study deer impacts on vegetation at both parks. Open plots have been sampled in a different study once every four years since 2006 by the NPS NCR Inventory and Monitoring Program. Data provided by these plots are used to calculate forest regeneration information. A park is considered to have sufficient forest regeneration if 67% of its vegetation plots are adequately stocked with tree seedlings (Schmit 2014). C&O Canal and Harpers Ferry NHPs both have less than 20% of their vegetation plots stocked adequately and do not have sufficient forest regeneration (Schmit 2014). These results are directly attributable to deer browsing and indicate that deer affect the understory structure, which diminishes the value of habitat for other wildlife.

DEER MANAGEMENT IN ADJACENT JURISDICTIONS

Deer management has been initiated in most of the larger parcels of parkland in Montgomery County, Maryland, nearly all state parkland, most of the property owned by the Washington Suburban Sanitary Commission upstream of Great Falls, and several other publicly owned properties in the vicinity of both parks. Nearly 30,000 acres of public land are now being managed for deer in Montgomery County. Deer populations have been reduced on average by more than 59%, and some state parks are seeing reductions of 84% to 89%. Some areas on Montgomery County lands have seen a reduction from 200 deer per square mile to a more acceptable density of around 30 per square mile or less, and fewer deer-vehicle

collisions have occurred around the parks where deer management is occurring (Montgomery County Deer Management Workgroup 2014). Deer management in Montgomery County is focused on issues related to high population density, not CWD. The county does not have a specific CWD element in its plan.

The county acquires its data by aerial and distance surveys and holds a meeting once a year to discuss progress and issues related to deer management. Park and county staff discussed the benefits of holding an annual meeting for C&O Canal NHP and Harpers Ferry NHP to discuss the effects of their deer management planning as implementation takes place. It is currently unknown whether deer management in Montgomery County is affecting deer density in C&O Canal NHP; however, there are no county parks near the Gold Mine tract. Additional data sampling likely would be necessary to determine this. County monitoring of vegetation and its recovery on county land has been minimal, and county resource personnel are reassessing their vegetation goals. Hunting is permitted on lands adjacent to both parks, including state lands and land owned by private organizations such as game and hunting clubs, and therefore must be considered in the management plan. The town of Harpers Ferry started a deer management program in 2012. It consisted of installing eight cameras around the town to monitor deer activity and estimate deer populations and hiring archery sharpshooters. The first year, the sharpshooters removed 28 deer from the area; in 2013, an additional 24 deer were removed; 17 deer were removed in 2014; and 5 deer were removed in 2015. Removal numbers in 2015 were lower because West Virginia did not allow bait stations because of CWD policy. The town of Harpers Ferry is completely surrounded by Harpers Ferry NHP, so if the deer population were lowered in the park, then the deer population most likely would decrease in town.

DEER MANAGEMENT IN MARYLAND, VIRGINIA, AND WEST VIRGINIA

Maryland White-tailed Deer Management Plan 2009–2018

The 2009–2018 Maryland White-tailed Deer Management Plan (MD DNR 2009) documents the history of white-tailed deer and white-tailed deer management in Maryland and describes the current status of white-tailed deer in Maryland and the positive and negative impacts of the species. The plan documents the responsibilities of the Maryland Department of Natural Resources (MD DNR) deer management program and other MD DNR staff as they relate to white-tailed deer management and outlines the goals and objectives for Maryland white-tailed deer management through 2018. The primary responsibilities of the plan can be grouped into five main categories: (1) deer population regulation; (2) deer population monitoring; (3) information and education; (4) addressing constituent demands; and (5) other management activities.

Hunting, particularly of antlerless deer, is a major cornerstone of the Maryland deer management program. The plan states "No other management strategy for regulating deer populations is as effective or as economical as deer hunting, and hunting is necessary to keep deer populations from growing beyond their biological carrying capacity" (MD DNR 2009). The plan also recommends and includes other deer management techniques in addition to hunting, recognizing that some communities incur deer problems within landscapes that are not conducive to hunting or other lethal management. The plan states that nonlethal deer management options can be effective in small areas or where deer are not overly abundant, but that nonlethal options often are ineffective for managing larger landscapes or reducing a local deer population sufficiently to reduce problems with humans or ecological effects.

Maryland's statewide deer population prior to the 2012–2013 hunting season was estimated at approximately 223,000 deer. The total number of deer harvested in Maryland during the 2012–2013 season was 87,541, which represents a 12% decline from the previous year's total of 98,029.

Virginia Deer Management Plan, Revised 2015

The first Virginia Deer Management Plan was completed in 1999, subsequently revised in 2006, and revised again in 2015. The plan incorporates input from various stakeholders, including sportsmen,

homeowners, agricultural producers, the commercial timber industry, and resource management agencies. The revised deer management plan guides management activities through 2024. The plan summarizes the history of white-tailed deer management, the current population status and hunting statistics, and future management initiatives. The plan addresses the deer population, habitat, damage, and deer-related recreation (VDGIF 2015a).

The big game checking system is the foundation of Virginia's deer management program. The check system, which is administered by the Wildlife and Law Enforcement Divisions, provides actual harvest numbers per county by requiring hunters to check every harvested deer to receive an official game tag. Check stations collect information on the animal's sex, date of kill, type of weapon used, and county of kill.

The Virginia Deer Management Plan describes several types of management programs in the state, including regulated hunting, mandatory checking, deer management assistance program, kill permits, the Damage Control Assistance Program, and the deer population reduction program. At the state level, deer harvest regulations are evaluated and revised every other year based on management goals. Regulation amendments may include adjustments to season lengths, bag limits, firearms seasons, and sex harvest permits. Deer harvest objectives and regulations are set on a county or management unit basis. Deer management objectives strive to achieve the cultural carrying capacity, which is defined as the number of deer that can coexist compatibly with humans. Most of Virginia's deer herds are below the biological carrying capacity, but exceed the cultural carrying capacity in several areas. In general, the density and health of the state's deer population is managed through antlerless deer hunting.

The Virginia Department of Game and Inland Fisheries (VDGIF) 2014 summary showed that 192,186 deer were harvested by hunters in Virginia, including 88,311 antlered bucks, 14,781 button bucks, and 89,026 does. The fall 2014 deer kill total was 22% lower than the previous year's reported harvest count and 17% lower than the last 10-year average of 230,422. Prior to that, the 2013 deer harvest summary indicates that 242,734 deer were taken, which was an increase of 13% over the 215,241 deer reported harvested in 2012 (VDGIF 2015b).

West Virginia Deer Management

West Virginia is revising its formal deer management plan (WVDNR 2011). A public hunting program for white-tailed deer is in place to help the state maintain its deer population at targeted levels. Each county sets harvest objectives to decrease or stabilize the population based on biological data (WVDNR, Rogers, pers. comm. 2016). Both deer and human populations are increasing in Jefferson County. The target deer density goal for the county is 15–20 deer per square mile (WVDNR 2011).

Most counties have antlerless deer seasons allowing the removal of does to lower fawn numbers in coming seasons. Special hunting permits for towns are available for localized deer reduction (e.g., the town of Harpers Ferry). In addition to its harvest management plan, the state may issue deer depredation permits, or wildlife damage permits, for deer reductions.

DEER MANAGEMENT EFFORTS WITHIN THE NATIONAL PARK SERVICE

Other national park system units have been involved in management planning efforts for deer and other ungulates. White-tailed deer plans and associated environmental impact statements have been completed and implementation is under way at several park units in the region, including Gettysburg National Military Park and Eisenhower National Historic Site, Valley Forge National Historical Park in Pennsylvania, Catoctin Mountain Park in Maryland, and Rock Creek Park in the District of Columbia. Additionally, a joint plan for Antietam National Battlefield, Monocacy National Battlefield and Manassas National Battlefield Park in Maryland and Virginia has been developed but not yet implemented. These parks have similar settings and habitat to what is found at the parks that are the topic of this plan/EA. The C&O Canal runs approximately 4 miles from Antietam and is approximately 30 miles from Manassas. Harpers Ferry is approximately 16 miles from Antietam and 23 miles from Monocacy. In addition,

Cuyahoga Valley National Park in Ohio also completed a deer management plan in 2014, and other park units on the east coast are developing plans.

The selected alternatives at all parks include sharpshooting to quickly reduce the number of deer, and some parks include reproductive control as a maintenance action to be used once the herd has been reduced to the desired deer density (assuming that there is an available reproductive control agent that is effective and meets NPS-established criteria, as described in "Chapter 2: Alternative B: Nonlethal Deer Management"). Gettysburg has the longest history of deer management; sharpshooting started in 1995. Results indicate that reducing deer density at Gettysburg has resulted in tree seedling regeneration and recruitment to sapling size and has made a substantial impact on the health of the forest and agricultural crops (NPS, Koenig, pers. comm. 2011b). After three removal actions that began at Catoctin in 2010, a measurable decrease in the deer population density occurred, from 123 to 66 deer per square mile, and vegetation monitoring indicates that seedling density has increased by eight to nine times since deer density was reduced from 123 to 15 deer per square mile in 2009 (NPS, Donaldson, pers. comm. 2016c). Although it is still early to judge the long-term impacts of deer management at Catoctin, these results are consistent with an improvement in forest regeneration (NPS, Donaldson, pers. comm. 2012a; Schmit et al. 2012a).

SCIENTIFIC BACKGROUND: DEER AND VEGETATION MANAGEMENT

DEER MANAGEMENT ISSUES AND RESEARCH OVERVIEW

Park staff have worked with technical experts and researchers to develop and implement methods and protocols for monitoring white-tailed deer population size and the impacts of browsing on forest plant communities. This research, in cooperation with local, state, federal, and regional entities, has informed the development of this plan/EA. Using other deer management efforts in the National Capital and other NPS regions, regional scientists established a monitoring protocol for deer populations and other resources at the parks, and established a basis for the resource thresholds at which deer management strategies would be implemented. Monitoring protocols and impact thresholds are a component of all action alternatives evaluated in the analysis, helping ensure that the deer population at the parks becomes a balanced component of a functioning ecosystem. Information evaluated by the technical experts and background materials provided by NPS are summarized in the sections that follow. Additional detail is provided in "Chapter 3: Affected Environment."

REGIONAL LANDSCAPE-LEVEL CHANGES

Before European settlement of North America, white-tailed deer populations are estimated to have been between 23 and 34 million (McCabe and McCabe 1984). Deer herds throughout the eastern United States were heavily exploited after the arrival of Europeans around 1600. By 1790, deer populations were low wherever Europeans had settled. However, since the early 1900s, as a result of low mortality rates because of a lack of predators, increased availability of food and habitat, stringent game regulations, and shortened hunting seasons, the deer population has increased. Today deer density in many areas of the eastern US exceeds 100 deer per square mile (Porter 1991), and researchers have established that such high deer densities have negative impacts on plant and animal species (Alverson, Waller, and Solheim 1988; Anderson 1994; Augustine and Frelich 1998; deCalesta 1994; McShea 2000; McShea and Rappole 2000; Côté et al. 2004).

Deer numbers have grown to an estimated current population in excess of 235,000 animals in Maryland (MD DNR 2011a), and in 2007, it was reported that Virginia's statewide deer population had been relatively stable during the past decade, fluctuating between 900,979 and 1,116,974 animals (mean of 945,000) (VDGIF 2015a). The West Virginia deer population was estimated at 825,000 in 2015 and has fluctuated between 750,000 and 900,000 in recent years (Deer Friendly 2015).

Deer thrive on habitat conditions created by suburban development. New roads, housing, and related enterprises fragment forests and farms and create "edge" habitats that provide plenty of food and ample shelter for deer. In addition, in national park system units in the eastern US, hunting is generally not allowed, and landscapes have traditionally been managed to allow for the preservation and rehabilitation of scenic and historic landscapes. The result is a mixture of forest, fields, shrub, and grassland, which constitutes excellent habitat for white-tailed deer. Direct impacts from intense deer browsing include reductions in plant species richness (number of species), plant density and biomass, height growth, and development of vertical structure. Loss of plant species and vertical structure, leading to the decline of animal species that depend on these plants, represents an indirect effect of browsing (Latham et al. 2005, Alverson, Waller, and Solheim 1988; Anderson 1994; Augustine and Frelich 1998; deCalesta 1994; McShea 2000; McShea and Rappole 2000).

POPULATION CHARACTERISTICS OF WHITE-TAILED DEER AT THE PARKS

At both parks, deer population trends, density, and health have been assessed through a variety of research and long-term monitoring projects, which are described in further detail in the "White-tailed Deer" section in the affected environment chapter. Deer density remains an important indicator of whether the deer population is affecting forest vegetation. The NCR distance sample protocols have been used to estimate deer density (NPS 2005a) where possible or, in cases where distance sampling is not feasible, wildlife cameras have been used for estimating. Counts have occurred at the Gold Mine tract at C&O Canal NHP and on Maryland Heights at Harpers Ferry NHP. As noted earlier in the chapter, deer density at both parks has varied from year to year, but remains consistently high in the areas surveyed.

OTHER VEGETATION MANAGEMENT ISSUES

Invasive nonnative plants pose a substantial threat to the integrity of natural ecosystems across the US. Spread of these species may affect native plant and animal communities by reducing the amount of light, water, nutrients, and available space. These changes in the native plant community can decrease habitat quality for native wildlife; alter hydrological patterns, soil chemistry, moisture-holding capacity, and erodibility; and cause changes in the fire regime (Randall 1996). The nonnative problem is particularly acute in urban parklands where extensive forest fragmentation and creation of "edge" environments, frequent human disturbance, and high deer densities enhance opportunities for invasive, nonnative plants to become established (NPS 2004a).

Executive Order 13112, "Invasive Species," requires federal agencies to control populations of such species in a cost-effective and environmentally sound manner. The parks will continue to manage nonnative invasive plants using multiple approaches, and NCR is developing a plan for all parks in the region. However, invasive plants are not the main cause of the resource issues that create the need for this deer management plan.

RELEVANT LAWS, REGULATIONS, PLANS, AND POLICIES

There are a number of federal laws, plans, and policies, including NEPA, NPS *Management Policies 2006*, executive orders, and others that are broadly applicable to this and other planning processes. Where they do apply, they are referenced in the appropriate place in this document. Several state and local plans are more uniquely relevant to this specific planning process, and are therefore described in this section.

STATE CHRONIC WASTING DISEASE PLANS AND POLICIES

The states of Maryland, Virginia, West Virginia, and Pennsylvania have developed response plans to address CWD in white-tailed deer populations. These four jurisdictions have been testing for CWD and implementing surveillance programs in recent years. The following summarizes the response and surveillance plans of these states.

Maryland Department of Natural Resources Wildlife and Heritage Service Chronic Wasting Disease Response Plan

This response plan was issued by the MD DNR Wildlife and Heritage Service and outlines Wildlife and Heritage Service management activities that address the disease's presence, determine the magnitude and geographic extent of the infection, and attempt to eliminate or control transmission of the disease.

In 2005, MD DNR developed a CWD response plan that outlines management activities intended to address the presence of CWD, help determine the magnitude and geographic extent of infection, and attempt to eliminate or control transmission of CWD. This plan is updated annually to reflect the current knowledge concerning CWD. The plan available at the time of this writing is dated 2015 (MD DNR 2015a). Included in this plan are general responses about CWD such as how to address the media and public relations, how to respond to positive CWD cases in free-ranging and captive deer in Maryland, and how to respond to discovery of CWD near the Maryland border (MD DNR 2011b, 2015a).

The Maryland CWD response plan details a systematic approach to detecting and determining the extent of CWD. If a positive CWD case is found, a CWD management area and a CWD surveillance area is established, and the state begins sampling deer to determine the prevalence of CWD. If no new cases are detected within the management area within five years, the area is considered CWD free. The state of Maryland also has established a program for responding to the potential discovery of CWD within 10 miles of the state border. Upon notification from an adjacent state of a CWD positive case within 5 miles of a Maryland border, sampling intensity increases substantially (MD DNR 2015a).

Beginning in 2010, sampling shifted to focus on Allegany and western Washington counties. These two counties were considered "high-risk" due to the growing incidence of CWD in Hampshire County, West Virginia, where CWD has been detected within approximately 6 miles of the Maryland border. CWD was also detected in Frederick County, Virginia, which is adjacent to the original West Virginia outbreak, in 2009 and 2010. The deer population in the remaining 13 counties of the state is considered low-risk because there are fewer captive deer facilities and the densities of free-ranging deer are lower (MD DNR 2011a).

MD DNR collects 50 random samples from hunter-harvested deer in each of the 10 high-risk counties and 30 samples from each of the 13 low-risk counties. Between 2002 and 2009, a total of 6,785 deer were tested in the state with no positive results (MD DNR 2011a). However, in February 2011, MD DNR was notified that one of the 360 samples collected from deer during the 2010–2011 hunting season tested positive for CWD. The infected deer was a yearling male harvested in November 2010 in Allegany County, Maryland, near where CWD is present in West Virginia (MD DNR 2015a). West Virginia confirmed CWD in free-ranging deer during 2005 in Hampshire County, approximately 9.5 miles south of the Maryland-West Virginia border of Allegany County.

Virginia Chronic Wasting Disease Plans

The Virginia CWD Response Plan is focused on preventing CWD introduction. If CWD is identified in Virginia or within 5 miles of the Virginia border, VDGIF is responsible for implementing a CWD response plan in the state. The CWD Response Plan, updated in 2012, outlines management activities to determine the prevalence and geographic extent of CWD infection and to control transmission of the disease (VDGIF 2012a). Acknowledging the fact that other states have not been able to eradicate CWD from free-ranging deer populations, the goal of the Virginia CWD Response Plan is to contain or slow the spread of the disease in free-ranging deer (VDGIF 2012a). The plan also contains provisions for captive populations.

If a positive CWD case is found, a surveillance area is established, and the state begins sampling deer to determine the prevalence of CWD. During the first hunting season following the confirmed diagnosis of CWD in Virginia, or within 5 miles of the Virginia border, mandatory testing of all hunter-harvested free-ranging deer greater than 6 months of age within the 79 square mile surveillance area is implemented. If

the one-year mandatory testing in the CWD surveillance area yields no new positive CWD cases, the state conducts limited testing on hunter-killed deer for the next several years. If additional positive cases are detected within the surveillance area, the plan establishes a containment area. The objectives for the containment area are to monitor the prevalence and geographic extent of the CWD and contain or slow the spread of the disease. To achieve CWD containment, multiple management techniques are employed including, but not limited to, population reduction, extended deer season and increased bag limits, mandatory CWD testing in surveillance areas, special designated CWD check station, prohibition of deer rehabilitation and deer feeding, prohibition of carcass transportation, and implementation of necessary depopulation and indemnification of captive cervids, fence security, and quarantine of cervid facilities. Containment areas are considered CWD free after five consecutive years of no new detections (VDGIF 2012a).

The Virginia plan includes response actions for discovery of CWD within 50 miles of the state border as well. This plan includes identifying all Virginia counties that are partially or wholly included in the 50-mile radius of the first positive CWD case as high-risk areas and surveillance is initiated per the VDGIF surveillance plan. The plan also contains provisions for captive populations.

Due to the 2005 positive CWD case in West Virginia that was within 50 miles of the Virginia border, the state of Virginia partially activated its CWD response plan. As a result, approximately 1,000 square miles of the western and northern portions of the Shenandoah, Frederick, Clarke, and Loudoun Counties were designated as an active surveillance area. Surveillance of road-killed and hunter-harvested deer in this area resulted in the collection of 559 samples. In addition, enhanced targeted surveillance was conducted in the high-risk and medium-risk areas, and targeted surveillance was conducted in the low-risk areas. Furthermore, CWD testing of elk and captive cervids was continued. This resulted in the collection of 749 samples during 2005. In 2006 the same surveillance strategies were conducted; however, limited statewide active surveillance of road-killed white-tailed deer was performed. As a result, 919 samples were collected during 2006. In 2007, statewide active surveillance of road-killed and hunter-harvested deer was conducted with an emphasis on sampling deer from western Frederick County as well as statewide targeted surveillance (VDGIF 2009). The first CWD positive deer identified in Virginia was detected in Frederick County in 2009. A second positive CWD case was detected in Frederick County during the 2010 hunting season, less than 2 miles away from the first. As a result of these detections, VDGIF designated a CWD containment area and initiated a CWD response management action plan. Two more positive cases were diagnosed in 2011 within 1 mile of the previous positive cases (VDGIF 2012a).

In 2012, VDGIF released its updated 2012–2013 CWD Surveillance and Management Plan to address further CWD detections in West Virginia (VDGIF 2012b). The plan identifies a range of potential measures and specific surveillance strategies that will be used in each of the areas, including statewide active surveillance of road-killed and hunter-killed deer, and intensive active surveillance in the containment area of Frederick and Shenandoah Counties.

West Virginia Chronic Wasting Disease Plan

In September 2005, CWD was detected in a road-killed deer in Hampshire County, West Virginia, near Slanesville. The West Virginia Division of Natural Resources (WVDNR) immediately implemented its CWD response plan designed to accomplish the following objectives:

- determine the distribution and prevalence of CWD through enhanced surveillance efforts;
- communicate and coordinate with the public and other appropriate agencies on issues relating to CWD and the steps being taken to respond to this disease; and
- initiate appropriate management actions necessary to control the spread of this disease, prevent further introduction of the disease, and possibly eliminate the disease from the state (WVDNR 2006).

The state's goal is to estimate the CWD prevalence with 98% confidence that CWD occurs at less than 1% prevalence in the area where the disease is found. In addition the state will sample deer statewide to be 98% confident that if the disease is present at or above 1% prevalence, it will be detected. This plan also outlines communication and coordination procedures, disease management actions, and immediate logistical needs (WVDNR 2006).

The plan was updated in 2006 and includes increasing CWD surveillance in a 5-mile radius around the initial positive CWD detection and a 1-mile radius around subsequent positive detections. Samples from the remainder of Hampshire County are obtained primarily from hunter-harvested deer. In surrounding counties, samples come primarily from road-killed deer and deer taken as a result of crop damage. In these counties, approximately 300 animals would be tested to establish with 95% confidence that if CWD occurs at 1% prevalence or greater, it will be detected through sampling efforts. In Jefferson, Berkley, and Morgan Counties, the state goal is to sample approximately 259 road-killed deer to determine with 95% confidence that if CWD is present in the population at or above 1% prevalence, it will be detected (WVDNR 2007).

Implementation of this plan resulted in identification of 37 additional positive CWD cases, all located within Hampshire County. The 37 total positive test results came from 2 road-killed deer, 1 in 2005 and 1 in 2008; 12 hunter-killed deer, 1 during the 2006 season, 6 during the 2007 season, and 5 during the 2008 season; and 23 deer collected by West Virginia Division of Natural Resources staff, 4 in 2005, 5 in 2006, 4 in 2007, and 11 in 2008. Since 2002 a total of 8,485 deer were tested (WVDNR, Crum, pers. comm. 2009a). The WVDNR website reports that in the 2012 deer seasons, samples from 672 hunter-harvested deer brought to game checking stations in Hampshire County, 2 stations in northern Hardy County, and 1 station in northern Morgan County were tested for CWD. Sixteen samples were found to have the abnormal protein associated with CWD. CWD has now been detected in a total of 131 deer in Hampshire County and 2 deer in Hardy County. Lowering encounter rates between infected and non-infected animals by prohibiting artificial supplemental feeding and baiting are generally accepted management practices for slowing the spread of an infectious disease among wildlife and initiating these prohibitions on a statewide or regional basis for deer is a major tool used by other states combating CWD. As of February 2013, all of Hampshire County, the northern portion of Hardy County north of Corridor H and State Route 55, and the portion of Morgan County west of Route 522 have regulations prohibiting the baiting and feeding of deer (WVDNR 2014).

STATE HUNTING REGULATIONS

The following provides information about hunting regulations and guidelines in the states of Maryland, Virginia, and West Virginia. While the states have the legal mandate and authority over deer populations, NPS is not precluded from managing natural resources within park boundaries, including deer. As a general rule, NPS has broad authority to manage wildlife and other natural resources within the boundaries of units of the national park system. Language from 16 United States Code (USC) 1 (recently changed to 54 USC 1001101) states that NPS "shall promote and regulate the use of the Federal areas known as national parks…by such means and measures as conform to the fundamental purpose of the parks…to conserve the scenery and natural and historic objects and the wild life therein…." This ability to manage natural resources, specifically wildlife within park boundaries was upheld by *New Mexico State Game Commission v. Udall*, supra, whereby the 10th Circuit of Appeals reversed and remanded a lower court's ruling, stating that the killing of deer within Carlsbad Caverns National Park is allowed pursuant to 16 USC 3, if it is for the purpose of protecting park resources from animals that have a negative impact on its lands. The NPS ability to manage wildlife resources has also been upheld in *Kleppe v. New Mexico* and *United States v. Moore*, despite conflicting state laws. Additionally, the direct control of ungulates as a means to restore natural communities is specifically stated in NPS *Management Policies 2006* (NPS 2006).

MD DNR Wildlife Division, VDGIF, and WVDNR all have the legal mandate and legislated authority to manage deer populations throughout their states. As part of this function, they set the goals and regulations for deer management in the state. In Maryland, the long-term goal of the state is to (1) ensure the present and future well-being of deer and their habitat; (2) maintain deer populations at levels necessary to ensure compatibility with human land uses and natural communities; (3) encourage and promote the recreational use and enjoyment of the deer resource; and to inform and educate Maryland citizens about deer biology, management options, and the effects that deer have on landscapes and people. Deer regulations cover hunting hours, licensing and stamp requirements, daily limits, legal hunting devices, and the use of dogs in hunting. In Virginia, VDGIF has specific regulations regarding mandatory sampling in the CWD Containment Area around Frederick and Shenandoah Counties as well as restrictions on transportation and disposal of carcasses or deer parts out of that area. Similar to the other two states, West Virginia has hunting regulations that address when and how hunts occur and sets harvest goals for hunting based on the deer population in each county. Jefferson County, in which Harpers Ferry NHP is located, has had an expanding deer population that the state expects to be limited as development in the county increases (MD DNR 2014a; VDGIF 2016; WVDNR 2014).

ISSUES AND IMPACT TOPICS

Issues describe problems or concerns associated with current impacts from environmental conditions or current operations as well as problems that may arise from the implementation of any of the alternatives. Potential issues associated with the plan/EA were identified during internal and public scoping. The issues and concerns identified during scoping were grouped into impact topics that are described in "Chapter 3: Affected Environment" and analyzed in "Chapter 4: Environmental Consequences."

IMPACT TOPICS ANALYZED IN THIS PLAN/EA

VEGETATION

There is evidence that deer overabundance has affected forest regeneration at these parks, and there is a need to promote forest regeneration and restore the abundance, distribution, structure, and composition of native plant communities by reducing excessive deer impacts. As discussed earlier in this chapter, researchers have established that high deer densities found in the parks have negative impacts on plant and animal species (Alverson, Waller, and Solheim 1988; Anderson 1994; Augustine and Frelich 1998; deCalesta 1994; McShea 2000; McShea and Rappole 2000; Côté et al. 2004), and NPS research and monitoring has shown a decline in forest structure that can be associated with deer (Schmit et al. 2012a). Indirect effects on the prevalence of nonnative species that are tangentially related to the alternatives considered may also occur because deer may browse these species or disperse their seeds.

WHITE-TAILED DEER

Maintaining a viable deer population while protecting other park resources within the parks is important to NPS. The parks have monitored the population trends and density of the deer population through distance sampling, and survey results in all parks indicate an overabundance of deer. Although high deer densities may adversely affect plants and other wildlife species, deer themselves are an important resource. It is important that this plan maintain a deer population in the parks while taking action to reduce adverse effects on the deer population itself.

In addition to the reduction in the population, the proposed actions also may impact the movement and behavior of the deer population. Fencing, the use of darts for reproductive control treatments, or any lethal actions could cause deer to avoid certain areas in the parks, and implementation of certain reproductive controls also could result in unanticipated physiological and behavioral changes within the deer population.

CWD, although not currently found in these two parks, is a potential future concern for the parks and the deer within them. CWD is a fatal neurological disease that affects behavior and body condition and has been identified in both free-ranging and captive white-tailed deer, mule deer, elk, and moose. The disease is easily transmissible, and this transmissibility increases prevalence of CWD over time. CWD prevalence can increase mortality and contribute to lower population growth rates (Miller et al. 2008; Manjerovic et al. 2014). Under appropriate conditions, this could lead to the local extirpation of deer (Almberg et al. 2011).

The closest known cases of CWD to the parks are in white-tailed deer in Hampshire County, West Virginia; in Maryland in Allegany County, including Green Ridge State Forest immediately adjacent to the C&O Canal NHP; in Frederick County, Virginia; and in a captive deer in New Oxford, Pennsylvania, near Gettysburg National Military Park (NPS, Ratchford, pers. comm. 2014a; MD DNR 2015a). These occurrences place CWD within 2 miles of C&O Canal NHP, and 45 miles of Harpers Ferry NHP. While much is still unknown about the spread of the disease and the long-term effects, there is currently no evidence that the disease can be transmitted to humans or domestic livestock.

OTHER WILDLIFE AND WILDLIFE HABITAT—TERRESTRIAL MAMMALS AND BIRDS

At certain levels, deer overabundance adversely affects other wildlife, particularly terrestrial mammals and birds, and their habitat indirectly by altering habitat and decreasing heterogeneity of the forest and plant structure through activities such as browsing, trampling, and seed dispersal. Studies have linked high deer densities to undesirable effects on other wildlife species, in particular, migratory and forest interior dwelling bird species (deCalesta 1994; McShea 2000; McShea and Rappole 2000; Virginia Department of Historic Resources 2003). A study in 1996–1997 at Cuyahoga National Park documented impacts of deer density on forest songbirds, showing that in areas of high deer density, the abundance of songbirds was less than in low-density areas (Petit 1998). Although no park-specific data currently exist to verify that impacts on the habitats of these forest interior dwelling species have occurred from deer browsing, in a study that looked at population declines of woodland birds in lowland England, Newson et al. (2011) reviewed several studies that indicate that overabundance of deer adversely impact bird populations (2011).

Deer management activities could affect other mammals. The use of bait piles could provide an additional food source for some species. In addition, the presence of increased human activities and associated noise during specific time periods could result in temporary behavior changes and the avoidance of management areas. Deer also can affect small mammal populations through competition for food such as acorns (McShea and Rappole 2000).

SPECIAL STATUS SPECIES

Although federally listed threatened or endangered species have been documented in the two parks, these species would not be affected by deer management activities (see the "Issues and Impact Topics Considered but Dismissed from Further Analysis" section in this chapter). However, special status plant and animal species (state-listed threatened or endangered species, rare and unusual species, or special status species) confirmed within the parks could possibly be affected. Some of these could be affected by deer overbrowsing (direct impacts on plants or change in habitat affecting wildlife) and/or by deer management actions that disturb the understory or involve foot traffic and trampling. Thirty-five state-listed threatened or endangered vascular plant species have been documented at the C&O Canal and Harpers Ferry NHPs (MD DNR 2015b), and 54 state-listed animal species of concern occur in the two parks. Note that special status plants are discussed under "Vegetation" in chapters 3 and 4, and special status wildlife is discussed under the "Other Wildlife and Wildlife Habitat" sections.

CULTURAL RESOURCES

Historic Districts and Cultural Landscapes

In some cases the presence and activities of high numbers of deer may affect the character of the cultural landscapes of the parks, and therefore affect important features of associated historic districts. A cultural landscape is defined by the Secretary of the Interior's standards as a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values (NPS 1996). Agricultural special use permits are issued to farmers at both parks as a means of managing the cultural landscapes and maintaining land use similar to what was present historically. The C&O Canal NHP has cropland, hay, and grazing, while Harpers Ferry currently has only hay crops as a result of a high level of deer depredation of its row crops. Deer browsing impacts the cultural landscapes within the parks by changing vegetation patterns and affecting crop yield, crop appearance, and economic and/or feed value return to the farmers. Additionally, certain deer management activities that result in fence construction or landscape alteration (e.g., vegetation changes) could impact the parks' cultural landscapes.

VISITOR USE AND EXPERIENCE

If deer management activities were to decrease the number of deer in the parks, chance sightings by visitors also would decrease. Some visitors to the parks may view deer sightings as an integral part of their visit. Deer management actions may decrease the potential for visitors to observe deer within the parks, causing less visitor satisfaction. Conversely, an overabundance of deer may decrease visitor satisfaction because deer browsing would prevent successful restoration of the landscape as a whole. An overabundance of deer also may have an indirect impact on other park visitors by altering the habitat of other species (i.e., changing the understory so that there are fewer migratory birds) and changing the visitor experience for those visitors who come to see species within that habitat. Increased deer browsing has the potential to impact these other resources and impact the satisfaction of these visitors.

Proposed deer management activities may involve noise from equipment or human presence and may require certain areas of the parks to be closed to the general public during management activities, which would also affect visitor use and experience.

PUBLIC AND EMPLOYEE HEALTH AND SAFETY

Various health and safety concerns could result from implementation of the alternatives described in this plan/EA. Health and safety applies to park visitors, local residents, and park employees and volunteers. All deer management activities would need to be conducted in a manner that would ensure the safety of park visitors, local residents, and park employees and volunteers.

A primary safety issue for visitors and local residents related to this plan involves injuries from deer-vehicle collisions. High densities of deer could affect the safety of visitors, employees, and volunteers using park roads (i.e., similar to the increases in deer-vehicle collisions that Montgomery County, Maryland, has experienced on nearby lands (Montgomery County Parks 2016). Several studies have shown that deer-vehicle collisions increase as local deer populations increase (DeNicola and Williams 2008; Rutberg and Naugle 2008a).

Deer-related diseases may also pose health risks to park visitors or area residents. Black-legged ticks (*Ixodes scapularis*), also known commonly as deer ticks, carry Lyme disease, and deer and rodents are preferred hosts depending on the stage of the tick's life cycle. Mice are the principal reservoirs of the spirochete *Borrelia burgdorferi*, the agent for Lyme disease. Though the deer cannot transmit the disease to humans or ticks, a high deer population provides more hosts, and there is concern that this could support a higher than normal tick population compared to lower deer densities (CDC 2007).

PARK MANAGEMENT AND OPERATIONS

Deer management activities have the potential to affect staffing levels and the operating budget necessary to conduct park operations. Park management and operations refers to the current staff available to adequately protect and preserve vital park resources and provide for an effective visitor experience. Natural resource management staff currently devote a sizeable portion of their time to deer management activities, which include annual fall spotlight surveys, vegetation monitoring, camera surveys, pellet plot surveys, and data analysis, and they would have even more responsibilities under any of the alternatives considered. Additional deer management activities undertaken by park staff could affect other areas of park operations. Deer management actions at the parks also would require staff time for coordination with the appropriate local and private entities and interpretation/public education.

IMPACT TOPICS DISMISSED FROM FURTHER ANALYSIS

The following impact topics were eliminated from further analysis in this plan/EA. A brief rationale for dismissal is provided for each topic. Potential impacts on these resources would be non-existent or minimal, and/or localized or temporary.

WATER RESOURCES

Water resources are of potential concern because of water quality issues in the Potomac and Shenandoah River watersheds from bacterial and other pollution. However, bacteria and nutrients can enter park streams from many sources, including from other wildlife and/or upstream residential and agricultural runoff, and contamination as a result of deer waste would be small in comparison to these other non-point sources. Loss of vegetation cover as a result of overbrowsing by deer would continue to occur under alternatives A and B, and deer trails would continue to be present across streams, which could result in increased soil erosion and sedimentation, resulting in small localized adverse effects on water quality and aquatic habitat. However, it would be difficult to discern which impacts would be directly attributable to deer and which impacts would be associated with other wildlife or other sources, including trampling and disturbance of streambanks and soils during management activities. None of the alternatives would be expected to affect water quantity. Because adverse impacts on water resources attributable to deer would not be discernible, water resources was dismissed from further analysis.

ENVIRONMENTAL JUSTICE

Presidential Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. According to the US Environmental Protection Agency (EPA), environmental justice is the

> …fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. The goal of this "fair treatment" is not to shift risks among populations, but to identify potentially disproportionately high and adverse effects and identify alternatives that may mitigate these impacts (EPA 1997).

The communities surrounding the parks contain both minority and low-income populations; however, environmental justice is dismissed as an impact topic for the following reasons:

- The park staff and planning team actively solicited public participation as part of the planning process and gave equal consideration to input from all people regardless of age, race, income status, or other socioeconomic or demographic factors.
- Implementation of the proposed alternative would not result in any identifiable adverse human health effects. Therefore, there would be no direct or indirect, adverse effects on any minority or low-income population.
- The impacts associated with implementation of the preferred alternative would not disproportionately affect any minority or low-income population or community.
- Implementation of the preferred alternative would not result in any identified effects that would be specific to any minority or low-income community.
- The impacts on the socioeconomic environment resulting from implementation of any of the action alternatives would be beneficial. Deer meat would be donated to local food banks whenever possible. In addition, the park staff and planning team members do not anticipate the impacts on the socioeconomic environment to appreciably alter the physical and social structure of the nearby communities.

NEIGHBORING LAND USE/SOCIOECONOMICS

High deer density in areas adjacent to the two parks causes some damage to crops and landscaping, and has caused some farmers on adjacent lands to apply for depredation permits and make insurance claims. Implementation of deer management likely would decrease the frequency of damage caused by deer to both crops and landscaping. The numbers of deer available for hunting at local hunt clubs near the park could change, but deer still would be available for hunting at these clubs, and the changes would not be likely to affect membership or viability of the clubs. This topic has therefore been dismissed.

CULTURAL RESOURCES

Archeology

Archeological resources, a type of cultural resources, are the remains of past human activity. The discipline of archeology documents the scientific analysis of these remains. Implementation of some of the proposed actions would have the potential to disturb archeological resources, but measures would be taken to avoid or minimize adverse effects. Archeological surveys would be conducted, and any proposed fencing would be located away from known sites. Additionally, construction monitoring would occur in potentially sensitive areas subject to subsurface excavation. Should any archeological resources be discovered, fencing installation would stop, and resources would be further evaluated and protected. Deer entrails would be buried only if there is an appropriate location that would not disturb archeological sites or potential resources (e.g., a previously disturbed area); otherwise, the entrails would be taken off site in barrels. Deer carcasses and waste not suitable for donation for consumption or for surface disposal would continue to be disposed of at an approved local landfill, not on site. Therefore, because any impacts on park archeological resources as a result of deer management activities would be minimal, and measures would be taken to avoid impacts, this topic was dismissed from further analysis.

OTHER WILDLIFE AND WILDLIFE HABITAT

Fencing and Wildlife Passage

Fencing for large-scale exclosures would be constructed to allow most wildlife passage. Wildlife species that are the size of deer or larger (i.e., bears, which are not common in the parks at this time) would not be able to move in and out of the exclosures. The exclosures would not result in measurable adverse effects on larger species, so this issue related to wildlife impacts was dismissed from further analysis.

Effects of Deer Repellents

All alternatives include the option of using deer repellents, which use an offensive odor, taste, or smell to repel deer. Many repellents include natural ingredients (e.g., sulfur, garlic, or predator urine); some contain capsaicin that is commercially produced as an extract from hot peppers. Park staff would review any repellents for effectiveness and safety/low toxicity. Repellents would be used in limited areas and selectively on certain plants and only in accordance with label instructions to avoid any adverse effects on non-target wildlife. For these reasons, a discussion of potential adverse effects expected from the use of repellents was not carried through in the analysis.

Herpetofauna

Several species of reptiles and amphibians occur in both parks, but deer density does not appear to substantially affect them. In a study at Cuyahoga Valley National Park, Greenwald, Petit, and Waite (2008) placed coverboards in and outside of deer exclosures and found higher numbers of redback salamanders (*Plethodon cinereus*) and slugs outside of the exclosures. Species that favor undisturbed habitats were not found outside of the exclosures, but the sample size was small (12 paired plots). The authors noted that redback salamanders and garter snakes are species that do well in disturbed habitats, and the coverboards might have provided refuge from the lesser vegetated areas for the salamanders.

Species that depend primarily on habitats other than dense brush or thick vegetative ground cover would be less affected by high deer numbers. Most frogs, snakes, salamanders, and turtles (e.g., bullfrogs, northern water snakes, and snapping turtles [*Chelydra serpentina*]) live in or near water during much of their lives and are therefore less affected by deer. Although herpetofauna inhabit forested areas, they mainly rely on near ground vegetation and leaf litter, and no studies were found that indicated adverse effects from deer browsing. Similarly, implementation actions would not affect herpetofauna more than minimally, with only minor disturbances expected from noise or the presence of field crews in limited areas of the parks. Therefore, further analysis of impacts on herpetofauna was dismissed.

Fish and Other Aquatic Species

Fish are present in rivers and streams within the parks, including the Potomac, Monocacy, and Shenandoah Rivers and other smaller rivers and streams. However, no impacts or minute impacts on fish or aquatic species are expected from deer management activities. Under alternatives A and B, continued deer overbrowsing could adversely affect the habitat for aquatic species by increasing erosion and soil runoff; however, these impacts are expected to be localized and would not noticeably affect fish and aquatic habitat. Similarly, management activities under all alternatives could result in increased erosion and soil runoff through construction of fencing or trampling, which could lead to temporary small-scale adverse impacts on aquatic habitat if waterbodies are nearby. Alternatives C and D likely would reduce the potential for soil erosion and sedimentation of aquatic habitat due to reduced vegetation loss over many years, resulting in long-term, beneficial impacts on fish and other aquatic species. Because adverse impacts on fish and other aquatic species would be small, the topic of fish and other aquatic species was dismissed from further analysis.

FEDERALLY LISTED SPECIES

Federally listed species are those species determined under the Endangered Species Act to be threatened or endangered and have been listed as such. Two federally listed species of amphipod and isopod; two species of bats (the Indiana bat [*Myotis sodalist*] and northern long-eared bat [*Myotis septentrionalis*]); and harperella (*Ptilimnium nodosum*), a flowering plant, are known to occur in the area and potentially in the parks. However, these species would be unlikely to be adversely affected by high deer density or by deer management activities, and they could ultimately benefit to some extent from reduced deer densities because of improved habitat. Specific reasons for the dismissal of these species follows.

Madison cave isopod (*Antrolana lira*) and Hay's spring amphipod (*Stygobromus hayi*)—these invertebrates are found in pools in caves and springs; the Madison cave isopod may occur in caves in Harpers Ferry NHP, although it has never been documented, and the Hay's spring amphipod may occur within C&O Canal NHP, likely in the District of Columbia portion of the park. The Hay's spring amphipod lives the majority of its life in a shallow groundwater zone below the surface (Pavek 2002). Neither of these species would be disturbed by management activities; any springs known to support the amphipod would be avoided during construction of any fencing or setting up of bait stations and implementation of sharpshooting or other controls. A reduced deer density would minimize the potential for surface springs to be degraded by soil compaction or erosion from deer trampling, which would in turn result in possible benefits to the species.

Harperella—this plant is federally listed as endangered and has been documented in C&O Canal NHP. However, it is found only on rocky or gravelly shoals and sandbars along the riverbed, which are not areas typically used by deer, and these areas would not be affected by deer management actions considered in this plan.

Indiana bat and Northern long-eared bat—these two bat species are federally listed as endangered and threatened, respectively, and are known to occur in both parks. These bats roost beneath peeling or sloughing bark on dead or mature trees, and they are not ground dwellers where deer are found. Potential impacts from deer management actions may include disturbance from noise and increased human presence during sharpshooting; however, this would have no impact to very minimal short-term impacts on these species, because they are active only at night and hibernate during winter months (USFWS 2015), when most of the management actions would occur. Seasonal and/or time restrictions on disturbing activities would eliminate or minimize any adverse impacts. Also, deer overbrowsing would eventually reduce available roost trees for the bats, so reduction in the deer populations would have an indirect benefit for these tree-dwelling species by allowing forests to regenerate and perpetuating summer roosting habitat (Caraher 2009).

INDIAN TRUST RESOURCES

Secretarial Order 3175 requires that any anticipated impacts on Indian trust resources from a proposed project or action by US Department of the Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes.

There are no Indian trust resources in the vicinity of these two parks. The lands in the project areas are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. As a result, the impact topic of Indian trust resources was dismissed from further analysis.

CHAPTER 2: ALTERNATIVES

INTRODUCTION

This chapter describes the actions that could be implemented for current and future management of white-tailed deer in C&O Canal and Harpers Ferry NHPs, including a plan to respond to CWD occurring in or near the parks. NEPA requires federal agencies to explore a range of reasonable alternatives and to analyze what impacts the alternatives could have on the human environment, which the act defines as the natural and physical environment and the relationship of people with that environment. The analysis of impacts is presented in "Chapter 4: Environmental Consequences," and the conclusions are summarized in the summary of impacts table later in this chapter.

The alternatives under consideration must include a "no action" alternative, as prescribed by NEPA regulations in 40 CFR 1502.14. The no action alternative in this document is the continuation of the parks' current management actions and policies related to deer and ongoing CWD surveillance and management.

Three action alternatives for deer management were identified. The public provided feedback on these alternatives and on other elements of this document during the planning process. These alternatives meet the objectives of this plan and the purpose of and need for action as stated in "Chapter 1: Purpose of and Need for Action" to a large degree. Because these action alternatives would be technically and economically feasible to implement and show evidence of common sense, they are considered reasonable (CEQ 1981).

The alternatives include various deer management actions as well as actions that address detection and response to CWD, which has now been found within approximately 2 miles of C&O Canal NHP and within approximately 45 miles of Harpers Ferry NHP in recent years. The chapter provides background information used in setting a deer density goal and action thresholds for implementing the preferred alternative. The chapter also provides a summary of adaptive management approaches, discusses alternatives considered but dismissed, and identifies the NPS preferred and environmentally preferred alternative.

OVERVIEW OF ALTERNATIVES

The alternatives selected for detailed analysis are briefly summarized below, with deer management actions described first, followed by CWD management components that would be included in the alternatives.

ALTERNATIVES—DEER MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Existing management would continue under alternative A, including deer and vegetation monitoring, research, potential use of protective caging and tree tubes, education and interpretation, opportunistic and targeted sampling for CWD, and agency/interjurisdictional cooperation. No new actions would be taken to reduce the effects of deer overbrowsing.

Alternative B: Nonlethal Deer Management

Alternative B would include all actions described under alternative A (with some modifications to monitoring schedules). It also would include several additional techniques that could be used to prevent adverse deer impacts, such as changing crop configurations or crop selection at the parks, using repellents for short-term situations or over growing seasons, and using aversive conditioning in selected areas or at specific times. The main focus of deer management under alternative B would be the use of a combination of nonlethal actions to address the impacts of high numbers of deer on vegetation and vegetative cultural landscape elements. These actions would include the construction of large-scale deer

exclosures for the purpose of vegetation restoration; installation of fencing to protect gardens, restoration areas, or agricultural fields; and the use of nonsurgical reproductive control of does to restrict deer population growth in the implementation areas to a point at which vegetation can recover. Any reproductive control agent used must meet NPS-established criteria (described in table 5, below).

Alternative C: Lethal Deer Management

Alternative C would include all actions described under alternative A (with some modifications to monitoring schedules) and the additional management techniques described under alternative B. However, instead of large-scale exclosures and reproductive control, the primary focus of alternative C would be on using lethal deer management actions to reduce the herd size. Direct reduction of the deer herd would be accomplished mainly by controlled harvest programs in designated implementation areas through sharpshooting with firearms and/or selective use of archery by park staff or authorized agents. Limited use of capture and euthanasia of individual deer would occur in those few circumstances where sharpshooting would not be considered appropriate due to safety concerns.

Alternative D: Combined Lethal and Nonlethal Deer Management

Alternative D would be the same as alternative C, including all actions described under alternative A (with some modifications to monitoring schedules) and the use of the additional management techniques under alternative B, but would add the potential use of reproductive control to maintain deer populations after the initial population density has been reduced. Alternative D would incorporate a combination of lethal and nonlethal deer management actions from alternatives B and C to address high deer density. Lethal actions (including sharpshooting with firearms and/or selective use of archery, with very limited capture/euthanasia if necessary) would be taken initially in designated implementation areas to reduce the deer herd numbers quickly. Population maintenance could be conducted in implementation areas either by nonsurgical reproductive control methods, if these are available and meet NPS criteria, or by sharpshooting with firearms and/or selective use of archery. Both of these population maintenance methods are retained as options to maintain maximum flexibility for future management.

ALTERNATIVES—CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

NPS would continue with opportunistic and targeted surveillance for CWD at both parks. C&O Canal NHP and Harpers Ferry NHP also would coordinate with the surrounding states regarding CWD matters.

Alternatives B, C, and D (All Action Alternatives)

All action alternatives would include long-term management responses to occurrences of CWD in or near the parks. When CWD is detected within 5 miles of either park, park staff would work with state wildlife professionals to determine if lethal removal of deer should occur within the park or if other responses may be warranted. High deer population density support greater rates of disease transmission (Wilson et al. 2002; Swinton et al. 2002) and have been positively correlated with prevalence of CWD (e.g., Farnsworth et al. 2005; Conner et al. 2008). Because the park at C&O Canal is long and linear, actions would be taken in the park within a certain radius of the CWD occurrence or within state-designated CWD action zones after consultation with the state. As with management actions, density reduction activities may occur only in areas that are geographically conducive to lethal management activities.

THRESHOLDS FOR TAKING ACTION UNDER ALTERNATIVES B, C, AND D AND THE DEER DENSITY GOAL FOR DEER MANAGEMENT

The action alternatives (B, C, and D) contain strategies to support forest regeneration and protect cultural landscapes. Before an action alternative can be implemented, the park must determine (1) where an action needs to be implemented; (2) when the action needs to be taken or modified (i.e., when damage to forest vegetation or cultural landscapes could approach levels that threaten the integrity of the resource); and (3) how many deer would need to be treated (for those alternatives that include reproductive control) or

removed (for those alternatives that include deer removal). The following discussion describes the thresholds for taking action (which are related to vegetation damage from deer browsing), and the deer density goal (which would be used to determine the number of deer that would be treated or removed) that were selected by the planning team, based on applicable research.

THRESHOLDS FOR TAKING ACTION—DEER DAMAGE TO VEGETATION (INCLUDING CULTURAL LANDSCAPES)

Forest Regeneration Thresholds

The planning team discussed methods of identifying an appropriate threshold for taking action to protect both woody and herbaceous park vegetation, which could then be considered by NPS for use at the parks. Because the deer population would be managed based on the success of forest regeneration, vegetation must be monitored to determine at what point browsing impacts would warrant implementation of the selected management alternative. The point at which action would be needed is called the threshold for taking action, or the action threshold.

The regeneration standard adopted by the planning team was developed based on research by Susan Stout (1998) in a similar eastern hardwood forest environment in Cuyahoga National Recreation Area, now known as Cuyahoga Valley National Park (McWilliams et al. 1995). Although ecological histories may vary, the forests at Cuyahoga and the forests in these two parks share many similarities, which support the use of this research. Stout's method measured the number of tree seedlings and their heights in circular (1-meter [3.28-foot] radius) sampling plots under both high and low levels of deer density and associated herbivory. Stout defined low deer density as 13 to 20 deer per square mile relative to levels observed in the Mid-Atlantic Region (Horsley, Stout, and deCalesta 2003) and is in the range of the desired deer density proposed for this plan. High deer density was defined as 56 to 64 deer per square mile (Horsley, Stout, and deCalesta 2003).

The planning team modified Stout's thresholds to account for the difference in plot sizes. The parks use square plots (either a single 2 meter by 2 meter plot, or four 1 meter by 1 meter plots, or twelve 1-meter by 1-meter plots), while Stout used circular 1-meter radius plots covering 3.14 square meters. Adjustments would be made for plot size to correspond with Stout's seedling thresholds (table 1).

TABLE 1. MINIMUM NUMBER OF SEEDLINGS PER PLOT

Deer Density [a] (deer/mi^2)	Seedling Thresholds per Stout's (3.14 square meters) Monitoring Plot
Low	10
High	30

Source: Stout 1998; McWilliams et al. 1995
Low density = 13–20 deer/mi^2; High density = 56–64 deer/mi^2 (Source: Horsley, Stout, and deCalesta 2003)

The NPS planning team decided to use Stout's suggested regeneration standard as the threshold for taking action under this plan. Therefore, to restore tree seedling recruitment to acceptable levels, monitoring would need to show that at least 67% of plots exceed the seedling per plot threshold at high deer density (Stout adapted from McWilliams et al. 1995). NPS would determine the level of regeneration every three years from data collected from the plots, as described in the monitoring plan presented in appendix D.

Cultural Landscape Thresholds

Because of the cultural significance of the parks, the planning team decided to develop another action threshold or thresholds that could be used to indicate the need to take action based on effects of deer on key elements of the parks' cultural landscapes. The planning team felt it was important to have a foundation for management based not only on tree regeneration, but also on the protection of cultural landscapes that are so clearly linked with the parks' missions and enabling legislation and the NPS

Organic Act and management policies. The group discussed the options for indicators or monitoring metrics that would show the effects of deer on crops (changes in yield).

Crop Yield Threshold

A crop field's cultural resource values include its spatial arrangement, healthy appearance, and type of crop (e.g., corn, hay, small grain). A crop field's economic value to the special use permittee/farmer is its yield either in bushels per acre or tons per acre. The success of the farmers at both parks is critical to retaining them as a partner in managing NPS lands, and crop yield is a measure of that success. Currently, farmers at Harpers Ferry have experienced depredation from deer and have switched to hay crops, but the park would like to reach a point where other crops will again be considered feasible.

Crop yields are measured by machinery, sampling, or sale. There is an expected yield per acre based on soil type, soil fertility, and crop species and variety. Farmers annually report their yield to park natural resources managers and the national and state agricultural statistics offices. Farmer reports are used for insurance purposes as well as for federal and state agricultural program benefits. There is an economic threshold for acceptable yield loss. Farm returns are either profit from crop harvest and sale or crop harvest and use for feed for livestock.

TABLE 2. CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK CROP YIELDS FOR LEASED AGRICULTURAL FIELDS

Corn for Grain						
Year	**County**	**Yield (bu/ac)**	**County Average (bu/ac)**	**Difference (bu/ac)**	**Difference (% of county average)**	**Percent of Average Yield Reported by County (%)**
2014	Montgomery	175	137.7	+37.3	+27.1	127
	Frederick, Lease A	81	166.6	-85.6	-51.3	48.6
	Frederick, Lease B	63	166.6	-103.6	+62.2	37.8
	Washington	133	164.6	-31.6	-19.2	80.8
2013	Washington, Lease A	85	147.1	-62.1	-42.2	57.8
	Washington, Lease B	155	147.1	+7.9	+5.4	105.3
	Frederick	60	154.2	-94.2	-61.1	38.9
2012	Washington, Lease A	100	126.8	-26.8	-21.1	78.9
	Washington, Lease B	112	126.8	-14.8	-11.7	88.3
2010	Frederick	95	71.2	+23.8	+33.4	133.4
	Montgomery	110	115.8	-5.8	-5.0	94.9

TABLE 2. CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK CROP YIELDS FOR LEASED AGRICULTURAL FIELDS

Soybean						
Year	**County**	**Yield (bu/ac)**	**County Average (bu/ac)**	**Difference (bu/ac)**	**Difference (% of county average)**	**Percent Difference (%)**
2014	Montgomery, Lease A	40	--	--		--
2013	Montgomery, Lease B	42	37.2	+4.8	+12.9	112.9
2012	Montgomery, Lease C	37	51	-14	-27.5	-72.5
2011	Montgomery, Lease D	32.2	51	-18.8	-36.9	63.1

bu/ac = bushels per acre

Based on the information above, the planning team agreed to use a threshold tied to crop yield at C&O Canal NHP, and eventually at Harpers Ferry NHP, should the park have crops other than hay in the future (past deer depredation has led to the shift to all hay crops). Action would be taken when the three-year average crop yield from farms within the park unit falls below 75% of the average yield reported by the county for similar agricultural production for corn (grain) and soybean where they are grown.

INITIAL DEER DENSITY GOAL

The deer density goal for the parks is defined as the number of deer per square mile that would allow for natural forest regeneration and preservation or enhancement of the cultural landscape components that contribute to the pattern of historic land uses. This density is used as an initial goal under the action alternatives.

Research has been conducted on tree regeneration and the impact of white-tailed deer on different forest types in the eastern United States. The predominant forest type in the parks is oak (*Quercus* spp.) / hickory (*Carya* spp.) forest, with American beech (*Fagus grandifolia*), maple (*Acer* spp.), and tulip poplar (*Liriodendron tulipifera*). American sycamore (*Platanus occidentalis*), hackberry (*Celtis occidentalis*), ash (*Fraxinus* spp.), and American elm (*Ulmus americana*) can be found in bottomlands and stream corridors. Research has suggested that in cherry (*Prunus* spp.) / maple forest types in the Allegheny Plateau (western Pennsylvania, West Virginia, and eastern Ohio), deer density should be 20 to 40 deer per square mile in unmanaged areas, and 15 to 18 deer per square mile in managed timber areas, to maintain natural regeneration (Tilghman 1989). Marquis, Ernst, and Stout (1992) suggest that tree regeneration fails with deer densities at 32 deer per square mile. This research also demonstrates that a shift in plant species composition occurs in beech/birch (*Betula* spp.) / maple forests when there are 18 deer per square mile, while an oak/hickory forest successfully regenerates at 6 deer per square mile (Marquis, Ernst, and Stout 1992). Research by deCalesta (1992, 1994) shows that seedling richness (the number of species in an area) begins to decline with just 10 deer per square mile, and that songbird habitat is negatively impacted with 20 to 39 deer per square mile in a cherry/maple forest. In a study in the Central Adirondacks that examined deer and forest regeneration in maple/beech/birch, hemlock (*Tsuga* spp.) / birch, and spruce (*Picea* spp.) / fir (*Abies* spp.) forest types, Sage, Porter, and Underwood (2003) found successful tree regeneration with a density of 13 deer per square mile from 1954 to 2001. Horsley, Stout, and deCalesta (2003) show that negative impacts began in cherry/maple forests at 21 deer per square mile within the Allegheny Plateau from 1979 to 1989. In that study, impacts on forest vegetation were examined at various deer densities (10, 20, 39, and 65 deer per square mile) and data were collected three, five, and ten years after the exclosures were established (Horsley, Stout, and deCalesta 2003). The

NPS National Capital Region Network (NCRN) vital signs monitoring use the 21 deer per square mile threshold in its analysis (Bates 2006). Based on this threshold, ten parks within the NCR exceeded desirable population densities in 2009, including both parks that are the subject of this plan. As of 2009, deer density at Short Hill and Elk Run in Harpers Ferry were the only sites of four sites studied in that park where deer density did not exceed the threshold; however, overall deer population at the park exceeded the threshold. NCRN monitoring shows that many parks have fewer seedlings than would be expected with natural regeneration levels (Schmit et al. 2012a).

Based on the recent research in forest types similar to those in the parks, the planning team adopted a range of 15 to 20 deer per square mile as the initial deer density goal. This goal may be adjusted based on the results of vegetation and deer population monitoring, as described in the "Adaptive Management Approaches Included in the Alternatives" section in this chapter.

ALTERNATIVES—DEER MANAGEMENT

ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

The no action alternative is required in NEPA analyses to provide a benchmark against which to compare the impacts of the action alternatives. Current management actions that would continue to be implemented include deer and vegetation monitoring, research (forest bird surveys, amphibian sampling, macro-invertebrate and fish sampling), protective caging to protect small landscaped areas, opportunistic sampling for CWD, agricultural and wetland restoration plans, and a recently completed deer herd health assessment. Cooperation with regional entities and stakeholders would continue. Monitoring efforts also would continue to assess forest regeneration and/or deer population numbers within the parks, although specific monitoring actions would vary between parks and could be modified or discontinued over time, depending on the results and the need for monitoring. The option to use educational and interpretive activities would continue to be available to the parks to inform the public about deer ecology and park resource issues; cooperation with regional entities and stakeholders would continue. No additional deer management actions would take place under this alternative.

Actions that would continue under alternative A are described below in detail. These actions also would be common to all action alternatives.

Current Actions

Monitoring and Research

Current monitoring of both vegetation impacts and deer population levels would continue and could be modified as necessary to better understand any correlations between the two or to account for current conditions. Monitoring and data collection activities include any or all of the following methods:

- Monitoring deer numbers using the established Distance 6.2 protocol to estimate the deer population density annually, where use of this method is possible (Underwood, Verret, and Fischer 1998).
- Using spotlight surveys (conducted as part of distance sampling) to monitor population composition (e.g., sex ratios).
- Using digital trail cameras, pellet plot counts, and infrared scans to assist with monitoring deer density. There are several parts of both parks where this is a more feasible method than distance sampling.
- Monitoring tree seedlings using an existing vegetation monitoring protocol to determine the status of forest regeneration. Vegetation plots are present at both parks: Harpers Ferry has 30 paired exclosed and open vegetation monitoring plots, and there are additional open unpaired plots at both C&O Canal NHP and Harpers Ferry NHP under the Inventory and Monitoring vegetation

monitoring program. Trees, saplings, seedlings, shrubs, vines, and herbs are monitored within the plots.

- Tracking research related to deer management, including the outcome of actions being taken in neighboring jurisdictions, and the latest research on various deer management methods, including reproductive control.
- Monitoring deer health if the population shows signs of disease, or if a disease has been discovered within the region (see discussion specific to CWD, below).
- Collecting data on deer-vehicle collisions.
- Monitoring the costs of the monitoring actions, including staff time, training, administrative, legal, and public communications costs.

Specific vegetation and cropland monitoring methods that would be used under alternative A, as well as the other alternatives, are described in appendix D. Monitoring of deer densities and vegetation is currently performed by regional NPS staff.

Small Area Protective Caging / Tree Tubes

Landscape plantings and small areas containing tree plantings or rare species would be protected from browsing by placing tree tubes around individual plants or small-scale fencing around planted areas. Landscape plantings typically consist of ornamental vegetation in and around buildings and in other park developed areas. Park staff may erect small cages or tree tubes around trees or seedlings that have been recently planted in restoration areas. If rare understory plant species that deer browse are found in the parks, they could be protected with fencing.

The caging used would be limited to the immediate area around the plants to be protected, typically less than 43 square feet (4 square meters) total, and would generally consist of a 5-foot-high, woven wire fence (typically a 1-inch by 2-inch mesh), with netting or other covering over the top as appropriate. Caging would typically be at least 5 feet tall to allow trees to grow beyond deer browsing height, at which point it would be removed. Tubes vary in height (generally from 3 to 4 feet) depending on the park and the species to be protected.

Educational and Interpretive Measures

Although neither park has focused on the use of educational and interpretive measures concerning deer, communication and input from other organizations and the public would be a component of alternative A and the other alternatives. Such activities would include continuing education and interpretive programs, displaying exhibits at visitor gathering areas, and producing brochures and publications about deer management issues. The parks' websites also would be used to discuss NPS activities related to deer management. Relevant articles may be published in local newspapers.

Continued Agency and Interjurisdictional Cooperation

The parks would continue to coordinate with other agencies involved in deer or wildlife management (e.g., US Fish and Wildlife Service [USFWS], MD DNR, VDGIF, Virginia Department of Conservation and Recreation, WVDNR, and county and local governments) on the implementation of deer management efforts. This coordination currently includes sharing study results and data on deer densities, as well as results of removal efforts.

ACTIONS COMMON TO ALL ACTION ALTERNATIVES

Implementation Areas

C&O Canal NHP and Harpers Ferry NHP have determined geographically suitable locations to implement either sharpshooting or immunocontraceptive activities. Geographically suitable areas also were considered to an extent upon selecting locations for exclosures.

C&O Canal NHP is a long linear park. Many parts of the park may not be appropriate for implementation of deer management because of its narrow profile. In these narrow areas, deer populations are capable of moving in and out of the park. The lack of a stable deer population within the park would render the use of immunocontraceptive ineffective; treated deer would interact with untreated deer outside of the park, and all new deer may be present in the park when it is time for the immunocontraceptive booster dose to be applied. The park's narrow areas also are not suitable for conducting safe lethal reduction activities because it is difficult to ensure that shots from firearms or bow and arrow remain within park property.

Harpers Ferry NHP's steep topography, proximity to trails and visitor use areas, and sensitive cultural or historic landscapes limit the park's choices of safe and effective implementation areas.

Implementation areas were chosen based on the following criteria:

1. enough acreage and width to allow deer management (either lethal reduction immunocontraceptive application, or placement of exclosures) to be feasible and safely implementable
2. geography that allows access (vicinity to roads or trails and accessible terrain)
3. locations that would reduce impacts on sensitive natural, cultural, or archeological resources

Additional areas that do not meet the above criteria but are adjacent to lands on which neighbors wish to implement deer management may also be chosen. If the combination of NPS land and neighboring land meet the criteria, then deer management could be implemented in these areas. The parks currently have identified 22 possible implementation areas that follow the criteria mentioned above. C&O Canal NHP and Harpers Ferry NHP will focus first on Great Falls and Maryland Heights implementation areas, respectively, because of known vegetation issues and a documented high population of deer. Management may take place in other implementation areas once management at the first two sites is underway and it is evident there is a need at other implementation areas, based on deer density and vegetation monitoring. Before deer management is implemented in a chosen area, additional monitoring for deer density or herd health (which also indicates that the herd may be in need of density reduction) would occur to best estimate deer population in the area, confirm a need exists, and determine the extent of the management action.

ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

Alternative B would include all actions described under alternative A (with some modifications to monitoring schedules). It also would include several techniques that could be used to prevent adverse deer impacts, such as changing crop configurations or crop selection at the parks, using repellents for short-term situations or over growing seasons, and using aversive conditioning in selected areas or at specific times. However, the main focus of alternative B would be the use of a combination of nonlethal actions to address the impacts of high numbers of deer on vegetation and vegetative cultural landscape elements. These actions would include the construction of large-scale deer exclosures for the purpose of forest regeneration; the installation of fencing to protect gardens, restoration areas, or agricultural fields; and the use of nonsurgical reproductive control of does to restrict deer population growth. Any reproductive control agent used must meet NPS-established criteria (described in table 5, below).

Additional Proposed Actions under Alternative B

Additional Techniques to Reduce Deer Impacts

The planning team identified several techniques that could be helpful in certain situations to reduce the adverse effects of deer browsing at the parks. Although these techniques may be implemented more frequently under alternative B, they are available for use under any action alternative. These include the following:

- **Fencing of larger areas** (wooded areas and crops)**—**These areas could be fenced where protection is the most needed and can be installed with minimal impacts. This would include using fencing around fields containing susceptible crops.
- **Crop protection—**This would include changing crop configuration or changing types of crops grown by substituting crops that are less palatable to deer, such as changing wheat varieties or growing milo instead of corn.
- **Aversive conditioning—**This involves moving deer out of certain areas using nonlethal hazing techniques such as noise or motion (e.g., alarms, sprinklers, and "deer scarecrows"). This option would be used only in specific areas for a short period of time where there is a need for temporary protection.
- **Limited application of deer repellents—**NPS may consider use of small amounts of commercially available odor- or taste-based deer repellents, used in accordance with label instructions, on landscaped areas, restoration plantings, or crops at each park. Repellents also could be used on plantings in cultural landscape areas where fencing would be undesirable because of its visual impact. Repellents work by reducing the attractiveness and palatability of treated plants to a level lower than that for other available forage. Repellents are more effective on less palatable plant species than on highly preferred species (Swihart and Conover 1991). Repellent performance seems to be negatively correlated with deer density, meaning that the higher the abundance of deer, the less likely the repellent would be effective. Success with repellents is measured as a reduction in damage; total elimination of damage should not be expected (Craven and Hygnstrom 1994). Large-scale application of repellents over forested areas is not practical because of high application cost, label restrictions on use, and variable effectiveness.

  Both odor and taste-based repellents are available in chemical and organic forms. Some of the more recently available products have the longest residence time (period of effectiveness between applications). Different brands may provide different results; therefore, park staff would experiment with the available products to determine which worked best in each application area. Both types of repellents can have a short residence time when applied to plant material and must be monitored and applied frequently to retain their effectiveness.

Large-Scale Exclosures

In addition to the small areas or individual trees that could be fenced, larger fenced exclosures would be constructed under alternative B to temporarily remove deer browsing impacts and allow forest regeneration. A large deer exclosure is defined as a fenced area of 1 or more acres constructed for the purpose of excluding deer from entering. It has been suggested that the minimum area that would need to be fenced at one time to meet the parks' forest regeneration goal would be from 5%–10% of the forested area (Pennsylvania State University, Bowersox, pers. comm. 2005). Based on this and on past deer management plans conducted for NPS, NPS decided to target a range of 5%–20% of the forested areas of the parks, with the actual percentage dependent on the characteristics of the parks, site logistics, and possible impacts. Forest cover totals about 13,532 acres at C&O Canal NHP and 2,442 acres at Harpers Ferry NHP.

NPS would construct large exclosures of various configurations to fit the landscape that would be located throughout the parks. Locations would be based on several criteria: they are relatively easy to access, yet are at least 25 meters (about 80 feet) away from visitor use areas or scenic views; they fit into the parks' topography and current trails systems in areas large enough to minimize impacts from edge effect and reduce costs associated with fencing, while not causing negative impacts on cultural or archeological resources and historic structures; and they avoid steep slopes and existing vegetation monitoring plots. Areas containing valuable habitats (rare community types, reforested areas, riparian areas, high quality woodlands, and other managed landscapes) would be targeted for protection. Potential deer exclosure locations for the parks are shown in figures 3 and 4 and are listed in table 3. The locations identified constitute about 5% of the forested acres at the C&O Canal NHP and about 7% of the forested acres at Harpers Ferry NHP. Although Maryland Heights is a priority implementation area because of the condition of the vegetation, the terrain is steep and hard to access, so no exclosures have been proposed there.

Fencing for large exclosures would be about 8 feet high and would consist of woven wire with openings that would allow other wildlife (smaller than deer) to move freely through the fence. Metal and wood posts would be used as supports. It is expected that the technical details (e.g., type of footer, post type and spacing) related to fence installation would vary based on factors such as site topography, geologic substrate, access, potential visibility, and presence of archeological resources.

Deer would be driven out of the exclosures by park staff before completion by having staff line up and walk toward the remaining open side of the exclosure, thereby herding any remaining deer out of the area before the last side is erected. All exclosures would be maintained by park staff. Maintenance would consist of visual inspection for fence integrity at least four times per year and after any major storm event. Park staff and/or qualified volunteers would drive out any deer found within an exclosure or any other animals that appear to be trapped within an enclosure. Visitors would not be able to use the areas inside exclosures during or after construction, unless access is provided in special circumstances.

Based on the experience of park staff and the regrowth noted in park vegetation monitoring exclosures over the past years, it is estimated that about 10 years would be required for adequate seedling recruitment and growth in the exclosures to exceed the typical deer browsing height—approximately 60 inches. This timeframe is supported by data from Horsley, Stout, and deCalesta (2003), as well as Webster, Jenkins, and Rock (2005), which show that browse-tolerant species had substantial recovery after eight years, and more browse-sensitive species were not able to recolonize well. Asnani, Klips, and Curtis (2006) also found that generalist species could recover in about a 14-year period, so a 10-year timeframe appears reasonable. After seedlings exceed browse height, the exclosures could be moved to other targeted areas. This would happen once during the life of this plan.

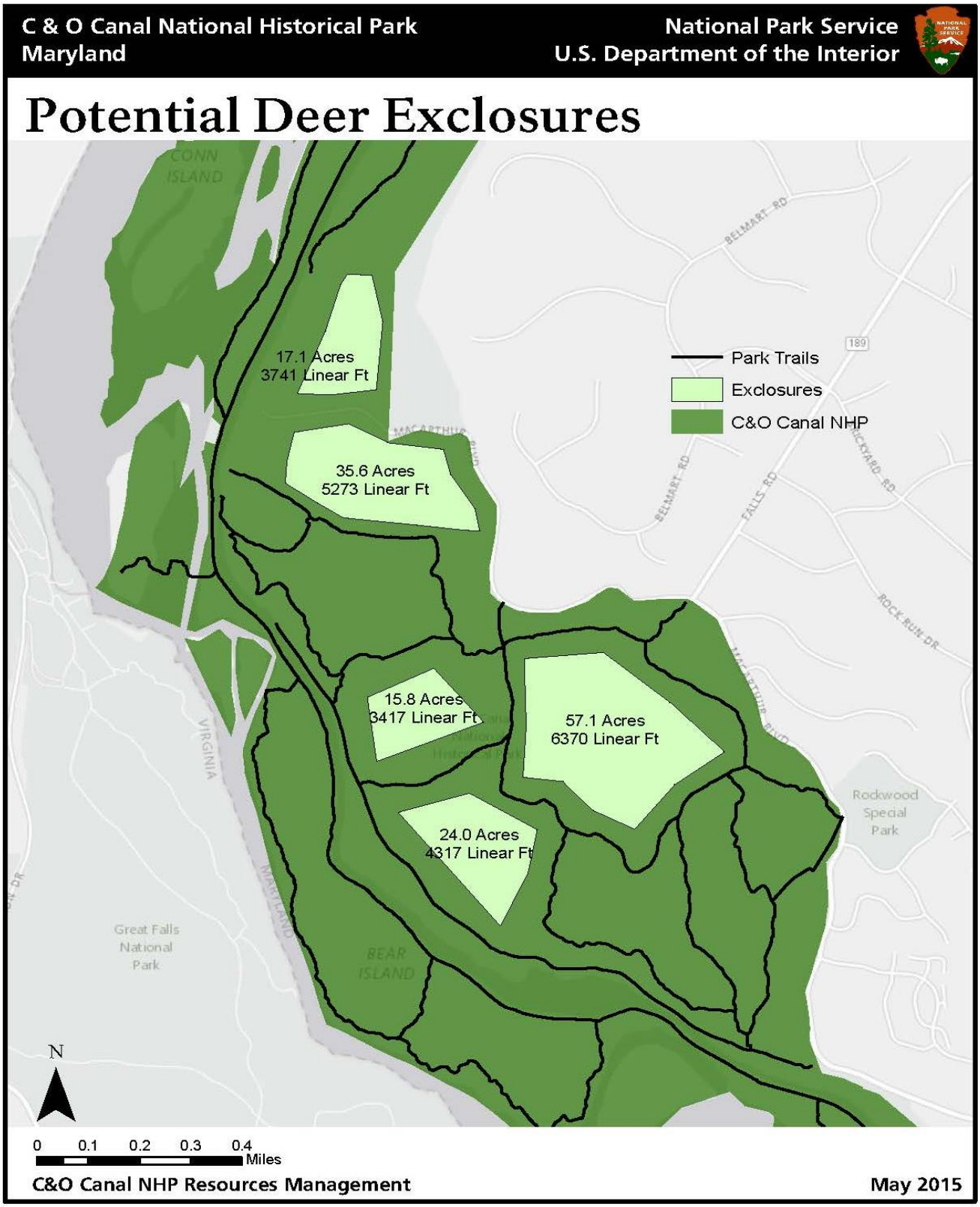

FIGURE 3A. CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK—POTENTIAL DEER EXCLOSURES AT GREAT FALLS

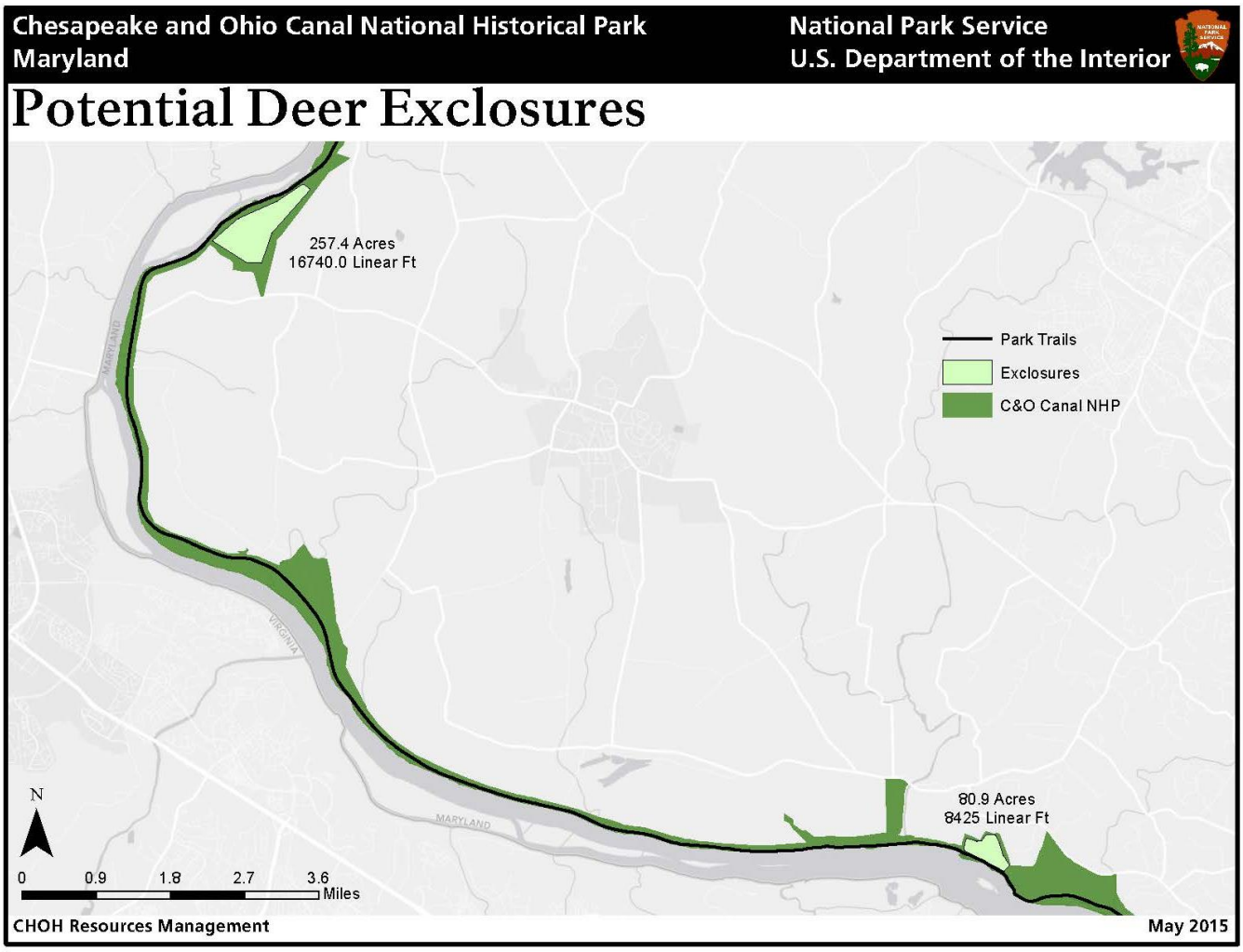

FIGURE 3B. CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK—POTENTIAL DEER EXCLOSURES AT WHITES FERRY

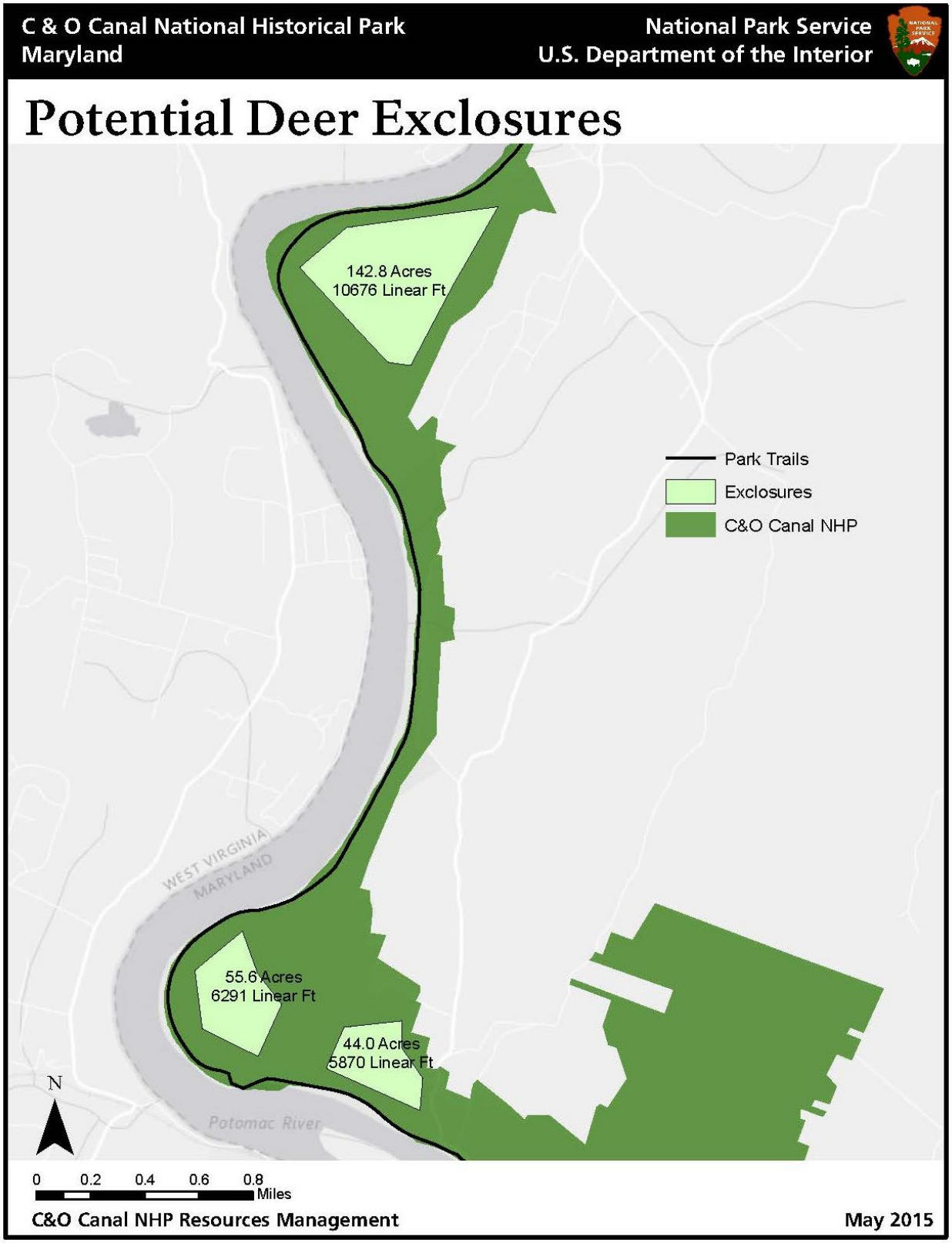

FIGURE 3C. CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK—POTENTIAL DEER EXCLOSURES AT THE HARPERS FERRY PORTION OF THE C&O CANAL NHP

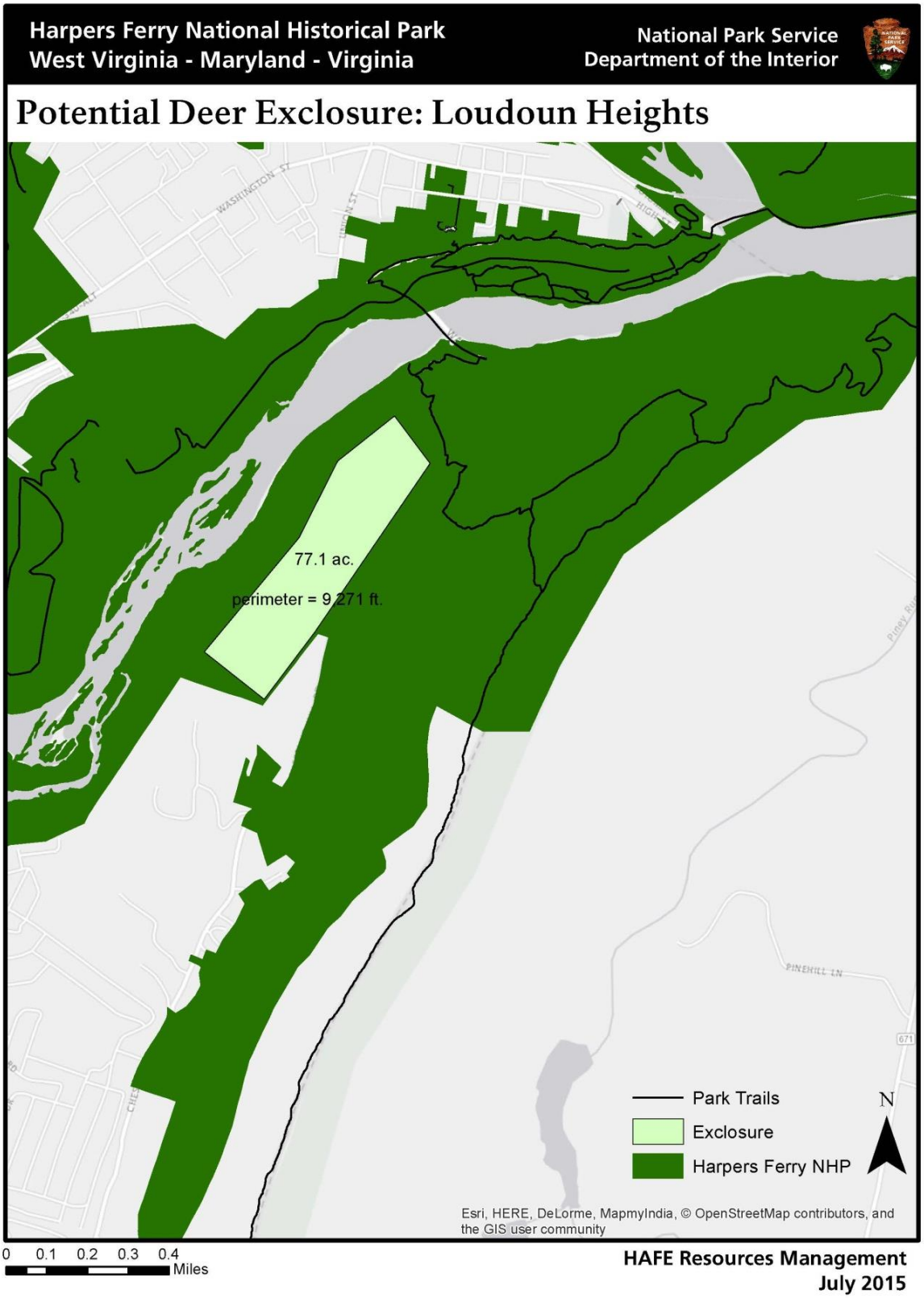

FIGURE 4A. HARPERS FERRY NATIONAL HISTORICAL PARK—POTENTIAL DEER EXCLOSURES ON LOUDOUN HEIGHTS

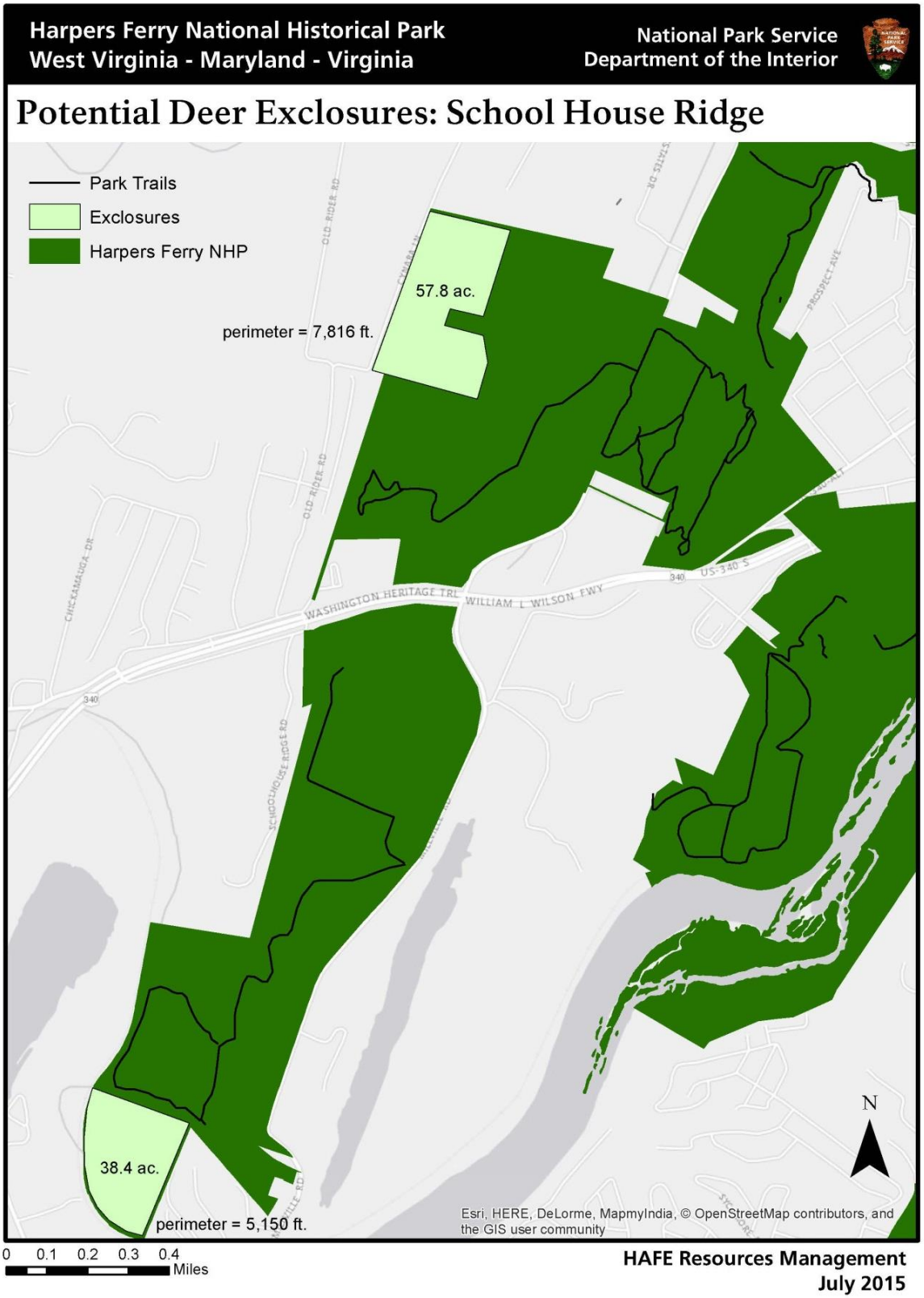

FIGURE 4B. HARPERS FERRY NATIONAL HISTORICAL PARK—POTENTIAL DEER EXCLOSURES AT SCHOOL HOUSE RIDGE

TABLE 3. POTENTIAL DEER EXCLOSURES FOR BOTH PARKS

Exclosure Area	Approximate Perimeter in Linear Feet	Approximate Acres	% of Forested Acres Fenced
Chesapeake and Ohio Canal National Historical Park			
Great Falls 1	3,741	17.1	0.1%
Great Falls 2	5,273	35.6	0.3%
Great Falls 3	3,417	15.8	0.1%
Great Falls 4	6,370	57.1	0.4%
Great Falls 5	4,317	24.0	0.2%
Whites Ferry 1	16,740	257.4	1.9%
Whites Ferry 2	8,425	80.9	0.6%
Harpers Ferry 1	10,676	142.8	1.1%
Harpers Ferry 2	6,291	55.6	0.4%
Harpers Ferry 3	5,870	44.0	0.3%
TOTAL	**71,120**	**730.3**	**5.4 % (of 13,532 acres)**
Harpers Ferry National Historical Park			
Loudoun Heights	9,271	77.1	3.1%
School House Ridge 1	7,816	57.8	2.4%
School House Ridge 2	5,150	38.4	1.6%
TOTAL	**22,237**	**173.3**	**7.1 % (of 2,442 acres)**

Nonsurgical Reproductive Control of Does

Several reproductive control agents have been developed and tested for use in deer population control. Those that could be considered for use are described briefly in table 4 and discussed in more detail in appendix E, which provides an overview of nonsurgical reproductive control technologies for deer management. Although particular product names are mentioned in this plan, NPS is not limited to using the particular products listed and would evaluate products based on their ability to meet criteria (as described below) to determine whether a suitable agent exists for implementation.

Alternative B would include treating female deer with a chemical reproductive control agent to reduce population growth. Research related to nonsurgical reproductive control technologies (immunological and nonimmunological) provides results that are highly variable and related to key elements such as efficacy and duration of contraceptive effect. There also are logistical issues related to the administration of these drugs that could affect success of implementation and sustainability of a reproductive control program at the parks. Therefore, only when the criteria listed in table 5 are met would reproductive control be implemented as a management technique.

TABLE 4. CURRENT REPRODUCTIVE CONTROL AGENTS

Issue	Standard (Native) PZP Vaccine	SpayVac ™ (PZP Vaccine)	GonaCon ™ (GnRH Vaccine)	Leuprolide (GnRH Agonist)
Mode of action	Blocks sperm penetration and fertilization; estrous cycles continue	Blocks sperm penetration and fertilization; estrous cycles continue	Prevents secondary hormone (luteinizing hormone and follicle stimulating hormone) secretion, which stops folliculogenesis and ovulation	Prevents secondary hormone (luteinizing hormone and follicle stimulating hormone) secretion, which stops folliculogenesis and ovulation
How administered	Injection	Injection	Injection	Injection
Number of doses	Twice initially and an annual booster	Once initially and booster every 3–5 years	Likely a single injection initially; if and when antibodies decline, retreatment would be required	Current formulation—annually
Time of administration	Treat before breeding season and allow sufficient time for antibody development	Treat before breeding season and allow sufficient time for antibody develop-ment	Treat before breeding season and allow sufficient time for antibody development	Treat immediately before breeding season on an annual basis

PZP = porcine zona pellucida; GnRH = Gonadotropin Releasing Hormone

TABLE 5. REPRODUCTIVE CONTROL AGENT CRITERIA

Reproductive Control Agent Criteria	Rationale for Criteria
1. There is a federally approved fertility control agent for application to free-ranging populations.	It is critical that all aspects of a fertility control program be consistent with federal laws and regulations and NPS policies.
2. The agent provides multiyear (3–5 years) efficacy.	Modeling efforts have clearly demonstrated that (1) "the efficacy of fertility control as a management technique depends strongly on the [multiyear] persistence of … the fertility control agent" and (2) the only scenarios in which fertility control is more efficient than culling at maintaining population size is when a multiyear efficacy is achieved (Hobbs, Bowden, and Baker 2000).
3. The agent can be administered through remote injection.	Remote delivery reduces the frequency of stressful capture and/or drug delivery operations. Capture would be necessary for the initial application because the animals would need to be marked, but the agent should be able to be delivered remotely for any subsequent doses.
4. The agent would leave no hormonal residue in the meat (i.e., meat derived from treated animals should be safe for human consumption according to applicable regulatory agencies, and safe for consumption by other animals).	Any fertility control agent applied in free-ranging wildlife populations that are contiguous with areas or with the same species that are hunted must be safe for human consumption, and there should be minimal ecological impacts on other species that could eat deer.
5. Overall, use of the agent results in an acceptable level of reduction in the free- ranging deer population with limited behavioral impacts.	No study has demonstrated that fertility control works to reduce deer numbers in free-ranging populations to the extent needed at the parks to allow for tree regeneration, so it is important that the ability to successfully reduce a free-ranging deer population be demonstrated. Also, it is important that any agent used meet NPS policies, including those regarding altered behavior (NPS 2006, section 4.4.1).

No reproductive control agents are currently available that meet all these criteria (see table E-1 in appendix E). Some of the criteria are met by certain agents; for example, recent advances in technology allow porcine zona pellucida (PZP) to be 95%–100% effective in year 1 and 65%–70% effective in year 2 (Rutberg et al. 2013), and the single year formulation of PZP can be remotely delivered. Currently, the agent that comes closest to meeting all the criteria is GonaCon™, which was approved and registered by EPA in 2009 for use as a contraceptive for controlling white-tailed deer populations (EPA 2009). It is possible that an agent that meets all the criteria could be developed during the lifetime of this plan; therefore, this option has been considered for detailed analysis. For the purposes of this discussion and environmental impact analysis, it is assumed that a reproductive control agent that meets these criteria would be available. The use of any reproductive control agents for population management would require approval from the EPA.

NPS would review the status of ongoing reproductive control research on a periodic basis through consultation with subject matter experts and review of new publications. When there are advances in technology that could benefit deer management in the parks, the choice of an appropriate agent would be determined based on how well the criteria were met, availability, cost, efficacy, duration, safety, and feasibility. See appendix E for a detailed overview of reproductive control agents and methods.

Administration of Reproductive Control

Timing of Application. Timing of application would depend on the agent used; however, many of the current agents require administration prior to the breeding season. For the purposes of this analysis, it is assumed the selected agent would be administered during the months of October through March. This is when the deer are easier to capture, when the fewest number of visitors would be in the parks, and when there would be less stress on the deer. Summer months would be avoided because of potential heat stress on the deer. Based on the criteria established for use of an agent, it is conservatively assumed that the selected agent would need to be reapplied every three years, although it is recognized that efficacy may vary and this frequency could be adjusted. If long-term studies show that efficacy is prolonged with repeated vaccinations, reapplication may be less intensive.

Number of Does Treated. To effectively reduce population size, treatment with a reproductive control agent must decrease the reproductive rate to less than the mortality rate, which is approximately 10% in urban deer populations. Under this alternative, it is assumed that it would be necessary to treat at least 90% of the does to reduce population growth (Hobbs, Bowden, and Baker 2000; Rudolph, Porter, and Underwood 2000). After several years of application at this rate of treatment, a small (e.g., 5 %) reduction in the population could be expected (Hobbs, Bowden, and Baker 2000). In another deer management plan completed at Valley Forge National Historical Park, a population model indicates that the reduction in the population using a reproductive control agent could be more than that, possibly up to 33% after 5 years and up to 60% after 10 years (NPS 2009).

The following provides nonsurgical reproductive control scenarios for each park for the initial implementation areas on Great Falls and Maryland Heights. Deer data from 2014 were used as the basis for the scenarios and calculations and are reasonable estimates, based on past monitoring at the parks. Numbers of deer affected and costs will change depending on the deer densities in the parks at the time the plan is implemented.

- **C&O Canal NHP—**the 2014 deer population at the Gold Mine tract at Great Falls was estimated at 56 deer, based on the estimated density of 67 deer per square mile (NPS, Bates, pers. comm. 2015b). Deer density survey data collected by NPS for the past three years at C&O Canal indicate that approximately 53% of the deer in the park (30 deer) are does (NPS, Bates pers. comm. 2016d). The number of does that could be treated ranges from 27 does (90% of 30) every three years (assuming minimal population reduction) to the following: years 1 and 4: 30 does treated; years 7 and 10: 20 does treated; year 13: 12 does treated (assuming a population reduction similar to what was predicted at Valley Forge National Historical Park).

- **Harpers Ferry NHP—**the park's 2014 deer population on Maryland Heights was estimated at 118 deer, based on the density of about 96 deer per square mile and the federal lands surveyed (NPS, Bates pers. comm. 2015b). NPS collected deer density survey data indicating that approximately 53% of the deer in C&O Canal NHP are does. Using this same estimate for Harpers Ferry NHP, then about 63 deer would be does. The number of does that could be treated ranges from 57 does (90% of 63) every three years to the following: years 1 and 4: 57 does treated; years 7 and 10: 42 does treated; year 13: 25 does treated (assuming a population reduction similar to what was predicted at Valley Forge National Historical Park).

  The parks would use identified implementation areas to strategically treat the populations in the first year, starting with Great Falls at C&O Canal NHP and on Maryland Heights at Harpers Ferry NHP, then work through other implementation areas (selected for geographic suitability for deer management activities). For initial applications that require capture to mark the deer, it is assumed that about four does can be treated per day, using two teams of two to three people (an estimate based on experience with capture and tagging at Valley Forge National Historical Park [NPS 2009]). Assuming the teams would work 5 days a week, about 20 does per week could be treated.

- **Application Procedures—**assuming a reproductive control agent is used that meets all criteria, does would need to be captured initially for marking to avoid multiple treatments of the same does in the same year and to facilitate tracking for future applications in subsequent years. Several methods of wildlife trapping could be used, including but not limited to drop nets and box traps. Deer also could be immobilized by darting with a tranquilizer gun (Schwartz et al. 1997). This method could be used in cases where deer had not been successfully attracted to a trap area. Safety issues during trapping and handling would be addressed by trained staff experienced in handling live deer, who would work in teams and use appropriate dress and insect repellents.

Most trapping methods involve using bait to attract deer to a specific area or trap. Box traps involve a confined space that safely holds the deer so that staff can approach it. Drop net traps also often use bait to attract deer to the drop zone, where suspended nets are triggered to drop over the deer and restrain it for staff to approach (Lopez et al. 1998). The method of capture would be selected based on the specific circumstances (e.g., location, number of deer, accessibility) for each deer or group to be removed. Given the large number of does that would need to be treated, bait piles would be used to concentrate does in certain locations to make the trapping process as efficient as possible. Marking likely would be accomplished using ear tags. Some capture and handling-related mortality could occur under this method as a result of tranquilizer use and stress on the doe (DeNicola and Swihart 1997; Kilpatrick, Spohr, and DeNicola 1997); generally, a mortality rate of 2% or less would be expected (Peterson et al. 2003; Kreeger and Arnemo 2012).

After the first application, the agent would be delivered by remote injection. Injection likely would be remotely delivered by dart or biobullet (plastic bullets impregnated with an immunocontraceptive), using a dart-type gun (similar to a shotgun). With the biobullet method, the biobullets remain with the doe and it is not necessary to recover spent darts.

As many does as possible would be treated daily until 90% of does were treated. Visitor access would be restricted in certain areas of the parks during the treatment period. The areas targeted for treatment would be chosen based on maximizing deer presence and accessibility while minimizing visitor inconvenience.

Monitoring

Vegetation. As deer are excluded from feeding within the large exclosures, open areas (areas outside the large exclosures) would be monitored for changes in vegetation because of probable increased browsing pressure. Forest regeneration would be monitored both inside and outside the exclosures as described

under alternative A. Additional monitoring of the large exclosures also would be conducted, with several large exclosures monitored each year for a select set of variables.

Reproductive Control. 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). The park would conduct fawn surveys during the summer to monitor reproductive control effectiveness, in addition to the ongoing spotlight/distance sampling or other density monitoring. Data collected would include numbers of fawns observed during a three-night survey in the summer, as well as numbers observed for the duration of the spotlight surveys. When possible, additional data used to estimate pregnancy rates would be collected from observations of the reproductive status of treated deer that are killed by vehicle collisions on roadways within the parks.

ALTERNATIVE C: LETHAL DEER MANAGEMENT

Alternative C would include all actions described under alternative A (with some modifications to monitoring schedules) but with a primary focus on using lethal deer management actions to reduce the herd size. Direct reduction of the deer herd would be accomplished mainly by controlled harvest programs through the use of sharpshooting with firearms and/or archery. This would be managed by park staff and carried out by NPS personnel or their authorized agents. Authorized agents include, but are not limited to, other agency personnel, contractors, or skilled volunteers. Details for the use of skilled volunteers is described in the "Sharpshooting" section below.

Sharpshooting would be used to initially reduce the deer population in areas of the park and as a maintenance treatment if needed. Sharpshooting would involve the use of firearms or archery; however, the use of archery would be considered on a case–by–case basis in certain areas where use of firearms is not appropriate, such as near more developed areas. If neither firearms nor archery is appropriate in an area, limited use of capture and euthanasia also would be considered.

Additional Techniques to Reduce Deer Impacts

The same techniques described under alternative B could be used by NPS in certain circumstances under alternative C. These actions include protective caging and repellents on rare, landscaped, or habitat restoration plants; changing the types of crops grown to substitute crops that are less palatable to deer; and aversive conditioning. These techniques are described in more detail under alternative B.

Sharpshooting

Sharpshooting would be used to initially reduce the deer population in the parks and as a maintenance treatment as needed. Team members, including any authorized agents, would be designated to shoot deer as directed by NPS and would assist with spotting and handling the carcasses (field dressing). Qualified team members would be responsible for taking CWD samples and assisting in removing salvageable meat. Every effort would be made to remove all salvageable meat from the field.

Qualified NPS employees or their authorized agents would be used to implement this alternative. All team members would be experienced with sharpshooting methods and would have the necessary sharpshooting qualifications, as determined by NPS. Training also would address safety measures to protect both visitors and NPS employees. The team members would be expected to coordinate all details related to sharpshooting actions, such as setting up bait stations, locating deer, sharpshooting, and disposition of the deer (donation of meat and/or disposal of waste or carcasses). The parks would develop annual operations plans for sharpshooting, training, and disposal of carcasses.

In most locations, high-powered, small-caliber rifles would be used from close range. Nonlead ammunition would be used for any lethal removal of deer to preserve the opportunity to donate the meat or to leave it in the field for scavenging wildlife. Every effort would be made to make the shootings as humane as possible. Deer injured during the operation would be put down as quickly as possible to minimize suffering. Noise suppression devices (silencers) and night vision equipment could be used to

reduce disturbance to the public. Activities would be conducted in compliance with all relevant firearm laws and regulations.

In certain more urban or developed locations, sharpshooting may be done using archery (bow and arrow). Possible locations would include areas of the parks that are near buildings or close to inhabited areas where the use of firearms is not advisable. Shooting with bow and arrow would be done from close range by NPS personnel or authorized agents specifically experienced with this type of deer removal. Capture and euthanasia would be used in very limited circumstances when sharpshooting using either firearms or archery would not be appropriate due to safety or security concerns.

Sharpshooting would occur primarily at night (between dusk and dawn) during late fall and winter months when deer are more visible and few visitors are in the parks. In some areas, sharpshooting could be conducted during the day or at other times of year if needed to maximize effectiveness and minimize overall time of visitor restrictions. Areas could be closed temporarily to park visitors, and NPS park rangers would patrol public areas to ensure compliance with park closures and public safety measures. The public would be notified of any park closures in advance. Information regarding deer management would be available at visitor contact facilities and posted on the parks' websites to inform the public of deer management actions. If more than one shooting location were used, areas would be adequately separated to ensure safety.

Bait stations could be used to attract deer to safe removal locations and would consist of small grains, apples, hay, or other food placed on the ground. The stations would be placed in park-approved locations away from public use areas to maximize the efficiency and safety of the reduction program. The amount of bait placed in any one location would vary depending on the bait used and the number of deer in the immediate area.

Skilled volunteers may be considered as authorized agents for lethal management actions. Several jurisdictions adjacent to both HAFE and CHOH use volunteers for deer management, and the parks want to maintain the option of using them in some areas. NPS's use of skilled volunteers would include individuals identified through an NPS-developed system. Before assisting with removal actions with firearms or bow and arrow, individuals would be required to demonstrate a level of firearm/bow hunting proficiency established by the parks. Other skilled volunteers would be required to demonstrate appropriate proficiency depending on their proposed involvement. Those skilled volunteers that qualify for participation would become part of a pool of available personnel that may supplement deer management teams. In addition, NPS personnel would directly supervise all skilled volunteers in the field during any deer management actions, directing which deer to shoot and where. Volunteers would not be permitted to take any part of the deer. Authorized agents under direct NPS supervision would assist in conducting efficient, humane removal of animals to meet resource management objectives. All firearm use would comply with relevant NPS directives related to firearm use in parks and federal firearm laws administered by the Bureau of Alcohol, Tobacco, and Firearms. The parks would develop specific guidelines for firearms and bow and arrow use and would incur costs to develop volunteer training and provide supervision of volunteer performance. It should be noted that lethal reduction or sharpshooting by skilled volunteers is not the same as hunting, as described further in "Alternatives Considered but Dismissed from Further Detailed Analysis, Managed Hunt/Public Hunting" section later in this chapter.

The decision to use skilled volunteers would be site specific and would allow managers to make strategic use of available resources. Factors considered when deciding to use skilled volunteers may include:

- the intensity of the effort
- the availability of park resources to maintain oversight of the training program and implementation efforts
- whether the parks can make use of current, active deer management programs occurring in surrounding jurisdictions

- availability of individuals who can safely demonstrate the required skill set

If the park decides to use skilled volunteers as authorized agents for lethal deer removal, their role would be included in the parks' annual plans for each year's management actions. The plans would describe how and where reduction activities would occur, provide a rationale for volunteer use, and describe methods (firearm/bow hunting). To ensure the safety of park staff, volunteers, park visitors, and park neighbors, the plans would also contain all safety measures, including, but not limited to: timing, park closures, required staff, location maps of park neighbors, and public information. Plans including the use of skilled volunteers would be subject to regional review and written concurrence of the Regional Director. Even though NPS may approve the potential use of skilled volunteers or state that it will use skilled volunteers in an annual implementation plan, use of skilled volunteers is at the park's discretion during any given year of implementation.

NPS staff and authorized agents working on lethal removal activities would be expected to work in teams under the supervision of an NPS team leader, shoot and process multiple animals in any one event, and spend the time necessary to ensure humane dispatch and quality meat recovery. NPS staff and authorized agents would not be allowed to keep the animal in part or in whole and would be expected to assist in processing the animals in preparation for disbursement. These activities could include gutting, skinning, quartering, boning, and packing animals to holding facilities or locations. Sharpshooters, including NPS personnel and authorized agents, would be certified in firearms training, specially trained in wildlife reduction, and be required to pass a proficiency test to qualify to participate in reduction activities.

Skilled volunteers would demonstrate through an NPS-application process the knowledge, skills, and abilities in the use of firearms; field dressing of animals; and preparation of wildlife for donation. Skilled volunteers also would demonstrate a passing qualification with NPS-assigned firearms, be trained in NPS-specific deer operational and processing procedures, and pass security screening. NPS would document a system of training and application for skilled volunteers.

Number of Deer Removed

Park staff would determine the number of deer to be removed from the parks based on the most recent population survey and an initial deer density goal of 15 to 20 deer per square mile, as well as past experience of other deer management programs, technical feasibility, and success of forest regeneration in later years of plan implementation. Based on 2014 deer density reports for the parks and the experience with lethal removal at other NPS parks such as Valley Forge National Historical Park, it is estimated that the desired deer density goal could be reached at C&O Canal NHP at the Gold Mine tract in about two years and at Harpers Ferry NHP at Maryland Heights in about five years. The parks would conduct similar reductions over time in other implementation areas. These estimates are based on the technical, financial, and logistic feasibility of removal at both parks, as well as the subsequent expected increase in the park deer populations resulting from both reproduction and immigration. Removal could proceed more rapidly if it is possible to remove more deer in each year and if the deer population numbers do not rebound as much as estimated.

As previously noted, several factors could influence the number of years required to reach the initial deer density goal. For example, as the deer population numbers decrease through successful reduction efforts, deer might become more adapted to the sharpshooting operations and more evasive, which could increase the effort necessary to reach the removal numbers in any year. If reproduction rates were higher and mortality lower than expected, population growth would be greater, and more deer would need to be removed. This could increase the time to reach the initial density goal or require more deer to be removed, if feasible and given available resources. The converse would be true if reproduction rates were lower and mortality rates higher than estimated, resulting in removing fewer deer and reaching the deer density goal in less time. Immigration of deer into the park property could also vary, and this would have an effect on the number of deer to be removed (Porter, Underwood, and Woodard 2004). Thus, monitoring would be

an essential part of this alternative, and actions could be adjusted as described in the "Adaptive Management Approaches Included in the Alternatives" section.

In addition, the number of deer removed in years following attainment of the desired density goal would be adjusted as described in the "Adaptive Management Approaches Included in the Alternatives" section. This number may vary annually depending on success of previous removal efforts, deer adaptation to removal efforts, regeneration response, and other factors.

Gender Preference

Both does and bucks would be removed based on opportunity, although there would be a preference for removing does, especially initially, because this would reduce the population level more efficiently over the long term. Buck-only removal would not control population growth because deer populations largely are dependent on the number of does with potential for reproduction (West Virginia University 1985).

The age and gender of all deer removed from the parks would be recorded to aid in defining the local population composition. This information would be compared with composition data collected during park population surveys. For implementation of management activities in other areas, NPS would monitor density and do similar calculations prior to taking action.

Capture and Euthanasia

Capture and euthanasia would be used in very limited circumstances where sharpshooting would not be appropriate due to safety or security concerns. Because capture and euthanasia would typically result in increased stress levels in captured deer compared to sharpshooting, this method of population control would be used only in select situations and would supplement the sharpshooting method described earlier. Neither park expects to use this, but it would be included in the plan in case its use is necessary.

If capture and euthanasia were required, the preferred technique for this method would be for qualified federal employees or authorized agents to trap the deer, approach them on foot, and euthanize them. Activities would be conducted at dawn or dusk when fewer visitors are in the parks. The number of deer removed by capture and euthanasia would be recorded, as well as the age and sex of the deer, location of removal, circumstances requiring removal and capture, and lethal method used.

Deer would be captured with nets or traps, similar to the trapping described under the reproductive control option for the initial administration of the selected agent. Deer also could be immobilized by darting with a tranquilizer gun (Schwartz et al. 1997). The method of capture would be selected based on the specific circumstances (e.g., location, number of deer, accessibility, and reasons that sharpshooting is not advised) for each deer or group to be removed. Captured deer would be euthanized as humanely as possible, in accordance with current veterinary recommendations such as those published by the American Veterinary Medical Association. However, if chemicals were used, it might not be possible to donate the meat from that animal as food, and the carcass might be unsuitable for surface disposal. In this case, the carcasses would be taken to a local landfill.

Disposal

NPS would donate deer meat (e.g., to local charitable organizations, nonprofit food banks) to the maximum extent possible or practical, as permitted by regulations and NPS guidelines (NPS 2007). If donation were not possible, then carcasses would be disposed of. When donating meat, the parks would follow current guidance from the NPS Office of Public Health and the Biological Resource Management Division with regard to donation of meat from areas affected by CWD, in addition to state and local requirements. Because the parks are within 60 miles of a known CWD case, CWD testing would be conducted to the extent needed to have 99% confidence that CWD is not present at more than 1% prevalence (NPS 2007) before any carcasses are considered for donation. Deer would be donated for consumption only if they are confirmed CWD-negative or if the required detection confidence level indicates that CWD is not present within the population.

If meat were suitable for donation, the animals would be field dressed in the parks. The entrails (internal parts) would be buried if there were an appropriate location; otherwise, entrails would be placed in drums for disposal at a processing or other appropriate facility. If the location were particularly remote, entrails could be left on the surface to decay or be scavenged. Carcasses brought back to the staging area would be stored in a refrigerated unit until any required CWD testing results are obtained and then transported to a butcher for processing.

Any deer carcasses that are not suitable for consumption or for surface disposal would be disposed of at an approved local landfill or other disposal facility that accepts deer carcasses. The parks would investigate appropriate landfills and costs as the need arises. In the few cases where a deer has been euthanized (without chemical use) at a given site, the waste or carcasses may be moved away from roads and trails or to a remote location and left on the surface to be naturally scavenged and/or decompose. The selected disposal option would depend on whether chemicals were used; suitability of meat for donation; amount of waste or carcasses; and distance from trails, roads, and nearby facilities and residences.

If CWD were found within 5 miles of one of the parks or if a CWD-positive case were identified within a park's deer population, the park would initiate the long-term CWD response plan (see "Alternatives—CWD Management," below) and associated disposal in accordance with the NPS Public Health guidelines for an area where CWD is known to occur (NPS 2007). Any CWD-positive carcasses, any processing batches containing a positive carcass, and any other deer parts would be disposed of off-site through alkaline digestion, incineration, or disposal at a local licensed municipal lined solid waste landfill. The Public Health guidelines preclude the donation of meat to food pantries, soup kitchens, or any entity that intends to redistribute the meat if the deer carcass is from an area where CWD is known to occur.

Monitoring

Vegetation

Throughout the removal actions, vegetation monitoring would be conducted to document any changes in the intensity of deer browsing and forest regeneration that might result from reduced deer numbers, following the monitoring protocol outlined in appendix D. Vegetation monitoring would be conducted at least as frequently as every three years to document vegetation recovery. If the park objectives were being met and forest regeneration was successful at the initial deer density goal, removal efforts would be maintained at the level necessary to keep the deer population at the target density. However, it would take several years for seedling numbers to respond to lower deer numbers, and this response would depend directly on how quickly the population was reduced. Likewise, the number of deer to be removed in subsequent years would be adjusted based on the success of previous removal efforts, projected population size, and vegetation and deer monitoring results. Park management could adjust the removal goal in either direction from the initial density goal depending on how well the parks' forest regeneration objectives had been met (see the "Adaptive Management Approaches Included in the Alternatives" section).

Deer Population

Deer population numbers would be monitored through the ongoing monitoring efforts discussed under the no action alternative and in "Chapter 1: Purpose of and Need for Action." The parks would use distance sampling, wildlife cameras, or other methods to document trends in population size.

ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT

Alternative D would include all actions described under alternative A (with some modifications to monitoring schedules) and the additional techniques described under alternative B, but alternative D is focused on incorporating a combination of lethal and nonlethal actions to address high deer density. Lethal actions (including sharpshooting with firearms and/or selective use of archery, with very limited capture/euthanasia if necessary) would be taken initially to reduce the deer herd numbers quickly.

Population maintenance could be conducted by nonsurgical reproductive control methods depending on factors such as availability of agents, whether the agent meets NPS criteria for use, and cost-effectiveness. If reproductive control is not used, sharpshooting with firearms and/or selective use of archery would be used for population maintenance. Both maintenance methods would be included in this alternative to maintain maximum flexibility for future management.

Additional Techniques to Reduce Deer Impacts

The same techniques described under alternative B could be used by the parks in certain circumstances under alternative C.

Sharpshooting

Direct reduction by sharpshooting with firearms and/or selective use of archery would be used initially to reduce the deer population in the parks and as a maintenance treatment if needed. Methods described in alternative C would be implemented. This action would begin in the first year of the plan, and for maintenance purposes could still be used depending on deer density and the decision to use an acceptable reproductive control agent.

Capture and Euthanasia

Capture and euthanasia would be implemented very sparingly in areas where sharpshooting is not possible, as described under alternative C. This procedure would include trapping or immobilizing deer using a technique designed to create the least stress. It is assumed that few deer, if any, would need to be taken this way.

Nonsurgical Reproductive Control

As described under alternative B, nonsurgical reproductive control could be implemented to maintain the deer population at the deer density goal where reduction has already occurred. Reproductive control may need to be implemented in conjunction with lethal efforts as a back-up method.

Also as described under alternative B, NPS would review the status of ongoing reproductive control research on a periodic basis through consultation with subject matter experts and review of new publications. When there are advances in technology that could benefit deer management in the parks, the choice of an appropriate agent would be determined based on how well the criteria were met, availability, cost, efficacy, duration, safety, and feasibility.

If reproductive control were initiated when the parks' deer population densities had reached the desired deer densities, it would commence at the time there are about 16 deer per square mile at the Gold Mine tract and about 20 deer per square mile on Maryland Heights, based on current densities (see table 6). Assuming the proportion of does in the remaining deer remains the same as described under alternative B (53%), and based on the results reported by Hobbs, Bowden, and Baker (2000), it would be necessary to treat 70%–90% of the does to maintain the population at the lowered density. Taking a conservative approach of treating 90% of the remaining does, NPS would treat 8 does at C&O Canal NHP and 10 does at Harpers Ferry NHP. Does would need to be treated every three years and marked for identification for subsequent retreatment during the initial application to keep the population at the desired level.

NPS would continue to monitor the deer population for growth. If the deer population increased during the reproductive control application under this alternative, periodic direct reduction may need to be conducted in conjunction with the reproductive control to maintain the population density at the identified goal.

The success of implementing reproductive control on a population that has undergone direct reduction for several years would depend on advances in reproductive control technology, sensitivity of the deer herd to humans, methods used by the sharpshooters, changes in immigration with reduced deer density, and general deer movement behavior (Porter, Underwood, and Woodard 2004; Naugle et al. 2002).

Monitoring

Monitoring would include the same techniques described under alternative C for sharpshooting and capture and euthanasia described under alternative B for reproductive control. Monitoring techniques also would include the current actions described under alternative A.

ALTERNATIVES—CHRONIC WASTING DISEASE MANAGEMENT

CWD is in the family of diseases known as the transmissible spongiform encephalopathies or prion diseases. Other transmissible spongiform encephalopathies include scrapie in sheep, bovine spongiform encephalopathy (BSE or mad cow disease), and Creutzfeldt-Jakob disease in humans. CWD causes brain lesions that result in progressive weight loss, behavioral changes, and eventually death in affected cervids, including deer. There is currently no evidence that the disease is transmissible to humans or domestic livestock; however, the disease could limit populations of deer. Although wildlife biologists are still learning about this relatively new disease, there is strong evidence that greater densities of deer and other ungulates increase the likelihood of transmission of CWD (see appendix C).

Generally, NPS has identified two levels of action pertaining to CWD based on risk of transmission (see appendix C): (1) when the disease is not known to occur within a 60-mile radius of the park; and (2) when the disease is known to occur within the park or within a 60-mile radius of the park. As of February 2014, the nearest known case of CWD in free-ranging deer was about 2 miles from C&O Canal NHP and 45 miles from Harpers Ferry NHP (NPS, Ratchford, pers. comm. 2014a).

ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION) FOR CHRONIC WASTING DISEASE

Under the no action alternative, NPS would continue CWD monitoring, which consists of opportunistic and targeted surveillance, at both parks. C&O Canal and Harpers Ferry NHPs also would coordinate with the surrounding states regarding CWD matters.

Targeted Surveillance and Testing

Opportunistic surveillance involves taking diagnostic samples for CWD testing from deer found dead or harvested within a national park system unit. Cause of death may be hunting, managed lethal reduction, predators, disease, trauma (e.g., from deer-vehicle collision), or undetermined. C&O Canal NHP has collected six deer through opportunistic surveillance (all six CWD tests were negative); Harpers Ferry NHP has not collected any CWD tests to date. The parks also have protocols in place or are developing protocols to perform targeted surveillance if deer are seen that appear to be ill.

In addition, NPS would continue to conduct targeted surveillance, which involves lethal removal and testing of any deer exhibiting clinical signs consistent with CWD. Targeted surveillance would have unnoticeable adverse effects on the current deer populations in the parks, would remove a potential source of CWD infection, and would be an efficient means of detecting new foci of infection. NPS staff would look for deer exhibiting clinical signs of CWD during their daily work activities, which often involve travel throughout the park or direct interaction with deer (e.g., deer surveys, deer-vehicle collision response). Under targeted surveillance, NPS staff would remove deer exhibiting clinical signs of CWD under the existing protocol for euthanasia of wildlife using an appropriate firearm.

Coordination with State Agencies Regarding Chronic Wasting Disease

Park staff would coordinate with the appropriate state agency (MD DNR, VDGIF, or WVDNR) and certified laboratories as necessary regarding surveillance methods, sample sizes, testing, and results. If there were positive test results from deer in or near the parks, C&O Canal and Harpers Ferry NHPs would coordinate with the state agencies to determine increased surveillance and decide if collecting deer for further testing is warranted. If there were no positive results, NPS would continue to conduct opportunistic surveillance depending on the proximity of the nearest positive case to the parks.

Disposal/Consumption of Deer Tested for Chronic Wasting Disease

The parks would follow NPS Public Health Service guidance pertaining to the donation of meat from a documented CWD area (NPS 2005b). Any deer confirmed with CWD would be disposed of in accordance with NPS Public Health Service disposal guidelines, and NPS would coordinate with state agencies (MD DNR, VDGIF, or WVDNR) as appropriate. The parks would follow protocols used in the NCR for surveillance sampling. Carcasses that are CWD negative would either be allowed to decompose in place for ecological benefit or would be disposed of using traditional methods (i.e., on-site burial in previously disturbed areas, away from any visitor use areas, or in landfills), depending on the circumstances (location, number of carcasses, etc.). If any positive results were obtained, carcasses would be disposed of off-site at approved landfills (if any) or by incineration, alkaline (tissue) digestion, or other method approved for disposal at the time disposal occurs (see "Testing and Carcass Disposal" in the section below titled "Alternatives B, C, and D—Long-Term Chronic Wasting Disease Response Plan").

ALTERNATIVES B, C, AND D—LONG-TERM CHRONIC WASTING DISEASE RESPONSE PLAN

Background

Under any of the action alternatives, the actions described under alternative A would continue (namely, surveillance and testing), and opportunistic surveillance would be added. However, a long-term CWD management plan would be adopted under any of the action alternatives to address concerns about CWD and its proximity to the parks.

Although the primary purpose of this plan/EA is to reduce impacts from deer on vegetation and habitat for other wildlife, integration of a long-term CWD response plan into the action alternatives is considered necessary because while CWD has not been found in the parks, it has been found in deer near portions of the C&O Canal NHP, and the chance of it occurring again near or in both parks is elevated. The planning efficiencies and cost savings associated with integrating the two plans. The direct relationship between the objectives, alternatives, and impact analysis of the deer management plan and the goals, response strategies, and environmental impacts of the CWD response plan make this integration both feasible and cost-effective. Both parks need a response plan that allows them to take action to reduce the numbers of deer to densities similar to those outside park boundaries or perhaps to lower levels in response to an immediate threat of CWD in or near the parks.

Opportunistic surveillance likely would be a more sensitive measure of disease detection compared to targeted surveillance because it includes testing animals that may have not been able to react quickly to oncoming vehicles or predators because of the effects of the disease. The CWD response and management plan is based on evidence that high deer population densities generally support greater rates of disease transmission (Wilson et al. 2002; Swinton et al. 2002), have been found to be positively correlated with the prevalence of CWD (e.g., Farnsworth et al. 2005; Conner et al. 2008), and that immediate action would be needed to reduce the deer population rapidly to reduce amplification of CWD. However, it is also assumed that NPS would coordinate with the states on sampling needed to assess the situation and identify the most appropriate response, and this response may not include reduction of deer density on NPS land. If reduction is needed, it would occur within a CWD management zone. Integration of CWD response represents an effort on the part of NPS to be proactive and fully prepared given the high level of risk. All actions across any implementation zones would be coordinated closely with the states, due to the scale identified in state CWD plans as necessary to address CWD (minimum 79 square miles) relative to the size of the parks. Cooperation with state efforts to address CWD would continue as long as these actions do not conflict with NPS or park mission and mandates, and actions taken within the park boundary may be conducted independently of state actions. A review of CWD, including scientific background and related NPS guidance, is included as appendix C.

Threshold for Taking Action—Chronic Wasting Disease Response

The threshold for taking action to address the presence of CWD in or near the parks is different from the thresholds for taking action related to deer impacts on vegetation described earlier. The threshold for taking action under the long-term CWD response plan would be tied to the distance of a confirmed case from the park boundary and location of the park in relation to a state-established CWD containment area (a 5-mile buffer around a documented CWD-positive case). For both parks, the NPS planning team decided that the long-term CWD response plan would be triggered only if a positive case of CWD were found within park boundaries or within 5 miles of the park boundaries, which means that one or both of the parks would fall within a state CWD containment area. The plan would allow the parks the option to reduce the deer population in the portion of the park within the CWD containment area to a density similar to that found outside the parks or even to a lower level as needed or limit response to increasing monitoring or cooperating with state program and testing requirements. However, if deer density reduction occurs, the deer population would not be reduced below 10 deer per square mile (see below). Removals within portions of either park within the 5-mile radius would be done quickly, similar to the removals proposed under the lethal alternative for deer management described later in this plan (under alternative C). The same threshold and actions would apply to any of the action alternatives, even the nonlethal deer management alternative B, because it is necessary to reduce deer density quickly to reduce the threat of CWD presence or amplification. Deer would be removed for surveillance monitoring in subsequent years, with the number removed dependent on the conditions at the time and coordination with the state. Based on the 2014 density estimates at the two initial sites (i.e., 67 and 96 deer per square mile, for the Gold Mine tract and Maryland Heights, respectively), between 9 and 14 deer could need to be removed for every 100 acres of viable implementation area in the CWD management zone to reach 10 deer per square mile density. It is not likely that reduction activities would occur outside the implementation areas.

The existing cases of CWD near the C&O Canal NHP occurred several years ago, although several more cases were identified in Allegany County, Maryland, near Cumberland, in March 2016, and CWD has therefore occurred within 5 miles of the western terminus of the canal. However, the state is recommending only increased surveillance within the CWD management zone at the time this EA was completed.

Chronic Wasting Disease Response

The lethal reduction actions would be carried out within the portion of the park within the CWD management area, assumed to be a 5-mile radius around the CWD case, as described under alternative C for deer management (i.e., sharpshooting with very limited capture and euthanasia). Sharpshooting activities initially would target areas immediately surrounding or closest to the positive case to ensure removal of animals that have been in contact with CWD-positive animals to potentially decrease the local prevalence of CWD. Areas where deer movements across the park boundary into surrounding communities are frequent and areas with higher concentrations of deer also may 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 because of the increased probability of infection in older animals and the spread potential posed by males (which have a larger home range than does). Removal actions would be carried out rapidly, and most likely in coordination with state efforts to reduce deer populations, so it is not possible to predict exactly how many deer would be removed or how long the action would last. It is expected that removals would be essentially the same as those shown for alternatives C and D for both parks, realistically taking about four to six years to accomplish. However, removals could be accelerated, for example, if needed to better coordinate with state response efforts. This would depend on available staffing and resources.

Reduction to Ten Deer per Square Mile as a Lower Limit

Implementation of a more intense reduction of the deer population to not less than 10 deer per square mile would be an option and would be based on coordination with the state. For the purpose of disease response, NPS does not want to reduce the number of deer within the parks to a density far below that outside the parks because it may increase the likelihood of potentially infected deer repopulating the parks from surrounding areas. However, NPS also does not want to maintain a deer density that is substantially higher than that in surrounding communities because that may increase the likelihood of disease amplification and spread into the parks. This approach allows the parks flexibility to work cooperatively with the state to address CWD if the state is able to achieve a population density lower than 15–20 deer per square mile in areas surrounding the parks. 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 ranges from 10–40 deer per square mile. It also is consistent with the stated objective of the plan/EA to maintain a deer population in the parks. The parks also would have the option to maintain the population density as low as 10 deer per square mile to remain consistent with surrounding deer densities and to avoid amplifying the disease. Additional removals that are part of this reduction would be based on available staffing and resources and may take more time to achieve, depending on the state's actions to reduce the deer population outside the parks.

Testing and Carcass Disposal

Carcasses would be disposed of 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 2012b) and the current state CWD response plan. Public health guidelines require that the people 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. When CWD occurs within 5 miles of the portions of the parks where the action is to be taken, or actions are taken within a CWD containment zone, these guidelines preclude the donation of meat to food pantries, soup kitchens, or any entity that intends to redistribute the meat (NPS 2012b). Park staff would remain in close contact with appropriate state agencies regarding disposal of CWD-positive deer and integration of the park and state approaches to carcass disposal. Three disposal methods are appropriate for CWD-positive carcasses: land filling (in licensed lined landfills if they are available and accepting deer carcasses), incineration, and alkaline (tissue) digestion. These methods would be carried out at off-site disposal facilities. Carcasses would be kept at the parks in refrigerated units pending test results and transported to off-site disposal facilities that accept the deer carcasses (either negative or positive).

Minimizing Environmental Contamination

Although it is unlikely that CWD prions can be removed completely from the landscape once introduced, actions can be taken to minimize potential environmental contamination by human activities. These actions would remain consistent with the constantly improving state of knowledge on this subject, which is monitored by the NPS Biological Resources Division staff who are involved with addressing CWD issues nationwide. The following additional activities would be required under all deer management alternatives 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 to minimize the transfer of body fluids onto the ground.
- Deer carcasses obtained through lethal removal actions 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).
- Handling of deer to obtain samples for CWD testing would occur on plastic tarps or other impervious surface to minimize the transfer of body fluids onto the ground.

ADAPTIVE MANAGEMENT APPROACHES INCLUDED IN THE ALTERNATIVES

The Department of the Interior requires its agencies to incorporate adaptive management principles, as appropriate, into policies and plans for the management of natural resources, and "conduct appropriate environmental monitoring to…evaluate progress toward achieving objectives whenever using adaptive management" (522 Departmental Manual 1, 1.5, B,C [NPS 2008f]; 43 CFR 46.145). In addition, the department has recently outlined the adaptive management approach in a technical guide developed to provide guidance to all of its bureaus and agencies (Williams, Szaro, and Shapiro 2007).

According to this technical guide,

> Adaptive management is a systematic approach for improving resource management by learning from management outcomes…An adaptive approach involves exploring ways to meet management objectives, predicting the outcomes of alternatives based on the current state of knowledge, implementing one or more of these alternatives, monitoring to learn about the impacts of management actions, and then using the results to update knowledge and adjust management actions. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable resource systems. Adaptive management should be used when decisions must be made despite uncertainty and where there is a commitment to using this approach. In addition to these two primary conditions, adaptive management should be used when (1) there is a real management choice to be made, (2) there is an opportunity to apply learning, (3) clear and understandable objectives can be identified, (4) the value of information gained is high, (5) uncertainty can be expressed as models that can be tested, and (6) monitoring is in place or can be put in place to reduce uncertainty (Williams, Szaro, and Shapiro 2007).

The deer management situation at both parks meets all these conditions, and adaptive management would be used in this planning effort, primarily in implementing the actions focused on deer impacts on vegetation.

USING THE ADAPTIVE MANAGEMENT PROCESS

For this plan, adaptive management begins with examining deer density as the primary factor limiting woody and herbaceous vegetation propagation, which affects forest regeneration and cultural landscape integrity. Monitoring under this plan would test for seedling stem density in open plots. If the action threshold is exceeded, then deer management actions would be taken as described in the sections that discuss thresholds for taking action. Data also would be collected to compare open and fenced plots. If there were no differences between the plots, data would be examined to identify the most important variables affecting plant regeneration. These could include light penetration, soil quality, or impacts of other organisms, in addition to deer density.

In addition, monitoring would be done to assess whether the cultural resource-related thresholds established by the planning team were exceeded. This would consist of monitoring crop yields at C&O Canal NHP and eventually at Harpers Ferry NHP, should that park be able to reestablish food crops (see appendix D).

Potential Adaptive Management Approaches

The following text describes some examples of how the adaptive management approach would be used.

Forest Regeneration Action Threshold

The action threshold could be modified based on the best available data for forest regeneration in a similar forest type, results of monitoring plot data, and deer density changes. Monitoring data would be compared to expectations (that forest regeneration would increase as deer density decreased). It is expected that it would take at least 10 years from the time that deer density was lowered until forest regeneration results would be realized in the monitored plots. If results after 10 years following achievement of the initial deer density goal did not meet expectations based on the action thresholds, the action threshold would be evaluated along with the monitoring data to determine what adjustments might be necessary.

Deer Removal Goal

For alternatives that would directly reduce the deer population through removal, the number of deer to be removed annually would be adjusted based on the monitoring of forest regeneration, deer population density surveys, and growth projections. When a management action is first triggered, the approximate number of deer to be removed would be defined by the difference between the estimated deer population density and the initial density goal selected (15 to 20 deer per square mile). However, because this density goal may not be achieved in the estimated number of years, annual removal goals would be revised based on the number of deer remaining in the herd after each year's removal actions and factoring in expected annual growth due to reproduction and immigration. This process of determining the number of deer to be removed each year would be repeated until the herd density goal was reached.

However, because the goal is to manage for successful forest regeneration and cultural landscape integrity within the parks, not for deer density, the results of removal would be documented by vegetation monitoring at least every three years. The number of deer to be removed could then be adjusted based on the response of the vegetation to a higher or lower deer density. If vegetation were observed to be regenerating before the lower deer density was reached, and cultural landscape thresholds were not exceeded, management actions then could be modified or adjusted. Similarly, management actions would be adjusted if no change in the vegetation were observed after implementation. It is important to note that deer densities in the parks may drop based on actions of other parties who are removing deer on their properties that are located within the park boundaries (inholdings). If deer density goals were reached, then adaptive management would consist of moving into maintenance actions as long as the forest regeneration (vegetation) and cultural landscape monitoring supports this. The following are examples of how an adaptive management approach could be implemented based on different outcomes related to forest regeneration:

- If the tree seedling regeneration threshold were met or exceeded prior to meeting the initial deer density goal, the deer density goal would be adjusted upward to a density that still would allow regeneration to occur, or different goals could be assigned to different areas of the parks depending on vegetation monitoring results.
- If forest regeneration were insufficient in terms of either seedling or sapling counts within 10 years after the initial deer density goal was reached, and no other signs of improvement were observed, then methods and protocols would be reviewed to identify the variables that were limiting expected results. The methods used then would be adjusted as necessary to correct for such factors. The goal would not be adjusted by any more than five additional deer per square mile until after a six-year monitoring period, at which point the density goal could be adjusted further.

- If the initial deer density goal of 15 to 20 deer per square mile were not reached within the expected timeframe, additional efforts would be made to reach the desired density through the use of other methods of removal or possibly by concentrating efforts more in one area and coordinating with entities outside the parks that are removing deer near that area.

Deer Exclosures

Large exclosures are proposed under alternative B. As some areas are exclosed, deer browsing pressure in other areas could increase. Areas inside and outside the proposed large exclosures would be monitored according to the protocol described for alternative A. If vegetation damage as a result of deer browsing increased substantially in unfenced areas, NPS staff at the parks could consider additional exclosures or other actions to reduce browse in unfenced areas.

Nonsurgical Reproductive Control

Reproductive control is proposed under alternatives B and D. However, there is limited information regarding its effectiveness as a long-term management technique for large, free-ranging populations. As science advances in this area, additional agents could be developed and tested for reproductive control on free-ranging deer or more efficient delivery methods could be approved. NPS would review the science at that time to determine if an agent would be appropriate for controlling the deer herd. The size, scale, and location of the application would depend on the specifications and efficacy of the drug.

Implementing Actions of the Plan/EA

A number of the actions in the plan/EA are based on recent vegetation monitoring, current deer density at the parks, existing technology, knowledge of deer population dynamics, and CWD. During the life of the plan, it is assumed that knowledge and experience with these issues would increase. Improved knowledge and experience may result in adjustments being made to the timing of actions (e.g., timing of lethal reduction, implementation of reproductive control, CWD response, or any of the other actions included in the plan/EA.) For example, alternative D (combined lethal and nonlethal actions) would be adjusted for each individual action as required to maximize forest regeneration. These actions also could be adjusted to incorporate new technologies or research. The initial plan would be to focus on direct reduction to decrease deer population density as quickly as possible, to minimize the number of deer to be removed over time, and to test action thresholds within a reasonable timeframe. After deer density was reduced to the initial goal, and if vegetation monitoring indicated that the tree seedling regeneration threshold is met or exceeded, maintenance of deer numbers might be achieved through reproductive control, depending on the state of the technology and as noted in the adaptive management parameters described above.

SUMMARY OF ALTERNATIVES

Table 6 compares the alternatives by summarizing the actions being considered within each alternative. The environmental analysis described in “Chapter 4: Environmental Consequences” looks at the effects of each alternative on each impact topic; these impacts are summarized in table 7.

TABLE 6. SUMMARY OF ALTERNATIVES

Activity	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
Deer Management Actions				
General Description of Deer Management Actions	This alternative would continue existing management of deer at the parks. This includes: • Deer monitoring, vegetation monitoring, data collection, and research • Use of limited protective caging and tree tubes to protect small landscaped areas and rare plants as needed • Opportunistic and targeted sampling for CWD • Educational and interpretive measures • Continued agency and interjurisdictional cooperation	Alternative B would include all actions described under alternative A (with some refinements to monitoring approaches), and also would include the use of: • Additional techniques for minimizing deer impacts: – Fencing of larger areas (wooded areas and crops): these areas could be fenced where protection is the most needed and where fencing could be installed with minimal impacts. This would include using fencing around fields containing susceptible crops. – Repellents: using small amounts of commercially available deer repellents on landscaped areas, restoration plantings, or cultural landscape areas where fencing would be undesirable because of its visual impact – Crop protection: changing crop configurations or types of crop to substitute crops that are less palatable to deer – Aversive conditioning: scaring deer out of certain areas with noise, motion; used only in specific areas where need temporary protection • Large exclosures: construct large-scale exclosures to protect about 5%–7% of the forested areas of the parks at any one time to allow for reforestation. Exclosures would be moved after majority of seedlings have exceeded top limit of deer browse (approximately every 10 years) • Nonlethal reduction efforts: implementing nonsurgical reproductive control of does to a point at which vegetation can recover. An acceptable reproductive control agent must be available and meet NPS established criteria.	Alternative C would include all actions described under alternative A (with some refinements to monitoring approaches), the techniques to minimize deer impacts listed under alternative B, and also would include: • Use of sharpshooting with firearms (or archery if areas of the park are too narrow or close to occupied buildings or residences) for controlled harvest programs to reduce deer population to an acceptable range and to maintain it at that level. • Use of capture and euthanasia in limited circumstances where sharpshooting would not be feasible due to safety concerns. • Donate meat, if possible (given any concerns or restrictions related to CWD). Sharpshooting would be done from close range by qualified NPS employees or authorized agents, who could be other federal employees, contractors, or skilled volunteers specifically experienced with this type of deer removal and who meet all qualifications, as described in the text.	Alternative D would include actions described under alternative A (with some refinements to monitoring approaches) and the techniques to minimize deer impacts listed under alternative B, with a primary focus of incorporating a combination of lethal and nonlethal deer management actions from alternatives B and C to address high deer density. This alternative would include: • Lethal actions (including sharpshooting with firearms or archery if areas of the park are too narrow or close to occupied buildings or residences, with very limited capture/euthanasia if necessary) to reduce the deer herd to the desired deer density. • Once the desired deer density has been reached, population maintenance could be conducted either via nonsurgical reproductive control methods, if these are available and meet NPS criteria, or by sharpshooting.
Reduction in Deer Population	None, other than mortality	Potentially reduce deer population if nonsurgical reproductive controls are successful and then only after the first several years of treatment or until natural mortality exceeded reproduction and reduced the population; population reduction would be gradual. Would not expect to reach desired deer density within the life of the plan.	Reduction of deer population to desired deer density in about two years at C&O Canal Gold Mine tract and in about five years on Maryland Heights; see table 10 for details. Other implementation areas would be addressed through the adaptive management process. Number of deer removed to meet goal is estimated at about 29–30 deer/year for Gold Mine tract, and 41–63 deer per year for Maryland Heights. To maintain the population at the desired level, remove an estimated 0–25 deer per year at Gold Mine tract and 15–30 deer per year on Maryland Heights. Capture and euthanasia would be used minimally if at all.	Similar to alternative C reduction to desired goal. Potential for future reductions through nonsurgical reproductive control (if feasible) used as a population maintenance technique, with sharpshooting available as needed to maintain the desired deer density.

Activity	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
Time Required to Achieve Desired Forest Regeneration	Forest regeneration cannot be achieved without reducing browsing impacts	Desired deer density and subsequent forest regeneration likely would not be achieved within life of this plan. A maximum of 10%–14% of the woody vegetation in the parks would be protected or regenerated over the life of the plan due to exclosures. Reproductive control would contribute to additional forest regeneration by gradually limiting deer numbers.	Regeneration changes expected about 3–4 years after deer density goal is reached (based on results seen at Gettysburg National Military Park) and trends toward regeneration success by end of plan.	Same as alternative C
Handling of Deer	Limited handling for research or injured deer	Deer would need to be handled to initially administer reproductive control agent to mark the deer so it is possible to tell if they have been dosed and when, although the criteria state that the agent should be able to be delivered remotely for subsequent doses.	No capture would be required for sharpshooting activities. For capture and euthanasia, minimize stress in accordance with American Veterinary Medical Association recommendations. Increased stress levels in captured deer compared to sharpshooting method.	Same as alternative B for reproductive control, and same as alternative C for other actions
Monitoring	Continued vegetation inventory and monitoring of deer population numbers to assess impacts	Monitoring of vegetation and deer similar to alternative A , plus: • Monitoring for impacts on agricultural crops as a proxy for cultural landscapes in addition to seedling/ forest regeneration monitoring • For reproductive control, monitor treated deer using additional surveys to determine reproductive control effectiveness (deer productivity) or other effects of immunocontraceptive agents (behavior, physiology, etc.) • Monitoring vegetation for signs of recovery within larger exclosures	Monitoring of vegetation and deer similar to alternative A , plus: • Monitoring for impacts on agricultural crops as a proxy for cultural landscapes in addition to seedling/ forest regeneration monitoring	Same as alternative A, plus: • If reproductive control were used, monitoring for treated deer using additional surveys to determine reproductive control effectiveness (deer productivity) or other effects of immunocontraceptive agents (behavior, physiology, etc.) • Monitoring for impacts on agricultural crops as a proxy for cultural landscapes in addition to seedling/ forest regeneration monitoring
Donation for Consumption or Disposal of Carcasses	Carcasses that are CWD negative would be allowed to decompose in place or would be disposed of using traditional methods (i.e., on-site burial in previously disturbed areas, away from any visitor use areas, or in landfills)	Similar to alternative A. Criteria require that the reproductive control agent used would allow meat to be safe for human and animal consumption.	Donation of meat for consumption would be to the maximum extent possible. Any deer carcasses not suitable for consumption or for surface disposal would be disposed of at an approved local landfill or other disposal facility that accepts deer carcasses.	Same as alternatives B and C
Regulatory Considerations	None	Must follow all label restrictions for the selected agent and would require EPA approval for any agent used. Additional requirements could be prescribed by NPS (e.g., marking).	All work would be done in compliance with all relevant firearms laws and regulations. Coordination with state/local/nonprofit/private entities might be needed to donate meat. Follow NPS, state, and local public health guidelines for CWD.	Same as alternatives B and C
Park Closure or Restricted Access	None	Restricted access within large exclosures areas (duration is long term—10 years) and temporary, restricted access within areas of active reproductive control activities. Months may vary with agent used, but likely would be in fall to winter. May include some restricted access to fenced areas or where aversive conditioning is occurring.	Areas temporarily closed or access restricted during lethal removal activities; closures or restrictions for deer management would be minimized by conducting activities mainly during periods between dusk and dawn and primarily in fall/winter months for larger reductions.	Same as alternatives B and C
Adaptive Management	No specific adaptive management related to deer management is included under this alternative	Changes in action thresholds or deer density goals; possible change in the reproductive control agent used and its application procedures; changes in numbers or locations of large exclosures. Could consider changes to crops or crop planting practices, or new aversive conditioning techniques based on deer damage results.	Changes in action thresholds or deer density goals or possible changes to implementation procedures. Could consider changes to crops or crop planting practices, or new aversive conditioning techniques based on deer damage results.	Changes in action thresholds or deer density goals, possible change in the reproductive control agent used and its application procedures, as well as the number or type of removal actions needed. This would include determining whether sharpshooting or reproductive control would be used for population maintenance. Could consider changes to crops or crop planting practices, or new aversive conditioning techniques based on deer damage results.

Activity	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
CWD Management Actions				
CWD Detection and Response	Opportunistic surveillance, coordinated with the state; targeted surveillance if deer with symptoms detected	All action alternatives would include long-term management responses to occurrences of CWD. When CWD is detected within 5 miles of either park, park staff would work with state wildlife professional to determine if lethal removal of deer should occur within the park to substantially reduce the deer population density, given that high densities support greater rates of disease transmission, and have been positively correlated with prevalence of CWD. At C&O Canal NHP, actions would be considered in the park within a 5-mile radius of the CWD occurrence, or within state designated CWD response areas, and not park-wide, and would be coordinated with the states to ensure actions were consistent with the states' responses.	Same as alternative B	Same as alternative B
Regulatory Considerations	None	Must follow NPS, state, and local public health guidelines for CWD	Same as alternative B	Same as alternative B
Park Closure or Restricted Access	None	Areas closed during lethal removal	Same as alternative B	Same as alternative B

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TABLE 7. SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
Vegetation	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:
	Substantial long-term, adverse impacts because browsing pressure would be expected to remain high in either all or a large portion of the parks throughout the life of this plan (15 years). This would reduce the abundance and diversity of native plants, suppress seedling growth, damage special status plants that are browsed, and cause damage to crops that are important components of the cultural landscape at C&O Canal.	Similar to impacts described for alternative A because reproductive control would result in only a gradual reduction in the deer population, and although the population goal could be met over the longer term, the exclosures would protect only a small portion of the woody vegetation in the parks at any one time and provide no protection for herbaceous species once the exclosures are removed. Long-term, measurable, adverse impacts because of the limited effectiveness of reproductive control and the exclosures in protecting forest vegetation from deer browse impacts. Short-term impacts from deer management implementation actions such as placement of bait piles because of trampling, and limited beneficial impacts from use of the techniques available to reduce deer access to crops and fields that reduce deer impacts from browse in these areas. Indirect, beneficial impacts from any lethal CWD response because of reduced deer density and reduced browse on park vegetation, but these would not outweigh the adverse effects of not taking deer management actions.	Long-term and beneficial overall impacts because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation throughout the parks to recover. Short-term adverse impacts from deer management implementation actions. Benefits from the limited use of deer management techniques to reduce impacts in certain locations or circumstances, as described for alternative B. CWD response actions would have similar impacts to alternative C.	Same impacts as alternative C. CWD response actions would have similar impacts to alternative C.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
	Cumulative Impact:	*Cumulative Impact*:	*Cumulative Impact*:	*Cumulative Impact*:
	Overall cumulative impacts would be long term and adverse, with alternative A contributing appreciable adverse increments to the cumulative impact on vegetation.	Similar to alternative A, with alternative B contributing appreciable adverse increments to the cumulative impact on vegetation.	Overall cumulative impacts would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on vegetation and special status plants.	Overall cumulative impacts would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on vegetation and special status plants.
White-tailed Deer	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:
	Long-term, measurable, adverse impacts because browsing pressure likely would remain high in the parks throughout the life of this plan (15 years) and would reduce the amount and quality of habitat and food available to deer and increase the risk of disease transmission. Adverse impacts of sustained high density deer populations could result in higher parasite load and burden of stomach worms that can be associated with high mortality. Short-term, unnoticeable, adverse impacts on deer from deer monitoring actions because of the disturbance and noise associated with the field crews. No measurable impacts from targeted and opportunistic CWD surveillance.	Similar to alternative A, because reproductive control would result in a gradual reduction in the deer population, and consequently the deer population would remain at relatively high levels throughout the life of the plan and reduce the amount and quality of habitat and food available to deer. Long-term, adverse impacts from the reduced quality of habitat and increased risk of disease that would occur with a continued high deer density. Long-term, beneficial impacts from CWD response actions that could involve the lethal removal of relatively large numbers of deer in some areas of the park, but these benefits would not outweigh the adverse effects of not taking actions that substantially reduce the deer herd.	Long term and beneficial overall impacts because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation throughout the parks to recover and better protect deer habitat. Reduced herd density would minimize the potential for nutritional stress and disease. Short-term, minimal, adverse impacts from implementing deer management actions because of noise and disturbance associated with the work crews. Short-term, measurable, adverse impacts on the parks' deer populations from removing a relatively large percentage of the population over a short period of time to achieve the desired long-term benefit. Long-term benefits from CWD actions resulting in the reduction of the potential for disease amplification, spread, and establishment.	Impacts would be similar to those described for alternative C, with long-term, beneficial effects as a result of the relatively rapid deer herd reduction that would allow the abundance and diversity of vegetation throughout the parks to recover and better protect deer habitat. There would be short-term and minimal, adverse effects from implementing deer management actions, and short-term, measurable, adverse impacts on the parks' deer populations from removing a relatively large percentage of the population over a short period of time to achieve the desired long-term benefit, as described under alternative C. Long-term, beneficial impacts from CWD response actions due to the reduction of the potential for disease amplification, spread, and establishment.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
	Cumulative Impact:	*Cumulative Impact*:	*Cumulative Impact*:	*Cumulative Impact*:
	Overall cumulative impacts would be long term and adverse, with the no action alternative contributing appreciable adverse increments to the cumulative impact on the white-tailed deer population.	Overall cumulative impacts would be long term and adverse, with alternative B contributing appreciable adverse increments to the cumulative impact.	Overall cumulative impacts would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on the white-tailed deer population.	Overall cumulative impacts would be long-term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on the white-tailed deer population.
Other Wildlife and Wildlife Habitat	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:	*Direct/Indirect Impact*:
	Long-term and minimal to potentially severe adverse effects on other wildlife, depending on the species and its habitat Long-term and minimal to potentially severe adverse impacts to special status wildlife species, depending on the species. Non-listed and special status wildlife species that depend on ground cover and young tree seedlings or understory shrubs for food or cover could be severely reduced or eliminated from the parks, with up to substantial, adverse impacts. Impacts on species that depend primarily on other habitats (not woodlands) or on the upper canopy for food and cover would be small enough to be unmeasurable because deer browse generally does not affect their habitat or food sources. CWD surveillance would not result in any detectable impacts.	Similar to alternative A because reproductive control would result in only a gradual reduction in the deer population. For these reasons, it is expected that the deer population would remain at relatively high density levels in the parks throughout the life of the plan, with continued substantial of deer browse damage. Exclosures would protect only a small portion of the forest in the parks at any one time. Non-listed and special status wildlife species that depend on ground cover and young tree seedlings or understory shrubs for food or cover could be severely reduced or eliminated from the parks, with potential severe adverse impacts, while impacts on species that depend primarily on other habitats (not woodlands) or on the upper canopy for food and cover would be minimal, as described above. Long-term, beneficial impacts from CWD response involving lethal removal of relatively large numbers of deer because it would reduce browse on wildlife habitat, but the benefits would	Overall long-term and beneficial impacts because the relatively rapid deer herd reduction would allow vegetation used as food and cover for many wildlife species and for special status wildlife species to become more abundant. Potential long-term, minimal, adverse effects on some species that prefer open habitat because there would be regrowth of understory, and short-term, unnoticeable, adverse impacts from disturbance and noise during the implementation of the action and use of deer management. CWD actions would have similar impacts as described under alternative B, and beneficial impacts from the reduction of deer and associated deer browse on vegetation/habitat.	Alternative D would have essentially the same impacts as alternative C, with long-term, beneficial impacts on non-listed and special status wildlife species as a result of the decrease in the deer herd and associated deer browse impacts on habitat, and limited, adverse impacts from the management actions themselves. CWD actions would have similar impacts as described under alternative B, and beneficial impacts from the reduction of deer and associated deer browse on vegetation/habitat.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
		not outweigh the adverse effects of not substantially reducing the deer herd.		
	Cumulative Impact	*Cumulative Impact*:	*Cumulative Impact*:	*Cumulative Impact*:
	The overall cumulative impact would be long term and adverse, with the no action alternative contributing an appreciable adverse increment to the cumulative impact on wildlife.	Alternative B would contribute appreciable adverse increments to the cumulative impact on wildlife and wildlife habitat.	The overall cumulative impact would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on vegetation.	The overall cumulative impact would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on wildlife and wildlife habitats.
Historic Districts and Cultural Landscapes	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*
	Long-term, measurable, adverse impacts because browsing pressure would be expected to remain high in either all or a large portion of the parks throughout the life of this plan (15 years) resulting in damage to vegetation that contributes to the historic districts and cultural landscapes of the parks.	Impacts would be similar to those described for alternative A because reproductive control would result in only a gradual reduction in the deer population. The exclosures would protect only a small portion of the woody vegetation in the parks at any one time, and no protection for herbaceous species once the exclosures are removed. Long-term, measurable, adverse impacts from the limited effectiveness of reproductive control and the exclosures in protecting forest vegetation from deer browse impacts. Short-term impacts from deer management implementation actions such as placement of bait piles because of trampling, and limited beneficial impacts from use of the techniques available to reduce deer access to crops and fields and thereby reduce deer impacts from browse in these areas.	The overall long-term and beneficial impacts on vegetation that contributes to the historic districts and cultural landscapes from the relatively rapid deer herd reduction that would allow the abundance and diversity of vegetation to recover. There would be short-term impacts (mainly from trampling) from deer management implementation action, and benefits from the limited use of deer management techniques to reduce impacts in certain locations or circumstances, as described for alternative B. CWD herd reduction actions would have similar impacts to the herd reduction actions in this alternative.	Same as alternative C

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
		Any CWD response that would be taken under the proposed long-term plan would provide indirect, beneficial impacts from reduced deer density and reduced browse on park vegetation, but these would not outweigh the adverse effects of not taking deer management actions.		
	Cumulative Impact:	*Cumulative Impact:*	*Cumulative Impact:*	*Cumulative Impact:*
	The overall cumulative impact on historic districts and cultural landscapes would be long term and adverse. Alternative A would contribute appreciable, adverse increments to cumulative impacts on cultural landscapes and historic districts because continued deer browsing would affect vegetation of the cultural landscapes of the parks.	In the absence of any CWD-triggered lethal response, the mostly long-term, adverse impacts of alternative B would contribute an appreciable, adverse increment to the overall long-term adverse cumulative impact. If CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional, localized, beneficial, cumulative impacts on historic districts and cultural landscapes associated with reduced browse impacts, which would reduce long-term, adverse, cumulative impacts.	In the absence of any CWD-triggered lethal response, deer management actions under alternative C would contribute an appreciable, beneficial increment to the overall adverse, cumulative impact. If CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be localized, additional, beneficial, cumulative impacts.	In the absence of any CWD-triggered lethal response, deer management actions under alternative D would contribute an appreciable, beneficial increment to the overall, adverse, cumulative impact because of the relatively rapid reduction in deer and associated reduction in damage to vegetation contributing to the parks' historic districts and cultural landscapes. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional, localized, beneficial, cumulative impacts.
Visitor Use and Experience	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*
	Both beneficial and adverse impacts on those visitors who may be primarily interested in viewing deer (beneficial in that there would be more deer to see, adverse in that the appearance of the herd could be poor if the herd experiences	Similar impacts to alternative A. Overall adverse impacts on visitor use and experience would gradually become beneficial in the long term, beyond the life of this plan, because vegetation would be expected to	Both beneficial and adverse overall impacts, given the differences in desired visitor experience, impacts on visitor use and experience. Short- and long-term, adverse impacts to some visitors because of	Similar to alternative C.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
	density-dependent health issues). Overall impacts related to a decreased ability to view scenery (including native vegetation and the historic landscape) and other wildlife would be long term and adverse. Long-term, beneficial impacts from implementation of ongoing park maintenance, operations, and development activities by improving visitor amenities, access, and interpretive opportunities over time.	recover over time and deer would continue to be present. Indirect, beneficial impacts related to the appearance of vegetation in the parks from any lethal CWD response but there would also would be adverse effects on visitor use and experience. The benefits would not outweigh the adverse effects of not taking deer management actions in the long term.	the lethal aspects of removal and temporary park closures. There would be long-term, beneficial impacts on many other visitors who value viewing a variety of wildlife, plants, and the cultural landscape as the forests recover. Any lethal CWD response that would be taken under the long-term response plan would result in impacts similar to the deer management action in alternative C.	
	Cumulative Impact: The overall cumulative impact would be long-term and adverse, with alternative A contributing both beneficial and adverse increments to cumulative impacts on visitor use and experience	*Cumulative Impact:* The overall cumulative impact would be long term and beneficial, with alternative B contributing beneficial increments to cumulative impacts on visitor use and experience	*Cumulative Impact:* The overall cumulative impact would be long-term and beneficial, with alternative C contributing beneficial increments to cumulative impacts on visitor use and experience	*Cumulative Impact:* The overall cumulative impact would be long-term and beneficial, with alternative D contributing beneficial increments to cumulative impacts on visitor use and experience
	Cumulative Impact: Overall cumulative impact would be long term and adverse, with alternative A contributing appreciable adverse increments to the cumulative impact on vegetation.	*Cumulative Impact:* Similar to alternative A, the overall cumulative impact would be long term and adverse, with alternative B contributing appreciable adverse increments to the cumulative impact on historic districts and cultural landscapes.	*Cumulative Impact:* Overall cumulative impact would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on historic districts and cultural landscapes.	*Cumulative Impact:* Overall cumulative impact would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on historic districts and cultural landscapes.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
Human Health and Safety	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*
	Both beneficial and adverse impacts. Slightly beneficial impacts on human health and safety from implementation of ongoing training and education activities because employee accidents would be highly infrequent. Long-term, adverse impacts would result from the continued high potential for deer-vehicle collisions resulting from a large deer population and the continued potential risk of exposure to Lyme disease. Long-term, minimal, adverse impacts from opportunistic and targeted surveillance.	Similar impacts to alternative A because reproductive control would result in only a gradual reduction in the deer herd. Short- and long-term, adverse impacts from implementation of management actions. Long-term, adverse impacts with respect to the potential for deer-vehicle collisions. Long-term, adverse impacts related to the continued potential for exposure to Lyme disease. Some adverse impacts and also indirect benefits from any CWD response actions, but these would not outweigh the adverse effects of not taking deer management actions that would be taken under the proposed long-term plan would have.	Short- and long-term overall adverse impacts related to the implementation of the plan. Long-term, beneficial impacts related to a reduced risk of deer-vehicle collisions as a result of the reduction in deer density. CWD response actions under a long-term response plan would have similar impacts to the deer management actions in this alternative.	Same as alternative C.
	Cumulative Impact:	*Cumulative Impact:*	*Cumulative Impact:*	*Cumulative Impact:*
	Overall cumulative impact would be long term and adverse, with the no action alternative contributing adverse increments to cumulative impacts on human health and safety.	Overall cumulative impact would be long term and adverse, with alternative B contributing adverse increments to cumulative impacts on human health and safety.	Overall cumulative impact would be long term and beneficial, with alternative C contributing minimal risks and an appreciable beneficial increment to cumulative impacts on human health and safety.	Overall cumulative impact would be long term and beneficial, with alternative D contributing minimal risks and an appreciable beneficial increment to cumulative impacts on human health and safety.

Impact Topic	Alternative A: Continuation of Current Management (No Action)	Alternative B: Nonlethal Deer Management	Alternative C: Lethal Deer Management	Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)
Park Management and Operations	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*	*Direct/Indirect Impact:*
	Long-term, minimal, overall adverse impacts on park management and operations. Each park's deer population is expected to fluctuate and remain at relatively high levels, resulting in long-term demands on park staff and finding time for managing the herd and protecting other resources.	Long-term, overall, adverse impacts, mainly due to the demands of installing and maintaining large exclosures and implementing and monitoring reproductive controls. Short and long-term, adverse impacts from any lethal CWD response that would be taken.	Adverse impacts during the period of direct reduction efforts because of the need for additional staff time or costs for monitoring and coordinating activities. The greater reduction of deer over a shorter period of time would reduce long-term, adverse impacts over time. Short and long-term, adverse impacts from any lethal CWD response that would be taken.	Long-term, adverse impacts during the period of direct reduction and reproductive control and diminishing long-term, adverse impacts during maintenance. Short and long-term, adverse impacts from any lethal CWD response that would be taken.
	Cumulative Impact:	*Cumulative Impact:*	*Cumulative Impact:*	*Cumulative Impact:*
	Overall cumulative impacts would be long term and both beneficial and adverse, with the no action alternative contributing adverse increments to cumulative impacts on park management and operations.	Overall cumulative impacts would be long term and adverse, with alternative B contributing appreciable, adverse increments to cumulative impacts on park management and operations from demands on staff and budget to implement the exclosures and reproductive control.	Overall cumulative impacts would be long term and adverse, with alternative C contributing measurable, adverse increments to cumulative impacts on park management and operations to implement direct reduction.	Overall cumulative impacts would be long term and both beneficial and adverse, with alternative D contributing adverse increments to cumulative impacts on park management and operations to implement direct reduction, coupled with reproductive control as a maintenance action if feasible.

ALTERNATIVES CONSIDERED BUT DISMISSED FROM FURTHER DETAILED ANALYSIS

The Council on Environmental Quality (CEQ) regulations for implementing NEPA require federal agencies explore and objectively evaluate all reasonable alternatives and to briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This section describes those alternatives that were eliminated from further study and documents the rationale for their elimination.

During the course of scoping, several alternatives were considered but deemed to be unreasonable and were not carried forward for analysis in this EA. Justification for eliminating these options from further analysis was based on the following factors:

- Technical or economic feasibility
- Inability to resolve the purpose and need for taking action to a large degree
- Duplicate other, less environmentally damaging or less expensive alternatives
- Conflict with an up-to-date and valid park plan, statement of purpose and significance, or other policy, such that a major change in the plan or policy would be needed to implement
- Require a major change to a law or policy
- Impose too great an environmental impact
- Address issues beyond the scope of the NEPA review
- Unallowable by another agency from which a permit is required, and is therefore environmentally infeasible

The following alternatives were considered but dismissed from further detailed analysis for reasons explained below.

MANAGED HUNT/PUBLIC HUNTING

During public scoping, some commenters advocated the use of hunting in the parks to manage the deer population. Public hunting is inconsistent with existing laws, policies, and regulations for Harpers Ferry and C&O Canal NHPs and all other units of the national park system where hunting is not authorized. Throughout the years, NPS has taken differing approaches to wildlife management but has maintained a strict policy of not allowing hunting in park units of the national park system where it is not congressionally authorized. In 1970, Congress passed the General Authorities Act and in 1978 the "Redwood Amendment," which clarified and reiterated that the single purpose of the NPS Organic Act is conservation. Although the Organic Act gives the Secretary of the Interior the authority to destroy plants or animals for the purposes of preventing detriment to park resources, it does not give the Secretary authority to permit the destruction of animals for recreational purposes. In 1984, after careful consideration of congressional intent with respect to hunting in national parks, NPS promulgated a rule that allows public hunting in national park areas only where "specifically mandated by Federal statutory law" (36 CFR 2.2). NPS reaffirmed this approach in the NPS *Management Policies 2006* (NPS 2006).

Changing these long-standing service-wide policies and regulations regarding hunting in parks is beyond the scope of this plan/EA and would be inconsistent with the purposes of the parks. Therefore, public hunting has been dismissed from detailed analysis, although use of skilled volunteers to assist in direct reduction is being included as an option for implementation. Because public hunting was not carried forward, all elements suggested related to public hunting also were dismissed from detailed analysis.

PREDATOR AUGMENTATION (COYOTES/BLACK BEARS) OR REINTRODUCTION (WOLVES)

Relationships between predators and prey are complex, and the impact of predators on herbivore populations is variable (McCullough 1979). Coyotes (*Canis latrans*) and black bears (*Ursus americanus*) are potential deer predators that reside throughout much of North America, and these predators are present in and around the parks. However, these species appear to be opportunists that take advantage of specific periods of deer vulnerability, and none of these predators has demonstrated a consistent ability to control deer populations. Even though coyote populations have increased and the coyote's range has expanded in the past 20 years, both deer and coyote populations have increased simultaneously in many areas. Biologists believe that coyotes are partly responsible for declining deer numbers in some areas, but changes in deer populations in other areas appear unrelated to coyote density. There is no evidence that coyotes can effectively reduce and control white-tailed deer populations to the levels prescribed in the plan (Coffey and Johnston 1997; Gompper 2002).

Most of the black bear's diet is plant material. Only approximately 10% of the black bear diet is not plant material, and most bears will scavenge carcasses of larger animals, although they are known to prey upon live fawns and other small mammals when the opportunity arises (Adirondack Ecological Center 2015).

Wolves are efficient deer predators, but they have been eliminated from much of the United States. Introducing or augmenting their presence in the parks would not be feasible because of their spatial needs relative to the area of the parks, feasibility considering state policies, and safety concerns. Wolves have home ranges averaging 30 square miles when deer are the primary prey (Mech 1991). Also, the linear nature of the C&O Canal NHP and proximity to development makes it impractical for predators such as wolves to be reintroduced or coyotes to be augmented. There are issues with possible adverse effects on surrounding rural or suburban residents, especially safety of pets, children, and small farm animals. The reasons described above relating to effectiveness, habitat limitations, and human safety concerns led this alternative to be dismissed.

USE OF POISON

Under this alternative, poison would be mixed with food sources such as grains to kill deer. Death from poisoning is often considered inhumane (UVM 1997). Death is not immediate, and health concerns resulting from people potentially hunting and eating poisoned deer that have wandered out of the parks could be an issue. Currently no toxicants, poisons, or lethal baits are registered for deer control. In addition, non-target native wildlife or roaming pets could potentially eat a tainted carcass or the poison itself (Bishop et al. 1999). Therefore, this alternative was dismissed.

CAPTURE AND RELOCATION

Capturing deer within the parks and relocating them would be in violation of NPS policy regarding translocation and the prevention of disease spread (NPS 2002a), and the state agencies also are not likely to support this option. Even if the policy were not in effect, permits would be required to relocate deer to areas a sufficient distance from the parks to ensure that they would not return. Given the abundance of deer in Maryland and Virginia and in most of the United States, areas for relocation would be very limited or nonexistent. Also, live capture and relocation methods can cause stress that can result in high mortality rates among captured and/or relocated deer. Implementation of this alternative could result in the death of more than 50% of the deer during the first year after release (Jones and Witham 1990). In one study only 15% of the relocated deer survived one year after relocation (O'Bryan and McCullough 1985). In addition, due to potential concerns related to CWD, it is possible that quarantine processes would be required. For these reasons, this alternative was dismissed as a viable option.

SUPPLEMENTAL FEEDING

Providing supplemental food to deer is often suggested as a way of reducing damage to natural or ornamental vegetation. However, the NPS *Management Policies 2006*, section 4.4.1, "General Principles

for Managing Biological Resources," and section 4.4.2, "Management of Native Plants and Animals," are aimed at allowing natural processes to occur whenever possible (NPS 2006) and would not support the concept of supplemental feeding. In addition, although providing alternative food sources could provide temporary relief from browsing to plants needing protection, it would not provide a long-term solution. Supplemental feeding could facilitate disease transmission. It also would increase survivability and reproduction in the deer population, thus compounding problems that already exist. Supplemental feeding encourages increased deer population growth and negative impacts on habitat and other wildlife, as well as greater deer-human conflict (NDTC 2009), and is therefore in conflict with the purpose and need of this plan. For these reasons, this alternative was dismissed.

FENCING THE ENTIRE PARK(S) (OR EXCLUSIVE USE OF FENCING)

Fencing the entire park or either of the parks would not effectively prevent deer from entering or leaving them, given the number of potential entry points (e.g., roads, driveways), the linear nature of the parks, geography and topography, and fragmentation of the parks. Fences approximately 8 feet high would be needed to prevent deer from jumping over the barriers, and fences of this height and extent would have too great of an environmental effect on the cultural landscapes of the parks. Even if an entire park were fenced, vegetation within the park would continue to suffer the effects of deer browsing because the deer population within the fenced area would continue to increase and the health of the contained herd would suffer. Therefore, either all deer within the fenced area would need to be removed, which would be inconsistent with NPS policy, or the deer population within the fence would need to be managed with other methods to meet the objectives of the management plan. For these reasons, this alternative was dismissed.

Exclusive use of fencing would not be sufficient to protect sensitive plant species and allow for forest regeneration. To protect sufficient area, fencing would need to cover a large portion of the parks, and this would result in too great an impact on visitor use, visual quality of the parks, cultural landscapes of the parks, and other wildlife species. Areas not fenced would be subject to increased pressures from deer browsing. For these reasons, exclusive use of fencing without other actions included to reduce deer numbers was eliminated as a reasonable alternative, but fencing would be included as a component of alternative B.

ELECTRONIC FENCING

The use of electronic fencing was considered as a tool, but it was eliminated as a reasonable option because of concerns about inadvertent and accidental contact with the activated fences by park visitors, general concern about efficacy of the fences (because deer can jump over electric fences), and the need to install and maintain a power source for the fence in potentially inaccessible areas.

REPRODUCTIVE CONTROL (AS A STAND-ALONE ALTERNATIVE)

Reproductive Control of Does

Reproductive control options to restrict the growth of the deer population were considered and were incorporated into alternatives B and D. However, reproductive control as a stand-alone alternative was dismissed because it would not meet the objectives of the plan in a timely manner because of the length of time reproductive control would take to reduce the deer population. The following reproductive control methods were not considered for further analysis for the reasons described below.

Surgical Sterilization

This alternative would initially implement a phased approach to surgically sterilizing does within the parks to potentially reduce the size of the population over a number of years through natural mortality. Even though both sexes can be treated, surgical sterilization of females is more effective for population control in polygamous species like white-tailed deer. In addition, males are generally more difficult to capture because they are more wary and less gregarious than does. Sterilization of does is an invasive

procedure, requiring either the surgical removal of ovaries or tubal ligation. Procedures require full anesthesia and must be conducted by a veterinarian. It is possible to conduct the surgery in the field. However, complications could result due to a relatively high incidence of infection, and mortality of individual deer could occur. If field surgery were required, a temporary or mobile field station could be set up to minimize the potential for infection and reduce impacts on visitors.

Surgical sterilization has several downsides including the following: treating a number of deer on a large scale is difficult; success is unlikely if deer are moving in and out of the parks (Merrill, Cooch, and Curtis 2006); and the procedure is labor-intensive, taking approximately 6 to 8 hours per deer to capture, transport, treat, and return to release. Even though this treatment is permanent for individuals, annual sweeps would be needed to treat new deer recruited into the area. In addition, a recent study at Cornell University indicates that surgical sterilization of does is not effective as a stand-alone method for controlling deer abundance in geographically open populations of white-tailed deer (Boulanger and Curtis 2016).

This alternative would have the advantage of permanently sterilizing individual does, and, because surgical sterilization is permanent, the animal would be handled only once. Does would be captured, tagged, surgically sterilized, and then released back into the parks. In addition to the stress of the capture, individual animals would also be stressed by tranquilizers/anesthesia, surgical procedures, and recovery, which could increase mortality rates of sterilized individuals. Additionally, the long-term effects of this alternative on population genetics or behavior have not been well documented. Some researchers suggest that, depending on the type of sterilization used, changes in animal behavior would be expected (Warren and Warnell 2000). Removal of the ovaries would change hormone production in the treated animal and would result in altered behavior. With a ligation procedure, normal hormone production would remain; however, this has been shown to result in repeated estrous cycles during the breeding season (Knox et al. 1988), extending the rut by modifying the male response behavior.

Due to the high numbers of deer needing treatment and the labor required to manage does by surgical sterilization, this issue was considered and dismissed because of concerns about feasibility and efficacy, stress to the animals, and long-term effects on population genetics and behavior.

Contragestives

A contragestive is a drug that is applied after a doe becomes pregnant that terminates the pregnancy. This method would need to be administered annually. Contragestive agents differ in two ways from contraceptive control methods: the time of application (during pregnancy rather than before) and the potential to harm the deer. If the drug is administered too late in the pregnancy, it could make the delivery of a dead fetus difficult, potentially harming the doe. However, if the contragestive is applied too early, the doe could become pregnant again. Efficacy is approximately 75%– 80%, depending on timing. This method could be used to supplement the effectiveness of contraceptives, essentially treating animals missed with contraceptive treatments or those for which the treatment was not effective. The difficulty would then become how to determine which deer are pregnant. This would require either extensive monitoring/observation of the deer or recapturing does to check for pregnancy.

Given the number of deer in the area and the size and configuration of the parks, large-scale implementation of contragestives would not be economically feasible because of the staff time and monitoring required to make the practice effective and because other more effective and less environmentally damaging alternatives exist. Even on a limited scale, the use of other reproductive control measures would provide greater efficacy than contragestives. In addition, contragestives may be considered inhumane because of their mode of action and their potential to harm the doe. There also is concern about potential effects to nontarget species (through food chain transfer). Therefore, for all these reasons, the parks dismissed the use of contragestives as a reproductive control option.

Reproductive Control of Bucks

Another form of reproductive control includes sterilization of bucks. In a study of sterilization of feral horses, sterilizing only dominant harem stallions resulted in relatively modest reductions in population growth. Substantial reproduction may occur even when 100% of the dominant harem stallions are sterilized if other males perform as little as 10% of the breeding. Adequate suppression of population growth may be attained only if a large proportion of all males in the population are sterilized (Garrott and Siniff 1992).

Another study on the use of vasectomy on wolves suggested that population reduction depends largely on the degree of annual immigration. With high immigration (which could be expected at the parks because of the presence of deer on neighboring lands), periodic sterilization produced only moderate reductions in population size relative to an untreated population. Similar reductions in population size were obtained by periodically removing large numbers of wolves (Haight and Mech 1997).

Under this alternative, long-term population stability would become an issue along with genetic variability (a few nondominant bucks could breed the entire herd). If females did not become pregnant, their estrous cycle could be extended, resulting in later pregnancies and lower survival for fawns born later in the year (as a result of a higher winterkill potential). The population dynamic and makeup of the herd could suffer under this alternative. Because of the concerns relating to effectiveness, population stability, and genetic variability, this alternative was dismissed from detailed analysis.

OTHER OPTIONS FOR MANAGEMENT OF CHRONIC WASTING DISEASE

Since the long-term CWD management plan is common to all action alternatives and includes the use of lethal removal, the team examined other options that could possibly be considered for long-term management of CWD to see if other alternatives for this part of the plan should be carried through for analysis. These options include those that are being discussed within NPS for similar long-term CWD management planning, including demographic culling; test and cull; reproductive control; use of predators; changing habitat and land use strategies, and reducing environmental contamination. For the reasons discussed below, it is the opinion of the planning team that none of these options would be sufficient or effective as a long-term management alternative if CWD were found in or within 5 miles of the park units.

Demographic culling (focusing on removal of males) was considered because there is some research that suggests the disease has higher prevalence in males when it first enters the population. However, females control the population and need to be targeted to decrease deer numbers. Testing deer for the presence of the disease and then removing any infected individuals ("test and cull") was suggested, but although this may work in some unique situations, there are a number of logistical issues that may prevent the use of this strategy as an effective disease management alternative (Wolfe, et al. 2004).

Use of just reproductive control or use of predators to reduce the deer population would not be effective in reducing the deer population to the extent needed for disease control for the same reasons that these were dismissed as general deer management methods. Also, reproductive control leaves a potentially infected animal on the landscape. Predation would not have a great enough impact on drive disease dynamics, and fawn predation would likely increase reproductive rates (a density dependent response).

Ideas regarding changing habitat or land use strategies that should be considered include reducing feeding and/or mineral licks, eliminating cervid farms, and changing meadows or croplands into habitat that is less attractive to deer. There are no feeding areas or deer farms in or near the parks now, and education would emphasize the importance of not feeding deer in general. Changing the habitat may not be possible without adversely impacting the cultural landscapes of the parks or would not be effective, as described above under "Landscape Modification" for deer management options. Very little, if anything, has been published on the results of taking a piece of land altered by human activity and trying to restore it to a more natural condition to see what the result is on CWD (NPS, Powers, pers. comm. 2012c). Research

has shown the opposite. Human alteration of the environment (creating edge habitat) has attracted deer, and with deer comes the possibility of CWD. Changing the mowing frequency, height of mowing, or use of prescribed burns would not be expected to have any meaningful impact on making areas less attractive to deer to the extent that would influence the spread of disease.

Finally, reducing potential environmental contamination by providing education and appropriate enforcement regarding the dumping of deer carcasses and gut piles on or near the parks is a good idea, but would not be effective as a stand-alone alternative. While it is illegal to dump gut piles on NPS land, it is difficult to prevent people from doing so. This practice would be targeted in educational materials by both the parks and likely the states if the area was to become a CWD containment area.

To summarize, none of the other options, including nonlethal options, were considered to be effective for the long-term management of CWD. The only option that would be considered potentially effective against the spread of CWD was population reduction, and this was therefore included as the CWD plan for all deer management alternatives.

NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

The preferred alternative is the alternative "which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic environmental, technical, and other factors" (CEQ 1981). NPS has identified alternative D as its preferred alternative upon consideration of factors such as the degree to which alternatives would meet plan objectives (see table 7), environmental impacts (see "Chapter 4: Environmental Consequences"), the degree to which alternatives provide management flexibility, and costs.

CHAPTER 3: AFFECTED ENVIRONMENT

INTRODUCTION

The "Affected Environment" describes existing conditions for those elements of the natural and cultural environment that could be affected by implementation of the actions considered in this plan/EA. The impact topics addressed are:

- vegetation, including special status species (plants);
- white-tailed deer;
- other wildlife and wildlife habitat, including special status species (wildlife);
- historic districts and cultural landscapes;
- visitor use and experience;
- health and safety;
- park management and operations.

Relevant impact topics were selected based on agency and public concerns, regulatory and planning requirements, and known or expected resource issues. The information provided in this chapter will be used as context for comparing the potential impacts of each alternative, which are presented in "Chapter 4: Environmental Consequences."

VEGETATION

OVERVIEW

The following discussion of vegetation pertains to both Harpers Ferry and C&O Canal NHPs. A detailed description of vegetation occurring at Harpers Ferry is provided, followed by a description of vegetation occurring along the Chesapeake and Ohio Canal. A roughly 1.5-mile portion of the C&O Canal traverses through the Maryland Heights area of Harpers Ferry NHP along the banks of the Potomac River. For this reason, the description of vegetation occurring along the Maryland Heights area is also applicable to that portion of the C&O Canal.

NATIVE PLANTS AT HARPERS FERRY NATIONAL HISTORICAL PARK

Note that the following information is taken from the General Management Plan prepared for Harpers Ferry National Historical Park in 2008 (NPS 2008a).

A wide variety of woody tree and shrub species occur in the approximately 70% of the park that is forested. Chestnut oak (*Quercus prinus*) is usually the dominant tree in the forest canopy on rocky soils of higher ridges such as Maryland Heights. Black oak (*Quercus velutina*) is also important on south-, west-, and east-facing slopes. Northern red oak (*Quercus rubra*) is found with chestnut oak on rocky, north-facing slopes, where eastern hemlock (*Tsuga canadensis*) was formerly prominent. Red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), and flowering dogwood (*Cornus florida*) are frequent understory trees, while mountain laurel (*Kalmia latifolia*), black huckleberry (*Gaylussacia baccata*), Blue Ridge blueberries (*Vaccinium pallidum*), deerberry (*V. stamineum*), and maple leaf viburnum (*Viburnum acerifolium*) are common shrubs (NPS 2008a).

Lower-elevation, north-facing slopes with base-rich soils support a mixed mesophytic forest of northern red oak, white ash (*Fraxinus americana*), sugar maple *(Acer saccharum*), basswood (*Tilia americana*), hackberry, bitternut hickory (*Carya cordiformis*), slippery elm (*Ulmus rubra*), tulip poplar, hop hornbeam (*Ostrya virginiana*), and pawpaw (*Asimina triloba*). Woody understory plants of the mesophytic forests include spicebush (*Lindera benzoin*) and American bladdernut (*Staphylea trifolia*) (NPS 2008a).

Two extensive types of floodplain riparian forests are located along the Potomac and Shenandoah Rivers—lower areas that flood on average every one to three years have silver maple (*Acer saccharinum*) as a prominent component with associated species such as sycamore, green ash (*Fraxinus pennsylvanica*), and cottonwood (*Populus deltoides*) and higher parts of floodplains have a diverse forest of sycamore, white and green ash, tulip poplar, bitternut hickory, hackberry, sugar maple, black walnut (*Juglans nigra*), and the locally rare Shumard oak (*Quercus shumardii*) (NPS 2008a).

Many fern species have been found occupying a wide variety of habitats. On the rock ledges and crevices, woolly lip fern (*Cheilanthes tomentosa*), the locally rare lobed spleenwort (*Asplenium pinnatifidum*), and the common polypody (*Polypodium virginianum*) are likely to be found. But on the steep, rocky, and partially shaded slopes of Short Hill, Maryland Heights, and Loudoun Heights, marginal shield fern (*Dryopteris mariginalis*) and Christmas fern (*Polystichum acrostichoides*) are more common. The floodplains and moist, shaded, low slopes surrounding the Potomac and Shenandoah Rivers support even more fern species, including intermediate shield fern (*Dryopteris intermedia*), New York fern (*Thelypteris noveboracensis*), and fragile fern (*Cystopteris protrusa*) (NPS 2008a).

Grasses and grass-like plants, including sedges and rushes, are a diverse and important part of plant communities. On the dry, rocky ridge tops of Maryland Heights, Loudoun Heights, and Short Hill, poverty grass (*Danthonia spicata*) and greenish sedge (*Carex virescens*) are the most frequent species encountered. At lower elevations on these ridges, cliff muhly (*Muhlenbergia sobolifera*), tall brome-grass (*Bromus pubescens*), and Bosc's panicgrass (*Dicanthelium boscii*) are commonly found. In floodplain forests, there are species such as nodding fescue (*Festuca subverticillata*) and deertongue grass (*Dichanthelium clandestinum*). Prairie grasses such as big bluestem (*Andropogon gerardii*), the locally uncommon prairie cordgrass (*Spartina pectinata*), and the bank-stabilizing Emory's sedge (*Carex emoryi*) are more likely to be seen along the riverbanks of the Potomac and Shenandoah (NPS 2008a).

Wildflower species such as woodland sunflowers (*Helianthus strumosus*), birdfoot violets (*Viola pedata*), and Virginia bluebells (*Mertensia virginica*) grow in the forest. Along the banks of the Potomac and Shenandoah Rivers, a different group of wildflowers can be seen, including monkeyflower (*Mimulus ringens*), wide-leaved joe-pye weed (*Eupatorium purpureum*), and the New England aster (*Aster novae-angliae*) (NPS 2008a).

NATIVE PLANTS AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

More than 1,200 species of vascular plants occur at Chesapeake and Ohio Canal NHP (NPS 2004a), including 1,258 native and 261 nonnative plant species that have been identified within the park (NPS 2014b). A total of 52 species of trees, 9 species of shrubs, and 17 species of vines have been documented within the park (Schmit et al. 2012a). Species that generally occur at higher elevations on the Potomac River in Maryland generally would be geographically associated with the northern extent of the park unit, while those occurring normally under conditions representative of lower elevations would occur near the southern extent of the park unit.

Box elder (*Acer negundo*), a short-lived tree common in early successional habitats prone to flooding, is the most prevalent tree species. Shade-tolerant upland tree species include chestnut oak, red maple, and American beech; early successional species range in shade intolerance and include tulip poplar, white ash, black cherry (*Prunus serotina*), bitternut hickory, and Eastern red cedar (*Juniperus virginiana*). Silver maple and American elm are important bottomland tree species, while green ash and common hackberry are important bottomland seedling species. Northern spicebush (*Lindera benzoin*) is the most common shrub (Schmit et al. 2012a). There are also 181 species of grasses, sedges, and rushes, 145 of which are native (Schmit et al. 2012a).

NONNATIVE PLANT SPECIES OCCURRING AT THE PARK UNITS

Nonnative species—also known as exotic, alien, or introduced species—are defined as species that occur in a certain place due to deliberate, accidental, direct, or indirect human actions. Invasive nonnative plants

can seriously threaten the integrity of native habitats, including eastern deciduous forests, by aggressively displacing and killing native plants, altering native habitats, and stifling forest regeneration. Though many factors affect the spread of nonnative plants, deer can also promote nonnative species through preferential foraging on native plants, habitat alteration (disturbance to vegetation and soils from trampling), and through seed dispersal from seeds carried on their coats or found in fecal matter (Knight et al. 2009; Vellend 2002; Myers et al. 2004; Williams and Ward 2006).

Extensive data collection undertaken between 2005 and 2009 by the NPS NCRN has determined that no park in the region is free of nonnative exotics. Exotic tree species are present throughout the region but are primarily a localized problem in forests. They made up 1.6% of all trees, 1.1% of all saplings, and 2.4% of all seedlings at survey points located within NCR park units. The most commonly occurring are tree of heaven (*Ailanthus altissima*) and white mulberry (*Morus alba*). Vines that grow into the crown of a tree can increase tree mortality by shading leaves or toppling trees due to the increased weight. About a quarter (25.2%) of the vines growing on monitored trees are exotic vines. The most commonly occurring are Japanese honeysuckle (*Lonicera japonica*) and English ivy (*Hedera helix*). Nonnative species accounted for 9.7% of all individual shrubs, and 6.5% of all shrub seedlings. Amur honeysuckle (*Lonicera maackii*) and autumn olive (*Elaeagnus umbellata*) are by far the most common. The percent of plots with invasive exotics varies considerably between parks. While most of the nonnative species are not widespread, several are found in a large number of plots throughout the region. The most common species are Japanese honeysuckle, which can grow either as a groundcover or a climbing vine, Japanese stiltgrass (*Microstegium vimineum*), and garlic mustard (*Allaria petiolata*). Both Japanese stiltgrass and Japanese knotweed (*Polygonum cuspidatum*) had a high percent cover on the plots they invaded (NPS 2010).

Nonnative Plants at Harpers Ferry National Historical Park

Harpers Ferry's long history of human habitation is responsible for the introduction of many nonnative plant species. These were brought into the area as ornamental landscape plantings, livestock feed, or for other purposes. Many nonnative and invasive plants are undesirable but continue to spread, especially in disturbed areas (NPS 2008a). Many decades of agricultural operations have eliminated native communities on portions of Murphy Farm, Nash Farm, Bolivar Heights, and Schoolhouse Ridge. Native communities remain only on steep slopes or otherwise inaccessible land.

Based on vegetation inventories conducted in the 1990s, more than 260 nonnative plant species have been identified in the park, including garlic mustard, Japanese honeysuckle, tree-of-heaven, Japanese stiltgrass, and wine berry (*Rubus phoenicolasius*). In 2002–2003, the NPS NCR's Exotic Plant Management Team inventoried 51 of the most invasive species and mapped their ranges. The inventory indicates that these plants inhabit more than 43,000 acres (cumulative acreage for all the nonnative species). Garlic mustard alone inhabits more than 2,000 acres of the national historical park (NPS 2008a).

Nonnative Plants at Chesapeake and Ohio Canal National Historical Park

Nonnative plant species occurring within the park unit include those described above as typically occurring in eastern forests. Schmit et al. (2012b) observed that a wide variety of nonnative species were present in the park unit based on monitoring conducted at 73 individual plots along the C&O Canal. Nonnative species included seven different species of nonnative trees, four species of nonnative shrubs, and eight species of nonnative vines found growing on trees in the park. Nonnative plants are very common on the forest floor of the C&O Canal. Out of the 73 plots monitored, only 8 were free of park-monitored forest floor nonnatives. Other nonnatives that are not tracked in monitoring were likely present. These plots are located in three locations, including Green Ridge State Forest downstream from the Paw tunnel, just upstream from Whites Ferry, and in Great Falls, Maryland. Each of these areas are in larger tracts of forest than is typical for most of the park. Seventeen species of nonnatives, as well as some unidentified honeysuckle (*Lonicera* spp.) were found on the forest floor, with garlic mustard being the most widespread species. Japanese stiltgrass had the highest cover in the park at 13%. This particular

species occurs in abundance in areas characterized by over-browsing by deer. Japanese honeysuckle also was very widespread in the park (Schmit et al. 2012b).

SPECIAL STATUS PLANT SPECIES

NPS is required under the Endangered Species Act to ensure that federally listed species and their designated critical habitats are protected on lands within the agency's jurisdiction. In addition, NPS considers state-listed or other rare species similarly in taking actions that may affect these species. An overabundance of deer and deer management actions have the potential to affect listed species as well as other wildlife. Federally listed plant species were dismissed from analysis in chapter 1, because the plants occur where they would be very unlikely to be affected by deer. Twenty-five state-listed threatened or endangered vascular plant species were documented to occur at C&O Canal and Harpers Ferry NHPs (NPS 2015c; MD DNR 2015b). A list is provided in appendix B.

In addition, the Virginia Department of Conservation and Recreation's Natural Heritage Division has designated Short Hill at Harpers Ferry, one of the potential deer management implementation areas, as the "Short Hill Mountain Conservation Site." This site has been given a high biodiversity significance rating. Several plants have been verified to occur on the state's heritage resources list as well as more plants that historically occurred there but have not been field verified since 1936.

CURRENT VEGETATION STATUS AND THE ROLE OF DEER

White-tailed deer are considered an important stressor on NCR forests, having increased in density from between 8.0 to 10.9 deer per square mile since pre-European times to 52 deer per square mile today in the eastern deciduous forest zone (Bates 2009). Factors such as fire suppression, the rapid spread of invasive, nonnative plants, and overabundant deer populations are working in concert to alter the regeneration, and hence, the natural successional pathways of the forests in the region (Bates 2015). Deer also can cause substantial damage to private property, forests managed for wood, and on crop yields (Bates 2015). The adverse impact that deer are having on crops is demonstrated by the finding that plots in the C&O Canal NHP sustained a crop weight loss of 28% from 2003 to 2004 as a result of white-tailed deer foraging (McShea and Bourg 2009).

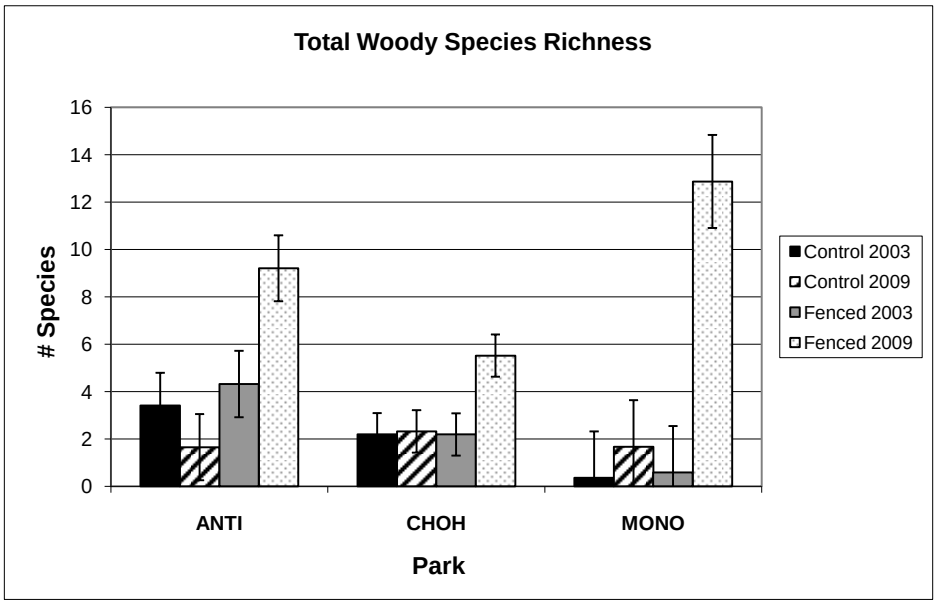
A multi-park study was conducted to evaluate the impacts of deer browse on park cultural landscapes and natural resources in Antietam and Monocacy National Battlefields, and the C&O NHP. The three parks partnered with the Smithsonian Institution in 2002 to study deer impacts on crops and regeneration of wooded areas. The study was conducted during the 2003 and 2009 field seasons. Impacts were assessed based on species richness, abundance comparisons, and seedling stocking rates. For each park, the study compared abundances for the most common woody seedling species in the control (open) and fenced plots. In general, there were fewer seedlings in 2009 than 2003, regardless of plot type (McShea and Bourg 2009). Silver maple was recorded only at C&O Canal NHP and was the most abundant seedling there in 2003, but was absent in 2009.

For native saplings, the effect of deer exclusion on their summed abundances at all three parks studies was statistically significant and positive. In all cases, the number of saplings was not statistically significantly different between open and fenced plots in 2003; however, by 2009 the fenced plots contained substantially more individuals. By 2009, box elder, hackberry, ashes (*Fraxinus* spp.), hickories (*Carya* spp.), and slippery elm were significantly more abundant statistically in fenced plots at C&O Canal NHP. Of the eight most common sapling species, only pawpaw showed no abundance differences in open versus fenced plots in any of the parks. Pawpaw is clonal and unpalatable to deer and therefore should not be affected by deer browsing (McShea and Bourg 2009).

An examination of invasive saplings showed that there was not an abundance difference between open and fenced plots in 2003, but by 2009 invasive sapling species had become significantly more abundant in plots at all three parks. Japanese honeysuckle decreased significantly in open plots from 2003 to 2009, but

increased substantially (though not significantly) in fenced plots during the same time. Multiflora rose *(Rosa multiflora*) was noticeably more abundant at C&O Canal NHP, but its numbers did not differ between open and fenced plots at either Antietam or Monocacy. This species was noticeably more abundant in fenced plots at C&O Canal NHP in both 2003 and 2009.

Although there was not a consistent pattern of seedling species richness in the study, long-term deer exclusion had a statistically significant positive effect on sapling species richness in all parks (figure 5). In all three parks studied, open and fenced plots began with the same number of species in 2003, yet by 2009 fenced plots harbored from 2 to 12 times more species than control plots (McShea and Bourg 2009). The increased richness and abundance was accompanied by a simultaneous increase in invasive nonnative species of saplings in all plots, with a greater magnitude of invasive species in fenced plots (McShea and Bourg 2009).



Source: McShea and Bourg 2009.

FIGURE 5. MEAN SPECIES RICHNESS PER PLOT OF ALL WOODY SAPLING SPECIES (NATIVE AND INVASIVE) IN CONTROL AND FENCED PLOTS AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK IN 2003 AND 2009

More recently, Schmit (2014) found that following deer management at NCR parks, overall seedling density has increased. At Catoctin Mountain Park, a measurable increase in seedlings and other vegetation was observed (NPS, Donaldson pers. comm. 2016c). However, the increase in seedling density of pawpaw at Harpers Ferry between 2006–2009 and 2011–2014 is statistically significant. Pawpaw also was the most common seedling species observed along the C&O Canal and at Harpers Ferry and from 2011 to 2014. As noted above, deer tend to avoid this species. It was also noted that non-pawpaw seedling density at C&O Canal and Harpers Ferry NHPs is lower than at other NCR parks that manage deer.

Parks are considered to be adequately stocked if the percentage of plots stocked above the desired threshold is greater than 67 percent (Stout 1998; McWilliams et al. 1995). This indicator of forest regeneration has continued to be monitored in the parks (Schmit and Nortrup 2015). Results from 2011–2014 show that less than 10% of forest plots were adequately stocked at the C&O Canal NHP and less than 20% of forest plots were stocked above the desired threshold at Harpers Ferry NHP. However, Harpers Ferry NHP is one of the few parks that has shown an increase in the stocking index. In the 2008–2011 period, zero plots at Harpers Ferry had adequate stocking, while in the current 2011–2014 period, about 15% (or three plots) are now adequately stocked. This rise in the stocking index however, is due in

large part to an increase in pawpaw, which deer avoid, from approximately 4,000 to 6,500 per hectare, in those three plots (Schmit and Nortrup 2015).

WHITE-TAILED DEER

GENERAL ECOLOGY

White-tailed deer are medium-sized ungulates, native to North America, and regarded as one of the most adaptable mammals in the world (Hesselton and Hesselton 1982). Among the reasons for this adaptability are the hardiness, reproductive capability, wide range of plant species accepted as food, and the tolerance deer express for close contact with humans.

Most abundant in the eastern woodlands, white-tailed deer are typically forest dwellers, but often frequent wetlands or woodland openings while feeding. Deer also forage along forest margins and on farmlands. When deer populations become excessive, damage to crops and forests may result. Excessive populations also may affect reproductive success and increase young animal mortality, depending on food availability and how harsh the winters are.

The diet of white-tailed deer consists of twigs from shrubs and trees, as well as herbaceous (non-woody) plants that are eaten frequently in spring and summer when they are abundant. Acorns, blackgum fruits, persimmons, and other kinds of fruits are consumed in late summer and fall. Native plant communities are preferred because of diversity and sustainability (Masters et al. n.d.). Some of the plants that deer browse heavily in the winter season are selected by necessity, rather than choice (Martin, Zim, and Nelson 1951).

White-tailed deer are well known for their ability to rapidly increase reproductive productivity, given abundant food resources, and to limit productivity in the presence of less nutritious forage (Verme 1965; Hesselton and Hesselton 1982). On good range containing abundant food, deer tend to produce more than one young, usually twins and sometimes triplets. Where food is limited, the number of births is typically restricted to a single fawn, and sometimes the does do not ovulate (Morton and Cheatum 1946; Verme 1965; Hesselton and Hesselton 1982). Nutrition plays an important role in influencing the onset of puberty, with yearling (1.5 year) does on submarginal range possibly remaining sexually immature, while doe fawns on nutritious range possibly becoming reproductively active as early as six or seven months of age (Verme and Ullrey 1984). The potential for rapid expansion of deer populations, coupled with the wide variety of plant species deer consume, can result in substantial impacts on plant communities (Marquis 1981; Shafer 1965).

DEER MOVEMENT

Deer movement has not been specifically studied at either C&O Canal or Harpers Ferry NHPs; however, deer movement has been studied at places in Maryland with environments similar to those found at the parks.

Rhoads, Bowman, and Eyler (2010) studied home range and movement routes of female exurban deer at the Fair Hill Natural Resource Management area in Cecil County, Maryland. The researchers studied 60 deer and found that seasonal home range generally increased from fawning (when home ranges are relatively small because fawns have limited mobility) through post-hunting seasons. The deer population studied appeared to reside on similar and overlapping ranges throughout the year. Home ranges in urban and suburban areas tend to be smaller than those in rural and agricultural areas. The extent and distribution of urban development and habitat fragmentation can affect the home range size for exurban deer, with higher levels of fragmentation restricting home ranges.

Similarly, Antietam National Battlefield captured and tagged white-tailed deer for movement studies within the battlefield. Between August 2004 and January 2005, 117 deer (7 of which died shortly after capture, likely as a result of capture myopathy) were captured and tagged (McShea and Stewart 2005). The results showed that 19 females, captured as fawns, traveled an average of 0.8 mile (1.3 kilometers

[km]). Twenty males, captured as fawns, traveled an average of 2.4 miles (3.9 km), with one traveling as far as 5.0 miles (8.0 km) and one traveling 13 miles (20.9 km). Forty-two females, captured as adults, traveled an average of 0.9 mile (1.5 km), with one female traveling as far as 6.5 miles (10.5 km) before returning to the park. Five males, captured as adults, traveled an average of 1.3 miles (2.09 km). The study indicates that female deer likely will remain on or near Antietam, and that males may exhibit longer movements that could not be detected due to small sample size (only 35 fawn, yearling, and adult males were captured during this study, and 15 of those were seen/harvested off NPS property) (McShea and Stewart 2005).

POPULATION SIZE AND DENSITY

White-tailed deer population density data has been collected at C&O Canal and Harpers Ferry NHPs, and includes spotlight surveys, infrared scans, camera counts, pellet counts, and vegetation-correlation through deer exclosures. Deer density data for specific locations and years within the parks are detailed below for the individual parks.

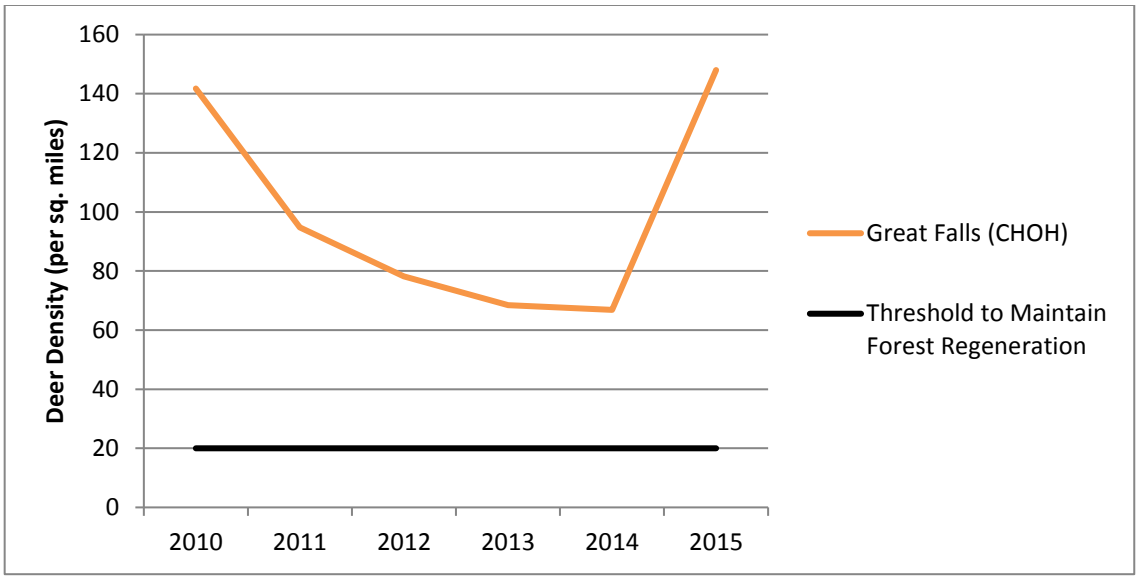
Chesapeake and Ohio Canal National Historical Park

C&O Canal NHP has conducted deer density surveys at the Gold Mine tract at Great Falls. Given the size of the park, there is a lack of available deer data park-wide. Deer density at the Gold Mine tract was estimated at approximately 142 deer per square mile in 2010 and at 148 deer per square mile in 2015 (table 8 and figure 6), representing an increase in density after several years of decline.

A herd health study for the C&O Canal NHP (Fenton 2016) looked at the herd in Allegany and Washington Counties and found that the deer in Allegany County carried "very heavy stomach worm burdens," indicating that the herd may exceed the carrying capacity of the habitat. The deer examined in Washington County exhibited a more normal stomach worm burden consistent with a deer population that is compatible with the carrying capacity of its habitat.

TABLE 8. RECORDED DEER DENSITIES AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

	Great Falls	
Year	Deer per Square Mile	Standard Error
2010	141.72	±15.07
2011	94.72	±16.71
2012	78.22	±5.78
2013	68.43	±7.85
2014	66.85	±11.91
2015	148	--



Note: Standard error is shown in table 8.

FIGURE 6. DEER DENSITY AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Harpers Ferry National Historical Park

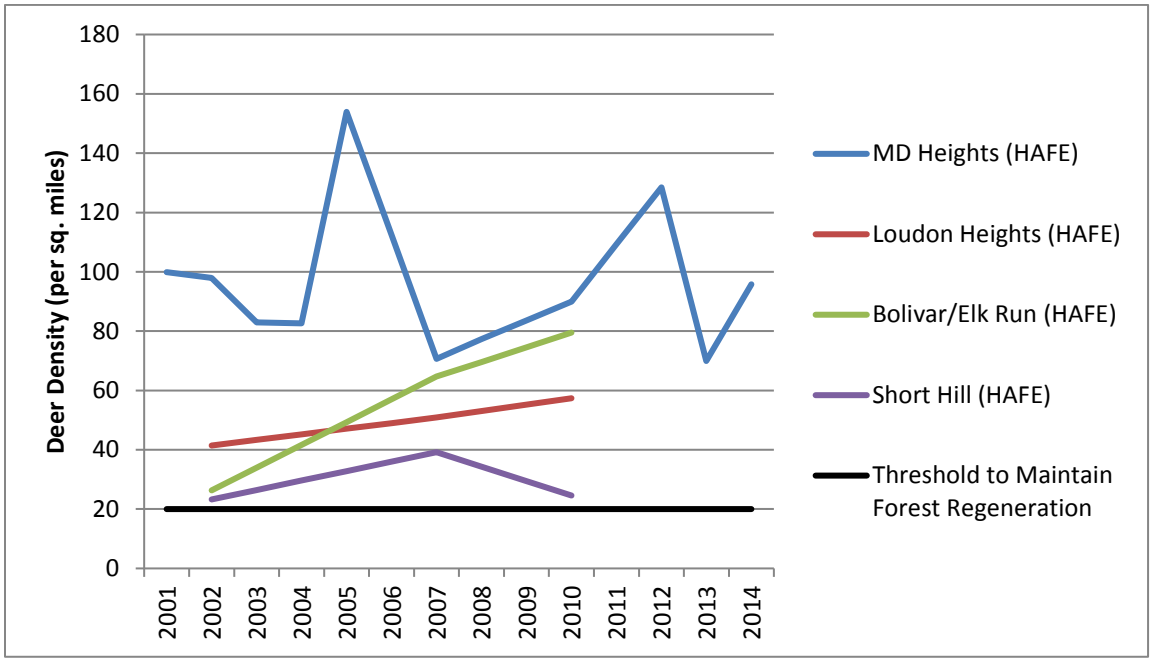
Harpers Ferry NHP has monitored all parts of the park, although staff has focused on Maryland Heights. At Harpers Ferry, park staff began to notice effects from deer overabundance and overbrowsing in 1998, and installed 100 deer pellet plots on Maryland Heights in 1999. In 2011, the park conducted an infrared scan that confirmed the presence of large numbers of white-tailed deer on Loudoun Heights (an estimate of 260 deer per square mile) (USDA APHIS, Elliott, pers. comm. 2012). In addition, the park has conducted deer surveys on Maryland Heights with digital trail cameras to estimate deer densities since 2012. US Department of Agriculture, APHIS-Wildlife Services also has conducted a ground-based infrared survey at the Murphy Farm and counted approximately 260 deer per square mile. In Harpers Ferry NHP from 2001 to 2014, deer density on Maryland Heights ranged from 70 to 154 deer per square mile. Deer density in other areas of Harpers Ferry, including Loudoun Heights, Bolivar/Elk Run, and Short Hill, ranged from 23 to 80 deer per square mile (table 9 and figure 7).

TABLE 9. RECORDED DEER DENSITIES AT HARPERS FERRY NATIONAL HISTORICAL PARK

	Maryland Heights		Loudoun Heights		Bolivar/Elk Run		Short Hill	
Year	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error
2001	99.87	32.2						
2002	97.93	33.07	41.44	7.56	26.31	7.09	23.25	±13.96
2003	82.98	48.2						
2004	82.59	51.88						
2005	153.92	64.23						
2006								
2007	70.68	35.33	50.86	25.5	64.67	24.63	39.18	±26.65
2008	77.31	30.3						

Year	Maryland Heights		Loudoun Heights		Bolivar/Elk Run		Short Hill	
	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error	Deer per Square Mile	Standard Error
2009								
2010	89.98	26.57	57.36	25.5	79.51	47.42	24.52	±20.88
2011								
2012								
2013	69.93							
2014								

Note: Data were not available for every location for every year. Sampling problems occurred in 2012 and 2014 on Maryland Heights, so those years are not shown.



Note: Standard error is shown in tables 10.

FIGURE 7. DEER DENSITY AT HARPERS FERRY NATIONAL HISTORICAL PARK

DISEASES OF CONCERN

A number of diseases of concern exists in eastern deer populations, including parasites, malnutrition, bluetongue virus, and epizootic hemorrhagic disease. The closest known cases of CWD to the parks are in white-tailed deer in Hampshire County, West Virginia; in Maryland in Allegany County, including Green Ridge State Forest immediately adjacent to the C&O Canal NHP; in Frederick County, Virginia; and in a captive deer in New Oxford, Pennsylvania, near Gettysburg National Military Park (NPS, Ratchford, pers. comm. 2014a; MD DNR 2015a). These occurrences place CWD within 2 miles of C&O Canal NHP and 45 miles of Harpers Ferry NHP. NPS is closely watching CWD because it is thought to be spread easily in areas with high concentrations of deer. Diseases of concern are described briefly below.

Bluetongue Virus

Bluetongue virus is a viral disease of ruminants, including white-tailed deer, transmitted by midges in the genus *Culicoides*. Bluetongue virus is considered to be a disease that has the potential to spread rapidly. White-tailed deer can be severely affected by bluetongue virus because virus infections cause sudden death, and the mortality rate can be extremely high (CFSPH 2015).

The disease is most prevalent in the United States in the southern and southwestern states. It is currently almost non-existent in the upper north central and northeastern states, where biting flies do not appear to transmit the viruses (CFSPH 2006).

Epizootic Hemorrhagic Disease

Epizootic hemorrhagic disease is an insect-borne viral disease of ruminants. The disease causes widespread hemorrhages in mucous membranes, skin, and viscera, the result of disseminated intravascular clotting. Strains of epizootic hemorrhagic disease can cause widespread vascular lesions similar to those described for bluetongue virus. Degenerative changes (focal hemorrhage or dry and gray-white appearance, or both) in striated musculature are prominent in the esophagus, larynx, tongue, and skeletal muscles. Epizootic hemorrhagic disease in white-tailed deer can lead to death. Often, deer are found dead around waterholes, suggesting that they had a high fever and were dehydrated (Stott 1998).

Not all deer infected with epizootic hemorrhagic disease or bluetongue virus will die; this is known because many normal deer have antibodies that indicate prior exposure to various viruses. Deer that recover develop immunity to the specific virus, which protects against reinfection by the same virus. However, it is not known how well this immunity cross-protects deer against other hemorrhagic viruses. When deer survive infection with a virus from one virus type (epizootic hemorrhagic disease or bluetongue virus), there is good evidence to indicate they are not protected from disease caused by subsequent infection with a different virus strain (SCWDS 2000).

Epizootic Hemorrhagic Disease has not been known to occur in the parks; however, it has been documented in the region. There was an outbreak at Monocacy National Battlefield in 2002, and two confirmed cases at the National Zoo and Theodore Roosevelt Island in 2007 (NPS 2011c, 2014c).

Chronic Wasting Disease

CWD belongs to a group of diseases known as transmissible spongiform encephalopathies. The diseases are grouped because of similarity in clinical features, pathology, and presumed etiology. The infectious agents are hypothesized to be prions (infectious proteins without associated nucleic acids). Transmissible spongiform encephalopathies cause distinctive lesions in the brain and consistently result in death.

Deer and elk affected by CWD show loss of body condition and changes in behavior. Affected animals may demonstrate a variety of behavioral signs, including decreased fear of humans and isolation from the remainder of the herd. Animals in the later stages of the disease become emaciated. Excessive drinking and urination are common in the terminal stages because of specific lesions in the brain. Many animals in terminal stages have excessive salivation and drooling. Death is inevitable once clinical signs are visible.

The clinical course of CWD varies from a few days to several months. While a protracted clinical course is typical, occasionally death may occur suddenly; this may be more common in the wild than in the relative security of captivity.

The health risk for humans consuming elk or deer infected with CWD is unknown; however, the risk is likely extremely low. The risk is based on an analysis of existing research studies that indicate no established link between the disease and similar human transmissible encephalopathy diseases. Current literature reviews and experts agree that more information is needed and that many questions remain unanswered about the transmissibility of CWD. Additional information on CWD diagnosis and management is included in appendix C.

OTHER WILDLIFE AND WILDLIFE HABITAT

OVERVIEW

The diversity of aquatic and terrestrial habitats at C&O Canal and Harpers Ferry NHPs provides foraging opportunities, breeding habitat, and shelter for a variety of wildlife species. Many of these species depend on habitat that can be affected by overbrowsing, especially species that use or inhabit the herbaceous and woody vegetation in the forest understory. The local wildlife also could be affected by actions taken for deer management. Herpetofauna and fish are not discussed in this section because impacts either would not or would not be expected to occur, as described in the "Impact Topics Dismissed from Further Analysis" section of the "Purpose and Need" chapter.

Chesapeake and Ohio Canal National Historical Park

Mammals

In addition to the white-tailed deer, 38 other mammals are known to be present at the park (NPS 2015c), many of which are ground-dwelling species found in habitats where deer also reside or rely on forest understory that is browsed by deer. Common small mammals include the white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), eastern mole (*Scalopus aquaticus*), eastern chipmunk (*Tamias striatis*), short-tailed shrew (*Blarina brevicauda*) (NPS 2015c). Medium-sized mammals common at the park include red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), and opossum (*Didelphis virginiana*) (NPS 2015c). Large mammals present at the park include white-tailed deer and coyotes. Black bears may pass through the parks, but neither park has a breeding population.

Birds

Bird species are abundant in the varying habitats of C&O Canal NHP. Surveys and sightings throughout the park have identified 239 local and migratory bird species (NPS 2011d). A diversity of habitats occur along the C&O Canal, and bird species include forest-dwellers, wading birds, waterfowl, and raptors. The species of greatest interest in this document are the species that occupy the same habitats as the deer and rely on the forest understory.

Forest dwelling birds are common in the wooded landscapes in C&O Canal NHP. The NCR Inventory and Monitoring program has approximately 385 forest plots throughout the region that are used to monitor bird species (NPS 2011e). The most common bird species in the forested regions at C&O Canal NHP in order of abundance include the blue-gray gnatcatcher (*Polioptila caerulea*), Carolina chickadee (*Poecile carolinensis*) and black-capped chickadee (*Poecile atricapillus*), American goldfinch (*Carduelis tristis*), northern cardinal (*Cardinalis cardinalis*), tufted titmouse (*Baeolophus bicolor*), red-eyed vireo (*Vireo olivaceus*), Acadian flycatcher (*Empidonax virescens*), Carolina wren (*Thryothorus ludovicianus*), common grackle (*Quiscalus quiscula*), and white-breasted nuthatch (*Sitta carolinensis*) (NPS 2011e).

Raptors commonly seen at the park include red-tailed hawk (*Buteo jamaicensis*) and red-shouldered hawk (*Buteo lineatus*). The bald eagle (*Haliaeetus leucocephalus)*, a formerly federally threatened species, is also found at the park (NPS 2011d). Additionally, barred owls (*Strix varia*) are common at the park. Raptors and owls prey on other birds and mammals. Scavengers like the American crow (*Corvus brachyrhynchos*) and turkey vulture (*Carthartes aura*) rely on the remains of other animals, including deer, for food at the park (NPS 2011d).

Harpers Ferry National Historical Park

Mammals

Approximately 36 different species of mammals have been known to occur at Harpers Ferry NHP (NPS 2015d), many of which are ground-dwelling species found in habitats where deer also reside, or rely on forest understory that is browsed by deer. Most of these are small mammals, including gray squirrel

(*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), southern flying squirrel (*Glaucomys volans*), and groundhog (*Marmota monax*). The American mink (*Neovison vison*) and short-tailed shrew are known to occur in the park but are not frequently observed (NPS 2008a). Additionally, a small mammal survey in 2003 detected Allegheny woodrat (*Neotoma magister*) within the park, as well as house mouse (*Mus musculus*) and white-footed mouse (McShea and O'Brien 2003). Medium-sized mammals commonly observed at the park include Virginia opossum and raccoon (NPS 2008a). In addition to deer, large mammals include coyote and black bears.

Birds

Approximately 174 species of birds are known to occur in the habitat provided at Harpers Ferry NHP (NPS 2015e). Known bird species include forest-dwellers, wading birds, waterfowl, and raptors. Great blue herons and Canada geese can be observed along the banks of Shenandoah Canal. In the forested regions around Maryland or Loudoun Heights, species such as the pileated woodpecker *(Dryocopus pileatus)* and Baltimore oriole *(Icterus galbula)* are likely to be seen (NPS 2008a). Raptors, such as the red-tailed hawks and turkey vulture are found in the skies over the park (NPS 2015e). Bald eagles may be seen over the park between late winter and early summer. The park and USFWS are presently monitoring a pair of peregrine falcons attempting to nest on the Maryland Heights cliffs since the spring of 2015. Along with bird species that reside there year round, many other species use the park during their spring and fall migrations (NPS 2008a; NPS 2015e).

SPECIAL STATUS WILDLIFE SPECIES

An overabundance of deer and deer management actions have the potential to affect species of concern as well as other wildlife. Migratory bird species listed by USFWS as birds of conservation concern are considered because deer browsing affects many of their habitats. Table B-2 in appendix B shows the birds of conservation concern documented to occur at the parks.

Chesapeake and Ohio Canal National Historical Park

The Maryland Wildlife and Heritage Service Natural Heritage Program tracks the status of native plants and animals that are among the rarest in Maryland and most in need of conservation efforts as elements of the state's natural diversity. Of these species, MD DNR recognizes the species listed in table B-3 in appendix B as endangered, threatened, rare, in need of conservation, or a candidate for state-listing.

Harpers Ferry National Historical Park

The natural resource agencies in Maryland, Virginia, and West Virginia, including MD DNR, VDGIF, the Virginia Department of Agriculture and Consumer Services, and West Virginia Division of Natural Resources, have legal authority for endangered and threatened species and are responsible for their conservation in and around Harpers Ferry NHP. Table B-1 in appendix B lists the rare and state-listed threatened or endangered wildlife species documented to occur at the park. The list includes one mammal and two birds (NPS 2008a).

CURRENT STATUS OF WILDLIFE AND THE ROLE OF DEER

There is more research on the effects of deer density on vegetation than on wildlife populations. However, the changes in vegetation represent a change in forest ecology and wildlife habitat and can affect other species of wildlife. A number of studies have shown distinct changes in bird abundance as a result of reducing deer density by exclosures (McShea and Rappole 2000). One researcher found that seedling richness began to decline with just 10 deer per square mile and that songbird habitat was negatively impacted with 20 to 39 deer per square mile within a cherry/maple forest (deCalesta 1997). Similarly, a nine-year study in the mid-Atlantic region found that a reduction in deer density changed the composition of forest bird populations (McShea and Rappole 2000). Three patterns of change were observed in bird populations within exclosures (where there were no deer): (1) species that preferred open understory (e.g., wood thrush) declined; (2) species that preferred a dense herbaceous ground cover (e.g., Carolina

wren) immediately increased, but then decreased as herbaceous species were replaced by woody species; and (3) species that preferred a dense, woody understory (e.g., ovenbird) gradually increased (McShea and Rappole 2000).

The habitat most affected by heavy deer browsing is the herbaceous and woody vegetation in the forest understory. Deer can browse vegetation from ground level to an average of 60 inches (150 centimeters) above the ground, and this is the habitat that is primarily affected. Other wildlife also use this understory habitat. Other species that compete with deer for available food include squirrels and mice (which feed on acorns and other food from trees) and rabbits (which feed on young woody stems and green vegetation) (Martin, Zim, and Nelson 1951). Heavy deer browsing also results in lack of cover for small mammals.

Vertical plant cover is an important habitat attribute to understory bird species. It has been correlated positively with the abundance and species richness of breeding birds (McShea and Rappole 1992) and the abundance and species diversity of wintering birds (Zebehazy and Rossell 1996).

Species that benefit from high deer numbers and resulting habitat changes are those that prey on deer (e.g., coyotes) or that feed on carrion (e.g., vultures). Predators also benefit from hunting other prey, such as mice and squirrels, in areas with less dense cover at ground level, thus allowing better views through the forest and less cover for prey to hide. However, as prey declines as a result of reduced cover, predators also decline.

Species that depend on the upper canopy of the forest, such as woodpeckers and other birds that nest high in the trees, would experience changes in their habitat related to deer densities over a longer period if forest did not regenerate over time. As the forest ages, improved habitat may become available for cavity-nesting birds and birds that feed on insects as older trees die or become stressed from disease or infestations. However, in the long term with little to no regeneration, dead trees will not be replaced by new trees, resulting in fewer trees that upper canopy species can use as habitat. A study of forest sapling stocking rates at both parks indicates that successful forest regeneration will not occur under current deer densities (NPS 2014d).

CULTURAL RESOURCES—HISTORIC DISTRICTS AND CULTURAL LANDSCAPES

HISTORIC DISTRICTS

Chesapeake and Ohio Canal National Historical Park

C&O NHP was established by an act of Congress on January 8, 1971, "to preserve and interpret the canal's historic and scenic features and to develop the potential of the canal for public recreation, including such restoration as may be needed." Thereafter, NPS documented the park and many of its component features in a National Register of Historic Places (National Register) nomination form accepted by the Keeper on August 8, 1979. That nomination recognized the potential for identifying additional historic and archeological resources. Since 1979, NPS has continued to document and evaluate newly identified cultural resources within the park. These findings were compiled in additional documentation to the 1979 National Register nomination and the registration form was brought to current National Register standards in 2012 (Cianci and Potter 2014).

C&O Canal NHP is a linear historic district that extends from Georgetown in Washington, DC, to Cumberland in Maryland. Encompassing 20,239 acres, the district's dominant feature is the C&O Canal, an 184.5-mile human-made waterway that follows the District of Columbia /Maryland side of the Potomac River, traversing Georgetown's urban setting, passing rural communities and wooded buffered areas in Maryland's Montgomery, Frederick, Washington, and Allegany Counties. It retains an astounding number of canal-related resources including the canal prism, towpath, and the lift locks that typify the canal's waterway. Extant lockhouses along the canal illustrate the critical role of lockkeepers in operating lift locks and maintaining the correct water level. Other transportation-related resources include bridges, bridge piers, roads, and trails. Along the canal's inland side are numerous industrial and

commercial ruins, dwellings, ancillary buildings, and structures that depict the important economic impacts that the canal had on community development. Since the federal government acquired portions of the canal in 1938, NPS has repaired or rebuilt the towpath in many places and restored or stabilized many of the locks, culverts, and other structures. Thus, the canal today reflects considerable reworking during and since its historic period (1828–1924) while retaining its essential character and continuity from Georgetown to Cumberland (Cianci and Potter 2014).

Understory growth and leafy canopy make a dense woodland setting along both sides of the canal for most of its length. This successional forest limits any open space in the district and restricts views that historically would have been much more open. During the 19th century, the rugged and pastoral character of the Potomac River could be seen from almost anywhere along the canal, along with rolling agricultural fields and sites up and down the canal (Cianci and Potter 2014).

Harpers Ferry National Historical Park

Harpers Ferry NHP is located at the confluence of the Shenandoah and Potomac Rivers, where the states of West Virginia, Virginia, and Maryland meet. The park includes more than 3,645 acres of land in all three bordering states. The rivers create a dramatic gap through the surrounding Blue Ridge Mountains and lend a scenic grandeur to an area rich in history. The majority of historical resources in the park relate to the period between 1803 and the Civil War when the two rivers were harnessed for power and transportation, and Harpers Ferry became an important manufacturing and commercial town, as well as the site of John Brown's Raid on the US armory (NPS 1993).

Harpers Ferry NHP was administratively listed in the National Register in 1966. In 1974, the original 1944 enabling legislation establishing the Harpers Ferry National Monument was amended to facilitate the expansion of the official park boundary to an unspecified limit not to exceed 2,000 acres. The legislation expanded the park boundaries beyond West Virginia to include additional lands in both Maryland and Virginia.

In 1980, legislation increased the acreage within the official park boundary with additional land to the east on the Virginia side of the Shenandoah River. Following the expansion, a formal National Register nomination form for Harpers Ferry NHP was prepared and accepted in 1980–1981. After further property acquisitions, a Multiple Property Documentation Form was completed in 1999 and expanded the historic context to include "Black Education in the Harpers Ferry/Bolivar area from 1864–1955" and "Patterns of Community Development in the post-Civil War Harpers Ferry Area, 1865-1955." As part of the Multiple Property Documentation, National Register forms were prepared for nine properties that had recently been acquired by Harpers Ferry NHP—Tattersal Property, Storer College, Grand View School; Shipley School; Bradley Nash Farm; Niswarner Tract; Bolivar Heights; the B&O Potomac River Bridge; and the Hydroelectric Power Plant. The Multiple Property Documentation and National Register forms were accepted by the National Register as additional documentation. In 2004, a boundary adjustment to Harpers Ferry NHP was approved by Congress and signed into law, at which time acreage managed by NPS was officially included within the boundaries of the park. Newly acquired NPS lands that are part of a historical park are automatically listed in the National Register. Five additional properties have been added to the boundaries of Harpers Ferry NHP since 1999—the United States Armory Musket Factory, Armory Woodland, School House Ridge, Murphy-Chambers Farm, and Baltimore & Ohio Railroad, Harpers Ferry Station.

CULTURAL LANDSCAPES

Cultural landscapes are an issue in deer management because an overabundance of deer and resultant deer browse could adversely affect the cultural landscapes within C&O Canal and Harpers Ferry NHPs, as could the erection of fences and large exclosures. Both deer browse and fencing could damage the integrity and character of the cultural landscapes, including the spatial patterns of open versus wooded

land and the viability of the historic agricultural landscape, such as crops and pasture lands. On the other hand, the presence of a certain population of deer could be appropriate to historic conditions at the parks.

A cultural landscape, as defined by The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes, consists of "a geographic area (including both cultural and natural resources and *the wildlife or domestic animals therein*) [emphasis added] associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (NPS 1996). There are four general types of cultural landscapes: (a) historic sites, (b) historic designed landscapes, (c) historic vernacular landscapes, and (d) ethnographic landscapes. A historic site is a landscape significant for its association with a historic event, activity, or person. A historic designed landscape, which includes parks and estates, is a landscape that was consciously designed or planned out by a landscape architect, master gardener, architect, or horticulturist. A historic vernacular landscape is a landscape that has evolved over time through use by the people whose activities and occupancy shaped it. An ethnographic landscape contains sites associated with traditional cultures that include both ancient Indian sites and places where cultural traditions continue today. The most common forms of cultural landscapes within the two parks are historic sites and historic vernacular landscapes.

Chesapeake and Ohio Canal National Historical Park

NPS Cultural Landscapes Inventories conducted between 2004 and 2012 have assessed six component landscapes along the canal (table 10). These consist of four canal lock communities, the pre-canal Ferry Hill Plantation site, and the Great Falls Tavern site, which is adjacent to the Gold Mine tract. These are not the only component cultural landscapes, but these are ones that have been inventoried and evaluated for National Register eligibility. These component landscapes are typical of the clusters found along the canal (Cianci and Potter 2014). Several of these landscapes are in the vicinity of potential future implementation areas.

TABLE 10. CULTURAL LANDSCAPES AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Name	Description
Pennyfield Lock	The small lock community at Pennyfield Lock (miles 19.00 to 20.00), one of 74 locks on the canal, retains the open character of a small canal-side settlement of the late 19th century (Cianci and Potter 2014).
Seneca Lock	Seneca Lock (miles 22.80 to 23.65) is historically significant in the same ways as the rest of the C&O Canal. In addition, its cultural landscape represents the site's important red sandstone quarrying activity that produced building stone for many locks and other structures along the C&O Canal. Seneca sandstone also was used in many prominent buildings in Washington, DC, and other eastern cities. The treeline along the river and berm sides of canal contributes to the cultural landscape (Cianci and Potter 2014).
Williamsport	Situated at the confluence of the Conococheague Creek and the Potomac River, Williamsport was first settled in 1740.Significant features of the Williamsport, Maryland Cultural Landscape (mile 99.96 to 99.85) represent the development, growth and decline of the C&O Canal over a 100-year period and the evolution of an industrial landscape. This includes constructed features and feeling of place (Cianci and Potter 2014).
Four Locks	The cultural landscape at Four Locks (miles 108.49 to 109.90) reflects the ascent of canal-based transportation and its ultimate decline in 19th century America. Its buildings, structures, and historic circulation system have a spatial clarity not found in any of the other canal-side communities. Contributing character-defining features include the agricultural land use, views across the farm fields, views up and down the canal, and views from high points (Cianci and Potter 2014).
Ferry Hill Plantation	The former plantation and town of Bridgeport represent a landscape of transportation and agriculture along the C&O Canal. The landscape includes a

Name	Description
	canal and river lock, as well as evidence of the ferry crossing, the town of Bridgeport, and other transportation and agricultural features (Cianci and Potter 2014).
Great Falls Tavern	The Great Falls Tavern (mile 14.30), now a visitor's center at Lock 20, was originally built in 1829 as a lockhouse. From the mid- to late 1800s, the building not only served overnighting canal boatmen, but also became a popular destination point for locals and a "favorite haunt" for congressmen and high officials. Contributing character-defining features include the arrowhead (Arrow Arum) on the canal wall north of Lock 20; grass along the towpath; native species located in floodplain upland areas and on Olmsted Island; nonnative tree species illustrative of historic house sites; the view of Great Falls from the overlook platform on Olmsted Island; the view of the canal, towpath, Mary's Wall, Mather Gorge, and the river, from the hillside trails above Lock 17; the view of the north façade of the tavern from the towpath looking south; and the north and south views along the towpath (Cianci and Potter 2014).

Harpers Ferry National Historical Park

The most common forms of cultural landscapes within Harpers Ferry NHP are woodlands, agricultural fields, and landscapes associated with operation of the United States Armory and other industrial sites, and later, the Battle of Harpers Ferry during the Civil War.

Several cultural landscape inventories and landscape reports of Harpers Ferry have been conducted over the last 25 years, beginning with studies on Virginius Island and Lower Town in 1990 and 1992, respectively. Additional studies have been completed in last 5 to 10 years. Table 11 lists all the cultural landscapes in the park.

Other NPS areas such as Bolivar Heights, Nash Farm, and Short Hill may exhibit the attributes of a cultural landscape, but they have not been formally identified or evaluated. The NHP preserves these areas in a manner that attempts to reflect a semblance of how they may have appeared during their period of significance such as in 1862 during the Civil War occupation.

TABLE 11. CULTURAL LANDSCAPES AT HARPERS FERRY NATIONAL HISTORICAL PARK

Cultural Landscape	Description
Allstadt Farm	The 327.46 acre property is historically significant in social, military, and industrial history. It was a prosperous farmstead that played roles in John Brown's Raid on Harpers Ferry and in the Battle of Harpers Ferry during the Civil War. During the early 20th century, the farm was the location of a successful dolomite limestone quarrying operation that grew to include workers housing and numerous industrial buildings that were part of the company town of Millville. Physical reminders of its four areas of history are seen throughout landscape today. Allstadt Farm is predominantly cropland with a number of small woodlots interspersed throughout, particularly in the western and southern portions of the property. The agricultural use of the property continues to the present through a permit program administered by NPS (NPS 2005c).
Bolivar Heights	The earliest known development of Bolivar Heights consisted of agricultural use. During the battle of 1862 federal forces were positioned on Camp Hill and Bolivar Heights to protect the town of Harpers Ferry. After being surrounded and bombarded by General "Stonewall" Jackson who had arrived to take Harpers Ferry, General Miles surrendered approximately 12,700 men. The agricultural setting of the Heights and the earthworks that were constructed to provide protection to the federal forces and their artillery remain intact (NPS 2008a).

Cultural Landscape	Description
Camp Hill	Camp Hill is a 32-acre landscape nestled between the convergence of the Shenandoah and Potomac Rivers and is one of the highest topographical points in Harpers Ferry. Camp Hill was first established when Armory Superintendent Major John Symington developed a comprehensive plan for the town in the mid-1840s. Symington's plan relocated the residences of the commanding officer, paymaster, and quartermaster to Camp Hill, and away from the unsanitary conditions and periodic flooding of the Lower Town. After the Civil War, the Freewill Baptists acquired several armory buildings on Camp Hill in the 1860s and opened Storer College, one of the first African American colleges at that time. The period of significance for Camp Hill is from the pre-Civil War years of military use to the Storer College closure (NPS 2012d).
Cavalier Heights	Cavalier Heights is an area of relatively undeveloped land southwest of the town of Bolivar, extending down the bluff to Shoreline Drive and the banks of the Shenandoah River (NPS 2008a). The Cavalier Heights Cultural Landscape has not been formally identified or evaluated.
Hall's Island US Rifle Factory and Shenandoah Riverfront	Within Harpers Ferry NHP, Halls Island is approximately a 19-acre linear section of land located on the shore of the Shenandoah River. In 1819, John H. Hall, a New England gunmaker, signed a contract with the War Department to produce 1,000 breechloading rifles—a weapon he had designed and patented in 1811. Under the terms of the contract Hall came to Harpers Ferry, where he occupied an old Armory sawmill along the Shenandoah River. The site soon became known as Hall's Rifle Works, and the small island on which it stood was called Lower Hall Island, Contributing landscape characteristics identified for Hall's Island through the analysis and evaluation of existing features include: natural systems and features; spatial organization; transportation as a land use; primary circulation features including Shenandoah Street, the canal, the river and the railroad; some aspects of the topography; archeology; and in the category of vegetation, there are two sycamores on the site that date back to the 1880s (Poss and Moss 2010).
Lockwood House	Situated on the crest of Camp Hill of Harpers Ferry, the 7-acre Lockwood House property overlooks the confluence of the Shenandoah and Potomac Rivers in the Gap in the Blue Ridge Mountains. The Lockwood House was built by the federal government as quarters for the Armory paymaster. After the Civil War, it was conveyed to Storer College and was the college's first structure. Much of the historic landscape fabric has been degraded or lost over time (Heritage Landscapes 2015).
Loudoun Heights	Loudoun Heights is the northern-most extension of the Blue Ridge located in Loudoun County, Virginia. The wooded and steeply sloped tract overlooks the town of Harpers Ferry from the south bank of the Shenandoah River. The "best preserved" Civil War encampments within Harpers Ferry NHP are located on the crest of Loudoun Heights and include stone hut foundations, tent platforms, and abandoned hearths. These encampments are illustrative of the intense but brief occupation of the mountain by US forces during the fall of 1862 (Winter and Frye 1992). The western side of Loudoun Heights is the United States Armory Woodland, acquired by the US government in 1813 to supply fuel, both wood and charcoal, for the nearby Armory. Loudoun Heights and the Armory Woodland are densely forested, which was important to their use to supply fuel to the armory and as site for military encampments. The Loudoun Heights Cultural Landscape has not been formally identified or evaluated.
Lower Town	Lower Town is the historic center of Harpers Ferry and is situated on a rocky peninsula between the Potomac and Shenandoah Rivers. The current landscape reflects the remnants of a thriving industrial and transportation center. Existing vegetation in Lower Town is grouped into three categories including: ornamental plantings in the developed areas, mixed deciduous forests on the hillside, and riparian vegetation along the two rivers. Specific types include oaks, maples, Virginia pines, sycamores, empress trees, cottonwood, magnolia, yew, and boxwood (NPS 1993).

Cultural Landscape	Description
Maryland Heights	Maryland Heights is 763-acre mountain tract that overlooks the town of Harpers Ferry. The cultural history of Maryland Heights is divided into three periods that are categorized by industrial, military, and domestic uses. During the first period, local ironworks cut the forests on Maryland Heights to manufacture charcoal, evidenced by the numerous remains of charcoal hearths and charcoal roads on Maryland Heights. The second period consisted of military occupation during the Civil War. Archeological surveys recorded 7 fortifications and 13 encampments from this era. Domestic occupation defines the third period, following the subdivision of the lands of the former Antietam Ironworks in 1848. Site features from this era include house foundations and stone walls. Similar to Loudoun Heights, Maryland Heights is primarily forested, which illustrates its historic land use patterns (Frye and Frye 1989). The Maryland Heights Cultural Landscape has not been formally identified or evaluated.
Murphy-Chambers Farm	The Murphy-Chambers Farm property covers 95 acres on a high, open bluff above the Shenandoah River 2 miles upriver (west) from its confluence with the Potomac River. The property is on a landform known as Bolivar Heights, which is a ridge that extends 1.7 miles from the Potomac River on the northeast (ridge crest of 600 feet) to the Shenandoah River on the southwest (ridge crest of 500 feet). The Murphy-Chambers Farm property contains three resources that contribute to its historical significance and integrity: the remnants of Union earthworks erected during the last months of the Civil War, the Murphy Farm House, and the John Brown Fort foundation site. At present, the property is permitted to a farmer as part of the park's Agricultural Use Program and used for the cultivation of hay, maintaining an agrarian appearance and perpetuating the site's long history of agricultural use (Kuhn 2014).
Nash Farm	Nash Farm is a small, early 20th-century dairy farm complex that is listed on the National Register. It consists of approximately five contiguous town lots in a relatively undeveloped section in the northwest comer of the town of Harpers Ferry. Surrounded by wooded lots, Nash Farm is situated on a grassy hill overlooking the Potomac River. Fruit trees and flowerbeds also form part of the domestic landscape (Wallace and Reed 2000). The farm comprises several buildings, including a dwelling, dairy barn, and a milk house. The Nash Farm Cultural Landscape has not been formally identified or evaluated (NPS 2008a).
School House Ridge North	School House Ridge North is historically significant for its involvement in military history (1861–1865), specifically the role it played during the Battle of Harpers Ferry between September 13 and 15, 1862. School House Ridge North also is historically significant for its agricultural history (1780–1868), which is indicative of the agrarian landscape established by many early European settlers. Much of School House Ridge North today still consists of cleared and regularly used farmland, as it did historically. Trees and a limited understory line the edges of wide open fields, breaking up the broad, rolling vistas. Thus the School House Ridge has two primary landscapes, characterized as woodland and farmland. Continuing land use on School House Ridge North includes an NPS agricultural permit, which maintains the agrarian character of the battlefield landscape as it appeared during the period of significance. Trees and other vegetation that are still present on the landscape, include hackberry, and several remarkable trees still mark the old fence lines (NPS 2008b).

Cultural Landscape	Description
Short Hill	This property is about 2.5 miles downstream from Harpers Ferry and is part of the scenic view of the "gap" featuring the confluence of the Shenandoah and Potomac Rivers and Maryland and Loudoun Heights. The Short Hill property was evaluated and determined eligible for listing on the National Register, but little is known about its resources. Documentation suggests that settlement and development of Short Hill began during the colonial era and continued through the early 20th century. An industrial community developed and structures such as mills, a dam, distillery, quarries, ferry landings, and residences, as well as supporting structures were present (NPS 2008a).
Virginius Island	Virginius Island comprises about 13 acres at the confluence of the Shenandoah and Potomac Rivers and is located entirely in West Virginia. The island is currently treated as an archeological preserve containing various archeological sites and building ruins associated with the 19th industrial and residential development on the island. The cultural landscape of Virginius Island has three periods of significance: 1750–1820, when the Shenandoah Canal was established and the first mill on the island was constructed; 1820–1855 when the island was organized into smaller parcels of land, the majority of structures were constructed, and the milling industry was established; and 1855–1890 when the island community was consolidated under one owner and experienced destruction caused by the Civil War and floods. These three identified periods are considered historically significant under National Register Criteria A, B, C, and D. Despite frequent flooding, remnants of features illustrating historic development remain visible on the island. These include industrial ruins of cotton and flour mills, and remains of historic waterways and residential structures (NPS 2012e).
United States Armory and Potomac Riverfront	The United States Armory at Harpers Ferry was one of only two federal armories in the country. Congress established the United States Armory at Harpers Ferry in 1796, two years after the Springfield Armory in Massachusetts. It played a key role in military and industrial history. Beyond crafting and storing weapons, the Armory became one of the first industrial centers in the country. The Armory was the site of John Brown's ill-fated attempt in 1859 to seize the stored guns to wage a battle for the freedom of slaves (Crosbie and Lee 2009).

Of the above listed cultural landscapes, Cultural Landscape Inventories have been prepared for Allstadt Farm, School House Ridge North, Murphy Farm, United States Armory and Potomac Riverfront, Virginius Island, and Camp Hill. Cultural Landscape Reports have been completed for Lower Town, Lockwood House, United States Armory and Potomac Riverfront, Virginius Island, Hall's Island, and Camp Hill; the report for Murphy Farm is in draft.

VISITOR USE AND EXPERIENCE

CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Visitation and Visitor Distribution

C&O Canal NHP is 184.5 miles long and runs along the Potomac River through the state of Maryland from the District of Columbia to the town of Cumberland. The park is a component of several other National Trail Systems, including the Potomac Heritage National Scenic Trail and the Appalachian National Scenic Trail. The park has multiple access points and is open year-round during daylight hours to allow for visitors to access a variety of history, nature, and recreational opportunities (NPS 2015f).

Visitor Activities

Numerous entry points along the entire length of the park allow visitor access to opportunities for enjoying the natural scenery and history of the park. Popular activities include hiking and biking, camping, boating, mobile tours, ranger-led programs, canal boat rides, fishing, horseback riding, walking tours, and various winter activities (NPS 2015f). A roughly 1.5-mile portion of the Chesapeake and Ohio Canal traverses through the Maryland Heights area of Harpers Ferry NHP, and visitor amenities associated with Harpers Ferry can be found along this stretch of the C&O Canal NHP. The C&O Canal passes within close proximity to the Lower Town, Virginius Island, Camp Hill, Loudoun Heights, and Maryland Heights areas of Harpers Ferry NHP where opportunities for guided tours, hikes, and historic interpretation activities exist. Although hazardous river conditions along the Potomac can preclude many recreational boating activities in this area, and no camping amenities exist along this segment of the park, nearby Huckleberry Hill provides opportunities for hiking, and other opportunities for visitor activities such as fishing and biking also exist in the area.

Seasonal Use Patterns

Annual visitation at the C&O Canal NHP has increased over the last decade, averaging about 4 million visitors per year over the last five years (figure 8), with 70% of visitation occurring between April and October (NPS 2015g). The lightest visitation occurs during the winter months of December to February (figure 9).

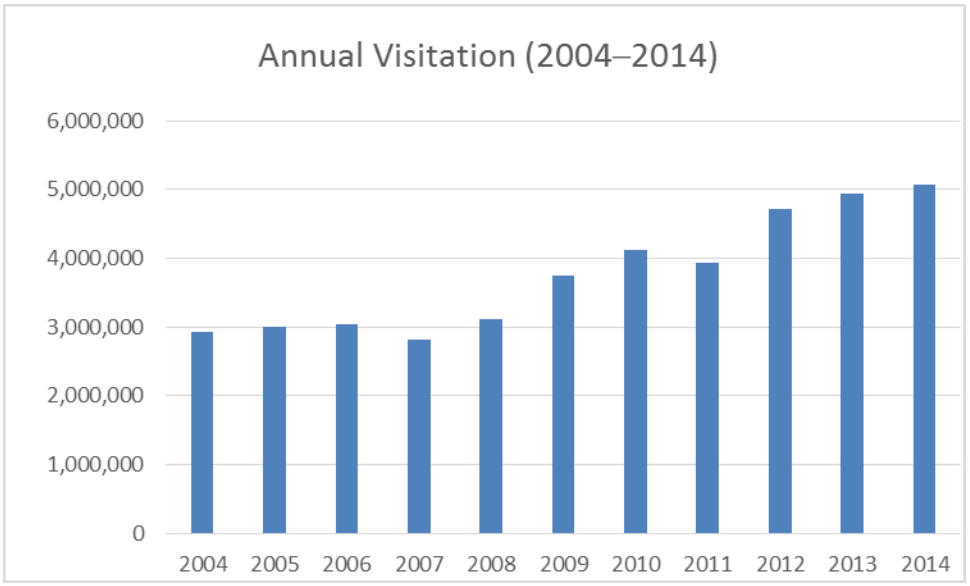


FIGURE 8. ANNUAL VISITATION AT CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK 2004–2014

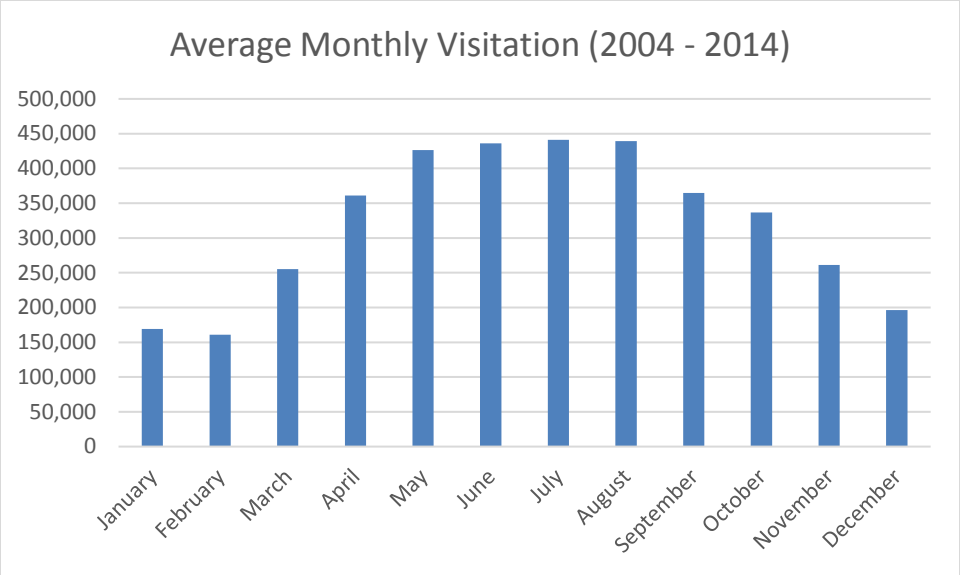


FIGURE 9. AVERAGE MONTHLY VISITATION AT CHESAPEAKE AND OHIO NATIONAL HISTORICAL PARK (2004–2014)

HARPERS FERRY NATIONAL HISTORICAL PARK

Visitation and Visitor Distribution

Harpers Ferry NHP is a major destination along the Appalachian Trail, is traversed by the C&O Canal, and is included in the Potomac Heritage National Scenic Trail. After Harpers Ferry was designated as a national monument in 1944, the town was restored to the 1859–1865 time period. Visitors typically enter the park at the Cavalier Heights entrance, which has an information center and provides access to a shuttle bus that lets visitors off at the bus pavilion in Lower Town. Visitors also are able to drive straight to Lower Town and begin their visit there. No public transportation to the outlying Civil War locations is provided, and visitors are required to use their own means of transport to access these areas. Interpretation and resource education is received primarily through self-guided walks among the historic structures and settings (NPS 2008a).

Visitor Activities

Park visitors come to historic sites to experience the area's natural and scenic beauty. Visitors interact primarily with NPS personnel at three staffed stations—the NPS entrance station, Cavalier Heights visitor information/contact station, and the information center in Lower Town (NPS 2008a). Opportunities exist at the park for guided tours, hikes, and historic interpretation activities. Other nearby visitor destinations also exist in the three-state region centered on the confluence of the Shenandoah and Potomac Rivers. Some of the choices include visiting Civil War battlefields and other historic sites, river rafting, and hiking.

Seasonal Use Patterns

Average annual visitation at Harpers Ferry NHP has been variable over the last decade (figure 10), averaging about 259,261 visitors per year with 85% of visitation occurring between April and October (NPS 2015g). The lightest visitation occurs during the winter months of December to February (figure 11).

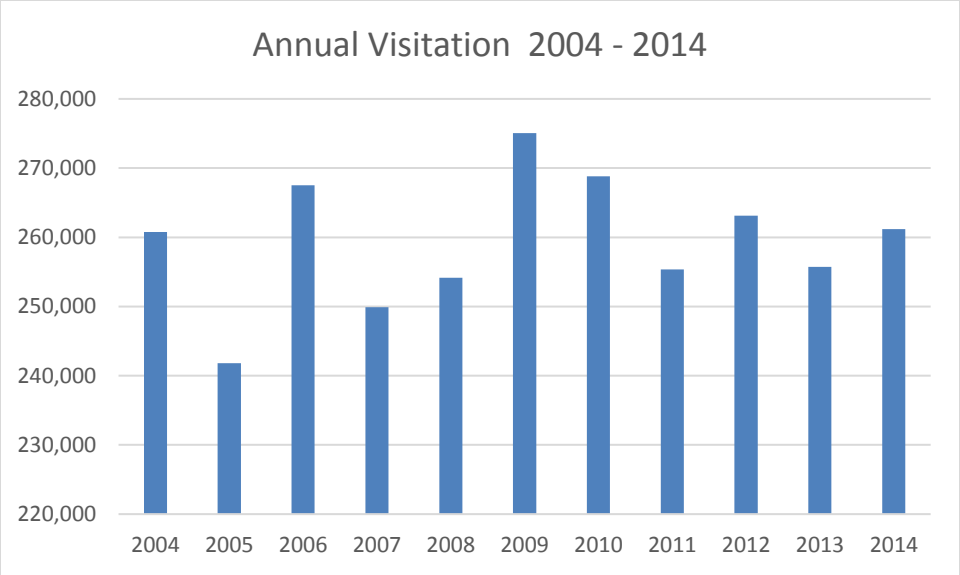


FIGURE 10. ANNUAL VISITATION AT HARPERS FERRY NATIONAL HISTORICAL PARK, 2004–2014

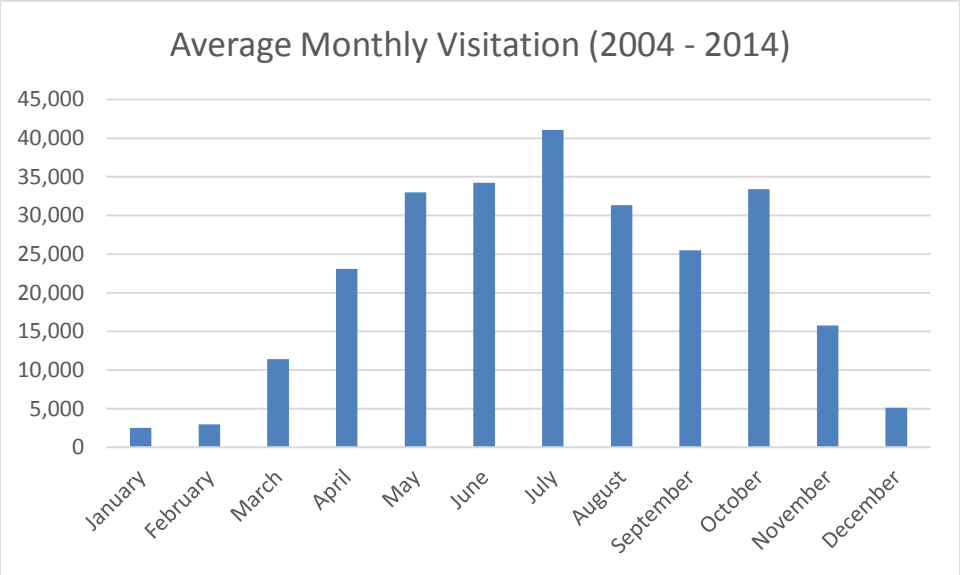


FIGURE 11. AVERAGE MONTHLY VISITATION HARPERS FERRY NATIONAL HISTORICAL PARK, 2004–2014

HUMAN HEALTH AND SAFETY

Deer management actions and activities have safety implications for employees and visitors. Human health and safety applies to park visitors, local residents, and park employees and volunteers. Common human health and safety concerns associated with management of deer in national parks include accidents and injuries involving employees and visitors, the potential for exposure to Lyme disease, and injuries related to collisions involving deer and motor vehicles.

CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Visitor/Employee Accidents and Injuries

An employee accident or injury is defined as an accidental event affecting any NPS employee that results in serious injury or illness requiring medical treatment, or in death. A visitor accident or incident is any such incident affecting any park visitor, local resident, or non-NPS person.

Lyme Disease

Deer-related diseases also may pose health risks to park visitors or area residents. Black-legged ticks, also known commonly as deer ticks, carry Lyme disease, which is the most common tick-borne disease in Maryland (MDHMH 2015). Deer and rodents are preferred hosts depending on the stage of the tick's life cycle. Mice are the principal reservoirs of the spirochete *Borrelia burgdorferi* considered the agent for Lyme disease. Though deer cannot transmit the disease to humans or ticks, a high deer population provides more hosts, and there is concern that this could support a higher than normal tick population compared to lower deer densities (CDC 2007). In the four counties traversed by the park, there were 350 reported cases of Lyme disease in 2014 (MDHMH 2014).

Deer-Vehicle Collisions

A primary safety issue for visitors and local residents involves injuries from deer-vehicle collisions. Deer-vehicle collisions are a threat to human safety and are one of the predominant sources of deer mortality. High densities of deer could affect the safety of visitors, employees, and volunteers using park roads. Several studies have shown that deer-vehicle collisions increase as local deer populations increase (DeNicola and Williams 2008; Rutberg and Naugle 2008a). Because of the many and varied sources, deer-vehicle collision data in the state of Maryland tend to vary from year to year depending on the effort put forth by the various agencies who report them (MD DNR 2014b). Data obtained by MD DNR from State Farm Insurance indicates that there have been an average of 33,250 deer-vehicle collisions in Maryland during each of the last five years (MD DNR 2014b). Table 12 shows reported deer mortality resulting from deer-vehicle collisions in the four Maryland counties traversed by the park during the 2013–2014 season (MD DNR 2014b).

TABLE 12. DEER-VEHICLE MORTALITY, 2013–2014

County	Deer Mortality from Vehicle Collisions
Montgomery	4,151
Frederick	1,371
Washington	524
Allegany	208
TOTAL	**6,254**

Source: MD DNR 2014b

HARPERS FERRY NATIONAL HISTORICAL PARK

Visitor/Employee Accidents and Injuries

Most injuries or accidents at Harpers Ferry NHP are sustained by maintenance staff and park rangers, who often perform manual work outdoors. All employees at the park receive training on how to do their jobs properly and safely, and this would extend to any work associated with deer management activities. No visitor or employee injuries have been sustained at the park as a direct result of interaction with deer. The park posts signage reminding visitors that harassing and/or feeding wildlife is illegal within national parks to minimize visitor encounters with wildlife (Harpers Ferry NHP, Parsons, pers. comm. 2015).

Lyme Disease

Deer-related diseases may also pose health risks to park visitors or area residents. As noted above there is concern that a high deer population could support a higher than normal tick population compared to lower deer densities (CDC 2007). The West Virginia Department of Health and Human Resources, Office of Epidemiology and Prevention Services, lists Jefferson County, where Harpers Ferry NHP is located, as one of seven counties in the state where Lyme disease is endemic (WVDHHR 2015). The park actively educates its employees regarding the signs and symptoms of Lyme disease (Harpers Ferry NHP, Parsons, pers. comm. 2015).

Deer-Vehicle Collisions

Similar to C&O Canal NHP, a primary safety issue for visitors and local residents at Harpers Ferry NHP involves injuries from deer-vehicle collisions. Deer-vehicle collisions are common in the region surrounding the park. A report funded by West Virginia Department of Transportation, WVDNR, and State Farm Insurance identified West Virginia as the state with the highest rate of deer-vehicle collisions nationwide based on data collected in 2012 and 2013. The eastern panhandle region was specifically identified as an area with a large number of roadway segments that experience a high frequency of deer-vehicle collisions (Nichols et. al. 2014). During the autumn breeding season, park management reminds employees to take extra care while driving because of the increased threat of collisions with active deer (Harpers Ferry NHP, Parsons, pers. comm. 2015).

PARK MANAGEMENT AND OPERATIONS

Deer management activities have the potential to impact staffing levels and operating budgets necessary to conduct park operations. Park management and operations refers to the current staff available to adequately protect and preserve vital park resources and provide for an effective visitor experience. As noted previously, natural resource management staff at the parks currently devote a sizeable portion of their time to deer management activities.

CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

C&O Canal NHP has a staff of approximately 71 full-time employees. This staff typically accommodates four to five million recreational visitors a year (NPS 2015h) while managing 20,239 acres of park lands, many actively used buildings, roads, trails, and extensive natural areas. NPS staff is assisted by seasonal employees and volunteers. NPS operations at C&O Canal NHP can be divided into the following functions: management (4 employees), business management (6 employees), interpretation, education, and public information (13 employees), law enforcement (13 employees), resources (6 employees), and maintenance (29 employees) (C&O Canal NHP, Carter, pers. comm. 2016). The park's base budget in fiscal year 2014 was $9,206,000.

The NPS NCR Natural Resources Science Group assists park resource management staff by providing services related to distance sampling and deer management statistics, as well as vegetation monitoring.

HARPERS FERRY NATIONAL HISTORICAL PARK

Harpers Ferry NHP has 93 permanent employees (as of early 2016). This staff typically accommodates more than a quarter million recreational visitors a year (NPS 2015i) while managing 3,745 acres of park lands, 80 actively used buildings, roads, trails, a shuttle bus fleet, and extensive natural areas. NPS staff is assisted by seasonal employees, volunteers, and the Harpers Ferry Historical Association. NPS operations at Harpers Ferry can be divided into the following functions: facility management, interpretation, law enforcement/fees, resource management, and administration (Harpers Ferry NHP, Parsons, pers. comm. 2015).

There are six other administrative NPS units located within or traversing sections of Harpers Ferry NHP, including C&O Canal NHP, Appalachian National Scenic Trail, Potomac Heritage Trail, Harpers Ferry

Center, Mather Training Center, and the National Catalog Center. The park's base budget in fiscal year 2014 was $5,957,000. One-time investments (e.g., major repair or construction projects) are financed through project money that is allocated to parks on a competitive basis and is in addition to base budget (NPS 2008a). A business plan for the park was prepared in 2002. This plan calculated actual costs to run the park and determined that the park was under-funded by roughly 36% (in fiscal year 2002). In light of funding shortfalls, the Harpers Ferry park management team has identified a number of strategies to reduce costs and increase available funding. This plan is currently being implemented (NPS 2008a).

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CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter analyzes the potential consequences of both beneficial and adverse impacts that would result from implementing deer management alternatives presented in this plan/EA, and the consequences that could occur from the implementation of the long-term CWD management plan that is common to all action alternatives. These analyses are done separately to avoid confusion, but it is important to recognize that the CWD management plan is an integral part of each of the action alternatives. A summary at the end of each topic presents the impacts of deer management combined with the impacts of the long-term CWD management plan for each alternative.

The chapter also presents a summary of laws and policies relevant to each impact topic, methods used to analyze impacts, and the analysis methods used for determining cumulative impacts. A summary of the environmental consequences for each alternative is provided in table 7, which can be found in chapter 2. The resource topics presented in this chapter, and the organization of the topics, correspond to the resource discussions contained in chapter 3.

METHODOLOGY FOR ASSESSING IMPACTS

The following elements were used in establishing impact intensity definitions and analyzing the potential effects of the alternatives on each resource category:

- General analysis methods as described in guiding regulations, including the context and duration of environmental effects
- Basic assumptions used to formulate the specific methods used in this analysis
- Methods used to evaluate the cumulative impacts of each alternative in combination with unrelated factors or actions affecting park resources

These elements are described in more detail below.

GENERAL ANALYSIS METHODS

The analysis of impacts follows CEQ guidelines and Director's Order 12 procedures and is based on the underlying purpose, as stated in "Chapter 1: Purpose of and Need for Action," of developing a deer management strategy that supports preservation of the parks' landscapes through the protection and restoration of native vegetation and other natural and cultural resources. This analysis incorporates the best available scientific literature applicable to the region and setting, the species being evaluated, and the actions being considered in the alternatives. For each resource topic addressed in this chapter, the applicable analysis methods are discussed, including assumptions.

Analysis Period

Goals, objectives, and specific implementation actions needed to manage deer at the parks are established for the next 15 years; therefore, the analysis period used for assessing impacts is up to 15 years. The impact analysis for each alternative is based on the principles of adaptive management, which would allow the NPS to change management actions as new information emerges from monitoring the results of management actions and ongoing research throughout the life of this plan.

Geographic Area Evaluated (Area of Analysis)

The geographic study area (or area of analysis) for assessment of indirect and direct impacts includes all lands within the boundaries of the two park units, except for socioeconomics and adjacent lands, which includes additional area around the parks. The area of analysis for socioeconomics/adjacent lands and for most cumulative impacts was extended to about 2.5 miles beyond the park boundaries to better capture

typical deer and wildlife movement outside the park boundaries and on neighboring properties. A distance of 2.5 miles was selected to capture the typical range found for most male and female deer (excluding occasional extremes) based on data from a deer movement study done at Antietam National Battlefield (McShea and Stewart 2005). The individual analysis for each resource topic begins with a description of the area of analysis.

Duration and Type of Impacts

Several basic assumptions are used for all impact topics (the terms "impact" and "effect" are used interchangeably throughout this document):

- *Direct impacts*—Impacts that would occur as a direct result of NPS management actions (e.g., impacts on vegetation from building exclosures or impacts on visitor use during the selected management action).
- *Indirect impacts*—Impacts that would occur from NPS management actions and would occur later in time or farther in distance from the action.
- *Short-term impacts*—Impacts that are temporary and would not have long-lasting effects, generally less than three years and usually associated with implementation of management actions. For CWD actions, this relates to the immediate effects of initially reducing the deer population.
- *Long-term impacts*—Impacts that would last beyond the time when management actions are taken, generally longer than three years and possibly lasting through the life of the plan, with potentially permanent effects, such as ongoing impacts on park operations or the beneficial effects on vegetation from reduced deer numbers.
- *Beneficial*—A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
- *Adverse*—A change that declines, degrades, and/or moves the resource away from a desired condition or detracts from its appearance or condition.

Both direct and indirect impacts are addressed in the analysis, although they may not be specifically labeled as such.

CUMULATIVE IMPACTS ANALYSIS METHODS

The CEQ regulations to implement NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, current, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). As stated in the CEQ handbook, "Considering Cumulative Effects" (CEQ 1997), cumulative impacts need to be analyzed in terms of the specific resource, ecosystem, and human community being affected and should focus on effects that are truly meaningful. Cumulative impacts are considered for all alternatives, including alternative A: No Action.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify those other actions at the parks and the surrounding areas (as appropriate) that could affect the various resources discussed in this plan and that are in addition to the actions already addressed within the alternatives analyzed.

The analysis of cumulative impacts was accomplished using four steps:

Step 1—Identify Resources Affected: fully identify resources affected by any of the alternatives.

Step 2—Set Boundaries: identify appropriate spatial and temporal boundaries for each resource.

Step 3—Identify Cumulative Action Scenario: determine which past, current, and reasonably foreseeable future actions to include for each resource. These actions are not only those within or undertaken by the park but also those actions by any entity that have had or will have an effect on the resources impacted by this plan.

Step 4—Cumulative Impact Analysis: determine the combined impact of the proposed alternative and the other identified actions of the cumulative scenario.

Table 13 summarizes the actions that were identified for the cumulative impact scenario for this plan, and additional information is provided in the following narrative.

Description of Actions Contributing to the Cumulative Impact Scenario

Land Development Outside the Park (Residential, Commercial, Transportation/Highways, and Utilities)

Past, present, and future development outside the parks is one of the most important factors that also affects the resources discussed in this plan/EA. The C&O Canal NHP, in particular passes through areas that have experienced growth and development. Land development is expected to continue, and this growth will likely be residential with some commercial development, and development of rights-of-way for associated utilities and highways. Land development generally involves removal of vegetation, which contributes to a reduction in natural habitat and fragmentation of forested habitat in the area surrounding the parks. Agricultural lands have been permanently lost and additional agricultural lands continue to be converted into other uses. Forest fragmentation and abandonment of agricultural lands has led to increases in edge habitat, which are prime areas for deer to forage. Land disturbances and use of construction equipment in various locations can exacerbate the spread of invasive nonnative species.

Ongoing Operations, Maintenance, and Development in the Parks

Past, present, and future actions in the parks involve new construction of facilities and trails; maintenance of existing buildings, roads, and trails; and day-to-day operations. This includes such actions as routine maintenance along roads, at picnic grounds, trail maintenance, and landscape maintenance (mowing and trimming). All of these actions, particularly any new construction, have the potential to affect vegetation and habitat through direct removal of vegetation where necessary, habitat fragmentation, and trampling, albeit on a relatively small scale.

Deer Management/Removals by Surrounding Entities

Public entities have taken steps to reduce deer populations in areas close to both of the parks. These include Montgomery County, Maryland and the town of Harpers Ferry. Related to the actions in Harpers Ferry, West Virginia offers a special urban archery season to control deer damage in urban areas (WVDNR 2009b). These actions have helped reduce local deer densities in certain areas. Actions of local entities are expected to continue annually for the remainder of the life of this plan and will aid in the regional reduction of the deer herds around the parks. There are no similar actions by public entities in Maryland, which relies on public hunting and deer depredation permits, discussed below.

Public Hunting/State Deer Management Plans

In Maryland, Virginia, and West Virginia, hunters remove many deer from the lands surrounding the parks. There are active hunt clubs near C&O Canal NHP, in particular. All three states have deer management plans (described in chapter 1) that support regulated public hunting as a means of controlling the states' deer populations, which can include deer populations that also use the parks.

Deer Damage Control on Private Property

In addition to public hunting, deer damage control or kill permits also are issued to private landowners outside the park boundaries, under the Damage Control Assistance Program in Virginia and the Deer Management Permit program in Maryland. This results in the removal of additional deer in areas around the parks. More information on deer management or control permits can be found in chapter 3 under "White-tailed Deer."

Actions that Contribute to Invasive Nonnative Species Increase and Control of Invasive Nonnative Species

Several actions in and around the parks have contributed to the problem of invasive nonnative species. This problem is particularly acute in parklands where extensive forest fragmentation and creation of "edge" environments, frequent human disturbance, and high deer densities enhance opportunities for invasive nonnative plants to become established (NPS 2004b). Both parks are experiencing impacts from invasive nonnative species.

The parks and other neighboring agencies also are addressing control of invasive species. Actions taken by both parks include assistance from the regional Exotic Plant Management Team and involve the use of various integrated pest management techniques such as herbicides, mechanical removal (pulling weeds, cutting), and cultural controls (changing planting practices or the environment in which plants grow).

Washington Suburban Sanitary Commission Water Intake Project in Montgomery County

The Washington Suburban Sanitary Commission (WSSC) is proposing to replace its water intake at the Potomac Water Filtration Plant because the existing intake structure is being adversely affected by its location. The plant is immediately adjacent to the C&O Canal. Installation of the new intake would require tree clearing for the construction of temporary roads, permanent driveways, and a parking lot, as well as the construction of embankments.

TABLE 13. CUMULATIVE PROJECTS

Impact Topic	Study Area	Past and Present Actions	Future Actions
Vegetation	Project study area	• Land development outside the parks • Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions • Actions to control nonnative species in the park	Same as current actions plus: • WSSC water intake project in Montgomery County
White-tailed Deer	Project study area	• Land development outside the parks • Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions	Same as current actions plus: • WSSC water intake project in Montgomery County

Impact Topic	Study Area	Past and Present Actions	Future Actions
Other Wildlife and Wildlife Habitat, including Special Status Species	Project study area	• Land development outside the parks • Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions • Actions to control nonnative species in the park	Same as current actions plus: • WSSC water intake project in Montgomery County
Historic Districts and Cultural Landscapes	Project study area	• Land development outside the parks • Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions • Actions to control nonnative species in the park	Same as current actions plus: • WSSC water intake project in Montgomery County
Visitor Use and Experience	Project study area	• Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions	Same as current actions plus: • WSSC water intake project in Montgomery County
Public and Employee Health and Safety	Project study area	• Ongoing operations, maintenance, and development in the parks • Deer management/removal by surrounding entities, including hunting and deer depredation actions	Same as current actions
Park Management and Operations	Project study area	• Ongoing operations, maintenance, and development in the parks • Actions to control nonnative species in the park	Same as current actions

IMPACTS ON VEGETATION

GUIDING REGULATIONS AND POLICIES

The NPS Organic Act of 1916 and the NPS *Management Policies 2006* (NPS 2006) direct parks to provide for the protection of park resources. The *Management Policies 2006* state that "the Service will not attempt to solely preserve individual species (except threatened or endangered species) or individual natural processes; rather, it will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological ecosystems" (NPS 2006, section 4.1). The policies further state, "The Service will not intervene in natural biological or physical processes, except […] to restore natural ecosystem functioning that has been disrupted by past or ongoing human activities, or when a park plan has identified the intervention as necessary to protect other park resources, human health and safety, or facilities" (NPS 2006, section 4.1). With regard to the

restoration of natural systems, the NPS "will reestablish natural functions and processes in parks" and it "will seek to return such disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated" (NPS 2006, section 4.1.5).

METHODOLOGY AND ASSUMPTIONS

Information is presented in chapter 3 on the types and distribution of vegetation in the parks. This information, communications with NPS staff, past monitoring data and reports, and other relevant scientific literature were used to identify baseline conditions within the area of analysis and to inform the assessment of impacts from the alternative actions. Analysis generally focuses on the first two implementation areas for deer management, the Gold Mine tract at Great Falls in the C&O Canal NHP and Maryland Heights at Harpers Ferry NHP. It is assumed that future implementation areas would be selected as need is confirmed through monitoring, and that effects would be similar to those at the initial implementation areas because environmental conditions in these other implementation areas are similar to the initial implementation areas. If, for some reason, conditions prove to be different, supplemental NEPA analysis may be required. CWD actions could occur anywhere.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of both parks. The area of analysis for cumulative impacts includes the parks and the area within 2.5 miles of the parks' boundaries, which encompasses typical deer movement outside the park boundaries.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

As described in chapters 1 and 3, there has been ongoing vegetation monitoring via exclosure studies since 2003, and Inventory and Monitoring plots since 2006. Studies such as paired plots to assess the impacts of deer on vegetation have been conducted at both parks, and results demonstrate that impacts on vegetation can be directly attributed to deer browsing and indicate that deer are affecting the integrity of the understory structure (see "Current Vegetation Status and the Role of Deer" in chapter 3). Under alternative A, it is expected that the deer population would continue at high densities within the parks, specifically in the initial focus areas of the Gold Mine tract at C&O Canal and Maryland Heights at Harpers Ferry, albeit with yearly fluctuations. Deer density data from 2015 indicate both of the parks exceed 20 deer per square mile (the high end of the desired deer density range). In both parks, it is expected that deer would continue to browse on plants and that tree seedling densities would remain low; measurable changes to the abundance and diversity of herbaceous vegetation throughout the area would occur, and crop damage would continue to occur.

Species composition has been found to be affected by deer browse, and these effects likely would continue under the no action alternative (Schmit 2014). Deer tend to browse more heavily on particular plants, and some plant species may be more affected than others by deer depending on where they occur within deer habitat. This can affect special status species, especially those that are palatable to deer. With the exception of pawpaw, a plant that is not palatable to deer, deer have been shown to have a statistically significant effect on the number of native saplings, based on the plots studied in the C&O Canal and other nearby parks (McShea and Bourg 2009).

In addition, deer activities, such as browsing, trampling that results in ground disturbance, and seed dispersal through waste or attachment to hair, have the potential to contribute to the increase of the number and type of nonnative plant species within the parks, (Myers et al. 2004; Vellend 2002; Williams and Ward 2006; Willson 1993; Duguay and Farfaras 2011), and the likelihood of this contribution rises as the population density rises. As the number of nonnative species increases, the native species within the parks encounter increased competition and can be adversely affected. According to annual deer density surveys, C&O Canal deer densities per square mile are three times that of surrounding Maryland counties. Deer may reduce the number of certain nonnative species that they browse on in open areas, but they can inadvertently spread these plants throughout the parks through their movement and waste and contribute

to establishment of nonnative species through soil disturbance and high levels of browse. Nonnative species likely thrived in the closed plots studied by McShea and Bourg (2009) as a result of the protection provided from deer browse and the fences that support vertical growth of some of the nonnative species such as Japanese honeysuckle.

Deer browse adversely affects crops that are essential components of the cultural and rural landscapes of these parks. Stewart et al. (2007) showed that deer have a substantial effect on corn production and quality. In their study, which included the C&O Canal NHP, as well as Antietam and Monocacy National Battlefields, fenced plots had higher weights of corn, more stalks with ears, and higher quality corn than open plots, and deer reduced crop yields by 5%–43% over the course of the study. As noted in chapter 3, the adverse impact that deer are having on crops is demonstrated by the finding that plots in the C&O Canal NHP sustained a crop weight loss of 28% from 2003 to 2004 due to white-tailed deer foraging (Stewart et al., 2007). It was noted that fields located in forest-dominated landscapes, such as most fields in the park, experience the highest overall damage. This is due, in part, to higher deer densities in predominately agricultural areas that provide refuge from hunting—these areas often exhibit enhanced carrying capacities (Stewart et al., 2007).

It is not expected that any periodic deer population fluctuations and temporary declines would be low enough or last long enough for forest regeneration to occur or vegetation of any kind to fully recover as long as deer densities remain above 20 per square mile. Based on these results and the expected high numbers of deer over the life of the plan, alternative A would have long-term, substantial, adverse impacts on vegetation as a result of the extensive deer browsing that would continue to occur at high deer densities. The majority of parks' vegetation would not be protected. Long-term, substantial, adverse impacts on vegetation would continue because no measures would be taken to limit or control deer population size or growth under this alternative, and the relatively small amount of fencing or protection would not be sufficient to support forest regeneration in the parks.

Monitoring vegetation plots and maintaining fenced areas would result in very limited trampling of vegetation as staff traveled to and around any fenced areas that are not located along trails. However, such impacts would be temporary because these activities typically take only a few days per year, and the amount of vegetation affected by these actions would be minimal because these activities would occur in only a few areas.

Overall, alternative A would result in long-term, substantial, adverse impacts on vegetation, including special status plant species. Throughout the life of this plan (15 years), browsing pressure would be expected to remain high in all of or a large portion of the parks because of a lack of deer management actions. Alternative A would reduce the abundance and diversity of native plants, suppress seedling growth, and cause damage to crops that are important components of the cultural landscapes.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

The 13 proposed exclosures would eliminate deer presence within about 5%–7% of the parks' forested areas at any one time (see chapter 2 for details and locations). Protecting these areas from deer browsing would allow native woody species to grow taller than heights reached by deer (about 60 inches or 150 centimeters) after about 10 years, at which time the exclosures would be removed, and additional nearby areas would be exclosed, as feasible. This action would have a long-term, beneficial impact on up to a maximum of 10%–14% of the woody vegetation in the parks after 15 years (the minimum life of the plan).

The effect of having no browsing protection on woody species in the remaining unfenced areas of the park would be similar to alternative A. It is expected that monitoring over the life of the plan would continue to show that most of the long-term unfenced plots would have low seedling regeneration. Exclosures would provide a long-term, beneficial impact on herbaceous vegetation, including herbaceous special status species, but these benefits would be limited to the location and time period of exclosure

areas. The restoration planting protections described under alternative A would continue to be used under alternative B, providing limited benefits. While this alternative may show some improvement over that seen under alternative A, based on the above analysis, it is expected to result in long-term, measurable, adverse impacts, when viewed over the life of the plan.

Constructing, maintaining, and monitoring the large exclosures would have some impact on the vegetation within the park as a result of trampling of small tree seedlings and herbaceous plants and the removal of existing woody vegetation. Even though fences would be located to avoid most trees, some trees likely would need to be removed during construction. Additionally, tree branches within 5 feet of either side of the fence would be removed to avoid branches hitting the fence in high winds or existing dead branches falling on the fence, thus minimizing future maintenance requirements. Given the relatively small size of the affected area of fence construction in relation to the size of the parks and the limited nature of the action, the impact of exclosure construction and maintenance would be barely detectable. Trampling during fence construction and removal of deer from within fenced areas, as well as during monitoring, would have short-term, minimal, adverse impacts because construction and monitoring would average only a few days per year and affect only a few areas, resulting in very small changes to vegetation. In addition, fencing can only be used in areas where the terrain is level enough that fences can be installed, and the ability for this tool to work park-wide would be limited.

For the purposes of this analysis, it is assumed that an acceptable chemical reproductive control agent would be available and feasible during the life of this plan as described in chapter 2. Implementing reproductive controls would have short-term (a few hours to a few days in any location), localized, unnoticeable, adverse impacts on vegetation from the presence of work crews and the associated minimal trampling of vegetation or clearing of work areas during trapping and handling of deer. The effect of reproductive control on the deer population and ultimately on deer browsing could be beneficial if the target deer density could be achieved within the life of this plan. However, the time required for the population to be reduced to the extent needed to allow for forest regeneration could be many years; researchers disagree on the time needed to reduce a population size using reproductive controls (Hobbs, Bowden, and Baker 2000; Nielsen, Porter, and Underwood 1997; Rudolph, Porter, and Underwood 2000). The actual time needed to observe a decrease would depend on a number of factors, such as the type of treatment, its effectiveness in stopping reproduction, the size of the population at the time of initial treatment, the actual mortality rate, and the percentage of the population that was treated. Other factors, such as untreated deer moving into the park and treated deer leaving the park, also would influence the time required to achieve reduced numbers.

With the open nature of the deer populations in the parks and the uncertainty of success with this method, it is likely that this would not be sufficient to result in a recovery in vegetation during the life of this plan, and measurable adverse impacts on forest vegetation, herbaceous special status plants, and special status plants subject to deer browse would continue until the population densities decreased more throughout the parks.

Alternative B includes use of various techniques to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents for short-term situations or over growing seasons, and using aversive conditioning in selected areas or at specific times. All of these actions would provide beneficial impacts and serve to reduce deer damage but only in a limited, localized context. Changing crops can prevent deer browse, but the substitute crop may not be one that is correct in the cultural context of the park, which could cause adverse effects on cultural resource values. The ability to grow a crop would need to be balanced against the effect of the change in crop. Although planting crops close together at the edge of fields to resist deer entry into the field is not a proven method, it could be initiated on a trial basis. Various aversive conditioning techniques (loud noises, scarecrow devices) would be useful in keeping deer away at certain times and in limited areas. These also would need to be used on a very selective basis and tested for effectiveness. These techniques would provide limited benefits that

would not substantially reduce overall measurable adverse effects on vegetation expected under alternative B if the deer densities remain high.

Overall, alternative B would result in long-term, measurable, adverse impacts on vegetation and special status plant species outside the exclosures as a result of the continued high levels of deer browse at high deer densities, which would reduce the abundance and diversity of native plants, suppress seedling growth, and damage crops.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Under this alternative, it is estimated that direct reduction would result in reaching the desired deer density goal at C&O Canal NHP at the Gold Mine tract in two years and at Harpers Ferry NHP on Maryland Heights in five years, based on deer density reports for the parks and the experience with lethal removal at other NPS parks such as Valley Forge. Park staff would determine the number of deer to be removed from the parks based on the most recent population survey and an initial deer density goal of 15 to 20 deer per square mile, as well as past experience of other deer management programs, technical feasibility, and success of forest regeneration in later years of plan implementation. It is expected that rapidly reducing the deer population and associated browsing pressure would allow the number of tree and shrub seedlings to increase and survive to saplings and into maturity in or near active implementation areas, providing the necessary growth for natural forest regeneration. This would result in long-term, beneficial impacts on forest vegetation, which could regenerate over time with decreased deer browsing, and on special status plant species. It is expected that crop damage at C&O Canal NHP would decrease to a level similar to that found outside the park, and damage to restoration tree plantings would similarly decrease.

The above conclusion is supported by much of the long-term vegetation plot monitoring data from these parks and others in the region. As described in chapter 3, long-term deer exclusion had a significant positive effect on sapling species richness; control and fenced plots began with the same number of species in 2003, yet by 2009 fenced plots harbored from 2 to 12 times more species than control plots (McShea and Bourg 2009). This study showed there were more seedlings in the fenced plots compared to the open plots, indicating that the elimination of deer browse would have a positive impact on seedling success. Studies at another park in the region focused on forbs showed that herbivory by deer severely impacted forb cover in all three forest types at the park (Gorsira et al. 2006) and because deer browsing suppressed vertical plant cover in each forest type in a manner similar to forb cover, a reduction to the desired density would have a long-term benefit on herbaceous cover as well as tree species.

Providing rapid deer herd reduction and control would result in long-term, beneficial impacts on vegetation because deer browsing would be substantially reduced, which would allow the abundance and diversity of vegetation throughout the park to recover and would result in less browse damage to crops at C&O Canal NHP and trees planted in both parks. It is expected that after approximately 10 years, monitoring would show increased tree seedling regeneration, and herbaceous plants would recover over varying periods, as has been the case at other parks (NPS, Donaldson, pers. comm. 2016c). Many plants would recover within a few years, resulting in a long-term, beneficial impact on park vegetation.

Effects on invasive species are more difficult to predict. As noted by McShea and Bourg (2009), it is likely that deer herbivory resulted in the decrease in invasive saplings noted in the open plots, and the invasive species already present in the fenced plots could increase when protected from deer browse, similar to native plants. However, if a reduction in deer is realized, actions taken in accordance with nonnative plant management plans in place at the parks would have an increased chance of success, since one mode of dispersing seeds (through deer waste or attachment to hair) would be reduced, representing a long-term, beneficial impact.

A number of other actions would occur as part of sharpshooting, as described in more detail in chapter 2, which would affect vegetation in limited areas. These actions include setting up bait stations, occupying

shooting areas, and transporting deer to locations for processing and disposal. Sharpshooting might take place from elevated positions, which would require portable tree stands to be temporarily hung in trees. Such portable stands do not damage the tree (no nails or screws) and would not have an adverse impact on woody vegetation. Removing deer carcasses from the site could require dragging over vegetation, which would temporarily trample some vegetation. All of these actions (bait stations, shooting stations, and transporting deer) would result in some trampling of vegetation; however, the area of impact would be small, and because reduction actions would take place mainly during late fall or winter months, these actions would not result in any measurable or perceptible change in herbaceous vegetation. The minimal adverse impact of trampling under this alternative would be short term.

A few deer may be removed using capture and euthanasia, if needed due to safety concerns. Limited trampling would occur with the setting up of traps (rather than setting up bait stations), resulting in short-term, adverse impacts that are generally unnoticeable in their effects on vegetation. Any waste or carcasses that would be left on the surface to naturally decompose would have no measurable impact on vegetation in the park.

Alternative C also includes the use of the techniques described in alternative B to prevent adverse deer impacts, including fencing of crops, changing crop configurations or selection at C&O NHP, and using repellents and aversive conditioning. Impacts would be the same as those described under alternative B—beneficial impacts that serve to reduce deer damage, but in a limited, localized context. Assuming that deer density is reduced to the desired goal in two to five years at the initial implementation areas, and that the timeframes for future implementation areas would be similar, it is likely that these techniques would be used more often in the first years of the program in cases where there is an immediate need to change crops, fence a vulnerable or sensitive area before more damage occurs, or scare deer from an important farm field; therefore, impacts would also be short term and localized. Once the desired deer density is reached, it is expected that few of these techniques would be needed, but they could add to the beneficial impacts of alternative C in certain areas or situations.

Overall, deer management actions under alternative C would result in long-term, beneficial impacts on vegetation and special status plants, particularly herbaceous species, because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation in and near the implementation areas to recover and reduce impacts on rare species from deer browsing.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

It is expected that reducing deer browsing pressure using direct reduction (sharpshooting) initially and either reproductive control or sharpshooting for maintenance would result in a noticeable increase in the number of tree and shrub seedlings and an increase in the number of seedlings surviving to sapling stage, both of which are necessary for natural forest regeneration. Herbaceous vegetation also would be able to recover, with many species expected to recover within a few years. Invasive species may increase if they had previously been browsed, but the spread of seeds by deer should decrease over time. Providing immediate reduction and control of the deer population would result in long-term, beneficial impacts on vegetation because deer browsing would be substantially reduced and the abundance and diversity of vegetation throughout the park could recover. Assuming that reproductive controls or sharpshooting would maintain the deer population size, impacts on vegetation and special status plants would be beneficial and long term because a substantial reduction in deer browsing would allow for the abundance and diversity of vegetation throughout the park to recover.

Similar to alternative C, it is expected that capture and euthanasia would be used only for safety reasons. Impacts would be the same as those described in alternative C, with short-term, adverse impacts that would have generally unnoticeable effects on vegetation. Also, as described for alternative C, a number of other actions would occur as part of the implementation of sharpshooting, such as setting up bait stations, occupying shooting areas, and transporting deer carcasses to locations for processing and transport, with

short-term, minimal impacts on vegetation given the small size of the affected area and the short duration of the impact. Some of the actions involved in implementing reproductive control (similar to constructing fences and implementing sharpshooting) also could result in trampling of vegetation; however, these actions would last only a few hours to a few days in any location, resulting in very minimal, adverse impacts on vegetation.

Alternative D also includes the use of the techniques described in alternative B to prevent adverse deer impacts, including fencing, changing crop configurations or selection at C&O NHP, and using repellents and aversive conditioning. Impacts would be the same as those described under alternative B; these would provide beneficial impacts and serve to reduce deer damage, but in a limited, localized context. Once the desired deer density is reached, it is expected that few of these techniques would be needed, but they could add to the beneficial impacts of alternative D in certain areas or situations.

Overall, deer management actions under alternative D would result in long-term, beneficial impacts on vegetation and special status plants because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation in and around the implementation areas to recover and would help protect rare plants from deer browsing.

IMPACTS OF ALTERNATIVE OF CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, continued opportunistic and targeted surveillance would not result in any measurable impacts on vegetation.

Alternatives B, C, and D (All Action Alternatives)

Impacts on vegetation from the deer reduction actions under the CWD response plan would be the same as those described for alternative C under the analysis of deer management actions, above. Rapidly reducing the deer population and associated browsing pressure would allow the number of tree and shrub seedlings to increase and survive into maturity in all areas of the parks and allow crops to survive without damage, resulting in long-term, beneficial impacts on vegetation. The intensity of the impacts from CWD activities may vary, depending on when the CWD actions occur in relationship to deer management actions. If CWD activities were to occur prior to deer management activities, the impacts would be more noticeable, while if they happened after the deer population already had been reduced as part of a deer management plan, less action would be needed for CWD and the impacts from CWD activities would be less intense and less noticeable.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions that could impact vegetation in and around the parks include actions with both adverse and beneficial impacts on vegetation. Adverse impacts on vegetation have occurred and will continue to occur from increasing urban and suburban development, including transportation projects and utility lines in the areas surrounding the parks, which have resulted in clearcutting, selective timbering, and removal of vegetation in specific areas, causing long-term, localized, adverse impacts. Ongoing park maintenance and operations would have similar long-term, adverse impacts on vegetation but would be localized and limited to the areas affected. The parks' nonnative plant management efforts and those of neighboring jurisdictions have had and will continue to have benefits to native vegetation by controlling and limiting the spread of invasive nonnative species. Beneficial impacts have resulted from past and current deer management efforts undertaken by neighboring agencies and landowners using deer depredation permits, which have resulted in reduced deer numbers in and around the park and reduced browsing pressure on vegetation. Public hunting has helped to reduce the deer population and provides a similar beneficial cumulative effect, particularly in the more rural areas surrounding the two parks. Clearing associated with the WSSC intake project will

reduce forest area immediately adjacent to the park and will have locally measurable, adverse effects from increased forest fragmentation.

As described above, impacts from past, present, and reasonably foreseeable future actions include long-term, adverse impacts as well as long-term, beneficial impacts. These impacts, when combined with the long-term impacts of deer management expected under alternative A because of continued deer browsing, would result in overall, long-term, adverse, cumulative impacts on vegetation. The no action alternative would contribute an appreciable adverse increment to overall cumulative impacts because the expected continued deer browsing would noticeably adversely affect vegetation.

Alternative B: Nonlethal Deer Management

The same past, current, and future actions described under alternative A also would occur under alternative B. In the absence of any CWD-triggered lethal response, the mostly long-term, adverse impacts of alternative B would contribute an appreciable adverse increment to overall cumulative impacts because of the lack of immediate reduction in the deer herd and the associated browsing impacts on vegetation and crops. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be localized additional beneficial, cumulative impacts on vegetation related to the associated reduced browse impacts, which would reduce long-term, adverse, cumulative impacts.

Alternative C: Lethal Deer Management

The same past, current, and reasonably foreseeable future actions described under alternative A also would occur under alternative C. In the absence of any CWD-triggered lethal response, deer management actions under alternative C would contribute an appreciable beneficial increment to overall cumulative impacts because of the relatively rapid reduction in deer and associated reduction in damage to vegetation, and reduction in sustained suppression of forest regeneration as a result of reduced deer browse. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional beneficial, cumulative impacts on vegetation related to the associated reduced browse impacts, which would add to the long-term, beneficial, cumulative impacts.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and reasonably foreseeable future actions described under alternative A would also occur under alternative D. In the absence of any CWD-triggered lethal response, deer management actions under alternative D would contribute an appreciable beneficial increment to overall cumulative impacts because of the relatively rapid reduction in deer and associated reduction in damage to vegetation, and reduction in sustained suppression of forest regeneration as a result of reduced deer browse. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional beneficial, cumulative impacts on vegetation related to the associated reduced browse impacts, which would add to the long-term, beneficial, cumulative impacts.

CONCLUSIONS

Alternative A: Continuation of Current Management (No Action)

Alternative A would result in substantial long-term, adverse impacts because browsing pressure would be expected to remain high in either all or a large portion of the parks throughout the life of this plan (15 years) as a result of the lack of deer management actions, and this would reduce the abundance and diversity of native plants, suppress seedling growth, damage special status plants that are browsed, and cause damage to crops and other vegetation that are important components of the cultural landscapes at

the parks. Overall cumulative impacts would be long term and adverse, with alternative A contributing appreciable adverse increments to the cumulative impact on vegetation.

Alternative B: Nonlethal Deer Management

The impacts of alternative B would be similar to those described for alternative A because reproductive control would result in only a gradual reduction in the deer population, and although the population goal may be met over the longer term, the risk of not meeting the goal would be high. Therefore, it is expected that the deer population would remain at relatively high density levels in the parks throughout the life of the plan, which would reduce the abundance and diversity of native plants, suppress seedling growth, and damage both special status plants that are browsed and crops and other vegetation that are important components of the parks' cultural landscapes. The exclosures would protect only a small portion of the woody vegetation in the parks at any one time and provide no protection for herbaceous species once the exclosures are removed. Alternative B would result in long-term, measurable, adverse impacts because of the limited effectiveness of reproductive control and the exclosures in protecting forest vegetation from deer browse impacts. There would also be short-term impacts from deer management implementation actions such as placement of bait piles because of trampling, and limited beneficial impacts from use of the techniques available to reduce deer access to crops and fields that reduce deer impacts from browse in these areas. Any CWD response that would be taken under the proposed long-term plan would provide indirect, beneficial impacts from reduced deer density and reduced browse on park vegetation, but these would not outweigh the adverse effects of not taking deer management actions. Similar to alternative A, overall cumulative impacts would be long term and adverse, with alternative B contributing appreciable adverse increments to the cumulative impact on vegetation.

Alternative C: Lethal Deer Management

Overall impacts on vegetation under alternative C would be long term and beneficial because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation throughout the parks to recover and would minimize impacts from deer browsing on special status plants. There would be short-term impacts from deer management implementation actions and benefits from the limited use of deer management techniques to reduce impacts in certain locations or circumstances, as described for alternative B. CWD actions would have similar impacts, with short-term impacts from surveillance and benefits from the reduction of deer and deer browse on vegetation. Overall cumulative impacts would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on vegetation and special status plants.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Alternative D would have essentially the same impacts as alternative C, with long-term, beneficial effects as a result of the decrease in the deer herd and reduced browse impacts on park vegetation, limited adverse impacts from the management actions themselves, and limited benefits from the use of the techniques described for all alternatives. CWD actions would have similar impacts, with short-term impacts (mainly from trampling) from surveillance, and benefits from the reduction of deer and deer browse on vegetation. Overall cumulative impacts would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on vegetation and special status plants.

IMPACTS ON WHITE-TAILED DEER

METHODOLOGY AND ASSUMPTIONS

The evaluation of deer was based primarily on a qualitative assessment of how expected changes to vegetation within the parks (as a result of increased or decreased browsing pressure) would affect the respective deer populations and their associated habitat. The evaluation also considered potential impacts

on the deer populations directly associated with implementation of the alternatives (e.g., change in daily movements to avoid sharpshooting).

It is important to note that impacts on deer, as with other wildlife, are analyzed in terms of the desired conditions for the deer populations as a whole, including their overall health and ability to function in as natural a condition as possible. Thus, destruction of individual animals and reduction of the herd size alone are not necessarily adverse impacts, if their effect is to improve the overall condition of the deer populations as part of the natural ecosystem.

Available information on the deer populations (demographics, conditions, population dynamics, behavior, and disease) was compiled and analyzed in relation to the management actions.

It is assumed that future implementation areas would be selected as need is confirmed through monitoring and that the impacts in those areas would be similar to those at the initial implementation areas. CWD actions could occur anywhere.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of the two parks. The area of analysis for cumulative impacts includes the parks and the area within 2.5 miles of the parks' boundaries, which encompasses typical deer movement outside the parks' boundaries.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

The no action alternative would result in long-term, measurable, adverse impacts on white-tailed deer because browsing pressure would likely remain high in the parks throughout the life of this plan (15 years), reducing the amount and quality of habitat and browse, and increasing the risk for disease transmission. Adverse impacts of sustained high density deer populations could also result in higher parasite load and burden of stomach worms that can be associated with high mortality. Deer populations at C&O Canal NHP in Allegany County have high stomach worm burdens and are at risk of higher mortality (Fenton 2016). High deer density populations also would increase the potential for the spread of CWD (Joly et al. 2006; Samuel et al. 2002). Based on this analysis, impacts of the no action alternative on deer population dynamics (deer density, productivity, mortality) would be long term and adverse.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

Use of large-scale exclosures would protect some deer habitat but would eliminate deer presence within 5%–7% of the forested areas of the parks at any one time. Large-scale exclosures would prevent deer from accessing portions of their existing home ranges. This could result in deer expanding their home ranges farther beyond the parks' boundaries and/or browsing more intensely in the areas that remain accessible within existing home ranges. When the exclosures are moved, there could be a short-term reduction in foraging outside of the parks because deer would seek to take advantage of the regenerated vegetation in the newly opened areas. This reduction, however, would be expected to be short-term, and deer would then have to seek out additional forage to support the growing population. As a result, there would be long-term, adverse impacts on deer habitat and associated adverse impacts on the deer population in the parks.

If successfully implemented, the use of reproductive control when feasible (see chapter 2) would help reduce the impact on deer by gradually decreasing their numbers and allowing habitat to improve over time. The use of reproductive control could reduce the deer populations in the parks to a limited extent if it were successfully implemented, but this would require many years to actually reduce the populations, based on modeling efforts (Hobbs, Bowden, and Baker 2000; Rudolph, Porter, and Underwood 2000; Merrill, Cooch, and Curtis 2006) as well as a comparison of field efforts that used lethal (Frost et al. 1997) and nonlethal methods (Rutberg and Naugle 2008b). A number of factors may influence the efficacy and reduction period of this method, including immigration/emigration of deer to/from the parks,

mortality and recruitment rates, the size of the population at the time of initial treatment, and the percentage of each deer population that was treated. Other factors, such as untreated deer moving into the parks and treated deer leaving the parks, also would affect the time required to reduce herd numbers. The benefit of this action would be proportional to the population reduction that it provided; therefore, a benefit could not actually be established until an improvement in vegetation and deer habitat was observed. Based on these factors, it is expected that reproductive controls could stop population growth, but would not reduce the numbers of deer to the desired deer density goal within the life of this management plan using current technology. For these reasons, impacts on deer habitat and deer would only slightly be offset by this alternative, resulting in long-term, but minimal, adverse impacts.

The intensity of long-term effects of implementing reproductive control on a free ranging deer herd is difficult to predict given the many variables. The actual administration of the reproductive control would result in disproportional impacts on does versus bucks. Some mortality could occur as a result of tranquilizer use and handling stress on the doe (DeNicola and Swihart 1997; Kilpatrick, Spohr, and DeNicola 1997); however, generally a 2% mortality rate or less would be expected (Peterson et al. 2003; Kreeger and Arnemo 2012), assuming that good capture techniques are used. Additionally, there may be potential physiological or behavioral changes associated with the application of a chemical reproductive control agent. However, any agent selected for use would be required to have limited impacts on deer behavior or physiology. Beneficial impacts are not expected to be realized through the life of this plan because population reduction would not be achieved. Reproductive control would result in short- and long-term, adverse impacts on the deer population at the parks.

Until reproductive control could be effectively implemented, white-tailed deer densities would be expected to remain high in both parks, potentially resulting in an increase in size of the deer home range and increased movements across the parks' boundaries into the surrounding communities. A shift in habitat use also may result as vegetative cover in the parks' forests continues to decrease. Based on this analysis, impacts of alternative B on deer behavior (movements, habitat use) are expected to be similar to those described for alternative A—long-term and adverse.

In addition, continued high deer densities also could increase the risk for disease and losses due to malnutrition and parasitism, contributing long-term, adverse impacts on deer herd health.

Administration of reproductive control agents would require capture, handling, and marking of deer. These activities may occasionally disturb deer and cause a temporary change in deer movements. However, these activities would be conducted during short periods over a relatively small area at any one time. Given the likely small size of the impacted area and the limited nature of the actions, the impacts of these activities on the deer population would be short-term, localized, and adverse.

Alternative B would include using various techniques to prevent deer from impacting resources in the parks, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. All of these actions would provide minimal, adverse impacts on the deer herds. Changing crops and repellents can prevent deer browse but also could result in an increase of deer browse in more palatable areas. Various aversive conditioning techniques (loud noises, scarecrow devices) could temporarily modify deer movement and behavior, resulting in expanded home ranges discussed above. Over time, however, deer could be expected to become conditioned to these disruptions and return to more normal home ranges. Overall, these techniques would provide limited impacts that would not substantially affect the impacts expected under alternative B if the deer densities remain high.

Overall, alternative B would result in long-term, measurable, adverse impacts on white-tailed deer because reproductive control would result in a small and gradual reduction in the deer population. Consequently, the deer population would remain at relatively high levels throughout the life of the plan, with associated adverse impacts as a result of reduced quality of habitat and increased risk of disease.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Over the long-term, reducing and maintaining deer density levels at 15 to 20 deer per square mile through sharpshooting would allow vegetation to recover, providing better foraging habitat for deer in both parks. When deer density is high, there is increased mortality of younger animals and younger reproductive productivity, in addition to enhanced disease risk. In addition, fawn mortality could be expected during extreme winter stress if the habitat quality and deer populations remain at current levels. As described in "Chapter 2: Alternatives," 15 to 20 deer per square mile is more closely aligned with levels that are in balance with other components of the ecosystem, namely a regenerating forest system. Removing a large percentage of the deer populations within a short time would have short-term, adverse impacts on the parks' deer populations. The results would be outside the natural range of variability, and there would be a sizeable change in deer numbers, but the deer populations would remain stable and viable. However, rapidly reducing the population to the desired range would have a beneficial effect on the long-term viability of the deer population within the parks by minimizing the potential for nutritional stress and disease and improving habitat.

Sharpshooting and euthanasia activities may affect deer due to the disturbance and noise associated with the action. Noise impacts would be minimal because noise suppressors would be used, and impacts of sharpshooting on the remaining deer herd would be limited mainly to the temporary displacement/disturbance of deer during the nighttime hours of the fall and winter months. Increased shooting efforts, however, could result in temporary alterations to deer home ranges as animals evacuate targeted areas. For these reasons, adverse impacts of noise related to sharpshooting and euthanasia to the deer population would be short-term and minimal.

Changes in deer movement may result from the use of bait piles, which would attract deer to specific locations, temporarily altering their normal movement patterns. However, these activities are conducted during short periods over a relatively small area at any one time, resulting in short-term, minimal, adverse impacts on deer behavior (e.g., movement).

Similar to alternative B, alternative C includes changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. As noted previously, these techniques would provide limited impacts that would not substantially detract from the beneficial effects expected under alternative C if deer densities are reduced.

Overall, alternative C would result in long-term, beneficial impacts on white-tailed deer because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation in and near the implementation areas in both parks to recover and better protect deer habitat, and it is likely that health issues associated with high population density would decrease in deer if the population density is more in line with habitat carrying capacity (Fenton 2016).

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

Similar to alternative C, the intent of this alternative would be to rapidly reduce deer density within the parks to allow for native vegetation to recover from deer browsing pressure. Research indicates that when habitat is stressed it cannot support healthy deer over the long term (Eve 1981). As described for alternative C, reduction of the deer population size would minimize the potential for nutritional stress and result in a deer density more closely aligned with levels that are in balance with other components of the ecosystem, namely a regenerating forest system. The reduced population would be able to support itself on the existing forage, while the parks' vegetative communities regenerated. Removing a large percentage of the deer populations over a few years would have short-term, adverse impacts on the parks' deer populations. The results would be outside the natural range of variability, and a sizeable change in deer would occur, but the deer populations would remain stable and viable. Rapidly reducing the population to the desired range would have a beneficial effect on the long-term viability of the deer population within

the parks by minimizing the potential for nutritional stress and disease and improving habitat. Impacts on the deer population would be adverse while habitat recovered; however, as vegetation regenerates, better foraging habitat would be provided for the deer.

As described for alternative B, the intensity of long-term effects of implementing reproductive control on a free ranging deer herd is difficult to predict. The actual administration of the reproductive control would result in disproportional impacts on does versus bucks. The effect on individual deer may be considered a substantial adverse impact (i.e., some mortality could occur), due to tranquilizer use and handling stress on the doe (DeNicola and Swihart 1997; Kilpatrick, Spohr, and DeNicola 1997). Additionally, there are potential physiological or behavioral changes associated with the application of a chemical reproductive control agent. It is expected, however, that the long-term adverse effect on the population would be minimal, as the adverse impacts over time would be offset by the beneficial effect of population reduction.

As described for alternatives B and C, changes in deer movement may result from the use of bait piles, which would attract the deer to specific locations, and shooting activities, which may push deer out of areas in each park. These activities, however, would be conducted during short periods of time over a relatively small area at any one time resulting in short-term, minimal, adverse impacts on deer behavior (e.g., movement).

Similar to alternatives B and C, alternative D would include changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. As previously explained, these techniques would provide limited impacts that would not substantially detract from the beneficial effects expected under alternative D if deer densities are reduced.

Overall, alternative D would result in long-term, beneficial impacts on white-tailed deer because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation in and near the implementation areas of both parks to recover and better protect deer habitat, and it is likely that health issues associated with high population density would decrease in deer if the population density is more in line with habitat carrying capacity (Fenton 2016).

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, surveillance would not result in any adverse impacts on white-tailed deer because any removals would be of already deceased deer or those showing signs of disease; no diseased deer have been observed and removed to date.

Alternatives B, C, and D (All Action Alternatives)

Impacts on deer from the deer reduction actions under the CWD response plan would be the same as described for alternative C under the analysis of deer management actions, above. Assuming that a rapid reduction of deer is implemented in conjunction with surrounding state CWD response plans and actions, this would minimize the potential for nutritional stress and disease, including CWD, resulting in a beneficial effect on the long-term viability of the remaining deer population within the parks. In addition, the likelihood of early detection of CWD would increase with additional deer removal, and a decreased population density would also reduce the speed that CWD becomes prevalent, resulting in benefits to the deer population (Manjerovic et al. 2014). The intensity of the impacts from CWD activities may vary, depending on when the CWD actions occur in relationship to deer management actions. If CWD activities were to occur prior to deer management activities, the impacts would be more noticeable, while if they happened after the deer population had already been reduced as part of a deer management plan, less action would be needed for CWD and the impacts from CWD activities would be less intense and less noticeable.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions that could impact white-tailed deer in and around the parks include actions with both adverse and beneficial impacts. Ongoing adverse impacts on white-tailed deer include urban and suburban development outside the parks, resulting in human disturbance, noise, and habitat loss, causing short- and long-term, localized, adverse impacts. Ongoing park operations and changes/increases in visitation would have similar short- and long-term, unobservable, adverse impacts limited to the areas affected by maintenance and human disturbance. Deer-vehicle collisions and deer damage control on private property provide obvious impacts on individuals within the population and can result in long-term, adverse impacts on deer herds if deaths result in orphaned fawns or a reduction in members of the herd that are at the height of their reproductive efficiency. Long-term, beneficial impacts have resulted from past and current deer management/removals by surrounding entities, public hunting/state deer management plans, and invasive species management at the parks. Deer management removals by surrounding entities and public hunting/state deer management plans are managed to reduce adverse effects on the overall herd while reducing population pressures. Invasive species management actions on these lands have resulted in improved habitat for these deer herds. The WSSC intake project will clear vegetation and reduce forest area immediately adjacent to the park, which could have locally measurable, adverse effects on white-tailed deer from increased forest fragmentation. As described above, impacts from past, present, and reasonably foreseeable future actions include short- and long-term, localized, adverse impacts as well as long-term, beneficial impacts. These impacts, when combined with the long-term, adverse impacts for deer management under alternative A from the continued growth in population, would result in long-term, adverse, cumulative impacts on the white-tailed deer population. Alternative A would contribute an appreciable adverse increment to the overall cumulative impact because of the lack of reduction in the deer herd and the associated impacts on the long-term herd viability.

Alternative B: Nonlethal Deer Management

The same past, present, and reasonably foreseeable future actions described under the no action alternative also would occur under alternative B, with short- and long-term, localized, adverse impacts and long-term, beneficial impacts on white-tailed deer. In the absence of any CWD-triggered lethal response, alternative B would contribute an appreciable adverse increment to the overall cumulative impact because of the lack of reduction in the deer herd. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional beneficial, cumulative impacts on the deer populations in the parks related to the associated reduced potential for disease amplification, spread, and establishment, which would reduce long-term, adverse effects.

Alternative C: Lethal Deer Management

The same past, present, and reasonably foreseeable future actions described under the no action alternative also would occur under alternative C. In the absence of any CWD-triggered lethal response, alternative C would contribute an appreciable beneficial increment to the overall cumulative impact by achieving healthy deer densities. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional beneficial, cumulative beneficial on the deer populations in the parks related to the associated reduced potential for disease amplification, spread, and establishment, which would add to the long-term, beneficial impacts.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, present, and reasonably foreseeable future actions described under the no action alternative also would occur under alternative D. In the absence of any CWD-triggered lethal response, alternative D would contribute an appreciable beneficial increment to the overall cumulative impact because of the reduction in browse damage to deer habitat. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional beneficial, cumulative impacts on the deer populations in the parks related to the associated reduced potential for disease amplification, spread, and establishment, which would add to the long-term, beneficial impacts.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, deer would experience long-term, measurable, adverse impacts because browsing pressure likely would remain high in the parks throughout the life of this plan (15 years), which would reduce the amount and quality of habitat and food available to deer and increase the risk of disease transmission. There would be short-term, unnoticeable, adverse impacts on deer from deer monitoring actions because of the disturbance and noise associated with the field crews. CWD surveillance would not result in any measurable impacts on white-tailed deer. As described under "Cumulative Impacts," overall cumulative impacts would be long term and adverse, with the no action alternative contributing appreciable adverse increments to the cumulative impact on the white-tailed deer population.

Alternative B: Nonlethal Deer Management

Similar results would occur under alternative B, because reproductive control would result in a gradual reduction in the deer population, and consequently the deer population would remain at relatively high levels throughout the life of the plan, which would reduce the amount and quality of habitat and food available to deer. The exclosures would protect only a small portion of the forest at any one time, requiring 10 years for regrowth above the browse line. Alternative B would result in long-term, adverse impacts because of the reduced quality of habitat and increased risk of disease that would occur with a continued high deer density. CWD response from the CWD management implemented as part of this alternative would involve the lethal removal of relatively large numbers of deer, which would provide long-term, beneficial impacts, but these would not outweigh the adverse effects of not taking actions that substantially reduce the deer herd. Alternative B would contribute appreciable adverse increments to the cumulative impact on the white-tailed deer population.

Alternative C: Lethal Deer Management

Overall impacts on white-tailed deer under alternative C would be long term and beneficial because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation throughout the parks to recover and better protect deer habitat. In addition, the reduced density would minimize the potential for nutritional stress and disease. There would be short-term and minimal, adverse effects from implementing deer management actions because of noise and disturbance associated with the work crews. There would also be short-term, measurable, adverse impacts on the parks' deer populations from removing a relatively large percentage of the population over a short period of time to achieve the desired long-term benefit. CWD actions would have long-term benefits from the reduction of the potential for disease amplification, spread, and establishment. Overall cumulative impacts would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on the white-tailed deer population.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The impacts associated with Alternative D would be similar to those described for alternative C, with long-term, beneficial effects as a result of the relatively rapid deer herd reduction that would allow the

abundance and diversity of vegetation throughout the parks to recover and better protect deer habitat. There would be short-term and minimal, adverse effects from implementing deer management actions, and short-term, measurable, adverse impacts on the parks' deer populations from removing a relatively large percentage of the population over a short period of time to achieve the desired long-term benefit, as described under alternative C. CWD actions would have long-term benefits from the reduction of the potential for disease amplification, spread, and establishment. Overall cumulative impacts would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on the white-tailed deer population.

IMPACTS ON OTHER WILDLIFE AND WILDLIFE HABITAT

METHODOLOGY AND ASSUMPTIONS

The evaluation of other wildlife was based on a qualitative assessment of how expected changes to each parks' vegetation (as a result of increased or decreased deer browsing pressure) would affect the habitat of other wildlife. The parks' wildlife species are directly affected by the natural abundance, biodiversity, and the ecological integrity of the vegetation that comprises their habitat.

Available information on known wildlife species was compiled and analyzed in relation to the management actions. Impacts on special status wildlife species would generally be the same as impacts on other species. Special status wildlife species that specifically would be affected are mentioned in the text. It is assumed that future implementation areas would be selected as need is confirmed through monitoring, and that effects would be similar to those at the initial implementation areas. CWD response actions could occur anywhere.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of the two parks. The area of analysis for cumulative impacts includes the parks and the area within 2.5 miles of the parks' boundaries, which encompasses typical deer movement outside the parks' boundaries.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

The vegetation/habitat conditions described in "Chapter 3: Affected Environment," for both vegetation and other wildlife and wildlife habitat indicates that deer have already affected the vegetation, and therefore the habitat, for other wildlife species within the parks. The herbaceous and woody seedling layers of the forest have been heavily browsed by deer, adversely affecting forest health and suggesting that the abundance and diversity of other wildlife using this understory habitat today is less than what it would be if deer browsing pressure was lower. Petit (1998) found that substantial deer browse of understory vegetation led to a reduction in abundance of understory bird species at Cuyahoga Valley National Park. McShea and Rappole (2000) found that avian species composition changes as the understory recovers from a period of extended deer browsing. This study is applicable to the situation at these parks because it was conducted at Shenandoah National Park, another NPS unit that does not manage deer populations. The study documented the statistically significant increase of low forest guild birds as the understory recovered from excessive deer browsing. This included several species that nest at the parks (red-eyed vireo, eastern towhee [*Pipilo erythrothalmus*], and wood thrush [*Hylocichla mustelina*]). Vertical plant cover is an important habitat attribute to understory bird species. It has been positively correlated with the abundance and species richness of breeding birds (McShea and Rappole 1992) and the abundance and species diversity of wintering birds (Zebehazy and Rossell 1996). Heavy deer browsing also degrades habitat and results in a lack of cover for small mammals, making them vulnerable to predation from hawks, owls, foxes, skunks, raccoons, and coyotes.

Special status wildlife species discussed in chapter 3 that were not dismissed from analysis could experience impacts similar to those described for non-listed wildlife species. For example, ground-dwelling birds such as the Canada warbler (*Cardellina canadensis)*, golden-winged warbler

(*Vermivora chrysoptera)*, Louisiana waterthrush (*Parkesia motacilla)*, Kentucky warbler (*Geothlypis formosa*), wood thrush, worm-eating warbler (*Helmitheros vermivorum*), and dark-eyed junco (*Junco hyemalis)*, which use the ground for foraging or cover, could be adversely affected because of understory reduction from deer browse. A species such as the blue-winged warbler (*Vermivora pinus)* that uses overgrown fields and agricultural lands for breeding purposes also could be adversely affected by heavy deer browse of agricultural plantings. The frequency with which these special status species are found could also decrease, if deer browse decreases species diversity (Petit 1998; McShea and Rappole 1992), as discussed in the previous paragraph.

As discussed in "Impacts on Vegetation," deer activities, such as browsing, trampling, and seed dispersal through waste or attachment to hair, have the potential to increase the number and type of nonnative species. Continued spread and increase of nonnative species have the potential to alter native habitats over the long term, resulting in modifications to wildlife habitat.

At continued high densities, deer also would compete directly with other wildlife species for available resources. The production of acorns and other tree nuts, also known as mast, is a critical food source for many small mammals, birds, and deer preparing for the winter season. Particularly during low mast production years, abundant deer populations may compete directly with other wildlife for this important resource. Reduction in the availability of this critical food source negatively impacts reproduction and over-winter survival of species such as the eastern chipmunk, gray squirrel, and white-footed mouse (Martin, Zim, and Nelson 1951; Miller and Getz 1977; Gashwiler 1979; Ostfeld, Jones, and Wolff 1996; Brooks and Healy 1988; McShea and Rappole 1992; McShea and Schwede 1993; McShea and Rappole 1997; McShea 2000). Other species that have a more diverse diet or that spend more time in the upper forest canopy (versus the shrub/ground layer) or leaf litter would be less affected by continued high deer density in unfenced areas of the parks.

Species that use deer as a food source, however rarely, such as coyotes, could benefit from high deer density or open understory conditions. Other animals also may feed on deer carcasses, like crows (*Corvus* spp.) and raccoons, and these could benefit from higher deer densities. Small predators, such as foxes and hawks, also could benefit from a more open understory because prey might be easier to find. However, if the habitat of the prey species deteriorated to the point where prey (mice, rabbits, ground-nesting birds) could no longer maintain viable populations within the parks, then predator species also would decline. Grassland nesting birds also would benefit from deer browsing that keeps woody plants from taking over grasslands.

Increases in wildlife movements may result as park staff travel to and from monitoring plots, install and maintain fencing, and conduct deer counts. A preferred method of deer population monitoring involves use of a spotlight from a vehicle along roadways and trails through the parks. This activity would be conducted at night in the fall. No disturbance to breeding or diurnal animals would occur under this alternative. However, these activities occasionally may disturb common species of nocturnal wildlife such as raccoons and owls. Additionally, these activities would be expected to occur only periodically (annually to every five years) and for short duration (hours to days). For these reasons, it is expected the impacts of these actions on wildlife species would be long term and adverse, but not particularly noticeable. Other methods of monitoring deer (e.g., wildlife cameras) would not have any measurable effects.

Overall, impacts of alternative A on other wildlife would vary considerably depending on the species, ranging from long-term and minimal to long-term and potentially substantial, as described in the analysis above. Species that depend on ground cover and young tree seedlings or understory shrubs for food or cover could be severely reduced or eliminated from the parks as a result of the decrease in ground cover vegetation; whereas, there would be minimal impacts on species that depend primarily on other habitats (not woodlands) or on the upper canopy for food and cover.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

The large, fenced exclosures would be constructed to allow forest regeneration within localized areas of the parks. The size of the openings in the fence (3 to 4 inches square) would allow small birds and mammals (e.g., songbirds, squirrels, raccoons) to pass in and out of these exclosures; other small to medium animals would be expected to be able to climb over (e.g., raccoon, opossum) or burrow under (e.g., fox, groundhog) the fencing. The added fence posts and fence also would provide perches for some birds, including hawks and owls. The fence could be an obstacle to others (e.g., birds hitting the fence). This action would make more ground/shrub layer habitat available to other wildlife than alternative A. However, because only a small portion of the parks (5%–7%) would be fenced off from browsing deer at any one time and because deer density outside the protected areas would be expected to remain high for many years (see following discussion), the beneficial impact on other wildlife and ground-dwelling special status wildlife species noted above in the no action alternative would be limited.

Reproductive controls could help reduce the impact on other wildlife by reducing the effects of deer browsing on wildlife habitat. However, reproductive control would reduce the deer population to a limited extent if it were successfully implemented, but based on modeling efforts (Hobbs, Bowden, and Baker 2000; Merrill, Cooch, and Curtis 2006) and a comparison of field efforts that used lethal (Frost et al. 1997) and nonlethal methods (Rutberg and Naugle 2008b), it would require many years to actually reduce the population. The actual time needed to observe a decrease would depend on a number of factors, such as the type of treatment used, its effectiveness in stopping reproduction, the size of the population at the time of initial treatment, the actual mortality rate, and the percentage of the population treated. Other factors, such as untreated deer moving into the parks and treated deer leaving the parks, also would affect the time required to reduce herd numbers. The benefit of this action would be proportional to the population reduction achieved and a corresponding improvement to understory habitat. Based on these factors, it is expected that reproductive controls could stop population growth, but it would not be possible to achieve the desired deer density goals for the parks during the life of this management plan.

Similar to alternative A, continued high deer density and associated browsing throughout a large portion of the parks would affect the overall forest health by reducing nesting and cover habitat as well as the availability of food for species that depend on ground/shrub layer vegetation for survival. These species, including ground and/or shrub-nesting birds (e.g., ovenbirds), would decline over time, with adverse, long-term, potentially severe impacts. Other species that have a more diverse diet (e.g., raccoons) or that spend more time in other habitat or the upper canopy (e.g., owls and raptors) would be less affected by high or increased deer density. Similar to alternative A, continued high deer density and associated browsing throughout the majority of the parks would reduce the availability of food for special status wildlife species that depend on ground/shrub layer vegetation for survival. This includes ground and/or shrub-nesting or foraging birds (e.g., worm-eating warbler and wood thrush). Conversely, many species that do not breed or otherwise depend on habitat affected by deer browsing or species that are not expected in areas that would be used for deer management actions would be minimally affected. This includes species that are mainly upper canopy nesters or migrant species, such as the common raven, that do not breed or nest in the parks. Species that use deer or their carcasses as a food source, such as coyotes and crows, grassland nesting birds, and small predators, such as foxes and hawks, also could benefit from the high deer densities that result in a more open understory. As a result, overall impacts on wildlife, including special status wildlife species, throughout the parks would be long term, adverse, and could be minimal to potentially substantial, depending on the species.

Human presence associated with the installation of fenced exclosures or the reproductive control techniques could adversely affect wildlife while the actions are being carried out. However, because only small areas of the parks would be affected for a short period, the adverse impact would be short term and unnoticeable. Bait could provide a beneficial food source to other wildlife during the time that reduction activities were conducted; however, the small quantity and short time periods that bait would be available would have a short-term impact on any species. Alternative B includes use of various techniques to

prevent deer from impacting resources in the parks, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. All of these actions would have beneficial impacts on wildlife and serve to reduce deer damage, but in a limited, localized context. Changing crops and using repellents can prevent deer browse, but likely would have an unobservable adverse impact on other wildlife. Wildlife that take advantage of crops for food or cover likely would adapt to the new crop variety and this would not affect any existing native wildlife habitats. Various aversive conditioning techniques (loud noises, scarecrow devices) would be useful in keeping deer away at certain times and in limited areas. These techniques also would be used on a very selective basis and tested for effectiveness. Such aversive conditioning techniques may result in temporary disturbance to other wildlife and special status wildlife species in the area; however, given that these techniques would be used over limited areas they would have short-term, localized, adverse impacts on wildlife populations in the parks.

Overall, alternative B would result in a range of impacts from short-term, localized, minimal, adverse impacts to long-term, potentially substantial, adverse impacts, depending on the species, because it is expected that the deer population would remain at relatively high density levels in the parks throughout the life of the plan and wildlife habitat would continue to be adversely affected by overbrowsing by deer.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

With a reduction in deer density through sharpshooting, a reduced degree of deer browsing throughout the majority of the parks would benefit species that use the same food sources (e.g., acorns), or otherwise depend on ground/shrub layer vegetation for their food and cover. Reduction of deer density would release plant communities from heavy browse pressure and substantially improve the quality and quantity of wildlife habitat throughout the parks, a benefit for overall forest health. As the forest herbaceous and shrub layers return and forests experience successful regeneration, wildlife communities would be provided with more high quality forage and nesting sites for ground and shrub-nesting bird species and increased wildlife cover. This would lead to increased reproductive success and higher survival for many wildlife species. Under alternative C, wildlife would be expected to improve in both diversity and abundance, a long-term, beneficial impact. Other species that have a more diverse diet (e.g., raccoons) or that spend more time in other habitat or the upper canopy (e.g., barred owls and woodpeckers) would be less affected by a reduced deer density, although a long-term benefit on upper canopy species would be gained in the future as the upper canopy is maintained through forest regeneration.

Impacts on special status wildlife species would be similar to impacts for non-listed wildlife species. As a result of a reduction in browsing pressure, the forests within the parks would be expected to regenerate and shrub and groundcover vegetation would propagate, providing cover and protection for species that depend on that habitat (i.e., ground nesting or foraging birds) with long-term, beneficial impacts. Special status wildlife species that depend primarily on other habitats such as wetlands, tree canopies, and tree bark, or cavity nesters would be less affected by a reduced deer density, although a long-term benefit on upper canopy species could occur in the future as forest regeneration maintained the upper canopy. Many special status species that do not depend on habitat affected by deer browsing or those that are not expected in areas used for deer management actions would experience no adverse impacts. Predators that use deer as a food source and grassland nesting birds could be somewhat adversely affected by a lower deer density or denser understory conditions. Other animals that feed on deer carcasses, such as crows and raccoons, also could be adversely affected. However, none of these species solely depend on deer as a food source, so the adverse impacts on these species would be long term and minimal at most. Predators could find a denser understory more difficult for hunting small prey than the current open condition, but better habitat conditions and an increase in the abundance of prey species also could benefit these predators.

Wildlife, other than deer, and special status wildlife species would be temporarily disturbed by the presence of humans placing bait stations, shooting deer, setting traps, and observing deer behavior. Bait

could provide a beneficial food source to other wildlife during the time that reduction activities were conducted; however, the small quantity and short time periods that bait would be available would have an unnoticed impact on any species. The surface disposal of deer waste and/or carcasses would provide a beneficial food source to scavengers like the coyotes, crows, and raccoons; however, under this alternative, it is expected that meat would be donated to the maximum extent possible or would be disposed of through an approved landfill. The small number of carcasses left for natural decomposition would not be substantially different than what occurs through natural mortality (e.g., disease, old age, car collisions). These human disturbances in each instance would result in long-term, adverse impacts that would not cause any measurable change to the habitat or responses by other wildlife species.

Alternative C would include the same techniques to prevent adverse deer impacts (i.e., changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning) as described in alternative B. These techniques would be used only occasionally over limited areas and for short time periods and would have short-term, temporary, adverse impacts on wildlife populations in the parks.

Overall, impacts of alternative C on other wildlife, including special status wildlife species, would be long term and beneficial because the relatively rapid deer herd reduction would allow vegetation used as food and cover for many wildlife species to become more abundant, particularly in areas in or near implementation areas where management has occurred.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

Similar to alternative C, a reduced degree of deer browsing throughout the majority of the parks would benefit species that use the same food sources or otherwise depend on ground/shrub layer vegetation for their food and cover. Reduction of deer density would release plant communities from heavy browse pressure and substantially improve the quality and quantity of wildlife habitat and the forest ecology throughout the parks. As the forest herbaceous and shrub layers return and forests experience successful regeneration, wildlife communities would be provided with more high quality forage and nesting sites for ground and shrub-nesting bird species and increased wildlife cover. This would lead to increased reproductive success and higher survival for many wildlife species. Under alternative D, wildlife would be expected to improve in both diversity and abundance, a long-term, beneficial impact. Other species that have a more diverse diet (e.g., raccoons) or that spend more time in other habitat or the upper canopy (e.g., barred owls and woodpeckers) would be less affected by a reduced deer density, although a long-term benefit to upper canopy species would be gained in the future as forest regeneration maintained the upper canopy.

Impacts on special status wildlife species would be similar to impacts for non-listed wildlife species. As a result of a reduction in browsing pressure, the forests within the parks would be expected to regenerate and shrub and groundcover vegetation would propagate, providing cover and protection for species like ground and shrub-nesting birds that depend on that habitat with long-term, beneficial impacts. Special status wildlife species that depend primarily on other habitats such as wetlands, tree canopies, and tree bark, or cavity nesters would be less affected by a reduced deer density, although a long-term benefit on upper canopy species could occur in the future as forest regeneration maintained the upper canopy. Many special status species that do not depend on habitat affected by deer browsing, or those that are not expected in areas used for deer management actions, would experience no adverse impacts.

Also similar to alternative C, predators that use deer as a food source could be somewhat adversely affected by a lower deer density or denser understory conditions. Other animals that feed on deer carcasses also could be adversely affected. However, none of these species solely depend on deer as a food source, so the adverse impacts on these species would be long term and minimal. Predators could find a denser understory more difficult for hunting small prey than the current open conditions, but better habitat conditions and an increase in the abundance of prey species also could benefit these predators.

Wildlife other than deer and special status wildlife species would be temporarily disturbed by the presence of humans placing bait stations, shooting deer, setting traps, implementing reproductive control techniques, and observing deer behavior, similar to alternative C. Bait could provide a beneficial food source to other wildlife during the time that reduction activities were conducted; however, the small quantity and short time periods that bait would be available would have a unnoticeable impact on any species. Surface disposal of deer waste and/or carcasses would provide a beneficial food source to scavengers; however, under this alternative, it is expected that meat would be donated to the maximum extent possible or would be disposed of through an approved landfill. The small number of carcasses left for natural decomposition would not be substantially different than what occurs today through natural mortality (e.g., disease, old age, car collisions). These human disturbances in each instance would be adverse, temporary, and would not cause any measurable change to the habitat or responses by other wildlife species.

Long-term reduction and controls on deer population growth would allow vegetation used as food and cover by other wildlife to become more abundant. For these reasons, the impact of alternative D on other wildlife would be long term and mostly beneficial, depending on the species, and existing adverse impacts would be reduced to minimal levels. The impacts of each method (sharpshooting, euthanasia, or reproductive control) on other wildlife would be essentially the same, as long as habitat was improved by reducing deer browsing pressure. Potential differences in impacts would relate to the time required for implementation and the resulting deer population size.

Alternative D includes the same techniques to prevent adverse deer impacts as described under alternative B. Similar to alternative B, these techniques would be used over limited areas and would have short-term, temporary, adverse impacts on wildlife populations in the parks.

Overall, impacts of alternative D on other wildlife including special status wildlife species would be long term and beneficial because the relatively rapid deer herd reduction would allow vegetation used as food and cover for many wildlife species to become more abundant, particularly in areas in or near implementation areas where management has occurred.

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, targeted and opportunistic CWD surveillance would not result in any measurable impacts on wildlife.

Alternatives B, C, and D (All Action Alternatives)

Impacts on wildlife from the deer reduction actions under the CWD response plan would be the same as described for alternative C under the analysis of deer management actions, above. Rapidly reducing the deer population would allow the number of tree and shrub seedlings to increase and survive into maturity and allow crops and trees to survive without damage, which would provide habitat for species that depend on the ground/shrub layer for survival and food sources, resulting in a beneficial impact. Predators that use deer as a food source and grassland nesting birds could be somewhat adversely impacted by a lower deer density or denser understory conditions. Other animals that feed on deer carcasses also could be adversely impacted. However, none of these species solely depend on deer as a food source, so the adverse impacts on these species would be long term and minimal at most. The intensity of the impacts from CWD activities may vary, depending on when the CWD actions occur in relationship to deer management actions. If CWD activities were to occur prior to deer management activities, the impacts would be more noticeable, while if they happened after the deer population had already been reduced as part of a deer management plan, less action would be needed for CWD and the impacts from CWD activities would be less intense and less noticeable.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions that could impact wildlife and wildlife habitat in and around the parks include actions with both adverse and beneficial impacts on the resource. Ongoing adverse impacts on wildlife habitat from increasing urban and suburban development outside of the parks have resulted in clearcutting, selective timbering, and removal of vegetation in specific areas, causing long-term, localized, adverse impacts on habitat and indirectly to wildlife. Ongoing park maintenance and operations and changes/increases in visitation would have similar long-term, adverse impacts on wildlife, limited to the areas affected by maintenance and human disturbance. The parks' nonnative plant management efforts and those of neighboring jurisdictions have had and will continue to have benefits on native vegetation by controlling and limiting the spread of invasive nonnative species. Native wildlife would experience a beneficial impact from an increase in native vegetation, especially animals that normally depend on native plants for food and cover. Beneficial impacts have resulted from past and current deer management efforts undertaken by neighboring agencies and landowners using deer depredation permits, which have resulted in reduced deer numbers in and around the park. These efforts have reduced browsing pressure on vegetation, which benefits wildlife associated with the browsed vegetation. Public hunting has helped to reduce the deer population and provides a similar beneficial, cumulative effect, particularly in the more rural areas surrounding the two parks. Clearing associated with the WSSC intake project will reduce forest area immediately adjacent to the park and will have locally measurable, adverse effects on wildlife from increased forest fragmentation.

As described above, impacts from past, present, and reasonably foreseeable future actions include long-term, localized, adverse impacts and long-term, beneficial impacts. These impacts, when combined with the long-term, measurable adverse impacts under alternative A from ongoing pressure on woody and herbaceous vegetation that makes up the wildlife habitat and the limited natural regeneration expected, would result in cumulative impacts that would be long term and adverse. The no action alternative would contribute an appreciable adverse increment to the overall cumulative impact because of the expected continued deer browsing that would adversely affect wildlife food and cover.

Alternative B: Nonlethal Deer Management

The same past, current, and future actions described under the no action alternative also would occur under alternative B, with long-term, localized, adverse impacts and long-term, beneficial impacts. In the absence of any CWD-triggered lethal response, deer management actions under alternative B would contribute a substantial adverse increment to the overall cumulative impacts because the exclosures and reproductive control actions taken would not be expected to result in a population reduction to the desired deer density goal in the parks within the life of this management plan, and would not protect wildlife species that depend on forest vegetation enough to offset the adverse effects of the continued high deer density expected. If CWD were to occur within 5 miles of the parks and a CWD response plan were triggered that substantially reduced the deer population, there would be additional cumulative beneficial impacts on vegetation/wildlife habitat related to the reduced browse impacts, which would reduce long–term, adverse, cumulative impacts.

Alternative C: Lethal Deer Management

The same past, current, and future actions described under the no action alternative also would occur under alternative C, with long-term, localized, adverse impacts as well as long-term, beneficial impacts. In the absence of any CWD-triggered lethal response, deer management actions under alternative C would contribute a substantial beneficial increment to the overall cumulative impacts because deer browsing pressure would be reduced through a rapid reduction of the deer population, allowing a greater proportion of the forest to regenerate within a few years for herbaceous species to 10 years for woody species and improving habitat for many other wildlife. If CWD were to occur within 5 miles of the parks

and a CWD response plan were triggered that substantially reduced the deer population, there would be additional, beneficial, cumulative impacts on vegetation/wildlife habitat related to the reduced browse impacts, which would add to long-term, beneficial, cumulative impacts.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and future actions described under the no action alternative also would occur under alternative D, with long-term, localized, adverse impacts as well as long-term, beneficial impacts. In the absence of any CWD-triggered lethal response, deer management actions under alternative D would contribute a substantial beneficial increment to the overall cumulative impacts because deer browsing pressure would be reduced through a rapid reduction of the deer population, allowing a greater proportion of the forest to regenerate within a few years for herbaceous species to 10 years for woody species and improving habitat for many other wildlife. If CWD were to occur within 5 miles of the parks and a CWD response plan were triggered that substantially reduced the deer population, there would be additional, beneficial, cumulative impacts on vegetation/wildlife habitat related to the reduced browse impacts, which would add to long-term, beneficial cumulative impacts.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, other wildlife would experience adverse impacts that could range from long-term and minimal to potentially severe, depending on the species and its habitat, as described in the analysis above. Special status wildlife species also would experience adverse impacts ranging from long-term and minimal to potentially severe, depending on the species. Non-listed and special status wildlife species that depend on ground cover and young tree seedlings or understory shrubs for food or cover could be severely reduced or eliminated from the parks, with up to substantial, adverse impacts. Impacts on species that depend primarily on other habitats (not woodlands) or on the upper canopy for food and cover would be small enough to be unmeasurable because deer browse generally does not affect their habitat or food sources. CWD surveillance would not result in any measurable impacts on other wildlife species. The overall cumulative impact would be long term and adverse, with the no action alternative contributing an appreciable adverse increment to the cumulative impact on wildlife.

Alternative B: Nonlethal Deer Management

Similar impacts to alternative A would occur under alternative B, with primarily adverse impacts ranging from long-term, localized, and minimal to potentially substantial, depending on the species, as described in the analysis. Reproductive control would result in only a gradual reduction in the deer population, and although the population goal could be met over the longer term, the risk of not meeting the goal would be high. For these reasons, it is expected that the deer population would remain at relatively high density levels in the parks throughout the life of the plan, with continued substantial of deer browse damage. Also, the exclosures would protect only a small portion of the forest in the parks at any one time, requiring 10 years for regrowth above the browse line. Non-listed and special status wildlife species that depend on ground cover and young tree seedlings or understory shrubs for food or cover could be severely reduced or eliminated from the parks, with potential severe adverse impacts, while impacts on species that depend primarily on other habitats (not woodlands) or on the upper canopy for food and cover would be minimal, as described above. CWD response from the CWD management implemented as part of this alternative would involve the lethal removal of relatively large numbers of deer, which would provide long-term, beneficial impacts, because it would reduce browse on wildlife habitat, but the benefits would not outweigh the adverse effects of not substantially reducing the deer herd. Alternative B would contribute appreciable adverse increments to the cumulative impact on wildlife and wildlife habitat.

Alternative C: Lethal Deer Management

Overall impacts on other wildlife under alternative C would be long term and beneficial because the relatively rapid deer herd reduction would allow vegetation used as food and cover for many wildlife species and special status wildlife species to become more abundant. There could be long-term, minimal, adverse effects on some species that prefer open habitat because there would be regrowth of understory, and short-term, unnoticeable, adverse impacts from disturbance and noise during the implementation of the action and use of deer management. However, the impacts of deer management actions under alternative C on other wildlife would be mostly beneficial and long-term, depending on the species. CWD actions would have similar impacts as described under alternative B, and beneficial impacts from the reduction of deer and associated deer browse on vegetation/habitat. As described under "Cumulative Impacts," the overall cumulative impact would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on vegetation.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Alternative D would have essentially the same impacts as alternative C, with long-term, beneficial impacts on non-listed and special status wildlife species as a result of the decrease in the deer herd and associated deer browse impacts on habitat, and limited, adverse impacts from the management actions themselves. CWD actions would have similar impacts as described under alternative B, and beneficial impacts from the reduction of deer and associated deer browse on vegetation/habitat. As described under "Cumulative Impacts," the overall cumulative impact would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on wildlife and wildlife habitats.

IMPACTS ON HISTORIC DISTRICTS AND CULTURAL LANDSCAPES

GUIDING REGULATIONS AND POLICIES

Federal actions that have the potential to affect cultural resources are subject to a variety of laws. The NHPA is the principal legislative authority for managing cultural resources associated with NPS projects. Generally, section 106 of the act requires all federal agencies to consider the effects of their actions on cultural resources listed on or determined eligible for listing in the National Register. Such resources are termed historic properties. Agreement on how to mitigate effects on historic properties is reached through consultation with the State Historic Preservation Officer; the Tribal Historic Preservation Officer, if applicable; and the Advisory Council on Historic Preservation, as necessary. In addition, federal agencies must minimize harm to historic properties that would be adversely affected by a federal undertaking. Section 110 of the act requires federal agencies to establish preservation programs for the identification, evaluation, and nomination of historic properties to the National Register. Other important laws or executive orders designed to protect cultural landscapes include Executive Order 11593, "Protection and Enhancement of the Cultural Environment."

Through legislation, NPS is charged with the protection and management of cultural resources in its custody. This is further implemented through Director's Order 28: Cultural Resource Management (NPS 2002b), NPS *Management Policies 2006* (NPS 2006), and the 2008 servicewide "Programmatic Agreement among the National Park Service, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers for Compliance with section 106 of the NHPA." These documents charge NPS managers with avoiding or minimizing to the greatest degree practicable, adverse impacts on park resources and values.

METHODOLOGY AND ASSUMPTIONS

NPS categorizes cultural resources as archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. As noted under "Issues and Impact Topics" in chapter 1,

only impacts on cultural landscapes and associated historic districts have been retained for detailed analysis in this plan/EA.

The descriptions of effects on cultural resources that are presented in this section are intended to comply with the requirements of both NEPA and section 106 of the NHPA. In accordance with the regulations of the Advisory Council on Historic Preservation on implementing section 106 (36 CFR 800, Protection of Historic Properties), impacts on cultural resources are to be identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that are either listed on or eligible to be listed in the National Register; (3) applying the criteria of an adverse effect on affected cultural resources either listed on or eligible to be listed in the National Register; and (4) considering ways to avoid, minimize, or mitigate adverse effects.

Under the Advisory Council on Historic Preservation's regulations, a determination of either *adverse effect* or *no adverse effect* must also be made for affected cultural resources eligible for listing in the National Register. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any of the characteristic that qualifies the resource for inclusion in the National Register (e.g., diminishing the integrity of the resource location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by the proposal that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5, Assessment of Adverse Effects). A determination of *no adverse effect* means there would either be no effect or that the effect would not diminish in any way the characteristics that qualify the cultural resource for inclusion in the National Register.

CEQ regulations and Director's Order 12 also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact. Any resultant reduction in the intensity of an impact due to mitigation, however, is an estimate of the effectiveness of mitigation under NEPA only. Cultural resources are nonrenewable resources, and adverse effects generally consume, diminish, or destroy the original historic materials or form, resulting in a loss in the integrity of the resource that can never be recovered. Although actions determined to have an adverse effect under section 106 of the NHPA may be mitigated, the effect remains adverse.

In analyzing how alternative approaches for deer management would affect the overall cultural landscape of C&O Canal and Harpers Ferry NHPs and the associated historic districts, primary attention was paid to the program's effect on vegetation as a character-defining feature of the cultural landscape and on views and vistas. Structures, statues, objects, and hardscapes often constitute contributing features of cultural landscapes as well, but they are not inherently subject to alteration by the action of deer. For this reason, the analysis of this topic will be similar in many respects to that for vegetation.

For the assessment of potential impacts on cultural landscapes and their associated historic districts, the principal sources reviewed were National Register nominations as well as the various Cultural Landscape Inventories, Cultural Landscape Reports, and other reports for both parks.

In general, the vegetation issues for deer management that most impact cultural landscape values in the parks are (a) tree cover and (b) the capacity to sustain adequate yields of traditional row crop growth. Appropriate tree cover also is critical to preserve vistas and mask intrusive views of off park development that diminish the feeling and association of the park with its period of significance.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of both parks.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

Open plot sampling data used to calculate forest regeneration information show that C&O Canal and Harpers Ferry NHPs both have less than 20% of their vegetation plots stocked adequately and do not have sufficient forest regeneration. These impacts can be directly attributed to deer browsing and indicate deer

are affecting the integrity of the understory structure. Cultural resource indicators selected for the parks also show the effects of deer browse on crops that are essential components of the cultural landscapes of the parks, as described in the "Vegetation" section, above. Under alternative A, it is expected that the deer population would continue at high densities within the parks, albeit with yearly fluctuations. It is expected that deer would continue to browse on plants to the extent that tree seedling densities would remain low, measurable changes to the abundance and diversity of herbaceous vegetation throughout the area would occur, and crop/tree damage would continue to occur in cultural landscape plantings. Deer populations would be expected to remain at high levels, and it is not expected that any periodic deer population declines would be low enough or last long enough for forest regeneration to occur or vegetation of any kind to fully recover as long as deer densities remained above 20 per square mile. Based on these results and the expected high numbers of deer over the life of the plan, the character-defining feature of the contrasting patterns of farmsteads, hardwood forests, open meadows, row crops, and pastures of the historic districts and cultural landscape would continue to deteriorate.

Monitoring vegetation plots and maintaining fenced areas would result in very limited trampling of vegetation as staff traveled to and around any fenced areas that are not located along trails. However, such impacts would be temporary. These activities typically take only a few days per year and the amount of vegetation affected by these actions would be minimal because they would occur in only a few areas. For these reasons, the impact of these activities would be minimally adverse.

Overall, deer management actions under alternative A would have long-term, adverse impacts (adverse effect) on cultural landscapes because of the substantial deer browsing that would continue to occur at high deer densities and the associated ongoing depredation of plantings and crops by deer in unfenced cultural landscape areas, which could jeopardize the integrity of the cultural landscapes and historic districts.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

The actions and associated impacts from limited protection of restoration plantings and deer and vegetation monitoring described under alternative A would continue under alternative B. Alternative B also would include several techniques to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. However, the main focus of alternative B would be two nonlethal actions: (a) the construction of large-scale deer exclosures (fencing) to promote forest regeneration and (b) nonsurgical reproductive control of does to restrict population growth (when this technology meets certain criteria).

Large fenced exclosures would be constructed in both parks under alternative B to allow forest regeneration to occur within enclosed areas that would not be accessible to deer. As noted in the "Vegetation" section, above, exclosures would provide a long-term, beneficial impact on herbaceous vegetation in about 5%–7% of the park at any one time. These benefits would be limited to the location and time period of exclosure areas, however. The restoration planting protections described under alternative A would continue to be used under alternative B, providing limited benefits. Although this alternative may show some improvement over the results seen under alternative A from the exclosures, it is expected to result in long-term, measurable, adverse impacts, when viewed over the life of the plan.

In addition to their efficacy in promoting tree regeneration, exclosures also must be analyzed from the standpoint of their visual impact on cultural landscapes. Fencing for large exclosures would be about 8 feet high and consist of woven wire with openings that would allow most other wildlife to move freely through the fence. Metal and wood posts would be used as supports. It is expected that the technical details (e.g., type of footer, post type, and spacing) related to fence installation would vary based on factors such as site topography, geologic substrate, access, potential visibility, and presence of archeological resources. The siting at the parks also would require various configurations to fit the landscape, with locations based on several criteria: they must be relatively easy to access, yet away from high use visitor areas or scenic views; they must fit into the parks' topography and current trails systems;

and they must avoid steep slopes and existing vegetation monitoring plots. The exclosures would, nonetheless, introduce new structural elements into the parks' overall landscape that would be inconsistent with the parks' contributing features. To mitigate these potential impacts on the cultural landscape, the exclosures would be located some distance from common visitor use areas so that they would not intrude on these landscapes. However, the exclosures might be visible during the winter and spring from locations within the park where the views contribute features to the cultural landscapes. While the exclosures would be difficult to see because of their materials and construction, their presence and visibility may result in long-term, adverse impacts on particular cultural landscapes due to their detraction from the scenic value of the landscape, depending on their location.

Alternative B also includes the use of a reproductive control agent. Implementing reproductive controls would have short-term (a few hours to a few days in any location), localized, minute, adverse impacts on historic districts and cultural landscapes. The effect of reproductive control on the deer population and thus deer browsing could be beneficial if the target deer density could be achieved within the life of this plan. However, the time required for the population to be reduced to the extent needed to allow for forest regeneration could be many years. Deer numbers would be expected to remain at high levels over the life of the plan; browsing would continue throughout the park, especially in areas with the highest deer density and cause a decline in the long-term abundance and diversity of native plant species, particularly on susceptible landscape plantings and/or crops that are integral to many of the parks' cultural landscapes. As a result, there would be long-term, substantial, adverse impacts on the parks' cultural landscapes (depending on the landscape and the plants importance to the landscape) over the life of the plan.

Alternative B includes use of various techniques to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. All of these actions would provide beneficial impacts and serve to reduce deer damage but in a limited, localized context. Changing crops could prevent deer browse, but the substitute crop may not be one that is correct in the cultural context of the landscapes, which would cause adverse effects on cultural resource values. The ability to grow a crop would need to be balanced against the effect of the change in crop. Planting crops close together at the edge of fields to resist deer entry into the field is not a proven method, but could be initiated on a trial basis. Various aversive conditioning techniques (loud noises, scarecrow devices) would be useful in keeping deer away at certain times and in limited areas, but could detract from the cultural values of the parks and interfere with visitor experience. These also would be used on a very selective basis for brief periods, and monitored for effectiveness. Overall, these techniques would provide limited benefits that would not substantially reduce the overall measurable adverse impacts expected under alternative B if the deer densities remain high.

Overall, under alternative B, there would be long-term, measurable, adverse impacts (adverse effects) on historic districts and cultural landscapes because in the majority of the area in these parks, agricultural crops and other vegetation would continue to be adversely affected by deer browsing until reproductive controls became effective and the population decreased, and fencing would not protect all vegetation, and there would be a limit on how much of the parks could be fenced without adverse visual effects on the cultural landscapes.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Under this alternative, it is estimated that the desired deer density goal could be reached at C&O Canal NHP at Gold Mine tract at Great Falls in two years and at Harpers Ferry NHP on Maryland Heights in five years based on deer density reports for the parks and the experience with lethal removal at other NPS parks such as Valley Forge. It is expected that rapidly reducing the deer population and associated browsing pressure would allow the number of tree and shrub seedlings to increase and survive to saplings and into maturity in all areas of the parks, providing the necessary growth for natural forest regeneration, and would result in long-term, beneficial impacts on vegetation that is an important element of the parks'

cultural landscapes. It is expected that crop damage would decrease to a level similar to that found outside C&O Canal NHP, and damage to tree plantings would similarly decrease.

Providing rapid deer reduction and control would therefore result in long-term, beneficial impacts on cultural landscapes and historic districts because deer browsing would be substantially reduced, which in turn would result in less browse damage to crops and trees planted in the park.

A number of other actions would occur as part of sharpshooting, as described in more detail in chapter 2, which would affect vegetation in limited areas. These actions include setting up bait stations, occupying shooting areas, and transporting deer to locations for processing and disposal. Sharpshooting could take place from elevated positions, which would require portable tree stands to be temporarily hung in trees. Tree stands could have visual impacts on cultural landscapes and historic districts, but any impacts would be short-term and minimal.

If needed, a few deer may be removed using capture and euthanasia due to safety concerns. While this activity would be used extremely rarely as a last resort and only in cases where sharpshooting is not feasible, if used it could take place within historic districts and cultural landscapes. Any traps would be unobtrusive on the landscape and would be temporary, but could result in trampling of vegetation. This action would have a short-term, limited impact on cultural landscapes and historic districts in the parks because of the potential for trampling of vegetative features in the parks' cultural landscapes and historic districts.

Alternative C also includes the use of the techniques described in alternative B to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. Impacts would be expected to be similar—beneficial, but in a limited, localized context.

Overall, under alternative C there would be long-term, beneficial effects on cultural landscapes and historic districts because of decreased browsing and associated decreased deer depredation of agricultural crops, with increased chances of viability for the parks' crops and maintenance of the parks' cultural landscapes, particularly for those cultural landscapes in or adjacent to active implementation areas.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

It is expected that reducing deer browsing pressure by a combination of sharpshooting initially, plus reproductive control for maintenance if feasible, would result in a measurable increase in the number of tree and shrub seedlings and an increase in the number of seedlings surviving to sapling stage, providing the necessary growth for natural forest regeneration. Herbaceous vegetation also would be able to recover, with many species expected to recover within a few years. Providing immediate reduction and control of the deer population would result in long-term, beneficial impacts on cultural landscapes because deer browsing would be substantially reduced and the abundance and diversity of vegetation throughout the park could recover. Assuming reproductive controls or sharpshooting could be used to maintain the deer population size, impacts on vegetation that is an important element of the parks' cultural landscapes and historic districts would be long term and beneficial because a substantial reduction in deer browsing would allow the abundance and diversity of vegetation throughout the park to recover.

As described under alternative C, it is not expected that capture and euthanasia would be required except when needed for safety reasons. Impacts would be as described under alternative C, with temporary traps that would be unobtrusive on the landscape but could result in some trampling of vegetation. This action would have a short-term, limited impact on cultural landscapes and historic districts in the parks because of the potential for trampling of vegetative features in the parks' cultural landscapes and historic districts. Also, as described under alternative C, a number of other actions would occur as part of the implementation of sharpshooting, such as setting up bait stations, occupying shooting areas, and transporting deer carcasses to locations for processing and transport, with short-term, minimal impacts on

cultural landscapes and historic districts given the small size of the affected area and the short duration of the impact.

Alternative D also includes the use of the techniques described in alternative B to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. Impacts would be the same as those described under alternative B; impacts would be beneficial and serve to reduce deer damage, but in a limited, localized context.

Overall, under alternative D there would be long-term, beneficial effects on cultural landscapes and historic districts because of decreased browsing and thus decreased deer depredations of agricultural crops, similar to alternative C. This would increase chances of viability for C&O Canal's agricultural areas and maintain the open and closed patterns of the rural cultural landscape.

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, CWD surveillance would not result in any measurable impacts on historic districts and cultural landscapes.

Alternatives B, C, and D (All Action Alternatives)

Impacts on historic districts and cultural landscapes from the deer reduction actions under the CWD response plan would be the same as those described for alternative C under the analysis of deer management actions, above. Decreased browsing and thus decreased deer depredation of agricultural crops would lead to increased chances of viability for the parks' agricultural areas and maintain the open and closed patterns of the cultural landscape, both of which would be a long-term, beneficial impact. Reduced browsing also would provide for regeneration of forest species, which is an important elements of the parks' cultural landscapes. The intensity of the impacts from CWD activities may vary depending on when the CWD actions occur in relationship to deer management actions and where the CWD actions occur. If CWD activities were to occur prior to deer management activities, the impacts would be more noticeable, while if they happened after the deer population had already been reduced as part of a deer management plan, less action would be needed for CWD and the impacts from CWD activities would be less intense and less noticeable.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions that could impact historic districts and cultural landscapes in and around the parks include actions with both adverse and beneficial impacts on historic districts and cultural landscapes. Long-term, localized, adverse impacts on historic districts and cultural landscapes have occurred and will continue to occur from increasing urban and suburban development, including transportation projects and utility lines in the areas surrounding the parks. These projects have resulted in removal of vegetation in specific areas and the addition of new buildings, structures, and circulation features that are not in keeping with the historic character of these resources, causing adverse impacts. Construction of facilities, roads, and trails in the parks have resulted in removal of vegetation in the cultural landscape in limited areas. However, maintenance of character-defining structures and restoration of landscape patterns have had long-term benefits. Future actions include the WSSC intake project, which will replace the water intake at the Potomac Water Filtration Plant directly adjacent to the C&O Canal. This project will have both temporary and long-term, adverse impacts to the C&O Canal from installation of the new intake that will require tree clearing, construction of temporary roads and permanent driveways, and a parking lot, as well as the construction of embankments. Short-term impacts will be caused by temporary roads and presence of construction equipment within the historic setting of the canal. The new, permanent construction and tree removal will have a long-term, adverse impact by altering vegetation and adding new roads and structures to the historic resource.

As described above, impacts from past, present, and reasonably foreseeable future actions include short- and long-term, adverse impacts and long-term benefits. These impacts, when combined with the long-term impacts of deer management under alternative A from deer browsing, would result in overall long-term, adverse, cumulative impacts on historic districts and cultural landscapes. Alternative A would contribute appreciable adverse increments to cumulative impacts on cultural landscapes and historic districts because of the continued deer browsing that would affect vegetation of the cultural landscapes of the parks.

Alternative B: Nonlethal Deer Management

The same past, current, and future actions described under alternative A also would occur under alternative B, including the short- and long-term, adverse impacts of the WSSC intake project in Montgomery County, adverse impacts of surrounding development, and adverse and beneficial impacts of park operations and maintenance. In the absence of any CWD-triggered lethal response, the mostly long-term, adverse impacts of alternative B would contribute an appreciable adverse increment to the overall cumulative impact because of the lack of immediate reduction in the deer herd and the associated browsing impacts on vegetation and crops that contribute to the historic districts and cultural landscapes of the parks. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional, localized, beneficial, cumulative impacts on historic districts and cultural landscapes associated with reduced browse impacts, which would reduce long-term, adverse, cumulative impacts.

Alternative C: Lethal Deer Management Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and future actions described under alternative A also would occur under alternative C, including the short- and long-term, adverse impacts of the WSSC intake project in Montgomery County, adverse impacts of surrounding development, and adverse and beneficial impacts of park operations and maintenance. In the absence of any CWD-triggered lethal response, deer management actions under alternative C would contribute an appreciable beneficial increment to the overall adverse, cumulative impact because of the relatively rapid reduction in deer and associated reduction in damage to vegetation contributing to the parks' historic districts and cultural landscapes. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be localized, additional beneficial, cumulative impacts. The intensity of the impacts from CWD activities may vary depending on when the CWD actions occur in relationship to deer management actions and where the CWD actions occur. If CWD activities were to occur prior to deer management activities, the impacts would be more noticeable, while if they happened after the deer population had already been reduced as part of a deer management plan, less action would be needed for CWD and the impacts from CWD activities would be less intense and less noticeable.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and future actions described under alternative A also would occur under alternative C, including the short- and long-term, adverse impacts of the WSSC intake project in Montgomery County, adverse impacts of surrounding development, and adverse and beneficial impacts of park operations and maintenance. In the absence of any CWD-triggered lethal response, deer management actions under alternative D would contribute an appreciable beneficial increment to the overall, adverse, cumulative impact because of the relatively rapid reduction in deer and associated reduction in damage to vegetation contributing to the parks' historic districts and cultural landscapes. However, if CWD were to occur within 5 miles of the parks and a CWD lethal removal response were triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional, localized, beneficial, cumulative impacts.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Alternative A would result in long-term, measurable, adverse impacts because browsing pressure would be expected to remain high in either all or a large portion of the parks throughout the life of this plan (15 years) because of the lack of deer management action, and this would damage vegetation that contribute to the historic districts and cultural landscapes of the park. As described under "Cumulative Impacts," the overall cumulative impact would be long term and adverse, with alternative A contributing appreciable adverse increments to the cumulative impact on vegetation.

Alternative B: Nonlethal Deer Management

Alternative B would have impacts similar to those described for alternative A because reproductive control would result in only a gradual reduction in the deer population, and although the population goal could be met over the longer term, the risk of not meeting the goal would be high. Therefore, it is expected that the deer population would remain at relatively high density levels in the parks throughout the life of the plan, which would damage vegetation such forests and crops that contribute to the historic districts and cultural landscapes of the parks. The exclosures would protect only a small portion of the woody vegetation in the parks at any one time, requiring 10 years for regrowth above the browse line, and no protection for herbaceous species once the exclosures are removed. Alternative B would result in long-term, measurable, adverse impacts because of the limited effectiveness of reproductive control and the exclosures in protecting forest vegetation from deer browse impacts. There also would be short-term impacts from deer management implementation actions such as placement of bait piles because of trampling, and limited beneficial impacts from use of the techniques available to reduce deer access to crops and fields and thereby reduce deer impacts from browse in these areas. Any CWD response that would be taken under the proposed long-term plan would provide indirect, beneficial impacts from reduced deer density and reduced browse on park vegetation, but these would not outweigh the adverse effects of not taking deer management actions. Similar to alternative A, the overall cumulative impact would be long term and adverse, with alternative B contributing appreciable adverse increments to the cumulative impact on historic districts and cultural landscapes.

Alternative C: Lethal Deer Management

The overall impact on vegetation under alternative C would be long term and beneficial because the relatively rapid deer herd reduction would allow the abundance and diversity of vegetation important to the parks' historic districts and cultural landscapes throughout the parks to recover. There would be short-term impacts (mainly from trampling) from deer management implementation action, and benefits from the limited use of deer management techniques to reduce impacts in certain locations or circumstances, as described for alternative B. CWD actions would have similar impacts, with short-term impacts (mainly from trampling) from surveillance and benefits from the reduction of deer and deer browse on vegetation. The overall cumulative impact would be long term and beneficial, and alternative C would contribute appreciable beneficial increments to the cumulative impact on historic districts and cultural landscapes.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Alternative D would have essentially the same impacts as alternative C, with long-term, beneficial effects as a result of the decrease in the deer herd and reduced browse impacts on park vegetation, limited adverse impacts from the management actions themselves, and limited benefits from the use of the techniques described for all alternatives. CWD actions would have similar impacts, with short-term impacts (mainly from trampling) from surveillance and benefits from the reduction of deer and deer browse on vegetation. The overall cumulative impact would be long term and beneficial, and alternative D would contribute appreciable beneficial increments to the cumulative impact on historic districts and cultural landscapes.

IMPACTS ON VISITOR USE AND EXPERIENCE

GUIDING REGULATIONS

The NPS *Management Policies 2006* (NPS 2006) state that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. Management goals include making available to the public traditional outdoor recreational opportunities that are not detrimental to the natural or cultural resources of the parks.

While preservation and conservation are key components of the NPS *Management Policies*, they also instruct park units to provide for recreational opportunities. NPS achieves its preservation and conservation purposes by working to maintain all native plants and animals as parts of the natural ecosystem, emphasizing preservation and conservation over recreation. NPS achieves this by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur (NPS 2006).

METHODOLOGY AND ASSUMPTIONS

Past visitor use data were used to estimate the potential effects of the alternative actions on visitors. Based on these data, the impact of each alternative on the ability of visitors to experience a full range of the parks' resources was analyzed.

STUDY AREA

The area of analysis, including the cumulative impacts analysis, includes all lands within the boundaries of the two parks.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

Under the no action alternative, the diversity and abundance of many species would be expected to diminish or remain low as the deer population remains high and overbrowsing of native plants continues. A distinctive browse line would be evident in areas with excessive numbers of deer, and, in addition, overbrowsing by deer gives nonnative plant species an opportunity to become established, which may deter native species propagation. Visitors who value native scenery or viewing the parks' cultural landscapes would be most affected, and adverse impacts on visitor experience from heavily browsed vegetation would be long term and localized. Visitors who value nature viewing also would be affected by the impacts of deer browse on wildlife, including deer themselves.

Under this alternative, it is expected that the deer population in the parks would remain at relatively high levels, adversely impacting native plants and, as a result, wildlife and wildlife habitat through overbrowsing. Overbrowsing could adversely impact habitat that supports the parks' bird species, particularly birds that use the ground or low shrub layer for nesting and feeding. Therefore, park visitors who value native plants and wildlife, as well as individual researchers or students from local universities or conservation groups who use the parks to teach students about vegetation and ecology, could experience long-term, adverse impacts as the diversity and abundance of native vegetation and wildlife habitat in the parks remains low or decreases as a result of deer browsing. Although it is not known what percent of visitors place a high importance specifically on seeing deer, any visitors who do so would have a higher chance of viewing deer under this alternative than under other alternatives, which would be a long-term benefit. However, an increase in deer numbers also could adversely affect the condition of the herds, and if the deer populations drastically declined as a result of disease or malnutrition, visitor experience could be adversely affected until the herd recovered. This would result in a long-term, adverse impact.

Tree tubes and small protective caging used to protect plants could occur in view of trails and/or roadways. These measures would indirectly adversely affect visitor experience as a result of their visibility. However, these actions also serve to protect rare plants and vegetation that visitors would not otherwise see due to excessive deer browsing, and they would have minimal impacts on visitor experience.

Monitoring efforts described under this alternative, such as deer population surveys and vegetation monitoring, would have little to no impact on visitors since surveys would be conducted at night when the parks are closed, and most visitors likely would interpret vegetation monitoring as consistent with scientific efforts expected at a unit of the national park system.

Overall, given the differences in desired visitor experience, impacts on visitor use and experience under alternative A would be both beneficial and adverse on those visitors who may be primarily interested in viewing deer (beneficial in that there would be more deer to see, adverse in that the appearance of the herd could be poor if the herd experiences density-dependent health issues). However, overall impacts related to a decreased ability to view scenery (including native vegetation and the historic landscape) and other wildlife would be long term and adverse.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

It is likely that some of the exclosures proposed under alternative B would be near trails and therefore would be visible to visitors. The use of large exclosures would adversely impact visitors that use the areas in or near the locations selected because these fenced areas would be obvious and would be closed to visitation. Visitors also would be affected by fence construction activities, which would result in temporary visual and noise intrusions, such as the presence of work crews and employees in certain areas of the parks. Visitors hiking, camping, or walking through the parks to view wildlife and scenery in low-use visitor areas would be most affected. Visitors also may be adversely affected by intrusions on the historic landscape and would experience a hampered ability to interpret the landscape. Those who primarily experience more developed areas of the parks might not be as affected by the sight of the exclosures, which would probably not be detectable from these areas. The parks plan to implement deer management educational and interpretive efforts under all alternatives, and visitors would be made aware of the reasons for the exclosures and their benefit to forest regeneration, which would beneficially impact visitors with the knowledge that the natural environment would eventually improve. Such information could offset adverse impacts related to visual aesthetics caused by the exclosures. There would be adverse impacts on visitor use and experience during the life of this plan, but benefits would be realized in the longer term as the forest regenerates as a result of the protection afforded by the exclosures.

The use of reproductive controls on does would be based on available technology. Deer would be treated with reproductive controls using traps to capture them prior to administering the injections by hand and marking them. These activities would occur primarily between October and March. Although these activities would occur during less busy visitation periods and would avoid highly used visitor areas to the extent possible, it is possible that some visitors would encounter ongoing treatment activities or that visitor access would be restricted around areas where bait piles were placed to attract deer for treatment. There could be some noise associated with the administration of the injections, but it would localized and would not be particularly noticeable—mostly voices of staff or agents as they work. To ensure that visitors would understand the nature of the treatment efforts, the parks would conduct educational programs to inform visitors about the procedures and explain why the treatments are necessary. However, visitors may see various aspects of the reproductive control operations, which could result in short-term, adverse impacts on their visitor experience.

With reproductive control, deer would be marked with ear tags or some equivalent marking to avoid multiple treatments of the same does in the same year or to facilitate tracking for future application in subsequent years. Visitors could be troubled by the sight of deer with artificial markings, particularly

those who primarily come to the parks to see deer. As discussed above, educational material would alert visitors to deer management activities and explain their purpose and expected outcomes.

Alternative B would include the use of various techniques to prevent adverse deer impacts, including changing crop configurations or selection at C&O Canal NHP, using repellents, and using aversive conditioning. All of these actions would provide long-term, beneficial impacts on visitor experience and serve to reduce deer damage, but in a limited, localized context. Fencing of crops would serve to protect smaller areas that are considered valuable, but there would be a limit on how much of the parks could be fenced without adverse visual effects on the cultural landscapes and adverse impacts on visitor access and use. Changing crops could prevent deer browse, but the substitute crop may not be one that is correct in the cultural context of the parks, which would cause adverse effects on visitor experience. Various aversive conditioning techniques (loud noises, scarecrow devices) would be useful in keeping deer away at certain times and in limited areas, but could interfere with visitor experience. These also would need to be used on a very selective basis and tested for effectiveness. Overall, these techniques would provide limited, long-term benefits and short-term, adverse impacts on visitor experience.

Given the differences in desired visitor experience, impacts on visitor use and experience under alternative B would be both beneficial and adverse to those visitors desiring to see deer, similar to alternative A, since deer would still be present in relatively high numbers for a long time. Overall adverse impacts on visitor use and experience would gradually become beneficial in the long term, beyond the life of this plan, because vegetation would be expected to recover over time and deer would continue to be present.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Visitors would be affected adversely primarily by area closures required to conduct the direct reduction activities. The parks would conduct sharpshooting activities when visitation is low (during winter months) and primarily at night and outside developed areas. The public would be notified of any park closures in advance, information regarding deer management would be displayed at visitor contact facilities, and information would be posted on the parks' websites to inform the public of deer management actions. Visitor access would be limited as necessary while reductions take place, and NPS personnel would patrol public areas to ensure compliance with park closures and public safety measures. Noise suppressors could be used to decrease impacts on the soundscape, and visitors only would be affected by noise if sharpshooting occurred during the day and in areas not restricted or closed to visitor use. Adverse impacts on visitors related to closures or noise from high-power, small caliber rifles with noise suppressors would be minimized by timing sharpshooting activities to take place during times of low park visitation. Adverse impacts would be both short- and long-term, as limited sharpshooting activities could continue beyond the initial reduction period to maintain the target population in the future.

If capture and euthanasia becomes necessary, deer would be captured as humanely as possible using methods such as nets or box traps, which visitors might see if hiking or walking near trapping locations. However, capture and euthanasia would occur at dawn or dusk when visitation is low. Because this method would be used only in limited circumstances, the likelihood of visitors being exposed to deer being captured and euthanized would be low. Adverse impacts from this action on visitor use would be unexpected over the life of this plan.

It is the parks' intention to donate as much of the meat as possible to local charitable organizations. If this is done, the animals would be field dressed in the parks. The entrails (internal parts) would be buried if there were an appropriate location; otherwise, entrails would be placed in barrels for disposal at a processing or other appropriate facility. If the location were particularly remote, entrails could be left on the surface to decay or be scavenged. In these circumstances, every effort would be made to reduce the visibility of carcasses to visitors or park neighbors, limiting adverse impacts to unnoticeable levels.

The parks plan to implement deer management educational and interpretive efforts under all alternatives, and visitors would be made aware of the reasons for the direct reduction activities and their benefit to forest regeneration.

Alternative C would have long-term, beneficial impacts for most visitors because the forests would regenerate relatively quickly in parts of the park in and near active implementation areas, creating increased ability to view a healthier understory and herbaceous plant such as spring wildflowers, and providing improved habitat for a variety of species. Forest regeneration would help ensure that visitors would be able to experience the parks as examples of the natural regeneration of disturbed lands and to experience nature's ability to regenerate. Beneficial impacts and forest regeneration would be realized relatively rapidly in areas most affected by deer browsing, as direct reduction would have an immediate impact on the size of the deer herd. Regeneration would begin to occur after the desired deer density was achieved, and the forest would be expected to meet regeneration goals approximately 10 years after the desired deer density is met. Maintaining a viable herd size would help ensure a more balanced ecosystem into the future.

With the reduction in deer, the opportunity to see deer would decrease, and visitors who are interested primarily in seeing deer would be adversely affected. However, the herd sizes would not be reduced to the extent that deer would become rare in the parks; rather, they would still be visible, but their presence would be more in balance with other elements of the ecosystem. Visitors who value seeing deer might also prefer seeing fewer deer if it means maintaining a viable herd, which could reduce the intensity of the adverse impact on these visitors. Visitors who value general wildlife viewing could experience beneficial impacts under this alternative as wildlife that had been affected by overbrowsing would occur as a result of the regenerated forest.

Some visitors may be opposed to lethal management of deer in the park and may experience adverse impacts from the implementation of this alternative. A study that analyzed the beliefs and attitudes towards lethal reduction of deer at Cuyahoga Valley National Park (Fulton et al. 2004) indicates that a minority of residents (15%–20%) surrounding that park can be expected to continue to find lethal control unacceptable as a management strategy for addressing abundant deer populations, despite the reasons for implementation of this strategy. Additionally, a lethal management program for deer in the parks is likely to have negative emotional impacts on a majority of those who feel lethal deer control is unacceptable and may discourage a portion of those individuals from visiting the park or participating in staff-led activities. If a lethal deer management alternative is implemented, educational and interpretive information would be provided to the public that addresses these issues in a respectful and honest fashion, but it is recognized that some visitors would have a negative reaction to this alternative.

Overall, given the differences in desired visitor experience, impacts on visitor use and experience under alternative C would be varied, with some visitors experiencing short- and long-term, adverse impacts as a result of the lethal aspects of removal and temporary park closures, but with long-term, beneficial impacts on many other visitors who value viewing a variety of wildlife, plants and the cultural landscape as the forests recover.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

Adverse impacts related to sharpshooting activities would be long term, but similar to alternative C, they would be minimized because they would occur primarily during fall and winter and at night. Beneficial impacts would result from a relatively rapid reduction in deer herd size, which would result in enhanced forest regeneration. Disposal of deer carcasses and waste would occur as described under alternative C. Visitors would be adversely affected to a limited extent by the continued use of small fenced areas and repellents. Reproductive control could be applied after initial reduction of the deer population through sharpshooting efforts. Therefore, reproductive control, if selected for use, would augment direct reduction to reduce deer browsing pressure and allow forest regeneration, increasing the quality of the parks'

scenery and the diversity of plants and animals. Resulting impacts on visitors would be long term and beneficial. Adverse impacts could occur from visitors being exposed to reproductive control activities and associated area closures, including seeing deer that have been tagged, and impacts could occur to that subset of visitors who are opposed to lethal removal. Educational and interpretive activities would help explain why deer management is needed.

Similar to the other action alternatives, visitors interested primarily in seeing deer could be adversely affected by the long-term reduction in the deer population. However, adverse impacts on these visitors would be very limited for the reasons mentioned under alternatives B and C.

Overall, similar to alternative C, impacts on the visitor use and experience under alternative D would vary, with some visitors experiencing adverse impacts, but with long-term, beneficial impacts on many other visitors as the forests recover.

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, opportunistic and targeted surveillance would have essentially no impacts on visitors because there would be a low likelihood of encountering these actions.

Alternatives B, C, and D (All Action Alternatives)

Impacts on visitor use and experience from the deer reduction actions under the CWD response plan would be the same as described for direct reduction activities under the analysis of alternative C. There would be short-term, adverse effects on visitation related to the implementation of the actions themselves, related to noise and area closures. The reduction in deer density would be expected have similar impacts to those described for alternatives C and D, with adverse impacts for some visitors as well as long-term, beneficial impacts.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions include actions with both adverse and beneficial impacts on visitor use and experience. Ongoing park maintenance, operations, and development activities would have long-term, beneficial impacts on visitor use and experience because they would maintain and improve visitor amenities, access, and interpretive opportunities over time. Past and current deer management efforts undertaken by neighboring agencies and landowners and hunting contribute beneficial, cumulative impacts because the associated deer population reduction helps somewhat in curtailing damage to native landscapes from deer overbrowsing. The replacement of the water intake at the Potomac Water Filtration Plant will have localized, adverse impacts on visitor use and experience at C&O Canal NHP in the short term resulting from noise, traffic, and visual impacts during construction activities so close to the park. In the long term, it will contribute no impacts to visitor use and experience.

As described above, impacts from past, present, and reasonably foreseeable future actions include primarily long-term, beneficial impacts. These impacts, when combined with the long-term, adverse and beneficial impacts to visitor use and experience under alternative A, would result in long-term, minimal, adverse, cumulative impacts on visitor use and experience. Alternative A would contribute both noticeable adverse and noticeable beneficial increments to cumulative impacts on visitor use and experience.

Alternative B: Nonlethal Deer Management

The same past, current, and future actions described under alternative A also would occur under alternative B. These would include long-term, beneficial cumulative impacts from ongoing park maintenance, operations, and development activities; beneficial impacts from actions taken by

neighboring jurisdictions and landowners and hunters to reduce deer numbers; and short-term, localized, adverse impacts from replacement of the water intake at the Potomac Water Filtration Plant.

As discussed above, alternative B would contribute short-term, adverse impacts resulting from a number of factors, but would have limited, long-term, beneficial impacts from forest regeneration and vegetation recovery efforts. In the absence of any CWD-triggered lethal response, deer management actions under alternative B would add an appreciable adverse increment to the overall cumulative impact because of the lack of immediate reduction in the deer herd and the associated browsing impacts on vegetation. If CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered, short-term, adverse and long-term, beneficial impacts would result.

Alternative C: Lethal Deer Management Alternative

The same past, current, and future actions and their associated impacts described under alternative A also would occur under alternative C. As described above, alternative C would have short-term, adverse impacts on visitor use and experience, but also long-term, beneficial impacts associated with the restored forest. In the absence of any CWD-triggered lethal response, deer management actions under alternative C would add appreciable beneficial impacts as a result of forest regeneration due to the restoration of natural resources. If CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered that substantially reduced the deer population, there would be additional adverse, cumulative and long-term, beneficial impacts on visitor use and experience.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and future actions and their associated impacts described under alternative A, also would occur under alternative D. As described above, alternative D would have short-term, adverse impacts on visitor use and experience but also long-term, beneficial impacts associated with a restored forest. In the absence of any CWD-triggered lethal response, deer management actions under alternative D would add appreciable beneficial impacts as a result of forest regeneration due to the restoration of natural resources. If CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered that substantially reduced the deer population, there would be additional adverse, cumulative and long-term, beneficial impacts on visitor use and experience.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Given the differences in desired visitor experience, impacts on visitor use and experience under alternative A would be both beneficial and adverse to those visitors who may be primarily interested in viewing deer (beneficial in that there would be more deer to see, adverse in that the appearance of the herd could be poor if the herd experiences density-dependent health issues). However, overall impacts related to a decreased ability to view scenery (including native vegetation and the historic landscape) and other wildlife would be long term and adverse. Implementation of ongoing park maintenance, operations, and development activities would result in long-term, beneficial impacts on visitor use and experience by improving visitor amenities, access, and interpretive opportunities over time. As described under "Cumulative Impacts" above, the overall cumulative impact would be long term and adverse, with alternative A contributing both beneficial and adverse increments to cumulative impacts on visitor use and experience.

Alternative B: Nonlethal Deer Management

Given the differences in desired visitor experience, impacts on visitor use and experience under alternative B would be both beneficial and adverse to those visitors desiring to see deer, similar to alternative A, because deer would still be present in relatively high numbers for a long time. Overall adverse impacts on visitor use and experience would gradually become beneficial in the long term, beyond the life of this plan, because vegetation would be expected to recover over time and deer would

continue to be present. Any CWD response that would be taken under the long-term response plan would provide indirect, beneficial impacts related to the appearance of vegetation in the parks but also would have adverse effects on visitor use and experience; these would not outweigh the adverse effects of not taking deer management actions in the long term. As described under "Cumulative Impacts" above, the overall cumulative impact would be long term and beneficial, with alternative B contributing beneficial increments to cumulative impacts on visitor use and experience.

Alternative C: Lethal Deer Management

Overall, given the differences in desired visitor experience, impacts on visitor use and experience under alternative C would be varied, with some visitors experiencing short- and long-term, adverse impacts because of the lethal aspects of removal and temporary park closures, but with long-term, beneficial impacts on many other visitors who value viewing a variety of wildlife, plants, and the cultural landscape as the forests recover. Any CWD response that would be taken under the long-term response plan would result in similar impacts, with beneficial impacts related to the appearance of vegetation in the parks but with adverse effects on visitor use and experience during implementation. As described under "Cumulative Impacts" above, the overall cumulative impact would be long term and beneficial, with alternative C contributing beneficial increments to cumulative impacts on visitor use and experience.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Similar to alternative C, impacts on the visitor use and experience under alternative D would vary, with some visitors experiencing adverse impacts, but with long-term, beneficial impacts on many other visitors as the forest recovers. Any CWD response that would be taken under the long-term response plan would result in similar impacts, with beneficial impacts related to the appearance of vegetation in the parks but with adverse effects on visitor use and experience during implementation. As described under "Cumulative Impacts" above, the overall cumulative impact would be long term and beneficial, with alternative D contributing beneficial increments to cumulative impacts on visitor use and experience.

IMPACTS ON HUMAN HEALTH AND SAFETY

GUIDING REGULATIONS AND POLICIES

The NPS *Management Policies 2006* state that, "while recognizing that there are limitations on its capability to totally eliminate all hazards, the Service …will seek to provide a safe and healthful environment for visitors and employees." The policies also state that "the Service will reduce or remove known hazards and apply other appropriate measures, including closures, guarding, signing, or other forms of education" (NPS 2006, section 8.2.5.1).

METHODOLOGY AND ASSUMPTIONS

The health and safety of both park visitors and NPS employees at the parks could be affected by implementation of the proposed deer management actions. Impacts on human health and safety would be related to the probability of being involved in a deer-vehicle collision or encountering a deer tick resulting in contracting Lyme disease under all alternatives, the use of firearms under alternatives C or D, and the potential for accidents that could result from implementation of the actions proposed under each alternative.

The purpose of this impact analysis is to identify the level of impact that implementing each of the proposed alternatives would have on the health and safety of visitors and employees at the parks. Past accident data from each park, along with statistics on deer-vehicle collisions and information on incidences of Lyme disease in the counties surrounding the parks were used to assess the potential impacts of the alternative actions on the health and safety of visitors and employees.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of both parks. The area of analysis for cumulative impacts includes the parks and the area within 2.5 miles of the parks' boundaries, which encompasses typical deer movement outside the park boundaries.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

Under alternative A, employees at the parks would continue to receive training on how to perform their jobs properly and safely, and this would extend to any work associated with deer management activities. Signage would continue to be posted reminding visitors that harassing and/or feeding wildlife is illegal within National Parks, in order to minimize visitor encounters with deer and other wildlife. Active efforts to inform and educate visitors regarding the signs and symptoms of Lyme disease would continue. During the autumn breeding season, park management would continue to remind visitors and employees to take extra care while driving because of the increased threat of collisions with active deer.

Implementation of the Actions

No accidents or injuries have occurred to date as a result of ongoing deer management activities at the parks. While the probability of an accident occurring at some future point would be greater than zero under alternative A, it is not anticipated that the frequency of accidents would increase in any measurable way from the continuation of current management, and implementation of the actions would have minute or slightly beneficial impacts, because the intent is to increase awareness of safety issues.

Deer-Vehicle Collisions

Under alternative A, the high deer population would continue to contribute to the likelihood of vehicle accidents experienced by visitors and staff using roads in and immediately surrounding the parks. The ongoing efforts by the parks to inform employees and visitors about the risk of deer-vehicle collisions would be anticipated to slightly reduce the probability of collisions. However, the potential for accidents and vehicle collisions would remain. The parks do not collect data on deer-vehicle collisions resulting in deer fatalities or injuries to people. As detailed in chapter 3, the counties surrounding the parks experience a high number of deer-vehicle collisions. Based on the smaller scale of the parks to the counties, generally lower speed limits on park roads, and relatively fewer roads within the parks, it is expected that deer-vehicle collisions at the parks would be lower than those presented in surrounding counties. C&O Canal NHP in particular has very few roads. For each of the parks, the probability of a deer-vehicle collision occurring would remain relatively higher under the no action alternative. Therefore, alternative A would result in long-term, adverse impacts on visitor and employee safety.

Lyme Disease

The persistence of a high deer population would provide more host animals and could support higher than normal deer tick populations compared to environments with a lower deer density. The continuation of existing management under alternative A would result in no reduction in the deer population; therefore, there would be no anticipated changes in tick populations within the parks. Although the number of visitors and employees that have encountered a deer tick or acquired Lyme disease within the parks is unknown, the chance for such impacts would continue under alternative A. The risk of exposure to Lyme disease would be mitigated slightly by ongoing efforts to educate visitors and employees about the disease.

Current understanding of Lyme disease dynamics does not allow an accurate prediction about how substantially a continued high deer density contributes to greater occurrence of Lyme disease (see additional detail under alternative C). Therefore, the precise impacts on the prevalence of Lyme disease under alternative A cannot be determined.

Overall, deer management under alternative A would result in long-term, adverse impacts on visitor and employee health and safety with respect to the risk of deer-vehicle collisions and exposure to Lyme disease.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

Implementation of the Actions

The level of employee involvement in deer management activities at both parks under alternative B would increase compared to alternative A. However, it is anticipated that the impacts would remain relatively low because of the safety precautions that would be taken and the use of properly trained employees or authorized agents.

Large exclosures would be constructed throughout the parks to meet forest regeneration goals. Employees at each park could be injured while constructing the exclosures, with the likelihood of injury dependent on the number of exclosures constructed; however, park staff typically exercise caution and apply safety techniques in all construction projects, as required by park training and awareness activities. Park staff would place exclosures in locations so as to minimize impacts on visitor use wherever possible, and fenced areas would be closed to visitors during and after construction, offsetting any potential safety issues. No impacts on visitor and employee safety are expected from increased vegetation monitoring because monitoring activities would apply primarily to the monitoring of exclosures, which would be closed to park visitors. During monitoring activities conducted in open forested areas, park staff would exercise appropriate safety precautions.

The application of additional techniques, such as changing crop configurations or crop selection at the parks, using deer repellents, or using aversive conditioning, also would occur under alternative B. While the application of these techniques would require staff time, all safety precautions would be taken and only trained staff would participate. Areas where these techniques would be applied would be closed to visitors during ongoing management activities to prevent harm.

Alternative B would include treating does with a chemical reproductive control agent to reduce population growth. The use of any reproductive control agents for population management would require approval from EPA, and any agent used would leave no residue in the meat making it safe for consumption (see NPS criteria for use in chapter 2). The use of the reproductive agent would require the capture of does for and delivery of the vaccine and marking to avoid multiple treatments of the same does, which would involve trapping and darting of deer. Reproductive control activities would take place from October through March, which is outside of the months of peak visitor attendance at both parks, and visitor access also would be restricted during the treatment period in areas of the parks where reproductive control activities are taking place to minimize the likelihood of any impacts on visitor safety. Although potential injuries (kicks, bites, stabbing with antlers) could occur during deer handling, injuries are expected to be minimal because qualified federal employees or authorized agents who are professionally trained to perform these tasks would capture and treat the deer, and the use of all applicable safety protocols and equipment would be required, including use of insect repellents. In addition, qualified federal employees or authorized agents would be trained in handling live deer to prevent disease transmission and prevent harm to employees. These precautions are expected to minimize the likelihood of any impacts on employee safety.

Overall, the safety precautions associated with the implementation of management activities under alternative B are expected to minimize the risk of any adverse impacts on visitor and employee safety. Area closures during ongoing management activities would be expected to minimize the probability of any short-term or long-term, adverse impacts on visitor safety to near zero. Short-term, adverse impacts on employee safety could result during initial construction of exclosures or handling of live deer during initial reproductive treatment activities. Long-term, adverse impacts could result from accidents that may occur during the continued implementation of the management activities described above. Given the

professional qualifications, safety precautions, training, and safety equipment that would be required of any personnel taking part in these activities, it is expected the likelihood of any employee accidents occurring would be minimal.

Deer-Vehicle Collisions

Under alternative B, it is not anticipated that there would be a substantial reduction in the deer population over the life of the plan. As a result, there would be no anticipated reductions in the existing number of deer-vehicle collisions. By preventing the deer population from accessing areas enclosed by fencing, it is also possible that more deer may be encouraged to move to other areas of the park or surrounding areas outside of the park, thus increasing the possibility of deer-vehicle collisions. This would result in long-term, adverse impacts on visitor and employee safety. These impacts would be similar to those described under alternative A for both parks.

Lyme Disease

With no substantial reduction in the deer population over the life of the plan, there would be no anticipated reductions in hosts for tick populations within the park under alternative B. Impacts would be expected to remain as characterized under alternative A.

Overall, deer management under alternative B would result in long-term, adverse impacts on visitor or employee health and safety similar to those described for alternative A, because reproductive control would result in only a gradual reduction in the deer population.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Implementation of the Actions

Under alternative C, the proposed use of sharpshooting and/or archery, along with capture and euthanasia activities, have the potential for adverse impacts on the safety of park employees and visitors at each of the parks. However, precautions would be taken to minimize risks to public and employee safety. Qualified federal employees or authorized agents would conduct the sharpshooting activities. All team members would be experienced with sharpshooting methods and would have the necessary sharpshooting qualifications, as determined by NPS. Training also would address safety measures to protect both park visitors and employees. If skilled volunteers were used, they would include individuals identified through an NPS-developed system. Skilled volunteers would be required to demonstrate, through an NPS application process, the required knowledge, skills, and abilities in the use of firearms, field dressing of animals, and preparation of wildlife for donation. NPS would document a system of training and application for skilled volunteers. Skilled volunteers would be directly supervised in the field by NPS personnel during any deer management actions.

Deer would be shot with high-power, small caliber rifles at close range. Nonlead ammunition would be used for any lethal removal of deer to preserve the opportunity to safely donate the meat or to leave it in the field for scavenging wildlife. Activities would be conducted in compliance with all relevant federal firearm laws administered by the Bureau of Alcohol, Tobacco, Firearms, and Explosives. In some locations, such as areas of the park that are near buildings where firearm use may be unsafe, a bow and arrow may be used as the method for sharpshooting. Shooting with bow and arrow would be done from close range by NPS personnel or authorized agents specifically experienced with this type of deer removal. To ensure the safety of park visitors, sharpshooting would primarily occur between dusk and dawn during late fall and winter months when deer are more visible and few visitors are in the parks. Noise suppression devices (silencers) and night vision equipment could be used to reduce disturbance to the public. Areas could be temporarily closed to park visitors, and NPS park rangers would patrol public areas to ensure compliance with park closures and public safety measures. The public would be notified of any park closures in advance. Information regarding deer management would be available at visitor

contact facilities and posted on the parks' websites to inform the public of deer management actions. If more than one shooting location were used, areas would be adequately separated to ensure safety.

Qualified federal employees or authorized agents also may capture and euthanize deer; such actions would occur in limited situations when sharpshooting was not appropriate. Adverse impacts on the safety of employees could increase from potential injuries (kicks, bites, stabbing with antlers) that could occur during deer handling. Every precaution would be taken to ensure the safety of employees, and employees would apply safety training and awareness activities designed to reduce safety risks.

The use of firearms under alternative C would introduce an additional safety risk that would not be present under alternatives A and B. It is anticipated that efforts to protect the safety of park visitors, such as area closures, restrictions on the timing of sharpshooting activities, and patrols by NPS law enforcement staff, would minimize the possibility of any impacts on visitor safety. There is potential for adverse impacts on the safety of employees or authorized agents during sharpshooting; however, because this technique would be limited in timing, duration, and location, and trained staff would implement substantial safety precautions, adverse impacts on the safety of NPS employees and authorized agents are considered unlikely. Similarly, capture/euthanasia efforts have the potential to result in adverse impacts on employee safety during the handling of live animals. However, the use of this technique is expected to be limited, and the safety precautions that park staff would follow would be expected to mitigate these potential impacts. Overall, implementation of proposed deer management actions under alternative C would result in long-term, minimal, adverse impacts.

Deer-Vehicle Collisions

Although the direct relationship is unknown, research suggests that a decrease in the local deer population could reduce the number of deer-vehicle collisions (Curtis et al. 2002). Other research concludes that reducing suburban deer populations through sharpshooting reduces deer-vehicle collisions (DeNicola and Williams 2008). The authors report that in three suburban communities, sharpshooting management projects reduced deer herds by 54%, 72%, and 76%, with resulting reductions in deer-vehicle collisions of 49%, 75%, and 78%, respectively. These communities were described as typical suburban developments with a matrix of suburban and commercial development, intermingled small agricultural plots, and undeveloped open space, similar to the area in and surrounding each of the parks.

Under alternative C, it is expected that the deer population would remain at relatively high levels in the short term, and changes in deer movements resulting from sharpshooting activities could temporarily increase the probability of deer-vehicle collisions, especially in areas with higher deer densities. In the longer term, the deer population would be reduced and the frequency of deer reduction activities would likewise be reduced, particularly around the implementation areas. Therefore, a reduction in deer-vehicle collisions would be expected under alternative C. It is likely that deer in the vicinity of the parks have become accustomed to foraging on ornamental plantings or crops grown outside the parks and would continue to do so. However, the number of deer crossing roads in and adjacent to the park to reach these plantings or to move between areas of the park would decrease. The likelihood of a deer-vehicle collision would be expected to decrease proportionately with the reduction of the deer population. This would result in a long-term, beneficial impact on visitor and employee health and safety at each of the parks.

Lyme Disease

With an expected reduction in the deer population during the first few years of the plan, there would be anticipated reductions in host animals for tick populations within both parks. Although the number of visitors and employees who have encountered a deer tick or acquired Lyme disease within the parks is unknown, the likelihood of encountering a deer tick may be reduced, but not eliminated. While a

reduction in deer density may contribute to a reduction in deer ticks carrying Lyme disease, it is uncertain exactly how much of an effect would occur. Mumford Cove, Connecticut, and Monhegan Island, Maine, are commonly cited as two places where the removal or drastic decrease in the deer population resulted in the near eradication of Lyme disease. It should be noted that Mumford Cove is located on a peninsula and is 132 acres, and the area of Monhegan Island is one square mile (640 acres); with each of the parks being substantially larger than these two areas. There also is research showing that localized absence of deer increases tick feeding on rodents, leading to the potential for tickborne hotspots (Perkins et al. 2006). This study indicates there was an increase in nymphs, which are the primary life form that do not rely on deer and that do transmit Lyme disease. Current understanding of Lyme disease dynamics does not allow an accurate prediction as to whether results obtained in one setting can be extrapolated to other areas with different ecological and geographical factors present. For these reasons, the impacts of deer reduction on Lyme disease prevalence cannot be determined. While the likelihood of encountering a deer tick would be reduced, it would not be eliminated; therefore, there would be long-term, adverse impacts on visitor and employee health and safety.

Overall, deer management under alternative C would result in short- and long-term, adverse impacts on visitor and employee health and safety related to the implementation of the plan. Alternative C would have long-term, beneficial impacts related to a reduced risk of deer-vehicle collisions as a result of the reduction in deer density.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

Implementation of the Actions

Actions to ensure the safe conduct of sharpshooting operations, including area closures, restrictions on timing of sharpshooting activities, and patrols by NPS enforcement personnel, would be the same as those described under alternative C. The public would be notified of any park closures in advance. Screening, training, and supervision of trained volunteers would likewise be identical to that described under alternative C. The parks would comply with all applicable federal firearm laws administered by the Bureau of Alcohol, Tobacco, Firearms, and Explosives. Safety precautions associated with the implementation of reproductive control activities, as described under alternative B, would be expected to reduce the risk of any adverse impacts on visitor and employee safety resulting from the application of reproductive control. Information regarding deer management would be displayed at visitor contact facilities, and information would be posted on the parks' websites to inform the public of deer management actions. Overall, the actions associated with alternative D would increase the potential risk of employee injury due to the use of firearms, the implementation of reproductive control, and the need to capture and euthanize some deer. However, safety precautions taken by park staff would offset these risks, as described under alternatives B and C, resulting in minimal, adverse impacts over the course of the plan.

Deer-Vehicle Collisions

As noted under the discussion for alternative C, although the direct relationship is unknown, research suggests that a decrease in the local deer population could reduce the number of deer-vehicle collisions (Curtis et al. 2002), and other research supports this (DeNicola and Williams 2008). The likelihood of being involved in a deer-vehicle collision would be expected to decrease proportionately with the reduction of the deer population under alternative D. This would result in a long-term, beneficial impact.

Lyme Disease

As described for alternative C, with an expected reduction in the deer population during the first few years of the plan, there would be anticipated reductions in host animals for tick populations within the parks; however, the effects of deer reduction on Lyme disease prevalence cannot be determined. While the likelihood of encountering a deer tick would be reduced under alternative D, it would not be eliminated; therefore, there would be long-term, adverse impacts on visitor and employee health and safety.

Overall, deer management under alternative D would result in long-term, minimal, adverse impacts on visitor and employee health and safety. Beneficial impacts would result from a reduced risk of deer-vehicle collisions as a result of the reduction in deer density.

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, opportunistic and targeted surveillance would have long-term, minimal, adverse impacts on health and safety because of the minimal chance of injury from these activities undertaken by trained staff.

Alternatives B, C, and D (All Action Alternatives)

Impacts on health and safety from the deer reduction actions under the CWD response plan would be the same as those described for alternative C under the analysis of deer management actions, above. There would be short-term and relatively minimal, adverse impacts related to the implementation of the actions themselves from the potential for injuries or accidents during deer removals or use of techniques to reduce deer damages. The reduction in deer density would be expected to reduce the likelihood of deer-vehicle collisions, with long-term, beneficial impacts.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions that could impact human health and safety in and around the parks include actions with both adverse and beneficial impacts. Ongoing park maintenance, operations, and development activities could have long-term, minimal, adverse impacts on health and safety resulting from the potential for infrequent accidents and injuries to employees during these activities. Beneficial impacts on employee or visitor health and safety are likely to result from deer management efforts undertaken by neighboring agencies and landowners using deer depredation permits and hunting because these activities would reduce deer numbers in and around the parks, reducing the potential for deer-vehicle collisions and reducing the number of potential hosts for ticks carrying Lyme disease. Overall, impacts from past, present, and reasonably foreseeable future actions include long-term, adverse and beneficial impacts. These impacts, when combined with the long-term, adverse impacts on visitor and employee safety under alternative A, would result in cumulative impacts that would be long term and adverse. The no action alternative would contribute small adverse increments to cumulative impacts on human health and safety.

Alternative B: Nonlethal Deer Management

The same past, current, and future actions described under alternative A also would occur under alternative B, including minimal, adverse impacts from ongoing park maintenance, operations, and development and beneficial impacts from actions taken by neighboring jurisdictions and landowners and from public hunting. In the absence of any CWD-triggered lethal response, the mostly long-term, adverse impacts of alternative B would contribute an appreciable adverse increment to the overall cumulative impact because of the lack of immediate reduction in the deer herd and the associated continued potential

for impacts related to the higher potential for deer-vehicle collisions with the expected very gradual reduction in deer density. However, if CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional adverse, cumulative impacts on health and safety related to risks associated with the actions and long-term, beneficial impacts on human health and safety related to the reduction of deer, which would not change the overall cumulative impact assessment.

Alternative C: Lethal Deer Management

The same past, current, and future actions and associated impacts described under alternative A also would occur under alternative C, including minimal, adverse impacts from ongoing park maintenance, operations, and development. Beneficial impacts would result from actions taken by neighboring jurisdictions and landowners to reduce deer numbers and from public hunting. In the absence of any CWD-triggered lethal response, deer management actions under alternative C would contribute minimally to the overall risks and would add several long-term benefits to the overall cumulative impact because of the relatively rapid reduction in deer population and associated reduction in potential for adverse human health and safety impacts. If CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional adverse, cumulative impacts on health and safety related to risks associated with the actions and long-term, beneficial impacts on human health and safety related to the reduction of deer, which would not change the overall cumulative impact assessment.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The same past, current, and future actions and associated impacts described under alternative A also would occur under alternative D, including minimal, adverse impacts from ongoing park maintenance, operations, and development. Beneficial impacts would result from actions taken by neighboring jurisdictions and landowners to reduce deer numbers and from public hunting. In the absence of any CWD-triggered lethal response, deer management actions under alternative D would contribute minimally to the overall risks and add several long-term benefits to the overall cumulative impact because of the relatively rapid reduction in deer population and associated reduction in potential for adverse human health and safety impacts. If CWD were to occur within or surrounding the parks and a CWD lethal removal response was triggered that substantially reduced the deer population in proximity to the CWD case, there would be additional adverse, cumulative impacts on health and safety related to risks associated with the actions and long-term, beneficial impacts on human health and safety related to the reduction of deer, which would not change the overall cumulative impact assessment.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Under the no action alternative, impacts on human health and safety would be adverse and long-term, as described in the analysis above. Implementation of ongoing deer management actions would have slightly beneficial impacts on human health and safety because employee accidents would be highly infrequent, and ongoing training and education efforts by the parks would increase employee and visitor awareness of safety issues. However, long-term, adverse impacts on human health and safety would result from the continued high potential for deer-vehicle collisions resulting from a large deer population and the continued potential risk of exposure to Lyme disease. Opportunistic and targeted surveillance would have long-term, minimal, adverse impacts on health and safety because there would be a minimal chance of injury from these activities undertaken by trained staff. As described under “Cumulative Impacts,” the overall cumulative impact would be long term and adverse, with the no action alternative contributing adverse increments to cumulative impacts on human health and safety.

Alternative B: Nonlethal Deer Management

Alternative B would have similar impacts to those described for alternative A because reproductive control would result in only a gradual reduction in the deer herd and the risk of not meeting the deer density goal would be high. There would therefore be short- and long-term, adverse impacts from implementation of management actions; long-term, adverse impacts with respect to the potential for deer-vehicle collisions; and long-term, adverse impacts related to the continued potential for exposure to Lyme disease. Any CWD response action that would be taken under the proposed long-term plan would have some adverse impacts and also would provide indirect benefits, but these would not outweigh the adverse effects of not taking deer management actions. As described under "Cumulative Impacts," the overall cumulative impact would be long term and adverse, with alternative B contributing adverse increments to cumulative impacts on human health and safety.

Alternative C: Lethal Deer Management

Overall, deer management under alternative C would result in short- and long-term, adverse impacts on visitor and employee health and safety related to the implementation of the plan, but there would be long-term, beneficial impacts related to a reduced risk of deer-vehicle collisions as a result of the reduction in deer density. CWD response actions under a long-term response plan would have similar impacts, with short-term, adverse effects from the actions themselves and long-term benefits from the reduction of deer tick hosts and the reduced potential for deer-vehicle collisions. The overall cumulative impact would be long term and beneficial, with alternative C contributing minimal risks and an appreciable beneficial increment to cumulative impacts on human health and safety.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Alternative D would have essentially the same impacts as alternative C, with long-term, minor risks and substantial benefits related to the relatively rapid reduction in deer population and associated reduction in potential for deer-vehicle collisions. CWD response actions under a long-term response plan would have similar impacts, with short-term, adverse effects from the actions themselves and long-term benefits from the reduction of deer tick hosts and the reduced potential for deer-vehicle collisions. As described under "Cumulative Impacts," the overall cumulative impact would be long term and beneficial, with alternative D contributing minimal risks and an appreciable beneficial increment to cumulative impacts on human health and safety.

IMPACTS ON PARK MANAGEMENT AND OPERATIONS

GUIDING REGULATIONS AND POLICIES

Park management and operations refers to the current staff available to adequately protect and preserve park resources and provide for an effective visitor experience. This topic also includes the operating budget necessary to conduct park operations.

METHODOLOGY AND ASSUMPTIONS

The discussion of impacts on park operations focuses on (1) the number of staff available to ensure visitor and employee safety, and (2) the ability of park staff to protect and preserve resources given current funding and staffing levels. It was assumed under all alternatives that each park's annual budget would be increased to implement a particular alternative. However, this funding is not guaranteed. Park staff knowledge was used to evaluate the impacts of each alternative, and the evaluation is based on the description of park management and operations presented in chapter 3.

STUDY AREA

The area of analysis for impact assessment includes all lands within the boundaries of both parks. The area of analysis for cumulative impacts also includes the park boundaries, which are the farthest geographic extent of park management and operations.

IMPACTS OF ALTERNATIVE A: CONTINUATION OF CURRENT MANAGEMENT (NO ACTION)

Because present deer management actions would continue under the no action alternative, each park's deer population is expected to continue to fluctuate and remain at high levels, resulting in long-term demands on park staff and funding for managing the deer herd and protecting other park resources. Existing park staff would be sufficient to continue performing current deer management functions at the present population level. However, it is expected that additional efforts by park staff would be required for implementation of other resource activities, such as control of nonnative plants or reestablishment of native vegetation due to the continued high density. At C&O Canal NHP, there are approximately 71 full-time employees. At Harpers Ferry NHP there are currently approximately 106 permanent, full-time employees. At both parks, natural resource staff currently devotes very little of their time to deer management. Under the no action alternative, there may be some additional time required for staff to install exclosures or other vegetation protection, resulting in long-term, relatively small, adverse impacts. Overall, deer management actions under the no action alternative would result in long-term, minimal, adverse impacts on park management and operations as described above.

IMPACTS OF ALTERNATIVE B: NONLETHAL DEER MANAGEMENT

Similar to the no action alternative, deer populations would continue to remain at high levels under alternative B, pending the implementation of reproductive controls, and numbers likely would continue to fluctuate annually. The nonlethal management measures outlined under alternative B would require additional staff time and seasonal staff, for which additional funding would be needed. Additional temporary staff likely would likely be needed for the initial construction of the large exclosures and additional monitoring sites. If staff from other park divisions were used, park operations in those divisions would be adversely affected during the construction period.

After the initial construction, the exclosures would be inspected and maintained, and relocated where possible after 10 years, at additional cost for supplies and labor. Furthermore, to reduce impacts on visitors as much as possible, some exclosures would be located in more remote areas of the park, adding to maintenance costs. These costs would be in addition to each park's present budget and would result in increased funding needs, with long-term, adverse impacts on park management and operations. Staff also would need to be reassigned, and the monitoring and inspection associated with the exclosures would represent additional duties.

Alternative B would include reproductive control of does, initially with treatment only at Great Falls and on Maryland Heights, and then at other implementation areas as need is demonstrated through monitoring. It is likely that at least initially, the task would be contracted out to experts with experience treating wildlife, although staff would work with the contractors, and possibly take over the effort as they gain experience. Funding would be needed, and it is expected that reproductive control costs would be higher than comparable direct reduction costs, based on per deer costs estimated for these operations in previous deer management efforts (NPS 2014c).

Due to the additional time and funding commitments that would be required to implement the fencing and reproductive control of does and the time required by park staff to participate in these activities, which could reduce time available for other efforts, the impacts on parks management and operations from implementing alternative B deer management actions would be noticeably adverse over the life of the plan.

Additional techniques such as smaller fencing, changing crop configuration or crop selection, and using repellents and aversive conditioning also could be implemented under alternative B. While the application of these techniques would require additional staff and funding, it is expected that this requirement would be minimal and would have a long-term, but limited, adverse impact on the budget and staff workload.

This alternative also would involve increased educational and interpretive activities and would therefore require additional funding and/or additional staff time to implement these activities. Increased responses to inquiries about the actions taken under this alternative likely would increase the workload of park biologists, rangers, and the Superintendent. This would result in adverse impacts on resource education and resource protection staff, but the intensity of the impacts would decline over time.

Overall, deer management actions under alternative B would result in long-term, adverse impacts on park management and operations mainly due to the demands of installing and maintaining large exclosures and implementing and monitoring reproductive controls.

IMPACTS OF ALTERNATIVE C: LETHAL DEER MANAGEMENT

Costs to the park for direct reduction through sharpshooting include ensuring that all authorized agents meet and understand requirements and would vary, depending on a number of factors, including the number of deer to be removed each year, access to deer, number and location of bait stations, training requirements, equipment availability, amount of data to be collected from the deer, and processing or disposal requirements. The majority of project funding, including all deer reduction activities and management of these, would be the responsibility of the parks. Any assistance offered by park staff would be considered part of regular duties, rather than project specific, and would not require additional project funding. Due to the time required by staff to participate in these activities and the funding increase that would need to be applied for, impacts would be adverse during the period of the reduction efforts, although costs for direct reduction would likely be less than costs for reproductive control.

As part of this alternative, both deer population studies and vegetation monitoring would be conducted to document any changes in deer browsing and forest regeneration that may result from reduced deer numbers. This monitoring program would continue after the density goals were reached to determine if vegetation was showing signs of recovery, and monitoring also would include a review of crop yield reports and assessment of orchard conditions. This monitoring would be similar to current park efforts that are already scheduled to continue and would result in long-term, minimal impacts on park operations and maintenance. Additional techniques as mentioned in alternative B would be implemented under alternative C. While the application of these techniques would require additional staff and funding, it is expected that this requirement will be minimal and would have a long-term, minute, adverse impact on the budget.

Additional techniques as described under alternative B also would be implemented under alternative D. While the application of these techniques would require additional staff and funding, it is expected that this requirement would be minimal and would have a long-term, low, adverse impact on the budget.

This alternative also would involve increased educational and interpretive and management activities and therefore would require additional funding and/or additional staff time to implement these activities. This would result in noticeable adverse impacts on resource education and resource protection staff. Adverse impacts also could be expected due to time needed to answer public inquiries about the actions taken, especially if visitors have conflicting opinions about using sharpshooting or any lethal means for reduction and require additional attention. This need likely would decline over the years, and adverse impacts also would be expected to decline over time.

Overall, as described above, deer management actions under alternative C would result in adverse impacts during the period of direct reduction efforts because of the need for additional staff time or costs for monitoring and coordinating activities. The greater reduction of deer over a shorter period of time would result in more short-term, adverse effects that would reduce over time as reduction efforts decrease. If

additional implementation areas were to be added, then the impact would be more long term because the reduction efforts would be more spread out over time.

IMPACTS OF ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL DEER MANAGEMENT (PREFERRED ALTERNATIVE)

Costs to the parks for sharpshooting would vary, depending on how many areas are targeted over the life of the plan and other factors. The majority of project funding, including all deer reduction activities and management of these activities, would be the responsibility of the park. Any assistance offered by park staff would be considered part of regular duties. Impacts on park management and operations are expected to be long-term and adverse.

After the initial reduction in density, alternative D could use reproductive control of each park's deer population by the methods described under alternative B. Park staff would need to spend additional time and labor to coordinate and monitor activities, resulting in long-term, adverse impacts. Sharpshooting used for population maintenance would be less expensive than reproductive control because it would require less labor and would vary with the number of deer removed and number of implementation areas ultimately included in the life of the plan.

Additional techniques described under alternative B also would be implemented under alternative D. While the application of these techniques would require additional staff and funding, it is expected that this requirement would be minimal and would have a long-term, low, adverse impact on the budget.

This alternative also would involve increased educational and interpretive activities and therefore would require additional funding and/or additional staff time to implement these activities, although these costs would be small in comparison to implementing deer management actions. There would be adverse impacts on resource education and visitor protection staff as a result, which would decline over time.

Overall, as described above, the combination of nonlethal and lethal management under alternative D would have long-term, adverse impacts on park management and operations during the period of direct reduction and reproductive control. Upon completion of initial deer herd reduction, more staff time would be available for other activities, resulting in diminishing long-term, adverse impacts.

IMPACTS OF ALTERNATIVE CHRONIC WASTING DISEASE MANAGEMENT

Alternative A: Continuation of Current Management (No Action)

Under alternative A, opportunistic and targeted surveillance would have very minimal effects on park staffing or budgets because the additional efforts required would be infrequent and require less than a day's time per action.

Alternatives B, C, and D (All Action Alternatives)

Under all of the action alternatives, any CWD response action under the long term CWD response plan would be implemented potentially quickly and would have a short-term, adverse impact on the park staff and budgets should it occur, with long-term, adverse impacts from the additional work to maintain low densities in the future.

CUMULATIVE IMPACTS

Alternative A: Continuation of Current Management (No Action)

Past, present, and reasonably foreseeable future actions include actions with both adverse and beneficial impacts on park operations and management. Ongoing park maintenance, operations, and development activities would have long-term, adverse impacts as a result of the allocation of budget and staff resources for trail improvements, facilities development, or other ongoing maintenance and development activities. Long-term, beneficial impacts could result from improvements to facilities or amenities over time result in long-term reductions in the need to allocate staff and budget to some of these activities. Actions that

have contributed to the spread of nonnative species and the resulting need to allocate staff and resources to control efforts for these species would have adverse effects on park operations and management. In the long term, efforts to control invasive, nonnative species would have beneficial impacts on park operations and management because of lower demand on staff and resources once invasive species have been brought to controllable levels.

As described above, the no action alternative would result in long-term, relatively small, adverse impacts from deer management activities because relatively little staff time and resources are currently devoted to deer management. These impacts, when combined with the long-term, adverse and beneficial impacts on park management and operations resulting from past, present, and future actions would result in long-term, minimal, adverse, cumulative impacts on park operations and management. Alternative A would contribute small, adverse increments to cumulative impacts on park management and operations.

Alternative B: Nonlethal Deer Management

Past, present, and reasonably foreseeable future actions that could impact park operations and management under alternative B would be the same as those described for the no action alternative. Long-term, adverse and beneficial impacts would result from ongoing park maintenance, operations, and development activities. Efforts to control invasive, nonnative species would have also have long-term, adverse and beneficial impacts on park operations. In the absence of any CWD-triggered response, deer management actions under alternative B would contribute an appreciable adverse impact to overall cumulative impacts because of the higher demands for staff or budget associated with reproductive control and maintenance of exclosures. If a CWD response action was triggered that substantially reduced the deer population, there would be additional adverse, cumulative impacts on park management and operations related to the additional workload and costs associated with the actions, which would add to adverse, cumulative impacts.

Alternative C: Lethal Deer Management

Past, present, and reasonably foreseeable future actions that could impact park operations and management under alternative C would be the same as those described for the no action alternative. Long-term, adverse and beneficial impacts would result from ongoing park maintenance, operations, and development activities, while long-term, beneficial impacts would result from past and current deer management efforts by agencies and private landowners. Public hunting would contribute similar long-term, beneficial impacts on park operations and management. Efforts to control nonnative species would have also have long-term, beneficial impacts on park operations.

In the absence of any CWD-triggered response, deer management actions under alternative C would contribute a noticeable adverse impact to overall cumulative impacts because of the higher demands for staff or budget associated with the logistical, personnel, equipment, and operations costs associated with lethal removal actions. Ongoing monitoring, enhanced educational and interpretive efforts, and intermittent lethal removal activities would result in long-term, adverse impacts on park operations and management. If a CWD response action was triggered that substantially reduced the deer population, there would be additional adverse, cumulative impacts on park management and operations related to the additional workload and costs associated with the actions, which would add to adverse, cumulative impacts.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

Past, present, and reasonably foreseeable future actions that could impact park operations and management under alternative D would be the same as those described for the no action alternative. Long-term, adverse and beneficial impacts would result from ongoing park maintenance, operations, and development activities, while long-term, beneficial impacts would result from past and current deer management efforts by agencies and private landowners. Public hunting outside the park would contribute

similar long-term, beneficial impacts on park operations and management. Efforts to control nonnative species would have also have long-term, beneficial impacts on park operations.

In the absence of any CWD-triggered response, deer management actions under alternative D would contribute a noticeable adverse impact to overall cumulative impacts because of the higher demands for staff or budget associated with the logistical, personnel, equipment, and operations costs associated with initial lethal removal actions and monitoring, enhanced educational and interpretive efforts, and intermittent maintenance activities using reproductive control. If a CWD response action was triggered that substantially reduced the deer population, there would be additional cumulative adverse impacts on park management and operations related to the additional workload and costs associated with the actions, which would add to adverse, cumulative impacts.

CONCLUSION

Alternative A: Continuation of Current Management (No Action)

Overall, deer management actions under the no action alternative would result in long-term, minimal, adverse impacts on park management and operations. Because present deer management actions would continue, each park's deer population is expected to fluctuate and remain at relatively high levels, resulting in long-term demands on park staff and finding time for managing the herd and protecting other resources. The overall cumulative impacts would be long term and both beneficial and adverse, with the no action alternative contributing adverse increments to cumulative impacts on park management and operations.

Alternative B: Nonlethal Deer Management

Overall, deer management actions under alternative B would result in long-term, adverse impacts on park management and operations mainly due to the demands of installing and maintaining large exclosures and implementing and monitoring reproductive controls. Any CWD response that would be taken under the long-term plan would provide short and long-term, adverse impacts on park management and operations. Overall cumulative impacts would be long term and adverse, with alternative B contributing appreciable adverse increments to cumulative impacts on park management and operations from demands on staff and budget to implement the exclosures and reproductive control.

Alternative C: Lethal Deer Management

Deer management actions under alternative C would result in adverse impacts during the period of direct reduction efforts because of the need for additional staff time or costs for monitoring and coordinating activities. The greater reduction of deer over a shorter period of time would reduce long-term, adverse impacts over time. Any CWD response that would be taken under the long-term plan would provide short and long-term, adverse impacts on park management and operations. Overall cumulative impacts would be long term and adverse, with alternative C contributing noticeable adverse increments to cumulative impacts on park management and operations to implement direct reduction.

Alternative D: Combined Lethal and Nonlethal Deer Management (Preferred Alternative)

The combination of nonlethal and lethal management under alternative D would have long-term, adverse impacts on park management and operations during the period of direct reduction and reproductive control. Upon completion of initial deer herd reduction, more staff time would be available for other activities, resulting in diminishing long-term, adverse impacts. Any CWD response that would be taken under the long-term plan would provide short and long-term, adverse impacts on park management and operations. Overall cumulative impacts would be long term and both beneficial and adverse, with alternative D contributing adverse increments to cumulative impacts on park management and operations to implement direct reduction, coupled with reproductive control as a maintenance action if feasible.

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CHAPTER 5: CONSULTATION AND COORDINATION

The intent of the NEPA is to encourage the participation of federal and state-involved agencies and affected citizens in the assessment procedure, as appropriate. This section describes the consultation that occurred during development of this plan/EA, including consultation with scientific experts and other agencies. This chapter also includes a description of the public involvement process and a list of the recipients of the final document.

PUBLIC INVOLVEMENT

The public involvement activities for this plan/EA fulfill the requirements of NEPA and Director's Order 12 (NPS 2011a).

THE SCOPING PROCESS

NPS divides the scoping process into two parts: internal scoping and external or public scoping. Internal scoping involves discussions among NPS personnel regarding the purpose of and need for management actions, issues, management alternatives, mitigation measures, the analysis boundary, appropriate level of documentation, available references and guidance, and other related topics.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have an opportunity to comment and contribute early in the decision-making process. For this plan/EA, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and to identify important issues or even other alternatives.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways scoping was conducted for this plan/EA.

INTERNAL SCOPING

The internal scoping process began in December 2014 in Harpers Ferry NHP, West Virginia. During the internal scoping meeting and a site visit, NPS employees identified the initial purpose and need for managing deer at the parks and identified issues and concerns associated with the current deer populations, the impact of deer on the ecosystem of the parks, and other deer management programs and plans used by nearby towns, counties, and other NPS parks. Preliminary alternatives also were discussed.

PUBLIC SCOPING

Public Scoping Meetings and Comments

The purpose of these meetings was to solicit public input, especially on issues and ideas for alternatives. The meetings were held in Harpers Ferry, West Virginia, Hagerstown, Maryland, and Potomac, Maryland. Notices of the meetings were posted on the NPS's Planning, Environment, and Public Comment (PEPC) website. Additionally, a newsletter was mailed on February 9, 2015, to the project's preliminary mailing list of government agencies, organizations, businesses, and individuals. The newsletter announced the public scoping meetings and summarized the purpose of and need for a deer management plan, preliminary alternatives, management options dismissed from further analysis, preliminary impact topics, and the parks' current deer research and management.

During the 40-day comment period, 79 pieces of correspondence were received from 6 states. Comments were received at the public scoping meetings from attendees. In addition, NPS received comments from individuals and organizations not present at the meetings by means of mail, email, and the PEPC website. NPS staff read all correspondence and specific comments within each piece of correspondence were identified and grouped by similar topic. Public comments were analyzed and a public scoping comment analysis report was created, which is now on file as part of the administrative record.

Commenters provided numerous suggestions for elements that could be incorporated into the preliminary alternatives. Several commenters supported lethal management, advocated use of managed hunts, or supported reproductive control options. A number of commenters explained why certain areas (Short Hill, Maryland Heights, and Four Locks) needed to be excluded from deer management. Other commenters voiced their concern for human and deer health.

AGENCY CONSULTATION

Letters initiating consultation under section 7 of the Endangered Species Act and section 106 of the NHPA and/or requesting information or comments were sent to the agencies as described below. Copies of these letters and any responses are provided in appendix A.

US FISH AND WILDLIFE SERVICE

USFWS' Information for Planning and Conservation system was consulted regarding the presence of federally listed rare, threatened, or endangered species in or near the parks. An official species list requested through the Information Planning and Conservation system is considered to be a USFWS official response. A copy of this plan/EA will be sent to the USFWS.

MARYLAND DEPARTMENT OF NATURAL RESOURCES, WEST VIRGINIA DEPARTMENT OF NATURAL RESOURCES, AND VIRGINIA DEPARTMENTS OF CONSERVATION AND RECREATION, AND GAME AND INLAND FISHERIES

C&O Canal NHP sent letters to WVDNR and MD DNR to initiate informal consultation about the presence of state-listed rare, threatened, or endangered species in or near the parks. Harpers Ferry NHP also sent letters to WVDNR, MD DNR, and the Virginia Department of Game and Inland Fisheries.

MARYLAND, VIRGINIA, AND WEST VIRGINIA STATE HISTORIC PRESERVATION OFFICES

In accordance with section 106 of the NHPA, and to initiate consultation with the State Historic Preservation Officers, C&O Canal NHP sent letters to the State Historic Preservation Offices in Maryland and West Virginia, and Harpers Ferry NHP sent letters to the State Historic Preservation Offices in Maryland, Virginia, and West Virginia. A copy of this plan/EA will be sent to these agencies.

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CHAPTER 7: GLOSSARY AND ACRONYMS

ACRONYMS

APHIS	Animal and Plant Health Inspection Service
BSE	bovine spongiform encephalopathy
C&O Canal	Chesapeake and Ohio Canal
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWD	chronic wasting disease
EA	environmental assessment
EPA	US. Environmental Protection Agency
GnRH	Gonadotropin Releasing Hormone
km	kilometer
MD DNR	Maryland Department of Natural Resources
National Register	National Register of Historic Places
NCR	National Capital Region
NCRN	National Capital Region Network
NEPA	National Environmental Policy Act
NHP	National Historical Park
NHPA	National Historic Preservation Act
NPS	National Park Service
ONRS	National Park Service, **OFFICE OF NATURAL RESOURCES AND SCIENCE**
PEPC	planning, environment, and public comment
plan/EA	plan / environmental assessment
PZP	porcine zona pellucida
USC	United States Code
USFWS	US Fish and Wildlife Service
VDGIF	Virginia Department of Game and Inland Fisheries
WSSC	Washington Suburban Sanitary Commission
WVDNR	West Virginia Department of Natural Resources

GLOSSARY OF TERMS

action alternative—An alternative that proposes a different management action or actions to address the purpose, need, and objectives of the plan; one that proposes changes to the current management. Alternatives B, C, and D are the action alternatives in this planning process. See also: "No Action Alternative."

adaptive management—The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from research and the period evaluation of management actions and the conditions they produce to either reinforce the viability of objectives, strategies, and actions prescribed in a plan or to modify strategies and actions in order to more effectively accomplish management objectives.

amplification—Increased prevalence of disease through a target population or a region.

antibody—An immunoprotein that is produced by lymphoid cells in response to a foreign substance (antigen), with which it specifically reacts.

antigen—A foreign substance, usually a protein or polysaccharide, which stimulates an immune response upon introduction into a vertebrate animal.

affected environment—A description of the existing environment that may be affected by the proposed action (40 CFR 1502.15).

bluetongue virus—An insect-transmitted, viral disease of ruminant animals, including white-tailed deer, which causes inflammation, swelling, and hemorrhage of the mucous membranes of the mouth, nose, and tongue.

browse line—A visible delineation at approximately six feet below which most or all vegetation has been uniformly browsed.

carrying capacity—The maximum number of organisms that can be supported in a given area or habitat.

cervid—A member of the deer family, such as white-tailed deer, mule deer, elk, moose, and caribou.

chronic wasting disease (CWD)—A slowly progressive, infectious, self-propagating neurological disease of captive and free-ranging deer, elk, and moose. CWD belongs to the transmissible spongiform encephalopathy group of diseases and is characterized by accumulations of abnormal prion proteins in neural and lymphoid tissue.

containment—To keep CWD from spreading outside of an area.

containment area or zone—A buffer area around confirmed positive CWD cases; terminology varies with the state involved. In Virginia, if additional CWD-infected free-ranging deer are found within or near the CWD surveillance area, a CWD containment area will be defined using county and/or state maintained roads or other geographic features. The primary objectives of establishing a containment area will be to monitor the prevalence and geographic extent of the CWD infection and contain or slow the spread of the disease. In Maryland, if additional infected deer are detected in selected surveillance areas, a new 5-mile radius boundary will be extended and sampling will be conducted at newly identified selected surveillance areas within the expanded area(s). As sampling progresses, a CWD Infection Zone) (containment area) will be identified using all available biological information and cultural/geographic features.

contragestive—A product that terminates pregnancy.

cultural landscape—A geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

cumulative impacts—Those impacts on the environment that result from the incremental effect of the action when added to the past, present, and reasonable foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minute but collectively significant actions taking place over a period of time (40 CFR 1508.7).

deer herd—The group of deer that have common characteristics and interbreed among themselves. For the purposes of this plan, this term is synonymous with deer population.

deer population—See deer herd, above.

demographic—Referring to the intrinsic factors that contribute to a population's growth or decline: birth, death, immigration, and emigration. The sex ratio of the breeding population and the age structure (the proportion of the population found in each age class) are also considered demographic factors because they contribute to birth and death rates.

depredation—Damage or loss.

direct reduction—Lethal removal of deer; includes both sharpshooting and capture/euthanasia.

distance sampling—An analytical method to estimate population density that involves an observer traveling along a transect and recording how far away objects of interest are.

endemic—Native to or confined to a particular region.

ecosystem—An ecological system; the interaction of living organisms and the nonliving environment producing an exchange of materials and energy between the living and nonliving.

epizootic hemorrhagic disease)—An insect-borne viral disease of ruminants that causes widespread hemorrhages in mucous membranes, skin, and visceral organs.

environment—The sum total of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

environmental assessment—A concise public document, prepared in compliance with NEPA, that briefly discusses the purposes and need for an action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

environmental consequences—Environmental effects of project alternatives, including the proposed action, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the human environment, and any irreversible or irretrievable commitments of resources which would be involved if the proposal should be implemented (40 CFR 1502.16).

environmental impact statement (EIS)—A detailed written statement required by section 102(2)(C) of NEPA, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short term uses of the environment versus the maintenance and enhancement of long term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).

ethnographic resource—Any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it.

euthanasia—Ending the life of an animal by humane means.

exclosure—A large area enclosed by fencing to keep out deer and allow vegetation to regenerate.

exotic species—Any introduced plant, animal or protist species that is not native to the area and may be considered a nuisance; also called nonnative or alien species.

extirpated species—A species that is no longer present in an area where it once lived.

fenced plot—An area enclosed by a fence to keep deer out so vegetation can grow without the influence of deer browsing.

folliculogenesis—The maturation of the ovarian follicle (see below).

follicle—One of the small ovarian sacs containing an immature egg.

follicle stimulating hormone—A hormone synthesized and secreted by the pituitary gland that (in females) stimulates the growth of immature follicles to maturation.

forest regeneration—For the purposes of this plan, the regrowth of forest species and renewal of forest tree cover such that the native forest sustains itself without human intervention.

fragmentation—The breaking up of large, contiguous blocks of habitat or landscape into small, discontinuous areas that are surrounded by altered or disturbed lands.

genetic variability—The amount of genetic difference among individuals in a population.

habitat—The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors).

hectare—A metric unit of area equal to 2.471 acres.

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

herbivore—An animal that eats a diet consisting primarily of plant material.

hypothesis—A tentative explanation for an observation or phenomenon that can be tested by further investigation.

immunocontraception—The induction of contraception by injecting an animal with a compound that produces an immune response that precludes pregnancy.

immunocontraceptive—A contraceptive agent that causes an animal to produce antibodies against some protein or peptide involved in reproduction. The antibodies hinder or prevent some aspect of the reproductive process.

irretrievable—A term that applies to the loss of production, harvest, and consumptive or nonconsumptive use of natural resources. For example, recreation experiences are lost irretrievably when an area is closed to human use. The loss is irretrievable, but the action is not irreversible. Reopening the area would allow a resumption of the experience.

irreversible—A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

leuprolide—A reproductive control agent that prevents secondary hormone secretion, which stops the formation of eggs and ovulation. Leuprolide is a GnRH agonist.

luteinizing hormone—A hormone that triggers ovulation in females.

monitoring—A process of collecting information to evaluate if an objective and/or anticipated or assumed results of a management plan are being realized (effectiveness monitoring) or if implementation is proceeding as planned (implementation monitoring).

National Environmental Policy Act of 1969—A law that requires all federal agencies to examine the environmental impacts of their actions, incorporate environmental information, and utilize public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA

with other planning requirements and prepare appropriate NEPA documents to facilitate better environmental decision making. NEPA requires federal agencies to review and comment on federal agency environmental plans/documents when the agency has jurisdiction by law or special expertise with respect to any environmental impacts involved (42 USC 4321-4327) (40 CFR 1500-1508).

no action alternative—The alternative in which baseline conditions and trends are projected into the future without any substantive changes in management (40 CFR 1502.14(d)). Alternative A is the no action alternative in this planning process.

opportunistic surveillance—Taking diagnostic samples for CWD testing from deer found dead or harvested through a management activity within a national park unit.

P-value—The probability in statistical significance testing, with a value ranging from zero to one, of an observed (or more extreme) result arising by chance, assuming the null hypothesis is true.

paired plot—Two plots used for monitoring that include a fenced and an unfenced plot.

palatability—The property of being acceptable to the taste or sufficiently agreeable in flavor to be eaten.

parasitism—A symbiotic relationship in which one species, the parasite, benefits at the expense of the other, the host.

penetrating captive bolt gun—A gun with a steel bolt that is powered by either compressed air or a blank cartridge. When fired, the bolt is driven into the animal's brain and renders it instantly unconscious without causing pain.

population (or species population)—A group of individual plants or animals that have common characteristics and interbreed among themselves and not with other similar groups.

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 or the total number of cased of a disease in a given location at a specific time.

prion—Protinaceous infectious particle; a microscopic particle similar to a virus but lacking nucleic acid, thought to be the infectious agent for certain degenerative diseases of the nervous system such as CWD.

Record of Decision—A concise public record of decision prepared by a federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

recruitment—Number of organisms surviving and being added to a population at a certain point in time.

reproductive control—A method or methods used to limit the numbers of animals in a population by decreasing the reproductive success of the animals, such as contraception or sterilization.

rut—An annually recurring condition or period of sexual excitement and reproductive activity in deer; the breeding season.

sapling—A young tree, generally not over 4 inches in diameter at breast height.

scoping—An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

seedling—A young plant grown from seed; a young tree before it becomes a sapling.

sex ratio—The proportion of males to females (or vice versa), in a population. A sex ratio of 50:50 would mean an equal number of does and bucks in a deer population.

sharpshooting—The authorized shooting of animals by specially trained professionals using appropriate weapons for means of effective and efficient lethal control.

species diversity—The variety of different species present in a given area; species diversity takes into account both species richness and the relative abundance of species.

species richness—The number of species present in a community.

spotlight survey—A method used to estimate deer numbers in an area by shining spotlights at night and counting the number of deer observed. This technique provides an estimate of deer numbers but not density.

surveillance area—A 5 mile radius established around the first CWD-positive case.

sustainable forest—A mature eastern deciduous forest with adequate native regeneration and understory growth and minimal invasive species.

targeted surveillance—Lethal removal of deer that exhibit clinical signs of CWD, such as changes in behavior and body condition, and testing to determine if CWD is present.

transect—A line along which sampling is performed.

transmissible spongiform encephalopathies—A group of diseases characterized by accumulations of abnormal prion proteins in neural and lymphoid tissues, which cause distinctive lesions in the brain and result in death.

unfenced plot—A specific unfenced area that allows effects on deer browsing to be seen and to be measured.

ungulate—A hoofed, typically herbivorous, animal; includes horses, cows, deer, elk, and bison.

vaccine—A suspension of killed or attenuated microorganisms that, when introduced into the body, stimulates an immune response against that microorganism.

vascular plant—A plant that contains a specialized conducting system consisting of phloem (food-conducting tissue) and xylem (water-conducting tissue). Ferns, trees, and flowering plants are all vascular plants.

viable white-tailed deer population—A population of deer that allows the forest to naturally regenerate, while maintaining a healthy deer population in the park.

woody plants—Plants containing wood fibers, such as trees and shrubs (see "Herbaceous Plant").

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APPENDIX A: CONSULTATION AND CORRESPONDENCE

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United States Department of the Interior

NATIONAL PARK SERVICE

HARPERS FERRY NATIONAL HISTORICAL PARK
P. O. BOX 65
HARPERS FERRY, WEST VIRGINIA 25425

IN REPLY REFER TO:

1.A.2. (HAFE-N1615) February 3, 2015

Ms. Julie Langan
State Historic Preservation Officer
Commonwealth of Virginia
2801 Kensington Avenue
Richmond, VA 23221

Dear Ms. Langan:

The National Park Service (NPS) is currently preparing a White-tailed Deer Management Plan/ Environmental Assessment (EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park in accordance with the National Environmental Policy Act (NEPA). Louis Berger is the NPS's consultant for this effort.

The plan/EA will address a number of issues connected with deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. Therefore, in accordance with the National Historic Preservation Act of 1966 (NHPA), as amended, and the regulations of the Advisory Council on Historic Preservation, the NPS wishes to formally begin consultation with your office with regard to the plan's potential to affect historic properties at Chesapeake and Ohio Canal and Harpers Ferry National Historical Parks. The NPS intends to coordinate the Section 106 review with its responsibilities under NEPA as identified in 36 CFR 800.3(a)(2)(b) and will be submitting the Draft EA to your office for your review. In accordance with 36 CFR 800.8(c)(2)(i), the Draft EA will serve as the Determination of Effect for cultural resources under Section 106 of the NHPA.

Information on the plan/EA may be found on the NPS's website at: http://parkplanning.nps.gov/NHPdeermanagement.

If you have any questions or concerns on the cultural resource or Section 106 aspects of the White-tailed Deer Management Plan/EA development, please contact me at 304-535-6224, or by email at rebecca_harriett@nps.gov.

Sincerely,

//SIGNED//

Rebecca L. Harriett
Superintendent

cc: Kevin Brandt, Chesapeake and Ohio Canal National Historical Park
Margaret Stewart, Louis Berger
Greg Jarvis, NPS, Denver Service Center

bcc: HAFE Subj HAFE Parsons
HAFE:MParsons:sh:304-535-6167:020315:2015 0203 Ltr to Julie Langan VA re Deer EA

United States Department of the Interior

NATIONAL PARK SERVICE

HARPERS FERRY NATIONAL HISTORICAL PARK
P. O. BOX 65
HARPERS FERRY, WEST VIRGINIA 25425

IN REPLY REFER TO:

1.A.2. (HAFE-N1615) February 3, 2015

Mr. Ray Fernald, Manager
Virginia Department of Game and Inland Fisheries
Environmental Services Section
P.O. Box 11104
Richmond, VA 23230

Dear Mr. Fernald:

The National Park Service (NPS), in accordance with the National Environmental Policy Act, is currently preparing a White-tailed Deer Management Plan and Environmental Assessment (plan/EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park. The purpose of this plan/EA is to develop a white-tailed deer management strategy that preserves the cultural landscape through the protection and restoration of native vegetation and other natural and cultural resources. The plan will also include strategies for detection, monitoring, and initial and long-term response to Chronic Wasting Disease in white-tailed deer should it be found in the vicinity of the parks.

The plan will address a number of issues related to deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. We welcome your input on any aspect of this project. We specifically seek information on the presence of any known state-listed rare, threatened, or endangered species that are known to exist in the vicinity of either park.

Additional information on the plan/EA may be found on the NPS's website at:
http://parkplanning.nps.gov/NHPdeermanagement.

Your input will help ensure that the environmental impacts of the proposal are properly considered in the planning process. If you have any questions or require any further information, please contact me at 304-535-6224, or by email at rebecca_harriett@nps.gov.

Sincerely,

//SIGNED//

Rebecca L. Harriett
Superintendent

cc: Kevin Brandt, Chesapeake and Ohio Canal National Historical Park
Margaret Stewart, Louis Berger
Greg Jarvis, NPS, Denver Service Center

bcc: HAFE Subj HAFE Parsons
HAFE:MParsons:sh:304-535-6167:020315:Ltr to Ray Fernald VDGIF re Deer EA

United States Department of the Interior

NATIONAL PARK SERVICE

HARPERS FERRY NATIONAL HISTORICAL PARK
P. O. BOX 65
HARPERS FERRY, WEST VIRGINIA 25425

IN REPLY REFER TO:

1.A.2. (HAFE-N1615) February 3, 2015

Ms. Rene Hypes, Environmental Review Coordinator
Virginia Department of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, 2nd Floor
Richmond, VA 23219

Dear Ms. Hypes:

The National Park Service (NPS), in accordance with the National Environmental Policy Act, is currently preparing a White-tailed Deer Management Plan and Environmental Assessment (plan/EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park. The purpose of this plan/EA is to develop a white-tailed deer management strategy that preserves the cultural landscape through the protection and restoration of native vegetation and other natural and cultural resources. The plan will also include strategies for detection, monitoring, and initial and long-term response to Chronic Wasting Disease in white-tailed deer should it be found in the vicinity of the parks.

The plan will address a number of issues related to deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. We welcome your input on any aspect of this project. We specifically seek information on the presence of any known state-listed rare, threatened, or endangered species that are known to exist in the vicinity of either park.

Additional information on the plan/EA may be found on the NPS's website at:
http://parkplanning.nps.gov/NHPdeermanagement.

Your input will help ensure that the environmental impacts of the proposal are properly considered in the planning process. If you have any questions or require any further information, please contact me at 304-535-6224, or by email at rebecca_harriett@nps.gov. Thank you for your assistance.

Sincerely,

//SIGNED//

Rebecca L. Harriett
Superintendent

cc: Kevin Brandt, Chesapeake and Ohio Canal National Historical Park
Margaret Stewart, Louis Berger
Greg Jarvis, NPS, Denver Service Center

bcc: HAFE Subj HAFE Parsons
HAFE:MParsons:sh:304-535-6167:020315:2015 0203 Ltr to Rene Hypes VA re Deer EA

United States Department of the Interior

NATIONAL PARK SERVICE
C&O Canal National Historical Park
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740

IN REPLY REFER TO
1.A.2 (Cultural and Natural Resources)

February 11, 2015

Barbara Sargent
West Virginia Division of Natural Resources
Operations Center
P.O. Box 67
Elkins, West Virginia 26241-323

Dear Ms. Sargent:

The National Park Service (NPS), in accordance with the National Environmental Policy Act (NEPA), is currently preparing a White-tailed Deer Management Plan and Environmental Assessment (plan/EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park. The purpose of the plan/EA is to develop a deer management strategy that supports preservation of the cultural landscape through the protection and restoration of native vegetation and other natural and cultural resources. The plan will also include longer-term strategies for detection, monitoring and addressing Chronic Wasting Disease in white-tailed deer at the parks (in addition to the short term detection and initial response plan already in place).

The plan will address a number of issues related to deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. We welcome your input on any aspect of this project. We specifically seek information on the presence of any known state-listed rare, threatened, or endangered species that are known to exist in the vicinity of the parks.

Additional information on the plan/EA may be found on the NPS's website at:
http://parkplanning.nps.gov/NHPdeermanagement.

Your input will help ensure that the environmental impacts of the proposal are properly considered in the planning process. If you have any questions or require any further information please contact Michelle Carter at 301-714-2225, or by email at michelle_carter@nps.gov.

Sincerely,

Kevin Brandt
Superintendent
Chesapeake and Ohio Canal National Historical Park

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park

United States Department of the Interior

NATIONAL PARK SERVICE
C&O Canal National Historical Park
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740

IN REPLY REFER TO
1.A.2 (Cultural and Natural Resources)

February 11, 2015

Mr. J. Rodney Little
State Historic Preservation Officer
Maryland Historical Trust
100 Community Place
Crownsville, MD 21032

Dear Mr. Little:

The National Park Service (NPS) is currently preparing a White-tailed Deer Management Plan/ Environmental Assessment (EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park in accordance with the National Environmental Policy Act (NEPA).

The Plan/EA will address a number of issues connected with deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. Therefore, in accordance with the National Historic Preservation Act of 1966 (NHPA), as amended, and the regulations of the Advisory Council on Historic Preservation, the NPS wishes to formally begin consultation with your office with regard to the Plan's potential to affect historic properties at Chesapeake and Ohio Canal and Harpers Ferry National Historical Parks. The NPS intends to coordinate the Section 106 review with its responsibilities under NEPA as identified in 36 CFR 800.3(a)(2)(b) and will be submitting the Draft EA to your office for your review. In accordance with 36 CFR 800.8(c)(2)(i), the Draft EA will serve as the Determination of Effect for cultural resources under Section 106 of the NHPA.

Information on the Plan/EA may be found on the NPS's website at: http://parkplanning.nps.gov/NHPdeermanagement.

If you have any questions or concerns on the cultural resource or Section 106 aspects of the White-tailed Deer Management Plan/EA development, please contact Mia Parsons at 304-535-6167, or by email at mia_parsons@nps.gov.

Sincerely,

Kevin Brandt
Superintendent
Chesapeake and Ohio Canal National Historical Park

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park

United States Department of the Interior

NATIONAL PARK SERVICE
C&O Canal National Historical Park
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740

IN REPLY REFER TO
1.A.2 (Cultural and Natural Resources)

February 11, 2015

Genevieve LaRouche, Field Supervisor
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochran Drive
Annapolis, Maryland 21401

Dear Ms. LaRouche:

The National Park Service (NPS), in accordance with the National Environmental Policy Act, is currently preparing a White-tailed Deer Management plan and Environmental Assessment (plan/EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park. The purpose of this plan/EA is to develop a white-tailed deer management strategy that preservation of the cultural landscape through the protection and restoration of native vegetation and other natural and cultural resources. The plan will also include strategies for detection, monitoring, and initial and long-term response to Chronic Wasting Disease in white-tailed deer should it be found in the vicinity of the parks.

The plan will address a number of issues related to deer management in the battlefields, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. We welcome your input on any aspect of this project. We specifically seek information on the presence of any known federally-listed rare, threatened, or endangered species that are known to exist in the vicinity of either park.

Additional information on the plan/EA may be found on the NPS's website at:
http://parkplanning.nps.gov/NHPdeermanagement.

Your input will help ensure that the environmental impacts of the proposal are properly considered in the planning process. If you have any questions or require any further information please contact Michelle Carter at 301-714-2225, or by email at michelle_carter@nps.gov.

Sincerely,

Kevin Brandt
Superintendent
Chesapeake and Ohio Canal National Historical Park

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park

United States Department of the Interior

NATIONAL PARK SERVICE
C&O Canal National Historical Park
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740

IN REPLY REFER TO
1.A.2 (Cultural and Natural Resources)

February 11, 2015

Mr. Paul A. Peditto, Director
Wildlife and Heritage Service
Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401

Dear Mr. Peditto:

The National Park Service (NPS), in accordance with the National Environmental Policy Act (NEPA), is currently preparing a White-tailed Deer Management Plan and Environmental Assessment (plan/EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park. The purpose of the plan/EA is to develop a deer management strategy that supports preservation of the cultural landscape through the protection and restoration of native vegetation and other natural and cultural resources. The plan will also include longer-term strategies for detection, monitoring and addressing Chronic Wasting Disease in white-tailed deer at the parks (in addition to the short term detection and initial response plan already in place).

The plan will address a number of issues related to deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. We welcome your input on any aspect of this project. We specifically seek information on the presence of any known state-listed rare, threatened, or endangered species that are known to exist in the vicinity of the parks.

Additional information on the plan/EA may be found on the NPS's website at:
http://parkplanning.nps.gov/NHPdeermanagement

Your input will help ensure that the environmental impacts of the proposal are properly considered in the planning process. If you have any questions or require any further information please contact Michelle Carter at 301-714-2225, or by email at michelle_carter@nps.gov.

Sincerely,

Kevin Brandt
Superintendent
Chesapeake and Ohio Canal National Historical Park

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park

United States Department of the Interior

NATIONAL PARK SERVICE
C&O Canal National Historical Park
1850 Dual Highway, Suite 100
Hagerstown, Maryland 21740

IN REPLY REFER TO
1.A.2 (Cultural and Natural Resources)

February 11, 2015

Ms. Susan Pierce
Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
The Culture Center
Capitol Complex
1900 Kanawha Boulevard East
Charleston WV 25305-0300

Dear Ms. Pierce:

The National Park Service (NPS) is currently preparing a White-tailed Deer Management Plan/ Environmental Assessment (EA) for Chesapeake and Ohio Canal National Historical Park and Harpers Ferry National Historical Park in accordance with the National Environmental Policy Act (NEPA). Louis Berger is the NPS's consultant for this effort.

The Plan/EA will address a number of issues connected with deer management in the parks, such as impacts to vegetation and wildlife, deer population health, and effects on visitor experience, among others. A primary focus of the plan/EA will be the effects of high deer densities on forest regeneration and important park cultural landscapes. Therefore, in accordance with the National Historic Preservation Act of 1966 (NHPA), as amended, and the regulations of the Advisory Council on Historic Preservation, the NPS wishes to formally begin consultation with your office with regard to the Plan's potential to affect historic properties at Chesapeake and Ohio Canal and Harpers Ferry National Historical Parks. The NPS intends to coordinate the Section 106 review with its responsibilities under NEPA as identified in 36 CFR 800.3(a)(2)(b) and will be submitting the Draft EA to your office for your review. In accordance with 36 CFR 800.8(c)(2)(i), the Draft EA will serve as the Determination of Effect for cultural resources under Section 106 of the NHPA.

Information on the Plan/EA may be found on the NPS's website at: http://parkplanning.nps.gov/NHPdeermanagement.

If you have any questions or concerns on the cultural resource or Section 106 aspects of the White-tailed Deer Management Plan/EA development, please contact Mia Parsons at 304-535-6167, or by email at mia_parsons@nps.gov.

Sincerely,

Kevin Brandt
Superintendent
Chesapeake and Ohio Canal National Historical Park

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park

Copy:
Margaret Stewart, Louis Berger
Greg Jarvis, NPS, Denver Service Center

Molly Joseph Ward
Secretary of Natural Resources

Clyde E. Cristman
Director

Joe Elton
Deputy Director of Operations

Rochelle Altholz
Deputy Director of Administration and Finance

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION

600 East Main Street, 24th Floor
Richmond, Virginia 23219
(804)786-6124

March 20, 2015

Rebecca Harriett
Superintendent
Harpers Ferry National Historical Park
P.O. Box 65
Harpers Ferry
West Virginia 25425

Re: White-tailed Deer Management Plan for Harpers Ferry National Historical Park

Dear Ms. Harriett:

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources within Harpers Ferry National Historical Park. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

According to the information currently in our files, the Short Hill Mountain Conservation Site is within the project area. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant. Short Hill Mountain Conservation Site has been given a biodiversity significance ranking of B3, which represents a site of high significance. The natural heritage resources associated with this conservation site are:

Glyptemys insculpta	Wood turtle	G4/S2/NL/LT
Lythrum alatum	Winged loosestrife	G5/S2/NL/NL
Vitis rupestris	Sand grape	G3/S1?/NL/NL
Sympphyotrichum shortii	Short's aster	G5/S1/NL/NL
Erythronium albidum	White trout lily	G5/S2/NL/NL
Maianthemum stellatum	Starry Solomon's plume	G5/S2/NL/NL
Senecio suaveolens	Sweet-scented Indian-plantain	G4/S2/NL/NL
	Central Appalachian/Piedmont Basic Mesic Forest	G4G5/S4/NL/NL
	Central Appalachian Acidic Boulderfield Woodland	G4/S3/S4/NL/NL
	Central Appalachian Dry-Mesic Chestnut Oak-Northern Red Oak Forest	G5/S4/SL/SL

In addition, Pink valerian (*Valeriana pauciflora,* G4/S2/NL/NL) and Yellow avens (*Geum aleppicum,* G5/SH/NL/NL*)* have been historically documented within the Short Mountain Conservation Site but have not been field verified since 1936.

Please note, Piney Run has been designated by the Virginia Department of Game and Inland Fisheries (VDGIF) as a "Threatened and Endangered Species Water" for the Wood turtle.

DCR supports the conservation of the documented rare resources within the park and the development of a white-tailed deer management plan. Due to the legal status of the wood turtle, DCR recommends coordination with VDGIF, Virginia's regulatory authority for the management and protection of this species to ensure compliance with the Virginia Endangered Species Act (VA ST §§ 29.1-563 – 570).

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the DCR, DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

There are no State Natural Area Preserves under DCR's jurisdiction in the project vicinity.
New and updated information is continually added to Biotics. Please re-submit project information and map for an update on this natural heritage information if the scope of the project changes and/or six months has passed before it is utilized.

The VDGIF maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Gladys Cason (804-367-0909 or Gladys.Cason@dgif.virginia.gov).

Should you have any questions or concerns, feel free to contact me at 804-371-2708. Thank you for the opportunity to comment on this project.

Sincerely,

S. René Hypes
Project Review Coordinator

CC: Ernie Aschenbach, VDGIF

COMMONWEALTH of VIRGINIA

Department of Historic Resources

Molly Joseph Ward
Secretary of Natural Resources

2801 Kensington Avenue, Richmond, Virginia 23221

Julie V. Langan
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
www.dhr.virginia.gov

March 20, 2015

Rebecca L. Harriett, Superintendent
National Park Service
Harpers Ferry National Historical Park
P.O. Box 65
Harpers Ferry, West Virginia 25425

Re: White-tailed Deer Management Plan/Environmental Assessment
Chesapeake and Ohio Canal and Harpers Ferry National Historical Park
Loudoun County, Virginia
DHR Project No. 2015- 0084

Dear Ms. Harriett:

On February 18, 2015 we received notification that the National Park Service intends to use the NEPA process to meet the Park's obligations under Section 106. We understand that the objectives of the plan include identifying ways to further protect the integrity and character of the parks' cultural landscapes, including the spatial pattern of open and forested land, contributing historic views and agricultural landscapes. Deer overabundance is an issue to be considered. We look forward to working with you as you develop the plan.

If you have any questions concerning our comments, or if we may provide any further assistance, please do not hesitate to contact at me at (804) 482-6088.

Sincerely,

Ethel R Eaton

Ethel R. Eaton, Ph.D., Senior Policy Analyst
Review and Compliance Division

Administrative Services
10 Courthouse Ave.
Petersburg, VA 23803
Tel: (804) 862-6408
Fax: (804) 862-6196

Eastern Region Office
2801 Kensington Avenue
Richmond, VA 23221
Tel: (804) 367-2323
Fax: (804) 367-2391

Western Region Office
962 Kime Lane
Salem, VA 24153
Tel: (540) 387-5443
Fax: (540) 387-5446

Northern Region Office
5357 Main Street
PO Box 519
Stephens City, VA 22655
Tel: (540) 868-7029
Fax: (540) 868-7033

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APPENDIX B: SPECIES OF CONCERN

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TABLE B-1. STATE-LISTED THREATENED OR ENDANGERED VASCULAR PLANT SPECIES DOCUMENTED TO OCCUR WITHIN THE TWO PARK UNITS

Species Type	Species Scientific Name	Species Common Name	Abundance	State Status	Palatability
Species occurring at Harpers Ferry NHP					
Vascular Plant	*Matelea carolinensis*	anglepod	Unknown	MD: E	Unknown
Vascular Plant	*Thuja occidentalis*	arborvitae	Unknown	MD: T	Yes (Carey 1993)
Vascular Plant	*Baptisia australis*	blue false indigo	Rare	MD: T	Unknown
Vascular Plant	*Bromus kalmii*	Canada bromegrass	Unknown	MD: E	Unknown
Vascular Plant	*Carex careyana*	Carey's sedge	Rare	MD: E	Unknown
Vascular Plant	*Iris cristata*	crested iris	Rare	MD: E	Unknown
Vascular Plant	*Aristolochia macrophylla*	dutchman's pipe	Unknown	MD: T	Unknown
Vascular Plant	*Cornus canadensis*	dwarf dogwood	Unknown	MD: E	Unknown
Vascular Plant	*Schizachne purpurascens*	false melic grass	Unknown	MD: E	Unknown
Vascular Plant	*Helianthus occidentalis*	fewleaf sunflower	Rare	MD: T	Unknown
Vascular Plant	*Eleocharis compressa*	flatstem spikerush	Rare	MD: E	Unknown
Vascular Plant	*Trifolium virginicum*	Kates mountain clover	Unknown	MD: T	Unknown
Vascular Plant	*Asplenium pinnatifidum*	lobed spleenwort	Rare	MD: E	Unknown
Vascular Plant	*Rosa blanda*	meadow rose	Unknown	MD: E	Unknown
Vascular Plant	*Melica nitens*	melic-grass	Rare	MD: T	Unknown
Vascular Plant	*Scutellaria saxatilis*	rock skullcap	Rare	MD: E	Unknown
Vascular Plant	*Carex shortiana*	Short's sedge	Unknown	MD: E	Unknown
Vascular Plant	*Quercus shumardii*	Shumard's oak	Rare	MD: T	Yes (Sullivan 1993)
Vascular Plant	*Silene nivea*	snowy campion	Rare	MD: E	Unknown
Vascular Plant	*Smilacina stellata*	star false solomon's seal	Unknown	MD: E	Unknown
Vascular Plant	*Hasteola suaveolens*	sweet-scented Indian-plantain	Rare	MD: E	Unknown
Vascular Plant	*Juncus torreyi*	Torrey rush, Torrey's rush	Unknown	MD: E	Unknown
Vascular Plant	*Pycnanthemum torrei*	Torrey's mountainmint	Rare	MD: E	Unknown
Vascular Plant	*Erythronium albidum*	white trout-lily	Rare	MD: T	Unknown
Vascular Plant	*Geum aleppicum*	yellow avens	Unknown	MD: E	Unknown
Species occurring at Chesapeake and Ohio Canal NHP					
Vascular Plant	*Matelea obliqua*	Anglepod	Unknown	MD: E	Unknown
Vascular Plant	*Astragalus distortus*	Bent Milkvetch	Unknown	MD: T	Unknown
Vascular Plant	*Carya laciniosa*	Big Shellbark Hickory	Unknown	MD: E	Unknown

Species Type	Species Scientific Name	Species Common Name	Abundance	State Status	Palatability
Vascular Plant	*Oryzopsis racemosa*	Black-Fruited Mountainrice	Unknown	MD: T	Unknown
Vascular Plant	*Iresine rhizomatosa*	Bloodleaf	Unknown	MD: E	Unknown
Vascular Plant	*Baptisia australis*	Blue Wild Indigo	Common	MD: T	Unknown
Vascular Plant	*Astragalus canadensis*	Canada Milkvetch	Unknown	MD: E	Unknown
Vascular Plant	*Carex careyana*	Carey'S Sedge	Uncommon	MD: E	Unknown
Vascular Plant	*Trachelospermum difforme*	Climbing Dogbane	Unknown	MD: E	Unknown
Vascular Plant	*Phacelia covillei*	Coville's Phacelia	Unknown	MD: E	Unknown
Vascular Plant	*Iris cristata*	Crested Iris	Unknown	MD: E	Unknown
Vascular Plant	*Carex davisii*	Davis' Sedge	Rare	MD: E	Unknown
Vascular Plant	*Agalinis auriculata*	Earleaf False Foxglove	Unknown	MD: E	Unknown
Vascular Plant	*Dirca palustris*	Eastern Leatherwood	Unknown	MD: T	Unknown
Vascular Plant	*Mecardonia acuminata*	Erect Water-Hyssop	Unknown	MD: E	Unknown
Vascular Plant	*Hasteola suaveolens*	False Indian Plantain	Unknown	MD: E	Unknown
Vascular Plant	*Eleocharis compressa*	Flatstem Spikerush	Common	MD: E	Unknown
Vascular Plant	*Paspalum fluitans*	Floating Paspalum	Unknown	MD: E	Unknown
Vascular Plant	*Diplazium pycnocarpon*	Glade Fern	Unknown	MD: T	Unknown
Vascular Plant	*Napaea dioica*	Glade Mallow	Unknown	MD: E	Unknown
Vascular Plant	*Hydrastis canadensis*	Goldenseal	Unknown	MD: T	Unknown
Vascular Plant	*Echinodorus cordifolius*	Heart-Leaved Burhead	Unknown	MD: E	Unknown
Vascular Plant	*Carex hitchcockiana*	Hitchcock's Sedge	Rare	MD: E	Yes (Hilty 2012)
Vascular Plant	*Muhlenbergia capillaris*	Long-Awned Hairgrass	Unknown	MD: E	Unknown
Vascular Plant	*Amelanchier nantucketensis*	Nantucket Serviceberry	Unknown	MD: T	Unknown
Vascular Plant	*Melica mutica*	Narrow Melic Grass	Unknown	MD: T	Unknown
Vascular Plant	*Triosteum angustifolium*	Narrow-Leaved Horse-Gentian	Unknown	MD: E	Unknown
Vascular Plant	*Rumex altissimus*	Pale Dock	Uncommon	MD: E	Unknown
Vascular Plant	*Krigia dandelion*	Potato Dandelion	Unknown	MD: E	Unknown
Vascular Plant	*Platanthera peramoena*	Purple Fringeless Orchid	Unknown	MD: T	Unknown
Vascular Plant	*Polygala polygama*	Racemed Milkwort	Unknown	MD: T	Unknown
Vascular Plant	*Desmodium rigidum*	Rigid Tick-Trefoil	Unknown	MD: E	Unknown
Vascular Plant	*Solidago simplex var. racemosa*	Riverbank Goldenrod	Unknown	MD: T	Unknown
Vascular Plant	*Scutellaria saxatilis*	Rock Skullcap	Unknown	MD: E	Unknown
Vascular Plant	*Sporobolus clandestinus*	Rough Rushgrass	Unknown	MD: T	Unknown
Vascular Plant	*Carex shortiana*	Short's Sedge	Uncommon	MD: E	Unknown

Species Type	Species Scientific Name	Species Common Name	Abundance	State Status	Palatability
Vascular Plant	*Quercus shumardii*	Shumard Oak	Unknown	MD: T	Yes (Sullivan 1993)
Vascular Plant	*Lipocarpha micrantha*	Smallflower Hemicarpha	Unknown	MD: E	Unknown
Vascular Plant	*Spermacoce glabra*	Smooth Buttonweed	Unknown	MD: E	Unknown
Vascular Plant	*Ruellia strepens*	Smooth Wild-Petunia	Unknown	MD: E	Unknown
Vascular Plant	*Smilacina stellata*	Star-Flowered False Solomon's Seal	Unknown	MD: E	Unknown
Vascular Plant	*Coreopsis tripteris*	Tall Tickseed	Unknown	MD: E	Unknown
Vascular Plant	*Melica nitens*	Three-Flowered Melic Grass	Unknown	MD: T	Unknown
Vascular Plant	*Scutellaria nervosa*	Veined Skullcap	Unknown	MD: E	Unknown
Vascular Plant	*Onosmodium virginianum*	Virginia False-Gromwell	Unknown	MD: E	Unknown
Vascular Plant	*Sida hermaphrodita*	Virginia Mallow	Unknown	MD: E	Unknown
Vascular Plant	*Helianthus occidentalis*	Western Sunflower	Unknown	MD: T	Unknown
Vascular Plant	*Erythronium albidum*	White Trout Lily	Unknown	MD: T	Unknown
Vascular Plant	*Lythrum alatum*	Winged Loosestrife	Unknown	MD: E	Unknown
Vascular Plant	*Paronychia virginica var. virginica*	Yellow Nailwort	Unknown	MD: E	Unknown
Vascular Plant	*Ranunculus flabellaris*	Yellow Water Crowfoot	Unknown	MD: E	Unknown

Source: (NPS 2015a)

TABLE B-2: BIRDS OF CONSERVATION CONCERN WITHIN CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK AND HARPERS FERRY NATIONAL HISTORICAL PARK

Species	Common Name	Seasonal Occurrence in Project Area	C&O Canal	Harpers Ferry
Haematopus palliatus	American oystercatcher	Year-round	X	
Botaurus lentiginosus	American bittern	Wintering	X	
Haliaeetus leucocephalus	Bald eagle	Year-round	X	X
Coccyzus erythropthalmus	Black-billed cuckoo	Breeding	X	X
Poecile atricapillus	Black-capped chickadee	Year-round	X	
Vermivora pinus	Blue-winged warbler	Breeding	X	X
Wilsonia canadensis	Canada warbler	Breeding	X	
Dendroica cerulea	Cerulean warbler	Breeding	X	
Passerella liaca	Fox sparrow	Wintering	X	X
Vermivora chrysoptera	Golden-winged warbler	Breeding	X	X
Gelochelidon nilotica	Gull-billed tern	Breeding	X	
Ammodramus henslowii	Henslow's sparrow	Breeding	X	
Oporornis formosus	Kentucky warbler	Breeding	X	X
Lxobrychus exilis	Least bittern	Breeding	X	
Lanius ludovicianus	Loggerhead shrike	Year-round, Breeding	X	X
Parkesia motacilla	Louisiana waterthrush	Breeding	X	X
Podilymbus podiceps	Pied-billed grebe	Breeding	X	X
Dendroica discolor	Prairie warbler	Breeding	X	X
Protonotaria citrea	Prothonotary warbler	Breeding	X	
Calidris maritima	Purple sandpiper	Wintering	X	
Melanerpes erythrocephalus	Red-headed woodpecker	Year-round, Breeding	X	X
Euphagus carolinus	Rusty blackbird	Wintering	X	X
Ammodramus caudacutus	Saltmarsh sparrow	Year-round	X	
Limnodromus griseus	Short-billed Dowitcher	Wintering	X	
Asio flammeus	Short-eared owl	Wintering	X	X
Egretta thula	Snowy egret	Breeding	X	
Bartramia longicauda	Upland sandpiper	Breeding	X	
Hylocichla mustelina	Wood thrush	Breeding	X	X
Helmitheros vermivorum	Worm-eating warbler	Breeding	X	X
Sphyrapicus varius	Yellow-billed sapsucker	Breeding	X	X

Source: NPS (2015b)

TABLE B-3: STATE-LISTED WILDLIFE OF CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK AND HARPERS FERRY NATIONAL HISTORICAL PARK

Species	Common Name	State-listed	C&O Canal	Harpers Ferry
Mammals				
Neotoma magister	Allegheny woodrat	MD-Endangered	X	X
Myotis sodalis	Indiana bat	MD-Endangered	X	
Myotis leibii	Eastern small-footed myotis	MD-Endangered	X	
Sylvilagus floridanus	Eastern cottontail	MD-Watchlist	X	
Sorex longirostris	Southeastern shrew	MD-Watchlist	X	
Sorex fumeus	Smoky shrew	MD-In need of conservation	X	
Birds				
Pandion haliaetus	Osprey	WV		X
Falco peregrinus	Peregrine falcon	MD, VA		X
Contopus cooperi	Olive-sided flycatcher	MD-Endangered	X	
Corvus corax	Common raven	MD-Rare	X	
Junco hyemalis	Dark-eyed junco	MD-Rare	X	
Parkesia noveboracensis	Northern waterthrush	MD-Rare	X	
Haliaeetus leucocephalus	Bald eagle	MD-Watchlist	X	
Setophaga caerulescens	Black-throated blue warbler	MD-Watchlist	X	
Setophaga cerulea	Cerulean warbler	MD-Watchlist	X	
Empidonax minimus	Least flycatcher	MD-Watchlist	X	
Botaurus lentiginosus	American bittern	MD-In need of conservation	X	

Source: NPS (2008; 2014)
Note: did not list herpetofauna.

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APPENDIX C: CHRONIC WASTING DISEASE

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This appendix summarizes guidance provided by the National Park Service (NPS) in response to chronic wasting disease (CWD), and it outlines management options available to parks for implementation in the absence of a specific CWD plan.

As of February 2014, CWD has been diagnosed in only two national parks—Rocky Mountain and Wind Cave National Parks. However, many national park system units are at high risk because of their proximity to known CWD cases in many areas of the United States. There have been cases of CWD near several national parks in the National Capital Region (NCR) and elsewhere, in wild white-tailed deer in Hampshire County, West Virginia, in Maryland in Green Ridge State Forest, in Frederick County, Virginia, and in a captive deer in New Oxford, Pennsylvania (NPS, Ratchford, pers. comm. 2014). While much is still unknown about the spread of the disease and the long-term effects, there is currently no evidence that the disease can be transmitted to humans or domestic livestock.

There is a high likelihood that the disease will be detected in other areas of the country following increases in disease surveillance as well as disease spread. CWD presents population decline risks to wild cervids and although there is no evidence to suggest that CWD is transferred to domestic animals or humans these risks are not completely understood. Therefore, CWD has become an issue of national importance to wildlife managers and other interested publics, as well as NPS managers.

NPS POLICY AND GUIDANCE

DIRECTOR'S CWD GUIDANCE MEMORANDUM (JULY 26, 2002)

The NPS director provided guidance to regions and parks on NPS response to CWD in a memorandum dated July 26, 2002. Even though the memo pre-dates current CWD distribution in the national park system, the guidance remains pertinent. The guidance addresses surveillance, management, and communication regarding the disease. It also strictly limits human assisted translocation of deer and elk into or out of national park system units. Deviation from the guidance memo requires a waiver approved by the director.

A NATIONAL PARK SERVICE MANAGER'S REFERENCE NOTEBOOK TO UNDERSTANDING CHRONIC WASTING DISEASE (VERSION 5: JANUARY 2012)

This notebook serves as an informational reference that summarizes some of the most pertinent CWD literature, management options, and policies as they pertain to units of the national park system. It is not meant to be an all-inclusive review of current literature or management options. CWD is an emerging disease, and the knowledge base is continuing to expand. This document will be updated as necessary to include information pertinent to the NPS.

ELK AND DEER MEAT FROM AREAS AFFECTED BY CHRONIC WASTING DISEASE: A GUIDE TO DONATION FOR HUMAN CONSUMPTION (MAY 2006)

This document provides an overview of the issues surrounding CWD as it relates to public health, and includes NPS recommendations for the use of cervid meat for human consumption from parks affected by CWD surveillance and management actions within or near areas where CWD has been identified or where CWD testing is being conducted.

DESCRIPTION AND DISTRIBUTION

CWD is a slowly progressive, infectious, self-propagating, neurological disease of captive and free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), Rocky Mountain elk (*Cervus elaphus nelsoni*), and moose (*Alces alces*). The disease belongs to the transmissible spongiform encephalopathy group of diseases (similar to scrapie and bovine spongiform encephalopathy). CWD is the only transmissible spongiform encephalopathy currently found in free-ranging animals. Transmissible spongiform encephalopathies are characterized by accumulations of abnormal prion (proteinaceous infectious particle) proteins in neural and lymphoid tissues (Prusiner 1982, 1991, 1997).

There is evidence that human-associated movement of cervids has aided in the spread of the disease in captive, and likely free-ranging, deer and elk (Miller and Williams 2003; Salman 2003; Williams and Miller 2003). Localized artificial concentration of cervids in areas with few natural predators likely aids in disease transmission (Spraker et al. 1997; Samuel et al. 2003; Farnsworth et al. 2005; Wild et al. 2011). There is strong evidence to suggest that anthropogenic factors, such as land use, influence CWD prevalence (Farnsworth et al. 2005). Therefore, human influences are likely a significant component of observed CWD distribution and prevalence. CWD is considered a nonnative disease process (Wild et al. 2011).

The historic area of CWD infection encompasses northeastern Colorado, southeastern Wyoming, and the southwest corner of the Nebraska panhandle (Williams and Miller 2002; Williams et al. 2002b). However, with increased surveillance that has occurred since 2001, the disease has been found with increasing frequency in other geographically distinct areas (Joly et al. 2003).

CLINICAL SIGNS

The primary clinical signs of CWD in deer and elk are changes in behavior and body condition (Williams et al. 2002b). Signs of the disease are progressive. Initially only someone who is quite familiar with a particular animal or group of animals would notice a change in behavior. As the clinical disease progresses over the course of weeks to months, animals demonstrate increasingly abnormal behavior and additional clinical signs (Williams and Young 1992). Affected animals can lose their fear of humans, show repetitive movements, and/or appear depressed but quickly become alert if startled. Affected animals rapidly lose body condition, despite having an appetite (Williams et al. 2002b). In the end stages of the disease they become emaciated. Once an animal demonstrates clinical signs, the disease is invariably fatal. There is no treatment or preventative vaccine for the disease.

DIAGNOSIS AND TESTING

CWD was initially diagnosed in deer and elk by testing a portion of the brain (histopathology techniques) (Williams and Young 1993). While this method is effective at diagnosing relatively advanced cases, it is not sensitive enough to detect early disease stages (Spraker et al. 1997; Peters et al. 2000).

In contrast, immunohistochemistry is a sensitive, specific, and reliable test that can be used to identify relatively early stages of chronic wasting disease. This technique can detect CWD prions in many tissues (brain, retropharyngeal lymph nodes, and tonsils) (O'Rourke et al. 1998).

In addition to immunohistochemistry, which takes several days to complete, new rapid tests also employ antibody technology to diagnose CWD. Each has various advantages and disadvantages. Only certified laboratories can perform immunohistochemistry or the rapid CWD tests.

No test available is 100% sensitive for CWD, which means that a negative test result is not a guarantee of a disease-free animal.

TRANSMISSION

There is strong evidence that CWD is infectious and is spread by direct (animal to animal) or indirect (environment to animal) lateral transmission (Miller et al. 2000; Miller and Williams 2003). Bodily secretions such as feces, urine, and saliva have all been suggested as possible means of transmitting the disease between animals and disseminating infectious prions into the environment (Miller et al. 2000; Williams et al. 2002b; Williams and Miller 2003). Maternal transmission cannot be ruled out, but it does not play a large role in continuing the disease cycle in either deer or elk (Miller et al. 1998; Miller et al. 2000; Miller and Williams 2003; Miller and Wild 2004).

Like other contagious diseases, CWD transmission increases when animals are highly concentrated. High animal densities and environmental contamination are important factors in transmission among captive cervids. These factors may also play a role in transmission in free-ranging animals (Miller et al. 2004).

Management actions that increase mortality rates in diseased populations can retard disease transmission by

1. Reducing the average lifetime of infected individuals. Reduced lifespan, in turn, can compress the period of time when animals are infectious, thereby reducing the number of infections produced per infected individual.

2. Reducing population density. The effect of reduced intervals of infectivity is amplified by reductions in population density because there are potentially fewer infectious contacts made. Both of these mechanisms may retard the transmission of disease. If these mechanisms cause the number of new infections produced per infected individual to fall below one, then the disease will be eliminated from the population (Tompkins et al. 2001). The likelihood of this occurring is unknown at this time.

DISPOSAL OF CHRONIC WASTING DISEASE INFECTED ORGANIC MATERIAL

Discarding known or suspect CWD-contaminated organic material, such as whole or partial carcasses, is likely to become an important issue for national park system units in the future. Each state, Environmental Protection Agency region, and refuse disposal area is likely to have different regulations and restrictions for disposal of potentially infected tissues. Currently there is no national standard for disposal. Because infected carcasses serve as a source of environmental contamination (Miller et al. 2004), it is recommended that known and suspect CWD-positive animals be removed from the environment.

Given the type of infectious agent (prions), there are limited means of effective disposal. In most cases, however, off-site disposal of infected material is recommended in approved locations. The available options for each park will vary and will depend on the facilities present within a reasonable distance from the park. Disposal of animals that are confirmed to be infected should be disposed of in one of the following ways:

- Alkaline Digestion—Alkaline digestion is a common disposal method used by veterinary diagnostic laboratories. This method uses sodium hydroxide or potassium hydroxide to catalyze the hydrolysis of biological material (protein, nucleic acids, carbohydrates, lipids, etc.) into an aqueous solution consisting of small peptides, amino acids, sugars, and soaps. During this process the prion proteins are destroyed.
- Incineration—Incineration is another disposal method commonly used by veterinary diagnostic laboratories. This method burns the carcass at intense temperatures (600–1000 degrees centigrade).
- Landfill—The availability of this option varies by region, state, and local regulations. Therefore, local landfills must be contacted for more information regarding carcass disposal, to determine if they can and will accept CWD positive carcasses or carcass parts.

MANAGEMENT

Chronic wasting disease has occurred in a limited geographic area of northeastern Colorado and southeastern Wyoming for over 30 years. Relatively recently, it has been detected in captive and free-ranging deer and elk in several new locations, including Nebraska, South Dakota, New Mexico, Utah, new areas of Wyoming and Colorado, and east of the Mississippi River in Wisconsin, Illinois, West Virginia, New York, Michigan and most recently in North Dakota, Minnesota, Virginia, and Maryland.

The NPS does not have a single overarching plan to manage chronic wasting disease in all parks. However, it has provided guidance to parks in how to monitor for and minimize the potential spread of the disease, as well as remove infected animals from specific areas. Generally, two levels of action have been identified, based on risk of transmission: (1) when CWD is not known to occur within a 60-mile

radius from the park, and (2) when the disease is known to occur within the park or within a 60-mile radius.

The chance of finding CWD in a park is related to two factors: the risk of being exposed to the disease (the likelihood that the disease will be introduced into a given population), and the risk of the disease being amplified once a population of animals has been exposed. The first risk is important for national park system units where no CWD cases have been identified within 60 miles of their border. The second risk applies to units where chronic wasting disease is close to or within their borders, as well as in proactive planning efforts. By evaluating the risk of CWD exposure and amplification, managers can make better decisions regarding how to use their resources to identify the disease.

Actions available to identify CWD are linked to the risk factors present in and around the park. When risk factors are moderate, surveillance for chronic wasting disease can be less intense (e.g., opportunistic) than when risk is high (NPS 2005e). When the risk is higher, surveillance of all types should be increased. Other management actions that are in place for the host species may limit risk of exposure or transmission by maintaining biologically appropriate population densities. Whether CWD is within 60 miles of a unit or not, coordination with state wildlife and agriculture agencies when conducting CWD surveillance is strongly encouraged.

OPPORTUNISTIC SURVEILLANCE

Opportunistic surveillance involves taking diagnostic samples for testing from deer found dead or harvested through a management activity within a unit of the national park system. Cause of death may be from being shot, predation, disease, trauma (hit by car), or undetermined. Opportunistic surveillance has little, if any, negative impact on current populations. Unless deer are removed, for either population management or research goals, relatively small sample sizes may be available for opportunistic testing. Animals killed in collisions with vehicles may be a biased sample that could help detect CWD. Research has indicated that CWD-infected mule deer may be more likely to be hit by vehicles than non-CWD infected deer (Krumm et al. 2005).

Opportunistic surveillance is an excellent way to begin surveying for presence of CWD without changing management of the deer population. This is a good option for park units where CWD is a moderate risk but where it has not yet been encountered within 60 miles of the park. Opportunistic surveillance should also be used in parks in close proximity to the disease.

TARGETED SURVEILLANCE

Targeted surveillance entails lethal removal of deer that exhibit clinical signs consistent with CWD. Targeted surveillance has unmeasurable negative 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 environmental contamination and direct transmission may occur before removal. Targeted surveillance is moderately labor intensive and requires educating park staff in recognition of clinical signs, as well as vigilance for continued observation and identification of potential CWD suspect animals. Training is available through the NPS Biological Research Management Division. Targeted surveillance is recommended in areas with moderate to high CWD risk (within 60 miles of known CWD occurrence) or in park units where CWD has already been identified.

POPULATION REDUCTION

Population reduction involves randomly removing animals by sharpshooting within a population in an attempt to reduce animal density, and thus decrease transmission rates. In captive situations, where animal density is high, the prevalence of CWD can be substantially elevated compared to that seen in free-ranging situations. Thus, it is hypothesized that increased animal density and increased animal-to-animal contact, as well as increased environmental contamination, enhance the spread of CWD. Therefore, decreasing animal densities may decrease the transmission and incidence of the disease. However, migration patterns and social behaviors may make this an ineffective management strategy if instead of

dispersing across the landscape, deer and elk stay in high-density herds in small home ranges throughout much of the year (Williams et al. 2002b). Population reduction is an aggressive and invasive approach to mitigating the CWD threat. It has immediate and potentially long-term effects on local and regional populations of deer and the associated ecosystem. This may be an appropriate response if animals are above population objectives and/or the need to know CWD prevalence with a high degree of accuracy is vital.

COORDINATION

Regardless of which surveillance method is used, each park should cooperate with state wildlife and agriculture agencies in monitoring CWD in park units, working within the park's management policies. CWD is not contained by political boundaries, thus coordination with other management agencies is important.

Additionally, as stated above, the NPS Biological Resource Management Division provides assistance to parks for staff training (e.g., sample collection, recognizing clinical signs of CWD) and testing (e.g., identifying qualified/approved labs or processing samples).

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APPENDIX D: MONITORING PLANS

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There are two relevant monitoring strategies for this deer management plan, one related to forest regeneration, and the other to integrity of the cultural landscape, specifically the ability of farmers to continue to farm at Chesapeake & Ohio (C&O) Canal National Historical Park (NHP). There are no crops other than hay grown at Harpers Ferry National Historical Park, although the park would like the option of returning to row crops when feasible.

Monitoring forest regeneration is based on Stout's (1998) work at Cuyahoga Valley National Park. Monitoring for cultural landscapes is based on economic analysis of crop yields in comparison with average county crop yields and on arboriculture standards related to the percentage of new growth browsed from the orchard trees in a season.

VEGETATION AND REGENERATION MONITORING METHODS

Managing deer populations, although monitored by density, will be informed by the response and success of native forest regeneration. Target deer population density will allow for sufficient regeneration of forest vegetation determined through long-term monitoring of native seedling species. C&O Canal and Harpers Ferry previously used various methods of long-term vegetation monitoring that showed the damaging impacts of excessive deer browse on native seedlings.

PAIRED FENCED/OPEN PLOTS

Harpers Ferry has a total of 30 paired fenced and unfenced (open) vegetation plots in the park.

In Maryland Heights section of the park, 12 paired plots were originally installed in 2010. Fenced exclosures are 1.5 m wide x 4.6 m long, and 2.4 m tall with occasional openings where the bottom of the fence is not in contact with the uneven ground surface. Deer are excluded, but small herbivores are not. Data is collected from a 1 m x 4 m plot within the fenced exclosure. A gate at one end of the rectangular exclosure allows access for sampling. The paired unfenced control plot is located 1.5m from the fenced study plot. Baseline vegetation was collected after installing the fencing. Vegetation data was collected again in 2012. Eighteen additional plots were installed in 2014 in other sections of the park. Random locations were provided by NCR Inventory and Monitoring Network. Baseline vegetation data was collected when installation was completed.

Sampling will be conducted annually, primarily during the months of July and August. Two principle types of quantitative data will be collected during the herbivory study, percent of vegetation cover data and vegetation thickness (a horizontal projection of cover used to estimate vertical distribution of vegetation).

The vegetation cover data will be collected using the point intercept method (Elzinga, C.L. et al. 1998). The sampling apparatus used for cover data consists of two wooden spreaders with 10 4-m sections of tape measure, one attached every 10 cm. One end of the tape measures is attached permanently to one of the spreaders. The other end of the tape measures is threaded through the vegetation and then clicked into place in a notch on the opposite spreader, ultimately providing 10 parallel 4-m lengths of tape measure. The benefit of using this apparatus rather than a more fixed sampling frame is that it provides the flexibility needed to set up in areas of varying plant density and height. Reproducibility of spreader location from year to year is addressed by equipping spreaders with a ring bolt at each end that could be slipped onto fixed sections of rebar marking the study plot corners at the end of the study plot nearer the exclosure gate. The opposite spreader is positioned temporarily at the same distance from the exclosure fence using candy cane stakes. Cover data are collected by lowering a plumb bob down through the layers of vegetation up to 2 m in height. Any species (or nearest identifiable taxon) touching the vertical string (or the tip of the plumb bob for prostrate vegetation) is recorded as a hit at that location. Locations lacking in living vascular vegetation are recorded as the first substrate cover class encountered by the plumb bob (e.g., litter, soil, wood). Vegetation is measured in this way every 20 cm along each of the 10 tape measures for a total of 200 locations per study plot. Percent cover is calculated for each species by dividing the total number of hits for that species by 200 and multiplying by 100 to obtain a percentage.

Taxonomic identifications will be made using Brown and Brown (1984, 1999). Final nomenclature follows the US Department of Agriculture PLANTS database (USDA, NRCS 2011 http://plants.usda.gov/). Species classifications regarding origin (native versus non-native) and life form (tree, shrub, woody vine, and herbaceous) generally follow the PLANTS database which the NPS Inventory and Monitoring Network program uses as standard.,. Data is summed by various groupings of species (i.e., woody, herbaceous, native, non-native, tree, shrub, and woody vine) to determine impacts of protection from deer herbivory on different components of the forest vegetation. Dominant species are identified for further analysis as all species providing at least 5% cover (arithmetic mean) during at least one sampling event.

Vegetation thickness is a horizontal projection of cover designed to provide estimates of the vertical distribution of vegetation, which can be useful in assessing the ability of habitat to provide cover for wildlife (Rossell et al. 2007). It is also referred to as horizontal cover or foliage volume (Nudds 1977; Noon 1981). Vegetation thickness is estimated for three height classes, Low (0-30 cm), Middle (30-110 cm) and High (110-190 cm). Estimates are obtained using a drop cloth of clear acetate marked with a grid system 8 squares wide by 19 squares high (Noon 1981). Since each square of the grid measures 10x10 cm, the dimensions of the grid are 80x190 cm. The drop cloth is used by attaching it with binder clips to the exclosure fence on the long side between the fenced plot and the unfenced control plot. Cover estimates are made by a sampler kneeling 1 m away from the study plot, looking through the vegetation in the study plot and estimating what percentage of each square on the drop cloth is obscured by vegetation. The total number of squares is recorded for each height class in that grid location. By repositioning the grid in 5 adjacent locations, vegetation thickness data are obtained for the entire 4 m-long study plot. Final vegetation thickness estimates are obtained for each height class by dividing the sum of covered squares for that height class by the total number of squares in that height class, and multiplying by 100 to obtain a percentage. Vegetation thickness estimates are obtained in this way for both the fenced plot and the unfenced control plot within the module.

Species richness is determined based on the cover data for each study plot, and represents the number of species (or taxa not otherwise represented in the study plot) providing cover during that sampling event.

The forest regeneration threshold on page 23 will be calculated with data collected from the USGS plots. The weighted index was modified by Hatfield and Krafft (2009) for vegetation analysis in Rock Creek Park (Stout 1998). The taller seedlings receive a higher weight because they are more likely to survive compared to the smaller seedlings.

Table 1. Hatfield and Krafft (2009) Weighted Seedling Index

Height Class	Weighted Value
0-25 cm	1
25-100 cm	2
101-125 cm	15
126-150	30
>150 cm	30

Differences between paired fenced plots and unfenced control plots are calculated and analyzed for a variety of variables using mixed model repeated measures analysis of variance to compare data among years. Variables analyzed are: cover by various groups of species (woody, herbaceous, natives, non-natives, trees, shrubs, woody vines) and individual dominant species, vegetation thickness, and species richness overall and for woody, herbaceous, native, non-native, trees, shrubs, woody vines. Cover data (including vegetation thickness) may be transformed prior to analysis using

a natural log transformation to improve normality. Since the difference between fenced – unfenced control may be negative, it is necessary to perform the log transformation by taking the difference of the logs rather than the log of the differences. Four variance-covariance structures will be modeled (compound symmetry, autoregressive, Toeplitz, and unstructured), and the best model selected via AICc comparisons (Littell et al. 1996). Post pairwise comparisons to determine whether the fenced – unfenced control differences varied among years are made using Tukey's Studentized Range Test of Least Squares Means (family-wise error rate with alpha = 0.05). Inspection of the least square means and associated t-tests are used to determine the significance of differences between fenced and unfenced control plots for each year (alpha = 0.05; applying modified Bonferroni due to multiple t-tests, which increases the likelihood of identifying a false result (i.e., not significant) as true (or significant).

FOREST MONITORING PLOTS

The National Capital Region Inventory and Monitoring Network (NCRN) established long-term forest and vegetation monitoring plots throughout the National Capital Region (NCR) parks, including C&O Canal and Harpers Ferry. Harpers Ferry NHP has 20 plots and the C&O Canal NHP has 75 plots. The long-term data is used to calculate tree, sapling and shrub densities, basal area of trees and saplings, and seedling density and regeneration.

NCRN randomly selected vegetation monitoring plots across forested lands in the parks using a generalized random-tessellation stratified survey across a 250 m square grid created using ArcGIS. Intersections of the grid were used as plot centroids, with established plots centered around those points.

Each plot consists of a 15 m radius circle, within which all tree species are identified and measured for diameter at breast height. Presence of vines, insect pests and signs of disease are also recorded. Tree saplings with diameter 1–10 cm and shrub species are identified, measured and recorded within three circular subplots with 3 m radius. Coarse woody debris greater than or equal to 7.5 cm in diameter and 1 m in length is measured and assessed for state of decay along three line transects representing radii of the circular plot.

Seedlings greater than 15 cm in height and less than 1 cm in diameter are measured within twelve 0.5 m × 2 m rectangular subplots located within the circular subplots (n=3) and along the coarse woody debris line transects (n=9). Seedling height is measured in cm and subsequently placed in one of 10 size classes for analysis.

CULTURAL LANDSCAPES

CROP YIELD THRESHOLDS

Most of the agricultural permittees at the C&O Canal keep crop data with annual yield records or attainment and submit the same annual crop yield summaries to the NPS that they would also submit to the USDA for multiple purposes including the National Agricultural Statistical Survey (NASS). These annual crop yield summaries are used to calculate the average yield for that year and are examined against the county average yield for that year, and sometimes against the projected yield by soil type and crop. Farmer reports are used for insurance purposes as well as federal and state agricultural program benefits. There is an economic threshold for acceptable yield loss. Farm returns are either profit from crop harvest and sale or crop harvest and use for feed for livestock.

An objective of achieving 75% of projected yields for crops is established based on an economic review, and interviews of the USDA Farm Service Agency, and of agricultural extension agents. This yield goal also meets goals for cultural landscape protection. According to the USDA Farm Services Agency and Washington County Cooperative Extension Service, yields below 80% of the projected yields begin to

become economically unviable, depending on the crop and on input and costs. Corn requires more input, so if corn yields are 20% less than the average county yield, input can begin to outstrip yield. There is less input required for soybean and other crops, so they can remain viable until yield drops below 60% of the county average yield (Cashell, pers. comm. 2012). Based on the information in above, the planning team agreed to use a threshold tied to crop yield at the two parks, initially at C&O Canal NHP, and at Harpers Ferry, should row crops be planted there. Action would be taken when the 3-year average crop yield from farms within the park unit fell below 75% of the average yield reported by the county for similar agricultural production.

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APPENDIX E: REVIEW OF WHITE-TAILED DEER FERTILITY CONTROL

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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 in many areas in the United States (Fagerstone et al. 2002). Traditional wildlife management techniques such as hunting and trapping are often unfeasible, publicly unacceptable, or illegal in many parks, urban, and suburban areas, forcing wildlife managers to seek alternative management methods (Kilpatrick and Walter 1997; Muller, Warren, and Evans 1997). The use of reproductive control as a wildlife management tool has been studied for several decades.

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 a closed population with no immigration or emigration. In an open population, where there is much animal movement into and out of an area being considered for treatment, the use of fertility control agents is not likely to be successful in decreasing a population (Rudolph, Porter, and Underwood 2000). Good estimates of population emigration, immigration, birth and survival rates are needed before predictive models can be used to approximate the effort required to successfully use contraception as a population management technique.

The purpose of this document is to provide NPS managers with: (1) a brief overview of contemporary reproductive control options as they pertain to white-tailed deer; (2) an outline of the primary advantages, disadvantages and challenges related to the application of wildlife fertility control agents including population management challenges, regulatory issues, potential logistical issues, and consumption issues; (3) an evaluation of current fertility control agents against criteria established by the parks for use of a reproductive control agent. This document is not intended to be exhaustive but to provide a scientifically sound basis for understanding and evaluating deer management alternatives that include reproductive control of female deer.

It is important to note that some of the most critical elements of a successful population level fertility control program focus on ecological and logistical questions rather than the efficacy of fertility control agents in individual animals. It should also be noted that technology and regulation is changing rapidly in this field and updated information should be reviewed prior to implementation of a deer management program that involves fertility control.

There is general agreement that because of the logistical difficulties of treating significant numbers of deer that controlling large, open, free-ranging populations of wild ungulates solely with a contraceptive vaccine is impractical and unlikely to succeed (Rutberg et al. 2004; Garrott et al. 1992; Garrott 1995; Warren 2000; Rudolph, Porter, and Underwood 2000; Cowan, Pech, and Curtis 2002; Merrill, Cooch, and Curtis 2003 and 2006). There is also agreement that fertility control as an exclusive means of managing populations cannot reduce wildlife population size rapidly (Rutberg and Naugle 2008a, Kirkpatrick and Turner 2008). The few long-term (> 10 year) research projects evaluating population level effects of PZP on long-lived species (horses and deer) support this statement. At Assateague Island National Seashore, PZP treatments were successful in reducing the wild horse population 16% (from 160 to 135 individuals) between 1994 and 2009 (15 years). The park expects to reach the target population size of 135 horses in another 8-9 years (Zimmerman 2009 pers. comm.). At Fire Island National Seashore, park managers report a 33% reduction in overall deer population size (from approximately 600 to 400 individuals) between 1994 and 2009 (Fire Island National Seashore, Bilecki, pers. comm. 2009). In the most intensively treated areas of the park deer population size decreased up to 55% over 15 years (Rutberg and Naugle 2008a). All population level studies have been conducted in relatively closed populations. The appropriateness of fertility control as a deer management tool is heavily dependent on specific park objectives and the purpose and need for management.

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 when the goal is population management (Warren 2000; Garrott and Siniff 1992).

Regulation of wildlife fertility control agents can be confusing. If a product is intended for use in a food-producing animal, it must be deemed safe for human consumers. Regardless of its use in food animals, a fertility control agent must be considered safe for use in the target species and not present environmental health hazards to non-target species. Until 2006, the Food and Drug Administration, was the agency responsible for regulation of wildlife contraceptives and their potential for drug residues. Since this time the Environmental Protection Agency has assumed responsibility for regulating contraceptives for use in free-ranging wildlife and feral animals (Fagerstone et al. 2010). After a product is federally registered with the EPA, it must also be registered for use in each individual state where a wildlife management agency or organization would like to apply a product.

The EPA in consultation with the contraceptive manufacturer/sponsor will determine the safety of the product and marking requirements for free-ranging animals treated with contraceptives. Prior to EPA registration products can be studied in free-ranging populations to gather safety and efficacy data under an experimental use permit which is obtained from the EPA by the product's sponsor. Until products are registered by the EPA, and marking requirements made explicit, animals treated with any fertility control product should be permanently marked.

Marking is also needed for long-term monitoring of contraceptive efficacy in individual animals, determining which deer have been treated during implementation and for efficient re-treatment, and to monitor population vital rates. Finally, while NPS units have jurisdiction for wildlife management within their borders, parks are strongly encouraged to cooperate and coordinate with state agencies to manage cross boundary wildlife resources whenever possible (43 CFR § 24). Therefore, parks should also communicate with appropriate state agencies regarding marking of treated animals in areas where deer may cross park boundaries. The disadvantages of permanent marking are primarily related to the substantial additional labor and costs of the first year's capture and marking of treated animals, sustainability of this effort over the long-term, capture associated stress to individual deer (compared to remote delivery), and potential social acceptance concerns. Despite these drawbacks, marking is nearly always warranted when considering a fertility control program.

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

IMMUNOCONTRACEPTIVES

It has been suggested that immunocontraceptive vaccines offer significant promise for future wildlife management (Rutberg et al. 2004). Immunocontraception involves injecting an animal with a vaccine that stimulates its immune system to produce antibodies against a protein (antigen) involved in reproduction (Warren 2000). In order to induce sufficient antibody production, an adjuvant is combined with the antigen. 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. Using a 2 dose vaccination protocol Curtis et al. (2002) demonstrated approximately 85-90% decrease in the number of fawns born per female after vaccination with either GnRH or PZP immunocontraceptive vaccines in white-tailed deer. Likewise, Rutberg and Naugle (2008a) showed a 75% decrease in annual fawn production using

traditional PZP vaccination in two relatively closed white-tailed deer populations and most recently demonstrated 95-100% decrease in fawning the first year and 65-70% the second year after a single vaccination using several long-term and delayed release PZP vaccines (Rutberg et al. 2013). In a more contemporary version of the GnRH vaccine Gionfriddo et al. (2009 and 2011a) found approximately 70-90% infertility the first year and 40-50% infertility the second year in white-tailed deer after a single vaccination. The GnRH vaccine has not been evaluated at the population level. Efficacy generally decreases as antibody production wanes when using any immunocontraceptive. Reduced pregnancy rates can usually be expected for 1-2 years post-treatment with immunocontraceptive vaccines although there is the potential for longer-term or even permanent sterility (Fraker et al. 2002; Miller et al. 2008; Miller et al. 2009; Gionfriddo et al. 2011a; Rutberg et al. 2013). Duration of infertility is strongly related to the conjugate-antigen design, the adjuvant used, how the vaccine is delivered, and the host's immune system (Miller et al. 2008, Kirkpatrick et al. 2009).

Porcine Zona Pellucida (PZP). The majority of immunocontraceptive research in wildlife has been conducted using PZP vaccines. PZP vaccines stimulate production of antibodies directed towards specific outer surface proteins of domestic pig ova (eggs). Pig ova are sufficiently similar to many other mammals' ova and antibodies produced will cross-react with the vaccinated animal's own ovum. PZP antibodies prevent fertilization, presumably by blocking the sperm attachment sites on the zona which surrounds the ovum. There are currently several PZP vaccine products being developed, one is called SpayVac®, another is simply called PZP, and finally there is heat extruded and cold evaporated pelleted PZP. Each can be mixed with different adjuvants, which may change their efficacy.

SpayVac® (ImmunoVaccine Technologies, Halifax) uses a liposome preparation of PZP mixed with an adjuvant to induce antibody production. This vaccine has been evaluated in a variety of species, including captive and to a lesser extent free-ranging white-tailed deer (Brown et al. 1997; Fraker et al. 2002; Locke et al. 2007; Rutberg and Naugle 2009; Rutberg et al. 2013). Potential advantages of SpayVac® compared to the native PZP vaccine are (1) a more rapid immune response, (2) higher antibody titers, (3) a higher proportion of antibodies that bind to target sites, and (4) longer duration of efficacy (Fraker and Bechert 2007; Miller et al. 2009). Although little long-term data on population level effects exists for SpayVac®, it is assumed effects are similar to those for the native PZP formulation.

The second PZP vaccine, often called "native" PZP, has been used extensively in captive wildlife species in the course of investigating its effectiveness (Kirkpatrick et al. 1997; Turner, Kirkpatrick, and Liu 1996; Walter et al. 2002a and 2002b). This vaccine requires multiple vaccinations (e.g., two the first year and yearly thereafter) to maintain high antibody titers. The native PZP vaccine has also been tested at length in free-ranging white-tailed deer (Rutberg and Naugle 2008a; Naugle et al. 2002; Rudolph, Porter, and Underwood 2000; Rutberg et al. 2004; Walter et al. 2002a and 2002b; Walter, Kilpatrick, and Gregonis 2003). Potential benefits of the native vaccine include the ability to deliver the vaccine remotely via darts, its safety in pregnant deer and non-target species (Barber and Fayrer-Hosken 2000), and the availability of at least some long-term data on population level effects (Rutberg and Naugle 2008a).

Finally, the delayed release heat extruded or cold evaporated pelleted PZP vaccine has recently been tested in free-ranging deer. Advantages are increased efficacy and single application which lasts up to 2 years but requires hand-injection and has strict vaccine storage requirements (Rutberg et al. 2013). There is no long-term or population level data on this new technology.

Challenges to the use of all PZP vaccines include lack of regulatory approval for use in free-ranging deer populations, behavioral impacts (e.g., continued estrous cycling), out of season fawning, and possibly changes in body condition. None of the PZP vaccines are currently registered for use in free-ranging deer but may be in the future (see above for regulatory issues).

PZP based vaccines often cause out of season breeding behavior in treated deer because reproductive hormones which are responsible for estrous cycling are not suppressed (Miller et al. 2009; McShea et al. 1997; Fraker et al. 2002; McShea and Rappole 1997). Repeated estrous cycling has the potential to extend

the population breeding season and male/female rutting behaviors. Additionally, extended estrous seasons may result in late pregnancies if the vaccine fails (Fraker et al. 2002; McShea et al. 1997). Fawning later in the summer/fall may lead to higher fawn mortality as winter ensues. Any effect that extends the rut also has the potential for secondary effects to both male and female deer. Increased attempts to breed may result in increased deer movements. It has been suggested that this may encourage deer-vehicle collisions. However, the only known research evaluating this specific issue reported that deer treated with PZP were at no greater risk of being involved in a deer-vehicle collision than untreated deer (Rutberg and Naugle 2008b).

Increased activity during rut can be energetically costly for both sexes. While this is likely offset by the lack of pregnancy demands in female deer it may have cumulative effects on energy expenditures in male deer (Walter, Kilpatrick, and Gregonis 2003; McShea et al. 1997). Alternatively, PZP-treated females may experience increased body condition and a longer life span compared to untreated individuals as a result of reduced energetic costs of pregnancy and lactation (Warren 2000; Hone 1992). For example, at Assateague Island National Seashore, the life span of horses treated with PZP has been extended from an average age at death of 20 years to 26-30 years (Kirkpatrick and Turner 2008, Zimmerman 2009 pers. comm.). Longer life span may extend the time needed to observe a decline in population size (Kirkpatrick and Turner 2008; Ransom et al. 2013). Studies in white-tailed deer investigating effects on body condition are equivocal (Walter, Kilpatrick, and Gregonis 2003; McShea et al. 1997). There are no long-term studies investigating potential extended survival in free-ranging wild deer.

Successful field application of a fertility control program requires both an effective agent and a practical delivery system (Cowan, Pech, and Curtis 2002). Although PZP vaccines may be successfully delivered remotely through darting, the native PZP vaccine that has been tested most extensively requires a series of two initial doses followed by periodic boosters in order to maintain infertility. The need for multiple doses leads to significant logistical issues when working with free-ranging white-tailed deer, particularly when the number of deer to be treated is high. SpayVac® does not require a first year booster and may prove to be easier to implement because follow-up doses would only be required every 3-7 years (Fraker 2009), however, to our knowledge SpayVac® has not been delivered remotely. The new long-term pellets (Rutberg et al. 2013) cannot be delivered via dart at this time.

Many studies have modeled and a few field studies have tested population-level effects of PZP vaccination (Rutberg et al. 2004; Nielsen, Porter, and Underwood 1997; Rudolph, Porter, and Underwood 2000; Rutberg and Naugle 2008a; Rutberg et al. 2013). Research evaluating the effectiveness of PZP in reducing the size of deer populations has focused on moderate to high density deer populations of relatively small size (< 300-500 individuals). Within these populations, long-term (> 10 year) data indicates that population size may gradually decline using PZP treatments (Kirkpatrick and Turner 2008, Rutberg and Naugle 2008a). Rutberg and Naugle (2008a) reported a 27% decline in the size of a small, relatively closed, suburban deer population (approximately 250 deer) between 1997 and 2002, as a result of PZP treatments and potentially other stochastic events. However, level of success in reducing population size varies widely. For example, deer density on Fire Island National Seashore was significantly reduced in some areas but reduced very little in other areas likely due to inability to treat significant numbers of does in certain areas (Rutberg and Naugle 2008a, Underwood 2005). Site specific modeling using accurate population demographic and vital rate data as well as knowledge of local deer behavior, land access availability and likelihood of achieving treatment application goals is needed to determine how fast a population can be reduced and how deep a reduction can be achieved.

Additional information on PZP may be obtained at:
http://www.aphis.usda.gov/wildlife_damage/nwrc/research/reproductive_control/index.shtml OR
http://www.pzpinfo.org.

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 (luteinizing hormone and follicle stimulating hormone) that control the function of reproductive organs (Hazum and Conn 1988). In an attempt to interrupt this process, research has focused on eliminating the ability of GnRH to trigger the release of reproductive hormones. One option is vaccination against GnRH. Antibodies produced in response to vaccination 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 and preventing ovulation.

GnRH vaccines have been investigated in a variety of wild and domestic ungulates (hoofed mammals) (Adams and Adams 1990; Curtis et al. 2002; Miller et al. 2000c; Miller, Rhyan, and Drew 2004; Gionfriddo et al. 2009; Gionfriddo et al. 2011a). One GnRH vaccine that has been developed specifically for wildlife contraception is GonaCon™. GonaCon™ is registered with the EPA as a restricted use pesticide to control white-tailed deer fertility. The label requires marking the treated animal to prevent accidental re-injection and giving the vaccine by hand-injection which limits the potential for non-target animal and environmental exposure to the vaccine.

Potential benefits of this vaccine include a relatively long-lasting contraceptive effect (1-2 years and potentially longer) and possibly the lack of repeated estrous cycles (Curtis et al. 2002). In free-ranging white-tailed deer, GonaCon™ is estimated to be 70–90% effective in preventing pregnancy during the first year post-treatment, and approximately 40–50% effective in the second year (Gionfriddo et al. 2009; Gionfriddo et al. 2011a), however long-term field efficacy data currently does not exist. Although the label indicates a minimum of 1 year efficacy, the contraceptive effect typically lasts two years and possibly longer in some individuals (Fagerstone et al. 2008). Repeated estrous cycling and other behavioral changes in white-tailed deer have not been consistently documented in association with GnRH vaccines (Curtis et al. 2008). However, Killian et al. (2008) reported that behavioral expressions of estrus were only decreased for 1-2 years post-treatment and increased in subsequent years despite does remaining infertile and Curtis et al. (2002) reported sporadic and delayed estrous cycling with prolonged fawning season in GnRH vaccinated deer as contraceptive effects waned.

GnRH vaccines have many of the same challenges associated with PZP including the need for repeated treatment to maintain long-term infertility, and the need to mark treated animals. Additionally, as with any vaccine which uses the adjuvant AdjuVac™, immune response to the adjuvant may interfere with determination of the animal's Johne's disease status (a gastrointestinal disease of potential regulatory importance for domestic livestock) (Miller et al. 2008). Managers should be aware of this prior to vaccination if neighboring lands have domestic livestock grazing.

Other challenges to use of GonaCon™ include potential health effects on treated deer (Kirkpatrick et al. 2011), lack of information related to effectiveness at the population level in free-ranging deer, and requirement for hand-injection. Killian et al. 2006a concluded that GonaCon™ was safe for deer and that there were no adverse health impacts associated with unintentional repeated vaccination. Granulomas and injection site abscesses are consistently associated with vaccination; however, they do not appear to cause negative health impacts (Curtis et al. 2008; Gionfriddo et al. 2009; Gionfriddo et al. 2011b). A ganuloma is a localized inflammatory response to the vaccine that occurs at the site of injection and can persist for many years post-treatment. Overall, no debilitating, long-term impacts to health or changes in behavior have been consistently associated with GnRH vaccination in female deer.

Similar site specific modeling and population data are required for evaluating the potential for success in managing a free-ranging deer population with GonaCon™ as was described for PZP immunocontraception.

Additional information may be obtained at:
http://www.aphis.usda.gov/wildlife_damage/nwrc/research/reproductive_control/index.shtml

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 highly active analogs of GnRH which are similar in structure and action to the endogenous hormone. 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). Continuous administration of the agonist is necessary to maintain infertility. This can be accomplished with controlled-release formulations or surgically implanted pumps or by daily administration.

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. The wide variation in response is likely due to a combination of type of agonist, dose, treatment regime, reproductive status, sex, and species (Becker and Katz 1997). Therefore, it is important to fully understand the effects of a product on a given species. Although many GnRH agonists are used in human as well as veterinary medicine only a few have been investigated in wildlife species (Becker and Katz 1997; Vickery 1986). GnRH agonists have been tested primarily in mule deer and elk and been shown to both suppress reproductive hormones and prevent pregnancy (Baker et al. 2005; Baker et al. 2004; Baker et al. 2002; Conner et al. 2007).

- **Leuprolide acetate**: Leuprolide is a GnRH agonist that when administered as a controlled-release formulation, results in 100% pregnancy prevention in treated female elk and mule deer (Baker et al. 2002 and 2004; Conner et al. 2007). In addition, the treatment is reversible, and the effects last only for a single breeding season (Baker et al. 2004; Trigg et al. 2001). Advantages of leuprolide acetate are that it is 100% effective in preventing pregnancy, is safe for human consumption (Baker et al. 2004), can be delivered remotely (Baker et al. 2005), does not result in physiological side effects, and there are few behavioral effects (Baker et al. 2004). Treatment did not suppress reproductive behavior during the breeding season but also did not prolong behaviors into the non-breeding season.

  Leuprolide is Food and Drug Administration-approved for use in humans and has been used experimentally in cervids. It is not currently approved for use in free-ranging wildlife as a fertility control drug. It is not known if this application will be pursued in the future. The need to deliver leuprolide subcutaneously via hand injection has traditionally been considered a significant barrier to the long-term application of this drug as a wildlife management tool. However, Baker et al. (2005) successfully applied the treatment through dart delivery which may extend the practical application of this contraceptive.

  Treatment using leuprolide differs from GnRH vaccines in that it does not require an adjuvant and does not induce an antibody reaction. Therefore, inflammatory responses to adjuvant components and other physiological effects, often observed with immunocontraceptives, have not been observed in association with leuprolide. It does, however, require a slow release implant that remains under the skin or in the muscle. Additionally, leuprolide does not likely pose a threat to the environment or nontarget species because the drug is not absorbed through the oral route of administration (Baker et al. 2004). Marking requirements for animals treated with leuprolide implants are currently unknown because it is not a registered wildlife contraceptive.

  One drawback to the use of leuprolide is the need to treat animals within a short timeframe prior to the breeding season (Conner et al. 2007). If a female is not retreated each year then she has the same chances of becoming pregnant as an animal that was never treated. The need to treat a potentially large number of individuals within a short period of time on an annual basis reduces

the feasibility of leuprolide as a wildlife management tool, particularly for large, free-ranging, open deer populations.

- **Histrelin acetate**: Histrelin acetate is effective in suppressing a key reproductive hormone in white-tailed deer (Becker and Katz 1995). However, testing was conducted 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 (either agonist or antagonist). A GnRH analog is a synthetic peptide similar to the body's own gonadotropin-releasing hormone. Using the analog as a carrier, a cellular toxin can be delivered to specific cells in the pituitary which produce reproductive hormones. Internalization of the toxin leads to cell death. When this occurs, the production of reproductive hormones (leuteinizing hormone and follicle stimulating hormone) is affected. This process has been studied in male dogs (Sabeur et al. 2003), domestic sheep (Nett et al. 1999), rats (Kovacs et al. 1997), and female mule deer (Baker et al. 1999) but the technology is still in the developmental stages and not ready for use in free-ranging wildlife.

Steroid Hormones. The field of wildlife contraception began with research examining the manipulation of reproductive steroid hormones (Matschke 1980, 1977a, 1977b). Treatment usually entails the application of synthetic hormones, such as norgestomet, and melangestrol acetate (Jacobsen, Jessup, and Kesler 1995, DeNicola, Kesler, and Swihart 1997a, Fagerstone et al. 2010). Available products are administered via slow release implants or repeated feeding and have demonstrated variable efficacy and duration of infertility. Most products that are available are used in domestic animal or zoological veterinary medicine and have not been tested widely in free-ranging wildlife. Issues related to using steroids include difficulties in treating large numbers of animals for extended periods of time, potential reproductive tract pathological side effects experienced by the treated animals, and concerns over the consumption of treated animals by nontarget species and humans. Although many of these hormones are used as growth promotants in domestic food animal production, they are not labeled for use in free-ranging wildlife. Currently, this method of contraception is not being pursued by the wildlife management community.

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 F2α (PGF2α) (Becker and Katz 1994; DeNicola, Kesler, and Swihart 1997b; Waddell et al. 2001). Lutalyse® is a commercially available form of PGF2α. Unlike many of the other alternatives, there are no issues related to consumption of the meat when the animal has been treated with this product. Challenges 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. These limitations make their use in free-ranging populations for fertility control purposes unlikely.

Sterilization. Surgical sterilization of females is an effective method of controlling reproduction and has been used extensively in domestic animal medicine. However, implementation requires capture, general anesthesia, and surgery conducted by a veterinarian, which is generally considered labor intensive and costly (Boulanger, et al 2012) and calls into question the long-term sustainability of sterilization as a wildlife management tool, except under very limited circumstances. Boulanger, et al (2012) notes that surgical sterilization is a costly but effective technique for reducing suburban deer herds if 80% or more of the female deer in a population are sterilized and that proportion is maintained over time. Overall success was greatest for closed populations. Only in rare circumstances is physical sterilization reversible.

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.

EVALUATION OF REPRODUCTIVE CONTROL AGENTS BASED ON SELECTION CRITERIA ESTABLISHED BY THE NPS

Five criteria were established by the NPS that reflect minimum desired conditions for using a reproductive control agent. Only when these criteria are met would reproductive control be implemented.

1.	There is a federally approved fertility control agent for application to free-ranging populations.
2.	The agent provides multiyear (3–5 years) efficacy.
3.	The agent can be administered through remote injection.
4.	The agent would leave no hormonal residue in the meat (i.e., meat derived from treated animals should be safe for human consumption according to applicable regulatory agencies, and safe for consumption by other animals).
5.	Overall, use of the agent results in an acceptable level of reduction in the free-ranging deer population with limited behavioral impacts.

Table E-1 provides a summary of how current reproductive control agents meet the criteria.

TABLE E-1: EVALUATION OF FERTILITY CONTROL AGENTS BASED ON NPS SELECTION CRITERIA

Agent	Criterion 1 Federally Approved	Criterion 2 Multiyear Efficacy (3+ years)	Criterion 3 Capable of Remote Administration	Criterion 4 Meat Safe for Humans	Criterion 5 Reduction in Free-ranging Populations with Limited Behavioral Impacts[h]
Immunocontraceptives					
"Native" PZP	No	No[a]	Yes[b]	Likely, but need approval	Population reduction only demonstrated in fenced populations or on a very small scale; causes repeated estrous cycles
SpayVac™	No	Possibly[c]	Unknown	Likely, but need approval	No demonstration of population reduction; causes repeated estrous cycles
Long-term pelleted PZP	No	Possibly[d]	No	Likely, but need EPA approval	
GnRH (GonaCon™)	Yes	Possibly[e]	Possibly[f]	Yes[g]	No demonstration of population reduction; behavioral impacts need to be further examined
GnRH Agonists					
Leuprolide acetate	No	No	Yes	Likely, but need EPA approval	No demonstration of population reduction; behavioral impacts need to be further examined
Histrelin acetate	No	No	No	Likely, but need EPA approval	No demonstration of population reduction; behavioral impacts need to be further examined
Other					

Agent	Criterion 1 Federally Approved	Criterion 2 Multiyear Efficacy (3+ years)	Criterion 3 Capable of Remote Administration	Criterion 4 Meat Safe for Humans	Criterion 5 Reduction in Free-ranging Populations with Limited Behavioral Impacts[h]
GnRH toxins	No	Unknown	Unknown	Likely but unknown	No demonstration of population reduction; behavioral impacts need to be further examined
Steroid hormones	No	No	Unknown	Unlikely, need regulatory guidance	No demonstration of population reduction; behavioral impacts need to be further examined
Contragestives	No	No	Yes	Yes	No demonstration of population reduction; behavioral impacts need to be further examined

a. Initial research on one-shot, multiyear PZP vaccine has demonstrated 88.3% efficacy in year 1 and 75% efficacy in the second year after treatment (Turner et al. 2008). Research is currently ongoing to evaluate effectiveness in year 3 and beyond. Rutberg has indicated that "based on the design of the vaccine and our experience with horses, it's unlikely that the vaccine would have much effect past the third year" (Valley Forge NHP, Rutberg, pers. comm. 2009a). However, research on this vaccine is ongoing and is expected to continue into the future.

b. The multi-year formulation of PZP is not capable of remote delivery, but the single year dose is.

c. SpayVac™ has demonstrated 80%–100% efficacy for up to 5–7 years in horses and deer (Valley Forge NHP, Fraker, pers. comm. 2009b; Miller et al. 2009; Killian et al. 2008). The term "possibly" is used because long-term studies (>5 years) have been conducted only in captive deer and had a small sample size in each treatment group (N = 5) (Miller et al. 2009). The only longer term study in free-ranging white-tailed deer did not evaluate past the third year (Rutberg et al. 2013).

d. Long-term pelleted PZP has not been adequately evaluated past year two in free-ranging deer to determine extended efficacy (Rutberg et al. 2013).

e. Research on one-shot, multiyear GnRH vaccine in penned/captive deer indicates GonaCon™ is 88%–100% effective in year 1, 47%–100% effective in year 2, and 25%–80% effective up to 5 years after treatment (Miller et al. 2008; Gionfriddo et al. 2009).The term "possibly" is used because the multi-year formulation has been used only in captive deer, had a small sample size, and lacks confidence intervals on the data. Work in free-ranging deer suggests lower efficacy rates and shorter duration of efficacy (Gionfriddo et al. 2009, 2011). GonaCon™ has been found to be less effective in free-ranging ungulates than captive ungulates (Gionfriddo et al. 2009).

f. Work published used dart delivery to administer the GnRH vaccine to elk (Killian et al. 2009).

g. According to the EPA GonaCon TM fact sheet (2009).

h. Reduction means reducing deer numbers in a free-ranging population to the extent needed at the parks to allow for tree regeneration.

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