CHAPTER 2

ALTERNATIVES

This "Alternatives" chapter describes the various actions that could be implemented for current and future management of white-tailed deer in Catoctin Mountain Park. The *National Environmental Policy Act* requires federal agencies to explore a range of reasonable alternatives and to analyze what impacts the alternatives could have on the human environment, which the act defines as the natural and physical environment and the relationship of people with that environment. The analysis of impacts is presented in "Chapter 4: Environmental Consequences," and is summarized in table 25 at the end of chapter 4.

The alternatives under consideration must include a "no-action" alternative, as prescribed by NEPA regulations at 40 CFR 1502.14. The no-action alternative in this document is the continuation of the current deer management plan — no major changes would be made to the current plan.

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

No-action alternative — The alternative in which baseline conditions and trends are projected into the future without any substantive changes in management.

Action alternative — An alternative that proposes different management actions to address the purpose, need, and objectives of the plan; one that proposes changes to the current management.

INTRODUCTION AND OVERVIEW OF ALTERNATIVES

This chapter describes the alternatives developed by the interdisciplinary team for this *Final White-tailed Deer Management Plan / Environmental Impact Statement*, as well as the background information used in setting a deer density goal and an action threshold for implementing the preferred alternative, based on forest regeneration. All alternatives were developed to meet the purpose, need, and objectives of this plan. Input from the science team and the public was considered and used to refine the preliminary alternatives as the planning process progressed.

The alternatives selected for detailed analysis are briefly described below. This is followed by a description of Catoctin's deer density goal and the threshold for taking action, which are needed to fully understand the action alternatives (i.e., alternatives B, C, and D). Next, detailed descriptions of each alternative are presented, followed by a discussion of adaptive management and how it could be applied to the alternatives. The remainder of the chapter addresses alternatives that were considered but eliminated from detailed analysis, and the identification of the agency's preferred and the environmentally preferred alternative.

The interdisciplinary team utilizes a rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify current and future management activities.

No-Action Alternative

- ***Alternative A: No Action*** — The existing deer management plan would continue under alternative A, including limited fencing, use of repellents in landscaped areas, monitoring, data management, and research. No new actions would occur to reduce the effects of deer overbrowsing.

Action Alternatives

- ***Alternative B: Combined Non-Lethal Actions*** — Alternative B would include all actions described under alternative A, but it would also incorporate several non-lethal actions to protect forest seedlings, promote forest regeneration, and gradually reduce deer numbers in the park. The additional actions would include the construction of large-scale exclosures, increased use of repellents in areas where large fenced exclosures would not be appropriate or feasible, and reproductive control of does.

- ***Alternative C: Combined Lethal Actions (Preferred Alternative)*** — Alternative C would include all actions described under alternative A above, but it would also incorporate two lethal deer management actions to reduce the herd size. The additional actions would include direct reduction of the deer herd by either sharpshooting or by implementing capture and euthanasia of individual deer in certain circumstances where sharpshooting would not be appropriate.

- ***Alternative D: Combined Lethal and Non-Lethal Actions*** — Alternative D would also include all the actions described under alternative A above, but it would incorporate a combination of specific lethal and non-lethal actions from alternatives B and C. These actions would include the initial reduction of the deer herd through sharpshooting, along with capture and euthanasia in areas where sharpshooting would not be appropriate. Reproductive control of does (and direct reduction, if needed) would be used for longer-term maintenance of lower herd numbers.

DEER DENSITY GOAL AND THRESHOLD FOR TAKING ACTION UNDER ALTERNATIVES B, C, AND D

The action alternatives (B, C, and D) contain actions to support forest regeneration and to protect, conserve, and restore native species and cultural landscapes. Before an action alternative may be implemented, the park must first determine (1) when action needs to be taken (i.e., when damage to forest vegetation reaches unacceptable levels), and (2) how many deer would need to be removed (for those alternatives that include deer removal). The following discussion describes both the threshold for taking action (which is 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 removed).

THRESHOLD FOR TAKING ACTION

The science team discussed methods of identifying an appropriate threshold for taking action to protect vegetation. Because the deer population is to be managed based on the success of forest regeneration, tree seedlings must be monitored to determine at what point the 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."

Since 1990 various vegetation monitoring projects have been conducted within Catoctin. In 1990, 45 open plots, each 20 feet square, were monitored for five years.

Since 1990 various vegetation monitoring projects have been conducted within Catoctin. In 1990, 45 open plots, each approximately 66 feet square (20 meters square), were established and monitored for five years (NPS 2000f). In 1997 open plots were paired with existing exclosures to document differences in areas with no deer browsing. These plots and their pairs were monitored from 1997 to 1999 and from 2000 to 2002. In 2004 six new exclosures were added adjacent to randomly chosen open plots to gather additional information on deer browsing impacts.

In 2004, based on data previously collected and the work of Dr. Susan Stout, the park adopted a monitoring protocol to document forest regeneration (NPS 2004i; Marquis et al. 1992; Stout 1999; Pavek 2000; McWilliams et al. 1995). This protocol is described further under the detailed description of alternative A. According to Stout's research, successful regeneration would be defined as 51 seedlings or more per open plot in 67% or more of the original 45 open monitoring plots.

As the park monitors the forest for signs of overbrowsing impacts, the level of regeneration would be determined every three years from data collected from the open plots described above. Based on Stout's research, successful regeneration would mean that 67% or more of the open plots contained 51 or more seedlings. Therefore, unsuccessful forest regeneration would be indicated when 33% or more of the plots contained fewer than 51 seedlings. This limit was selected as the threshold for taking action under this plan, and it was also used in developing the impact thresholds for woody vegetation regeneration used in the impact analysis.

INITIAL DEER DENSITY GOAL

The deer density goal refers to an appropriate density that would allow for natural forest regeneration. This density would then be used as an appropriate goal under any of the action alternatives. Based on a review by the science team of pertinent scientific literature (Tilghman 1989; Marquis et al. 1992; deCalesta 1992; Horsley et al. 2003; and Sage et al. 2003), the recommended deer density ranges from 10 to 40 deer per square mile, depending on several factors. The most recent research recommends a density of 13 deer per square mile for regeneration within a maple / beech / birch forest (Sage et al. 2003); negative impacts of deer browsing start to appear at 20 deer per square mile (Horsley et al. 2003). Additionally, Stout (1999) suggests that a low deer density of 13 to 21 deer per square mile allows for forest regeneration in Pennsylvania forests.

Based on the science team's recommendation, the park selected a range of 15 to 20 deer per square mile as the initial deer density goal. The team suggested that a range would be appropriate for the initial goal, and the range suggested is supported by recent findings and research for regeneration in forest types similar to those in Catoctin. This goal may be adjusted based on the results of vegetation and deer population monitoring, as described in the "Adaptive Management" section.

ALTERNATIVE A: NO ACTION
(EXISTING MANAGEMENT CONTINUED)

Catoctin Mountain Park would continue to implement the current deer management plan. This would include population monitoring (including distance sampling and herd health checks), as well as activities to protect native plants, such as fencing off and monitoring small areas to protect certain species and applying repellents, as outlined in the current Catoctin *Deer Management Plan* (NPS 1995b). Current monitoring efforts would continue to record forest regeneration and deer population numbers within the park. Educational and interpretive activities would continue to be used to inform the public about deer ecology and park resource issues. No additional deer management activities would take place under this alternative. Because alternative A includes no measures to reduce the white-tailed deer population or to control population growth, it is assumed that the population would increase over the life of the plan (15 years). The amount of increase is unknown; however, population growth is expected to follow past trends and would likely reach or exceed the previously recorded high of 195 deer per square mile, with numbers fluctuating annually due to factors such as weather, herd health, removals outside the park (hunting, depredation permits), and food availability. This alternative serves as the baseline for analyzing and comparing the effects of the other alternatives.

The actions that would continue under alternative A are described below in detail. These actions would also continue under all other alternatives as well.

Under all alternatives small fenced areas would continue to be used to protect selected trees, landscape vegetation, and rare native plants or habitats.

CURRENT ACTIONS

FENCING OF SMALL AREAS

Small areas containing sensitive vegetation would be fenced to protect selected trees, landscape vegetation, and rare native plants or habitats. Landscaped areas typically consist of nonnative vegetation in and around buildings and in other park developed areas (e.g., camps); fencing would be used around individual plants or groups of plants that need to be protected from browsing. The park also has two state-listed plant species (the large purple-fringed orchid and the American ginseng) that are currently fenced at all known locations. As other rare understory plant species were found in the park, they would be protected with additional fencing. In addition to fencing rare plants, park staff have erected approximately 250 fences around trees that have been recently planted in campgrounds and picnic areas.

The fencing would be typically less than 43 square feet (4 square meters) and would consist of a 5-foot-high, welded wire fence (typically a 1-inch by 2-inch mesh) with netting or other covering over the top. Twenty of these small fenced areas currently exist in the park, and one 4,000-square-foot fence protects sensitive vegetation in a small wetland area.

LIMITED APPLICATION OF REPELLENTS

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).

Deer repellent products are generally either odor-based or taste-based. Odor-based repellents incorporate a smell that is supposed to be offensive to deer, such as human hair, soaps, garlic, rotten eggs, blood meal, or seaweed, and they tend to work best in areas where deer have not adapted to close human interaction. Taste-based repellents incorporate a taste that is offensive to deer, such as hot pepper juice. These repellents tend to work in areas where deer have adapted to close human interaction and where odor-based repellents are not effective.

Both repellent types are available in chemical and organic forms. The organic repellents are biodegradable and are expected to be the least harmful to the environment. Some of the most recently available products, such as Plantskydd®, Liquid Fence®, and Deer Busters®, have the longest residence time (period of effectiveness between applications). Many other brands are also commercially available (e.g., Deer Blocker®, Gempler's®, Deer-Off®, Scoot Deer®, and Deer Scram®). 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. Many commercial repellents indicate that they persist after normal rain events, with varying persistence of one to six months.

Under alternative A repellent use in the park would continue to be minimal and would be limited to landscaped areas. The park applied approximately 2 quarts of Deer-Off® in 2004, on landscaping plants around the visitor center. Multiple applications were used in accordance with the product label. The park would continue to try different repellents in similar situations as a means to minimize deer browsing on landscaping. Repellents could also be used in cultural landscape areas where fencing would be undesirable.

TESTING FOR CHRONIC WASTING DISEASE (DEER HEALTH CHECK)

Chronic wasting disease (CWD) is in the family of diseases known as the transmissible spongiform encephalopathies (TSEs) or prion diseases. Other TSEs include scrapie in sheep, bovine spongiform encephalopathy (BSE or mad cow disease), and Creutzfeldt-Jakob disease (CJD) in humans. Chronic wasting disease causes brain lesions that result in progressive weight loss, behavioral changes, and eventually death in affected deer and elk. There is currently no evidence that the disease is transmissible to humans or domestic livestock; however, the disease could limit populations of deer and elk and could result in profound impacts on the recreational value of these species.

CWD is a self-propagating neurological disease that can affect captive and free-ranging deer.

Generally, the National Park Service has identified two levels of action pertaining to chronic wasting disease based on risk of transmission (see appendix D for further information): (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 2005, the nearest known case of chronic wasting disease in free-ranging deer is within 60 miles of the park. Therefore, the park will initiate the following actions.

Testing

The park will initiate opportunistic surveillance on every available carcass until a statistically valid[1] sample size has been reached to ensure reasonable certainty that chronic wasting disease is not present within the park's deer population. Opportunistic sampling means taking biological samples from available dead animals (e.g., road kill, predation). This does not mean animals will be killed for the purpose of CWD surveillance. It is assumed for sample size that this would represent a random sample; however, it is acknowledged that opportunistic sampling is likely to be a more sensitive measure of disease recognition. The time necessary to reach a statistically valid sample size will vary depending on the opportunities available annually. It is expected to take a number of years.

In addition to opportunistic surveillance as described above, the park may also perform targeted surveillance as a component of this alternative. Targeted surveillance involves lethal removal and testing of any deer exhibiting clinical signs consistent with chronic wasting disease.

Coordination

The park will coordinate with the state wildlife and/or agriculture agencies regarding surveillance methods and results.

Disposal / Consumption

The park will follow NPS Public Health Service guidance pertaining to the donation of meat from a documented CWD area (NPS 2005c). Any deer confirmed to be infected with chronic wasting disease will be disposed of in accordance with NPS Public Health Service disposal guidelines.

MONITORING, DATA MANAGEMENT, AND RESEARCH

Current monitoring of both vegetation impacts and deer population levels would continue and would be expanded as necessary to better understand any correlations between the two.

Monitoring and data collection activities that would be common to all alternatives could include any or all of the following:

1. This may mean sampling to achieve 95% or 99% confidence that if chronic wasting disease is present at a 1% or greater prevalence, it will be detected. For example, with a population of 1,000 deer, approximately 370 animals would need to be tested. After a valid sample size is reached, the park may discontinue sampling until conditions warrant additional testing.

- Monitoring deer numbers by parkwide observations. The park would continue to use the distance sampling method to estimate the deer population density annually using an established protocol (NPS 2004f).

- Use of spotlight surveys (conducted as part of distance sampling) to monitor population composition (i.e., age, sex ratios).

- Monitoring tree seedlings using an existing vegetation monitoring protocol to determine the status of forest regeneration (NPS 2004i).

- Conducting surveillance for evidence of deer overbrowsing where deer are found in high densities. This could include the erection of additional deer-proof exclosures as experimental controls.

Deer spotlight surveys would be conducted annually to collect data to estimate the deer population density using the distance sampling method.

- Monitoring deer health as the population shows signs of disease, or if a disease has been discovered within the region. Opportunistic and targeted surveillance (see appendix D) would be implemented for CWD and other diseases.

- Monitoring the costs of the management plan, including staff time, training, administrative, legal, and public communications costs, plus the costs of monitoring as described above.

All actions involving direct management of individual animals would be conducted in a manner that would minimize stress, pain, and suffering to the greatest extent possible. NPS staff would guidelines of the American Society of Mammalogists (ASM). Every effort would be made to minimize the degree of human contact during procedures that require the handling of deer (ASM 1998).

Specific deer population and vegetation monitoring methods that would be used under alternative A, as well as the other alternatives, are included in appendix F.

EDUCATION

Communication with and input from other organizations and the public would be a key component of alternative A, as well as the other alternatives. Such activities would include continuing education and interpretive programs, displaying exhibits at visitor centers, producing brochures and publications, and conducting teacher workshops and education about the negative effects of feeding deer. The park would continue to sponsor campfire programs, offsite programs for schools, and exhibits for the local community, which would incorporate information about deer management activities. The park's website would also be used to discuss what the park is doing related to deer management, and relevant articles would be published in local newspapers.

IMPLEMENTATION COSTS

The costs associated with alternative A would primarily be for monitoring, plus limited fencing and repellent application, as shown in table 1. The materials cost for fencing and repellent use are included, but do not include labor costs for applying these actions as the labor is assumed to be covered in existing labor costs.

The cost associated with CWD testing is expected to be in the range of $50 to $75 per deer to cover lab and collection costs. A specific number of deer to be tested in a given year cannot be predicted. However, approximately $25 of that cost would be for the lab test, which would be conducted by the NPS Biological Research Management Division at no cost to the park. Similarly the collection cost (physical collection of a sample from the carcass) is expected to be less than the $25 to $50 estimate, assuming that staff would be trained in proper sample collection and handling, and the overlap with labor costs to dispose of the carcass. Therefore, the cost of CWD testing is assumed to be covered in existing labor costs.

TABLE 1: COST ESTIMATE — ALTERNATIVE A: NO ACTION

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Distance Sampling / Spotlight Surveys	Three nights of survey plus data analysis	$1,000	$15,000
Vegetation Monitoring of Existing Plots	Data collection and analysis	$7,000	$105,000
Maintenance of Existing Monitoring Plots	Four visits/year/ exclosure; minimal materials cost (varies by year)	$1,500 (labor)	$22,500
Deer Herd Health Check	Every 5 years, plus yearly supplemental health monitoring activities	$6,000 every 5 years plus $600 annually	$18,000 $9,000 $27,000
Fencing for Species Protection	Small areas fenced	$120	$1,800
Repellent Use	Limited use around developed/landscaped areas	$80	$1,200
		Total	**$172,500**

ALTERNATIVE B:
COMBINED NON-LETHAL ACTIONS — LARGE EXCLOSURES, INCREASED USE OF REPELLENTS, AND REPRODUCTIVE CONTROL OF DOES

A combination of several non-lethal actions would be implemented under alternative B, in addition to the actions described under alternative A, to protect forest seedlings, promote forest regeneration, and gradually reduce deer numbers in the park. The additional actions would include constructing large-scale fenced exclosures, additional use of repellents in areas where exclosures would not be appropriate or feasible, and controlling doe reproduction.

During the development of the alternatives, it was determined that implementation of any of the non-lethal actions alone would be insufficient to address forest regeneration and would not meet plan objectives. For example, the use of fencing or repellents alone would not reduce deer density. The use of reproductive control alone would take longer than the life of the plan to have an effect and would not provide immediate protection for sensitive areas. Therefore, alternative B is composed of a combination of non-lethal actions.

ADDITIONAL ACTIONS PROPOSED UNDER ALTERNATIVE B

LARGE EXCLOSURES

In addition to the smaller areas that would be fenced under all alternatives, alternative B would include larger fenced exclosures to further allow reforestation. It has been suggested that the minimum area that would need to be fenced at one time to meet the park's forest regeneration goal would be 5%–10% of the forested area (Bowersox, pers. comm. 2005). Therefore, park staff would construct up to 15 large exclosures, each approximately 1,000 feet square (305 meters square), and each covering 23 acres (9.3 hectares) or a total of 345 acres (140 hectares), or approximately 6% of the park. The exclosures would be scattered throughout the park, with five each in the west, central, and eastern areas. Exclosures would be placed to minimize visual impacts to neighbors. When defining exclosure locations and the amount of fencing required, park staff would also consider the proposed locations in relation to visitor use areas, park boundaries, accessibility, and maintenance requirements. High use visitor areas or areas with the potential for adverse visual impacts would be avoided as much as possible. Large exclosures would be at least 0.25 mile from the park boundary and would be located so that deer could not be concentrated or funneled into specific park areas. Preference would also be given to placing exclosures around naturally occurring disturbed areas (e.g., blowdowns or disease stricken areas) to encourage rapid natural regeneration. Potential areas for exclosures are shown on the "Proposed Exclosure Locations Map" on page 53.

Large-scale exclosures would be used to protect vegetation and prevent browsing by animals.

The exclosure fences would be a minimum of 8 feet high and would consist of woven wire with 3- to 4-inch openings to allow most small animals to move freely through the fence. Metal posts would be placed every 12 feet along each

side of the exclosure, with concrete reinforced 4- by 4-inch wooden posts at 100-foot intervals and as corner supports. Electric fencing would not be used in the park based on concerns for visitor safety, difficulty in accessing a power source, and long-term maintenance requirements.

Deer would be driven out of the exclosures by park staff before completion. Visitors would not be able to use the areas included in the exclosures during or after construction. 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. If any deer were found within an exclosure, they would be removed, as would any other animals that appeared to be trapped within the exclosure.

It is estimated that at least 10 years would be required for seedling growth in the exclosures to exceed the typical deer browsing height (approximately 60 inches or 150 cm). After seedlings exceeded this height, the exclosures would be moved to immediately adjacent areas in order to reuse one side of the previous exclosure, thus minimizing relocation and labor costs.

It is assumed that most of the recovered woody vegetation in the exclosures would persist after 10 years in most of the exclosures. However, the herbaceous layer in the original exclosures would be exposed to deer browsing pressure after the exclosure was removed. Therefore, for purposes of the plan and the impact analysis presented in "Chapter 4: Environmental Consequences," it is assumed that the exclosures in alternative B would achieve the objective of woody regeneration in 6%–12% of the park over the life of the plan (15 years), and that the objective of herbaceous regeneration would be met within a maximum of 6% of the park at any one time.

INCREASED USE OF REPELLENTS

Under alternative B commercially available deer repellents would be used in selected park areas where exclosures would cause unacceptable visual impacts and where repellents would likely have some success. Repellents would be applied during the growing season near developed areas where installation of exclosures would be undesirable or not possible. Large-scale application of repellents is not practical due to high application cost, label restrictions on use, and variable effectiveness.

Repeated applications of spray repellents would be necessary due to weather and emergence of new growth. Because the effectiveness of repellents is variable, they would be used on an experimental basis until the level of effectiveness was established. NPS staff or approved contractors would apply repellents with backpack sprayers, because all-terrain vehicle use is not permitted within the park.

REPRODUCTIVE CONTROL OF DOES

Technology

Reproductive control of does would be implemented under alternative B and would be based on current technology. Several reproductive control agents are currently being developed and tested for use in deer population control (Fraker et al. 2002). These include PZP (Naugle et al. 2002; Turner et al. 1996; Kilpatrick et al. 1992); uniquely formulated PZP, such as SpayVac®; GnRH (Miller et al. 2000, 2001; Curtis et al. 2002, Fraker et al. 2002); prostaglandin $F_{2\alpha}$ (DeNicola et al. 1997); and leuprolide (Baker et al. 2002, 2004). Each of these agents is described briefly in table 2 and in more detail in appendix E, which provides an overview of reproductive control technologies for deer management.

While no product has been approved by the U.S. Food and Drug Administration (FDA) specifically for the purpose of controlling reproduction in white-tailed deer, this is not a requirement for use of such products. Several FDA-approved products are available for therapeutic (medical) use in either domestic animals (prostaglandin $F_{2\alpha}$) or humans (leuprolide). These products can be used with a veterinary prescription under the *Animal Drug Use and Clarification Act of 1994*. The prescribing veterinarian and the client (the national park unit) must clearly understand how and why the drug will be used in an off-label manner. It is the responsibility of the prescribing veterinarian to give an appropriate meat withdrawal period for food-producing animals that may enter the human food chain. The veterinarian may determine there is no meat withdrawal period for a particular drug. If this is the case, the animal does not need to be marked. If there is a meat withdrawal period, then the animal needs to be appropriately marked.

TABLE 2: REPRODUCTIVE CONTROL AGENTS

Issue	Standard PZP Vaccine	SpayVac (PZP vaccine)[a]	GnRH Vaccine	Leuprolide (GnRH agonist)	Prostaglandin F2α (contragestive)
Mode of action	Blocks sperm penetration and fertilization; estrous cycles continue	Blocks sperm penetration and fertilization; estrous cycles continue	Prevents secondary hormone (luteinizing hormone [LH] and follicle stimulating hormone [FSH]) secretion, which stops folliculogenesis and ovulation	Prevents secondary hormone (LH and FSH) secretion, which stops folliculogenesis and ovulation	Pre-term pregnancy termination
How administered	Injection	Injection	Injection	Injection	Injection
Number of doses	Twice initially and an annual booster	Initially a single injection; if and when antibodies decline, female would need to be retreated	Likely a single injection initially; if and when antibodies decline, retreatment would be required	Current formulation —annually	Single injection per pregnancy
Timing	Treat prior to breeding season and allow sufficient time for antibody development	Treat prior to breeding season and allow sufficient time for antibody development.	Treat prior to breeding season and allow sufficient time for antibody development	Treat immediately prior to breeding season on an annual basis	Treat when animal is pregnant

Note:

a. The company producing SpayVac® has stated that it will no longer begin new research projects involving SpayVac®.

Other reproductive control agents are currently available only for research use and are available under an Investigational New Animal Drug exemption by the FDA. The important aspect of a research setting is that new information regarding the safety and efficacy of the experimental drug is carefully and systematically gathered by a researcher.

Under alternative B the park would initiate a reproductive control program using an agent approved for off-label veterinary use; for purposes of this discussion, it is assumed that leuprolide or a similar agent would be used. (See appendix E for more details on reproductive control agents.) The park would also monitor the status of ongoing reproductive control research. If advances in technology could benefit deer management in the park, then the future choice of a reproductive control agent could change, and the final choice would be determined by availability, cost, efficacy, duration, and safety at the time the action was implemented.

Administration of the Reproductive Control Agent

TIMING OF APPLICATION. Leuprolide (or a similar agent) would need to be administered in the two months prior to the deer rut (the breeding season), which is also a peak visitor use period. At Catoctin, the application of leuprolide would occur primarily in September and October.

Reproductive controls, such as contraception and sterilization, limit the numbers of animals in a population by decreasing the reproductive success of the animals.

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. In urban deer populations, mortality rates are approximately 10%. Based on research of reproductive controls in a free-ranging deer population, it would be necessary to treat at least 90% of the does annually in order to halt population growth (Hobbs et al. 2000; Rudolph et al. 2000). After several years of application at this rate of treatment, a small (e.g., 5%) reduction in the population could be expected (Hobbs et al. 2000).

Catoctin's 2004 deer population is estimated at 936 deer. Based on distance sampling data, approximately 70% of the deer in the park or 655 deer are does (NPS unpublished data). Therefore, a minimum of 590 does (90% of 655) would need to be treated annually.

APPLICATION PROCEDURES. Depending on the reproductive control agent to be used, treated does would need to be marked for non-consumption or to facilitate identification of which does have been treated to avoid multiple treatments of the same does. This can be accomplished using ear tags stating "Not for Human Consumption." With the ear tag technique, each doe must be captured and handled at least once initially and may require additional annual treatment. Tracking and capturing previously treated does would require time to locate the doe or to lure it to a trap site so that it could be temporarily restrained and treated. After does have been handled one or more times, successfully capturing them for subsequent treatments can become very difficult (Rudolph et al. 2000; Underwood, pers. comm. 2005). Given that 590 does would need to be treated, any technique requiring capture would be extremely difficult to implement over the two-month period during which the drug must be administered.

One method that has been developed to deliver treatments without the physical capture or handling of does is a remote dart application (biobullet) delivered with a dart-type gun (similar to a shotgun). With this method the biobullets remain with the doe and so it is not necessary to recover spent darts. Factors for consideration with this method include the maximum distance to the doe that allows the needed penetration for delivery, consistency in dosage delivery, and accurate documentation of which deer have been treated.

Telemetry darting would be the primary capture method used because leuprolide has not yet been successfully delivered from a biobullet. With this method a tranquilizer is fitted with a radio transmitter, which allows the animal to be located after the tranquilizer has taken effect. The dart is then recovered, the doe marked, the control agent administered, and the doe released. Some handling-related mortality could occur under this method due to tranquilizer use and stress on the doe (DeNicola and Swihart 1997; Kilpatrick et al. 1997); no more than 5% mortality would be accepted by the park. The application of annual treatments by remote delivery can be time consuming and expensive, and human and animal safety precautions must be addressed. An alternative capture method would include the use of traps or nets.

Given the large number of does that would need to be treated, bait piles would be used to concentrate does in certain locations so that the darting could be done as efficiently as possible. As many does as possible would be treated daily until 90% of the does had been treated (estimated 60 days at 10 deer treated per day). Visitor access would be restricted in certain areas of the park during the treatment period. The areas targeted for treatment would be chosen based on maximizing deer presence and accessibility, while minimizing visitor inconvenience. The treatment of does would be conducted during the off-peak visitor hours (early morning and evening) and weekdays to the extent possible, but would need to occur in the period immediately preceding the deer rut, which is the relatively high fall tourist season (September and October).

TRAINING. Regardless of the technique implemented, qualified federal employees or contractors trained in the administration of reproductive controls would perform these activities. Training would include safety measures, particularly related to use of the dart gun, to protect both visitors and NPS employees. If more than one shooting location was used to remotely administer controls with dart guns, these areas would be adequately separated for safety reasons. Federal employees or contractors would also be qualified to handle live does in order to prevent disease transmission or any harm to the animal or the employee.

MONITORING

LARGE EXCLOSURES AND REPELLENTS

As deer were excluded from feeding within the large exclosures and/or in repellent-treated areas, open (non-treated) areas 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 (NPS 2004i). Additional monitoring of the 15 exclosures would also be conducted on a three-year rotation, with 5 large exclosures (and adjacent paired open plot) monitored each year.

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 et al. 2000). To monitor treated animals, a spotlight survey would be conducted in the summer, at which time observations would indicate if reproduction had occurred. Additional observations would be made during the annual distance sampling surveys conducted in the fall.

CWD TESTING

Testing for chronic wasting disease would occur as described under alternative A, page 47.

IMPLEMENTATION COSTS

Costs of implementing alternative B would include the same costs described under alternative A (continued monitoring programs, limited fencing, and repellent use), plus costs of constructing and maintaining large exclosures, some increased repellent use, and reproductive control and monitoring. The overall cost of implementing alternative B would depend on the number of deer treated, methods used, number of personnel, and monitoring costs. These costs are not yet explicitly defined, but estimates based on certain assumptions are provided in table 3.

TABLE 3: COST ESTIMATE — ALTERNATIVE B: COMBINED NON-LETHAL ACTIONS

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Same actions as alternative A (common to all alternatives)	See alternative A	See alternative A	$172,500
Large Exclosures			
• Construction	15 exclosures (each 1000′ square @ $4 / linear foot).	$240,000 (first year only)	$240,000
• Relocation	Every 10 years at 50% of original cost.	$120,000 (once every 10 years)	$120,000
• Maintenance	One person-day/exclosure/year, with up to four visits/year.	$10,400 ($2,400 for labor, plus $8,000 for materials and additional visits due to weather)	$156,000
• Vegetation Monitoring	Data collection and analysis of 5 paired plots each year, completing all 15 plots in 3 years.	$2,300	$34,500
Increased Use of Repellents	Assume could be applied to twice the area as compared to alternative A.	$160	$2,400
Reproductive Control	Cost will depend on number of deer treated and current available technology. Assume 90% of does (590) treated each year, beginning at year 1.	$1,000/deer x 590 does = $590,000	$8,850,000
• Deer Population Monitoring	Three days of survey plus data analysis each summer.	$1,000	$15,000
		Total	**$9,590,400[a]**

Note:

a. Total cost could be reduced considerably if reproductive control costs could be decreased based on improved technology.

LARGE EXCLOSURES

Large exclosures would be a minimum of 8 feet tall, using woven wire fence, metal fence posts, and wooden 4- by 4-inch posts set in concrete on the corners and every 100 feet. Material and installation costs are estimated at $4 per linear foot of fence (Voigt, pers. comm. 2005g). The cost of one 1,000-foot-square exclosure would be approximately $16,000, and 15 exclosures would total $240,000. It is estimated that it would take up to 150 working days to construct all exclosures.

Exclosures would be relocated probably every 10 years. Costs for this are estimated at half the original cost, or a total of $120,000, to relocate 15 exclosures.

Maintenance costs could be substantial due to the remoteness of some exclosures. Labor to inspect and maintain fences is estimated at approximately one person per day for each exclosure annually, assuming up to four visits per year. Using an average rate of $160 per day, and 15 days to cover all of the exclosures, the annual maintenance cost would be $2,400 for labor. An additional $8,000 per year would be needed for maintenance materials and additional visits due to weather. The additional vegetation monitoring cost for five exclosures per year would be approximately $2,300 (based on annual monitoring costs used in alternative A).

REPELLENTS

Repellents are estimated to cost $450–$500 per acre. The labor cost to apply repellents would be approximately $8–$12 per acre, depending on location and remoteness of the area. In 2004 the park applied approximately 2 quarts of repellent, at a cost of $40 per quart for product and labor (a total of $80 per year). This cost is expected to double under this alternative, for a total of $160 per year.

REPRODUCTIVE CONTROL

A study in New York (one of the few conducted on a suburban, free-ranging deer population) estimated that the minimal annual time commitment per deer for reproductive control (using PZP) was approximately 20 hours, costing in the range of $450 to $1,000 per deer (Rudolph et al. 2000). At Cleveland Metro Parks labor was about $450 per deer, and vaccines and equipment about $450 per deer (DeNicola, pers. comm. 2004b). Vaccine trials in Connecticut cost $1,128 per deer for 30 deer over two years, with 64% of the cost going to labor (Walter et al. 2002). These suburban examples may underestimate the effort needed in a wildland setting, where the labor costs to locate deer for treatment can be substantially higher than in urban settings (Watry et al. 2004).

Costs per deer would include costs for the reproductive control agent, labor and equipment, and bait piles. Two hundred dollars is the estimated cost per dose of leuprolide. Additional handling and processing costs associated with delivering the treatment would also apply. In the wildland setting at Catoctin, the expected costs for implementing reproductive controls would likely be at the high end of

the range, and for this analysis $1,000 per deer is used. However, these costs could decrease based on improved technology.

The additional monitoring required for reproductive controls would be similar to the distance sampling protocol, with three days of survey during the summer to document the number of fawns.

ALTERNATIVE C: COMBINED LETHAL ACTIONS — SHARPSHOOTING AND CAPTURE AND EUTHANASIA (PREFERRED ALTERNATIVE)

Alternative C would continue the actions described under alternative A, with two additional lethal actions used in combination to reduce and control deer herd numbers. Qualified federal employees or contractors[2] would conduct sharpshooting to reduce the deer population, and individual deer would be captured and euthanized in certain circumstances where sharpshooting would not be appropriate.

ADDITIONAL PROPOSED ACTIONS UNDER ALTERNATIVE C (PREFERRED ALTERNATIVE)

SHARPSHOOTING

Sharpshooting would consist of using trained sharpshooters to shoot deer within the park in designated areas. Methods, removal numbers, and gender preferences are described below.

Methods

Qualified federal employees or contractors would be used to implement this alternative. These employees would be experienced with sharpshooting methods and would have the necessary sharpshooting qualifications. They typically 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) (Sullivan, pers. comm. 2005).

High-power, small caliber rifles would be used from close range. 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 and night vision equipment would be used to reduce disturbance to the public. Activities would be in compliance with all federal firearm laws administered by the Bureau of Alcohol, Tobacco, and Firearms.

Sharpshooting would primarily occur at night (between dusk and dawn) during late fall and winter months when deer are more visible and few visitors are in the park. In some restricted areas, sharpshooting may be done during the day if needed, which could maximize effectiveness and minimize overall time of restrictions. If this is done, the areas would be closed to park visitors. The public would be notified of any park closures in advance, exhibits regarding deer

2. In addition to other federal contracting requirements, for the purposes of this plan, a contractor is a fully-insured business entity, nonprofit group, or other governmental agency engaged in wildlife management activities that include trapping, immobilization, and lethal removal through sharpshooting and chemical euthanasia. The contractor must possess all necessary permits and be able to pass any needed security clearances.

management would be displayed at visitor centers, and information would be posted on the park's website to inform the public of deer management actions. Visitor access could be limited as necessary while reductions were taking place, and NPS park rangers would patrol public areas to ensure compliance with park closures and public safety measures (Voigt, pers. comm. 2005a).

As a safety measure, sharpshooting would not occur within 100 feet of a building or within 400 feet of the park boundary. Qualified federal employees or contractors trained in all aspects of direct reduction actions would perform these activities. Training would include safety measures to protect both visitors and NPS employees. If more than one shooting location was 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 could range from 20 to 100 pounds, depending on the bait used and the number of deer in the immediate area (DeNicola, pers. comm. 2004b).

NPS Public Health Service guidance pertaining to the donation of meat from a documented CWD area would be followed (NPS 2005c). Meat from any animal confirmed to be infected with chronic wasting disease would not be consumed, and the carcass would be disposed of in accordance with NPS Public Health Service disposal guidelines if CWD is found.

Disposal

In cases where one to a few deer have been shot or euthanized at a given site, the waste or carcasses would be scattered and left above ground to be naturally scavenged and/or decompose. This would be dependent on the suitability of meat for donation, amount of waste or carcasses, and distance from trails, roads, and facilities.

In cases where the meat from deer is unsuitable for donation to charity or surface disposal, the carcasses and waste would be buried. Disposal pits would be in one or more of the following locations within the park: Camp Misty Mount pasture, Camp Greentop paddock, and/or Camp Round Meadow bulk storage area. All of the locations listed are in previously disturbed areas and none contain archeological resources. Disposal pits would be approximately eight feet wide by eight feet long by four feet deep. They would be dug prior to direct reduction activities and covered and surrounded with privacy fencing to prevent entry. Soil removed from the pits would remain on site and be covered to prevent erosion.

Carcasses and waste would be transported to the pit(s) within 12 hours of direct reduction. A layer of carcasses and waste would be put into the pit. That layer would be covered by hand with approximately one foot of the soil that was removed from the pit. Another layer of carcasses and waste would be put on top of the soil layer and covered with approximately one foot of soil. The final layer of carcasses and waste would be covered with approximately three feet of soil.

The soil covering the filled pit would be covered with straw or wood chip to prevent erosion. The fence would be secured between uses to prevent entry.

If the pits are not completely filled between direct reduction activities or if the is soil frozen, the pit would be covered with tarps or plywood, and privacy fencing would be installed to prevent entry and reduce visibility. When conditions permit, the carcasses and waste would be covered with soil or the pit filled.

When the weather and season are appropriate, the soil covering the pits would be seeded with an NPS approved seed mix and mulched. Any soil not used to refill the pits would be used in other locations within the park.

Should chronic wasting disease be found in the deer herd, the park would follow NPS Public Health Service guidelines for disposal of deer infected with the disease.

Numbers of Deer Removed

Based on the 2004 survey, Catoctin's deer population is estimated at 936, or 104 deer per square mile for the 9 square miles of park. Park staff would determine the number of deer to be removed from the park based on the most recent survey and a population goal of 15 to 20 deer per square mile. At least three years would be required to reach this goal, given the limited accessibility to some areas of the park and changes in population movements as the population decreased.

- *Year One* — The USDA Wildlife Services has estimated that, with concentrated efforts, about half of the deer could be removed the first year (468 deer), assuming periodic removal efforts over a five-month period (November to March). This would reduce the population to 52 deer per square mile.

- *Year Two* — Assuming a 20% growth rate in the deer herd (a general rate commonly used by deer managers considering reproduction, mortality, and recruitment), the deer population would be an estimated 562 deer by the second year. If half of this population was removed, 281 deer would remain in the park, or about 31 deer per square mile.

- *Year Three* — Assuming the same 20% growth rate in the deer herd, the deer population would be 338 by the third year. Removing half of these deer would leave 169 deer in the park, which would be in the range of 15 to 20 deer per square mile.

- *Subsequent Years* — Assuming the same 20% growth rate in the deer herd, a minimum of 33 deer would need to be removed annually in subsequent years to maintain the desired population size. However, it is expected that as the density decreased and forest regeneration increased, deer reproductive rates would also increase. Therefore, it is more likely that the removal number to maintain the population at 15–20 deer per square mile would range from 50 to 100 deer per year.

Several factors could influence the number of years to reach the initial deer density goal. As the deer population decreased through successful reduction efforts, deer might become adapted to the sharpshooting operations and become more evasive, increasing the effort necessary to reach the removal numbers in any year. Existing reproduction and mortality rates might differ from the estimate used in this projection. If reproduction rates were higher and mortality lower than estimated, the population growth would be greater than 20%, and more deer would need to be removed, potentially increasing the time to reach the initial density goal. The converse would be true if reproduction rates were lower and mortality rates higher than estimated, resulting in fewer deer having to be removed, and efforts could take less time. Immigration of deer into the park could also have a significant effect on the number of deer to be removed, especially if the goal was toward a low population density (Porter et al. 2004).

The number of females in the population would also influence reproduction rates. As the population composition shifted closer to a 50:50 sex ratio because does would be preferentially removed during the first few years, reproduction rates should decrease because fewer females would be reproducing.

Gender Preference

There would be a preference for removing does because this would reduce the population level more efficiently over the long term. During the first three years of treatment, both does and antlered deer (bucks) would be removed based on opportunity. Buck-only removal would not control population growth, as deer populations are largely dependent on the number of does with potential for reproduction. Harvest of does is necessary to stabilize or reduce populations, and for a rapid decrease in deer population, at least 15 does should be taken for every 10 bucks during the first three years of treatment (West Virginia University 1985).

Records would be kept on the age and gender of all deer removed from the park to aid in defining the local population composition. This information would be compared with composition data collected during park population surveys.

CAPTURE AND EUTHANASIA

Capture and euthanasia would only be used in circumstances where sharpshooting would not be appropriate due to safety or security concerns. This is expected to be 3% or less of the total number of deer being removed. The preferred technique for this method would be for qualified federal employees or contractors to trap deer, approach them on foot, and euthanize them. Activities would occur at dawn or dusk when few visitors are in the park.

Deer would be captured with nets or traps and euthanized as humanely as possible. Euthanasia methods could include a combination of penetrating captive bolt gun and potassium chloride or exsanguination, firearm technique, or other humane technique. Several methods of wildlife trapping could be used, including but not limited to drop nets and box traps. Most trapping methods involve using bait to attract deer to a specific area or trap. Box traps involve a confined space that would safely hold the deer so that staff could 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 (location, number of deer, accessibility, and reasons why sharpshooting was not advised) for each deer or group to be removed.

Deer could also 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. Similarly, if for some reason the penetrating captive bolt gun or firearm technique could not be used to euthanize a trapped animal, injecting a lethal dose of a drug (under supervision of a veterinarian or NPS park practitioner) could be used. However, when chemicals are used for either immobilization or for euthanasia, the meat from that animal may not be able to be donated as food, and the carcass may be unsuitable for surface disposal. If this is the case, the carcasses would be buried as described under the "Sharpshooting" section.

Qualified federal employees or contractors trained in the use of penetrating captive bolt guns, firearms, or tranquilizer guns would perform these actions. Training would include safety measures to protect both visitors and NPS employees. Federal employees or contractors would also be qualified to handle live deer in order to prevent disease transmission and prevent any harm to an animal or an employee. Appropriate safety measures would be followed when setting drop nets or box traps.

Because capture and euthanasia would typically result in increased stress levels in captured deer compared to sharpshooting, this method of population control would only be used in select situations and would supplement the sharpshooting method described earlier.

The number of deer removed by capture and euthanasia would be recorded, including the age and sex, location of removal, circumstance requiring removal and capture, and lethal method used. Qualified federal employees or contractors would follow the guidelines of the American Veterinary Medication Association to minimize stress, pain, and suffering to the greatest extent possible (AVMA 2007)

MONITORING

SHARPSHOOTING

Throughout the removal efforts, vegetation monitoring (NPS 2004i) would be conducted to document any changes in deer browsing and forest regeneration that might result from reduced deer numbers. However, it would take several years for vegetation to respond to lower deer numbers and would be directly dependent 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 growth of the population, and vegetation and deer monitoring results.

Current monitoring of vegetation impacts and deer population levels would be expanded as necessary.

Vegetation monitoring would be conducted annually to document vegetation recovery. If the park objectives were being met and forest regeneration was successful at the target deer density goal, removal efforts would be maintained at the level necessary to keep the deer population at the target density. Management adjustment of the removal goal in either direction from the initial density goal could be made based on how close the conditions indicated by vegetation monitoring were to the park's forest regeneration objectives (see adaptive management section).

CAPTURE AND EUTHANASIA

The same monitoring conducted for sharpshooting would be used for capture and euthanasia.

CWD TESTING

Testing for chronic wasting disease would occur as described under alternative A, page 47. Under this alternative, a statistically valid sample may be reached sooner than under alternative A given increased testing opportunities.

IMPLEMENTATION COSTS

Costs of implementing alternative C would include the same costs described under alternative A (continued monitoring programs, limited fencing, and repellent use), plus the cost of sharpshooting and capture/euthanasia. Estimated costs for alternative C are discussed below and summarized in table 4.

TABLE 4: COST ESTIMATE — ALTERNATIVE C: COMBINED LETHAL ACTIONS (PREFERRED ALTERNATIVE)

Action	Assumptions	Annual Cost	Cost for the 15-year Planning Period
Same actions as described for alternative A (common to all alternatives)	See alternative A	See alternative A	$172,500
Sharpshooting	Year 1 — 468 deer removed ($200/deer) Year 2 — 281 deer removed ($200/deer) Year 3 — 169 deer removed ($200/deer) Years 4 through 15 — 75 deer (average of 50–100) removed each year for 12 years ($400/deer)[a]	Year 1 —$93,600 Year 2 —$56,200 Year 3 —$33,800 Years 4–15 — $30,000	$543,600
Capture and euthanasia	15 deer maximum / year (range of $100 – $1,000/deer)	$1,500 – $15,000/ year	$22,500 – 225,000
		Total	**$738,600 – 941,100**

Notes:

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

b. This cost could increase if the deer density goal was not reached by the third year.

c. Costs for this method would vary but would likely be in the lower to middle end of this range.

SHARPSHOOTING

Factors affecting the final cost of implementing this alternative include deer density, number of deer to be removed, ease of access to deer, number and location of bait stations, equipment availability, amount of data to be collected from deer, and processing requirements. The greatest costs would generally be incurred when the deer and bait stations were difficult to access, when deer were wary of humans, the removal area was large, and when deer densities were lower (requiring more time to find each deer). Conversely, lower costs could be expected when the removal area was smaller, deer density was high (less time to find each deer), and deer were accustomed to human activities (DeNicola, pers. comm. April 2004a). For this alternative, it is assumed that a qualified federal employee or contractor would conduct the lethal removal activities, and process the deer, collect biological data, and prepare meat for transfer to a local food bank (as appropriate), and/or arrange for disposal of deer carcasses (if needed).

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

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

CAPTURE AND EUTHANASIA

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

ALTERNATIVE D: COMBINED LETHAL AND NON-LETHAL ACTIONS

Alternative D would include all actions described under alternative A, plus a combination of certain additional lethal and non-lethal actions from alternatives B and C to reduce deer herd numbers. The lethal actions would include both sharpshooting and capture/euthanasia, and these actions would be taken initially to quickly reduce the deer herd numbers. Reproductive control of does (with direct reduction, if needed) would then be implemented as a maintenance tool to keep deer numbers at an acceptable level.

ADDITIONAL PROPOSED ACTIONS UNDER ALTERNATIVE D

SHARPSHOOTING

Direct reduction by sharpshooting would be used to initially reduce the deer population in areas of the park and as a maintenance treatment if needed. Methods described in alternative C would be implemented. This action would continue for a minimum of three years, at which time it is estimated that the population would be reduced to the initial density goal of 15–20 deer per square mile. The disposal methods described under alternative C would apply to alternative D as well.

CAPTURE AND EUTHANASIA

Capture and euthanasia would be implemented in areas where sharpshooting was not possible. This procedure would include trapping or immobilizing deer using the technique that would create the least amount of stress. The disposal methods described under alternative C would apply to alternative D as well.

REPRODUCTIVE CONTROL

Reproductive control would be implemented, as described under alternative B, to maintain the lowered deer population level after direct reduction efforts had reduced the population size. The success of implementing reproductive controls on a population that has undergone direct reduction efforts 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 et al. 2004; Naugle et al. 2002). It should be expected that getting close enough to administer remote injections would become increasingly difficult after direct reduction efforts due to deer behavior changes in response to previous human interaction (Underwood, pers. comm. 2005).

Assuming a park deer population density of 15 to 20 deer per square mile when reproductive control was initiated, the park's deer population would be a maximum of 180 animals. This number of deer would be close to the maximum size suggested for application of reproductive controls in free-ranging deer populations. Assuming that the sex ratio composition of the reduced deer population was approximately 50:50, there would be 90 does in the population.

The majority of the does (90%, or 81 does) would need to be treated and marked for identification for subsequent retreatment. It is estimated that up to 5 deer per day could be treated (taking 16 days), given the increased effort to locate deer with lower deer numbers. The population would continue to be monitored for growth. If the deer population increased during the reproductive control application under this alternative, periodic direct reduction would be initiated to maintain the population density at the identified goal.

MONITORING

Monitoring under this alternative would include the same monitoring techniques described for CWD testing (alternative A), although a statistically valid sample may be reached sooner than under alternative A given increased testing opportunities. Monitoring would also include the same techniques described for sharpshooting and capture and euthanasia (alternative C), and reproductive controls (alternative B). This would include spotlight surveys to assess the effectiveness of reproductive controls, and vegetation monitoring to document changes in forest regeneration.

IMPLEMENTATION COSTS

Costs of implementing alternative D would include the same costs described under alternative A, plus additional costs for sharpshooting, capture and euthanasia, and reproductive control. Estimated costs for alternative D are discussed below and summarized in table 5.

TABLE 5: COST ESTIMATE — ALTERNATIVE D: COMBINED LETHAL AND NON-LETHAL ACTIONS

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Same actions as described for alternative A	See alternative A	See alternative A	$172,500
Sharpshooting	Same level of effort as alternative C years 1–3 plus 2 subsequent years	Year 1 — $93,600 Year 2 — $56,200 Year 3 — $33,800 plus 2 more years — $30,000 / year	$243,600
Capture and Euthanasia	Similar to alternative C	See alternative C	$22,500 – 225,000
Reproductive Control	For estimate, assume treatment of 81 deer annually starting after year 3 (for 12 years)	$1,000 / year / deer or $81,000 / year	$972,000
• Deer Population Monitoring	Three days of survey plus data analysis each summer	$1,000	$15,000
		Total	**$1,425,600 – 1,628,100[a]**

Notes:

a. This cost could increase if the deer density goal was not reached by the third year.

b. Costs for this method would vary but would likely be in the lower to middle end of this range.

c. Reproductive control costs could be reduced considerably with improved technology.

SHARPSHOOTING

The cost for using sharpshooting to reduce the overall population size would be the same as in alternative C for years 1 through 3, plus a potential need for periodic removal in 2 of the remaining 12 years. Costs for using this method would depend on the number of deer removed annually.

CAPTURE AND EUTHANASIA

The cost for using capture and euthanasia to supplement the sharpshooting effort would be the same as for alternative C.

REPRODUCTIVE CONTROL

It is assumed that reproductive control would begin in year 4 and that 90% of the does in the population would be treated in this year and subsequent years. Costs could be reduced considerably depending on the results of the direct reduction efforts, the cost per deer based on current technology, and the year treatment begins.

ADAPTIVE MANAGEMENT APPROACHES INCLUDED IN THE ALTERNATIVES

All of the action alternatives (B-D) described in this chapter incorporate adaptive management approaches to meeting the objectives of the plan. Each alternative includes a management action followed by a period of monitoring to evaluate the results of the action. By using an adaptive management approach, managers will be able to change the timing or intensity of management treatments to better meet the goals of the plan as new information is obtained. The adaptive management approach and its integration into the action alternatives are more fully described below.

Successful management of natural systems is a challenging and complicated undertaking. The Department of the Interior requires that its agencies "use adaptive management to fully comply" with the Council on Environmental Quality's guidance that requires "a monitoring and enforcement program to be adopted . . . where applicable, for any mitigation" (516 DM 1.3 D(7); 40 CFR 1505.2). Adaptive management is based on the assumption that current resources and scientific knowledge are limited. Nevertheless, an adaptive management approach attempts to apply available resources and knowledge and adjusts management techniques as new information is revealed. Holling (1978) first described the principle of adaptive management as requiring management decisions and policies to be viewed as hypotheses subject to change.

USING THE ADAPTIVE MANAGEMENT PROCESS

Adaptive management requires an examination of a hypothesis to be tested. For this plan, adaptive management starts with the hypothesis that deer density is the primary factor limiting woody vegetation regeneration. Monitoring under this plan would test for a significant difference in seedling numbers between open plots and enclosed plots. If there was a difference, then deer management actions would be taken, as described previously under "Threshold for Taking Action." If not, data would be examined to identify the most important variable(s) affecting regeneration. These could include light penetration, soil acidity, and fern/grass cover, in addition to deer density.

The adaptive management approach can be divided into the following basic steps: assessment, design, implementation, monitoring, evaluation, and adjustment or continuation (Nyberg 1998). Ideally, the resulting management of an ecosystem will improve as more information is gathered, analyzed, and incorporated into the process. Adaptive management requires setting quantitative objectives, exploring alternative management strategies, monitoring progress, and evaluating performance in terms of risks and benefits (Goodman and Sojda 2004). The applicability and success of decisions depends on the frequency and precision of monitoring (Williams 1997).

Adaptive management incorporates scientific experimental methods in the management process while remaining flexible to adjust to changes in the natural world, as well as policies that govern it. The goal is to give policy makers a better framework for applying scientific principles to complex environmental decisions (Wall 2004). Figure 1 illustrates an adaptive management approach.

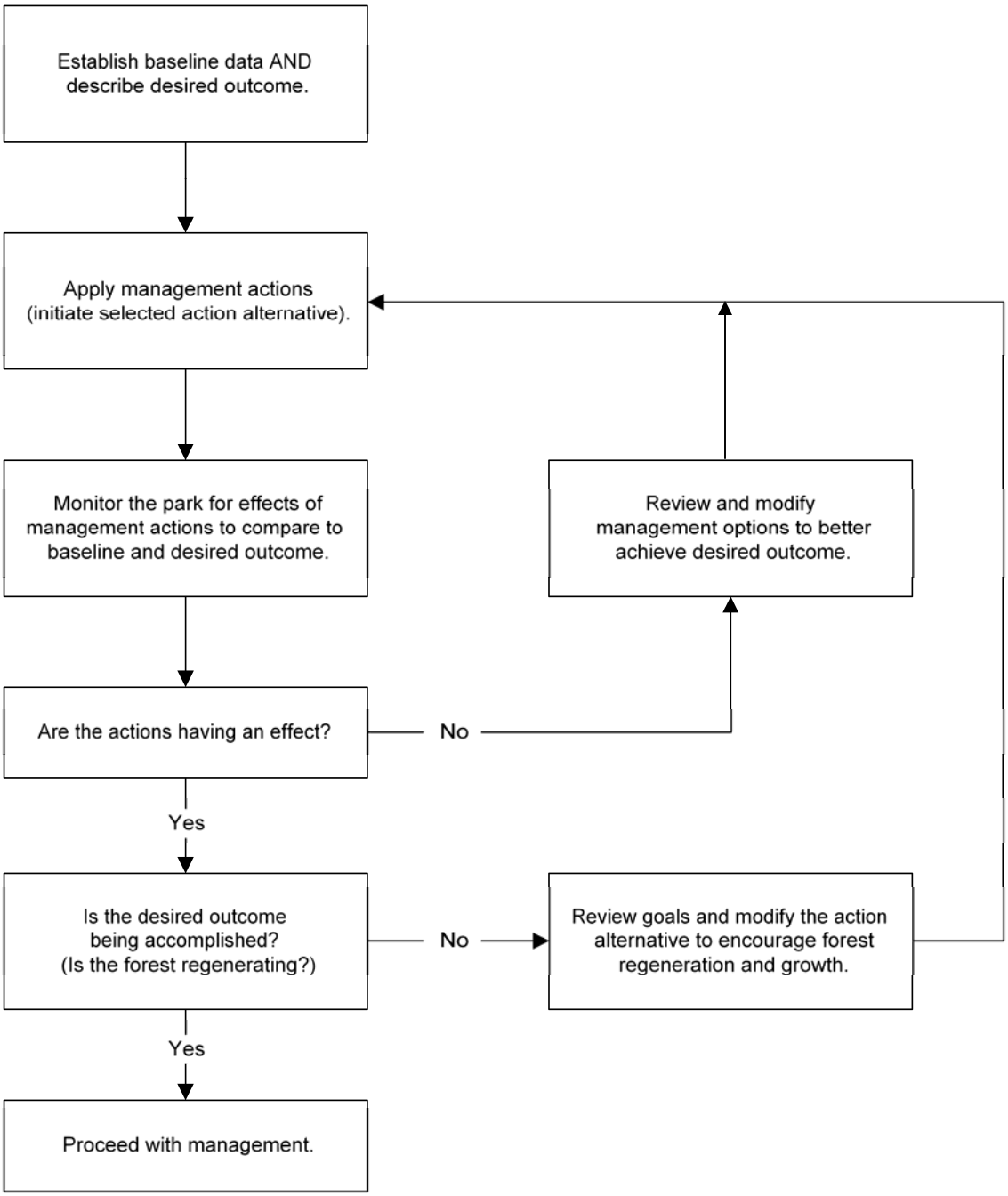

FIGURE 1: AN ILLUSTRATION OF THE ADAPTIVE MANAGEMENT APPROACH FOR THE ACTION ALTERNATIVES

Under this plan the following six steps would constitute the adaptive management approach. For illustrative purposes, alternative B is used as an example for each of these steps.

1. *Monitor the baseline data* — Existing conditions would be recorded and monitored to establish a set of baseline conditions for future comparison.

2. *Apply the management action* — Deer would be managed using an action alternative described in this document; for example, alternative B could apply a combination of large exclosures, repellents, and doe reproductive control.

3. *Monitor the effectiveness of each management action* — Monitoring would determine whether the management actions were achieving the desired outcome. For example, is reproductive control reducing or limiting growth of the herd? Is forest regeneration occurring in the 6% of the forest being protected with exclosures? Or is protection of 6% of the forest enough to achieve regeneration within a reasonable time frame?

4. *Monitor for effects of management actions on other resources* — Resources in the park would be monitored during and after management actions to determine whether there were any unacceptable effects on native vegetation, wildlife, sensitive species, or cultural resources.

5. *If monitoring indicates that the goal of forest regeneration is not at an acceptable level, reconsider the management actions* — For example, under alternative B, this could result in additional large exclosures, or increased reproductive control of does. Similarly, if an action was found to have unintended effects on deer or other components of the environment, modifications would be considered. For example, if the reproductive control agent was causing unacceptable behavioral changes in deer, then the agent could be changed.

6. *If the management action is effective, and the forest is regenerating, consider modifications to the intensity of the action* — For example, if deer density was reduced through reproductive control, the number of deer treated might be able to be reduced and still have the same effect.

POTENTIAL ADAPTIVE MANAGEMENT APPROACHES

It is envisioned that the adaptive management approach would be used to a limited extent in the following areas (see the discussion for each alternative for additional details).

PLOT LOCATIONS FOR VEGETATION MONITORING

Plot locations for vegetation monitoring would be relocated as seedlings reached sapling heights in excess of 60 inches (150 cm), indicating that regeneration was success. Plots would be monitored annually until the sapling heights, as described above, were reached.

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 six years from the time that deer density was lowered until forest regeneration results would be seen in the monitored plots. If results after six years did not meet expectations, 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 results of the previous year's removal effort, the monitoring of forest regeneration, deer population density surveys, and growth projections. When a management action was 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 (e.g., 15 to 20 deer per square mile). Using this example, if the initial deer density was 104 deer per square mile, then between 84 and 89 deer per square mile would have to be removed. However, because this density goal could not be achieved in one year, 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 an annual growth rate. 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 within the park, not for deer density, the results of removal would be documented annually, so that the number of deer to be removed could be adjusted based on the response of the vegetation to a lower deer density. If the vegetation was observed to be regenerating before the lower deer density was reached, management actions could then be modified or adjusted. Similarly, management actions would be adjusted if no change in the vegetation was observed after implementation. The following are examples of how this adaptive management approach could be implemented based on different outcomes:

Successful forest regeneration, regrowth of forest species and renewal of forest tree cover such that the natural forest sustains itself without human intervention, is the main goal of the management plan.

- If forest regeneration occurred prior to meeting the initial deer density goal, the deer density goal would be adjusted upward to the density that would still allow regeneration to occur.

- If no response in forest regeneration occurred within 6 years after the initial deer density goal was reached, then the density goal could be lowered by five additional deer per square mile, with a six-year monitoring period before further reductions were made in density goals.

- If the initial deer density goal of 20 deer per square mile was not reached within six years, additional efforts would be made to reach the desired density through the use of other methods of removal, such as increasing the use of capture and euthanasia in areas where sharpshooting was not effective.

- If no response in forest regeneration occurred after a goal of 10 deer per square mile was reached, then methods and protocols would be reviewed to identify the variables that were limiting expected results, and the methods used would be adjusted as necessary to correct for such factors.

LARGE EXCLOSURES AND REPELLENTS

Large exclosures and increased use of repellents are proposed under alternative B. As some areas were treated, deer browsing pressure in other areas could increase, making additional treatments necessary in these areas. Thus, over the course of management actions, the investment in materials and maintenance could increase. Areas inside and outside the proposed large exclosures would be monitored similar to the monitoring protocol described above (NPS 2004i). If regeneration further deteriorated in untreated areas, additional exclosures or a change in repellent use would be considered.

REPRODUCTIVE CONTROL

Reproductive control is one of the proposed measures under alternatives B and D. However, there is limited information regarding the safety, efficacy, and feasibility of applying reproductive control agents in large free-ranging populations. As science catches up to the need for management, additional agents could be developed and tested for reproductive control on free-ranging deer. The park could review the science at that time to determine if other agents were appropriate for the park. The size, scale, and location of the application would depend on the specifications and efficacy of the drug.

ALTERNATIVE D IMPLEMENTATION

Alternative D (combined lethal and non-lethal actions) would be adjusted as described for each individual action as required to maximize forest regeneration. These actions could also be adjusted to stay current with 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 time frame. After deer density was reduced to the initial goal, and if vegetation monitoring indicated that vegetation was regenerating, maintenance of the deer might be achieved through reproductive control, depending on the state of the technology and as noted in the adaptive management parameters described above.

HOW ALTERNATIVES MEET OBJECTIVES

As stated in the "Purpose of and Need for Action" chapter, all action alternatives selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives were individually assessed in light of how well they would meet the objectives for this plan and environmental impact statement, which are stated on page 4. Alternatives that did not meet the objectives were not analyzed further (see the "Alternatives Eliminated from Further Consideration" section in this chapter).

Table 6 on page 77 compares the alternatives by summarizing the elements being considered, while table 7 on page 79 compares how each of the alternatives described in this chapter would meet the plan objectives. "Chapter 4: Environmental Consequences" describes the effects of each alternative on each impact topic, including the impact on recreational values and visitor experience. These impacts are summarized in table 8 on page 81.

TABLE 6: COMPARISON OF ALTERNATIVES

	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Management Actions	Continue limited use of fencing and repellents, plus deer monitoring, data gathering, data management and research, herd health checks, and education.	All actions under alternative A, plus: • Construct 15 large exclosures to protect resources throughout the park if needed. • Increased use of repellents where fences would be undesirable near buildings. • Implement reproductive control of does.	All actions under alternative A, plus: • Use direct reduction methods (sharpshooting and capture / euthanasia where sharpshooting would not be advisable) to reduce deer herd numbers. • Focus in areas of the park documented to have substantial browsing impacts. • Donate meat, if possible.	All actions under alternative A, plus use a combination of techniques from alternatives B and C: • Use direct reduction methods (sharpshooting and capture / euthanasia where sharpshooting would not be advisable) to reduce deer herd numbers. • Apply reproductive controls to maintain population size, with direct reduction used periodically, if needed. • Donate meat, if possible.
Reduction in Deer Population	None, other than natural sources of mortality.	Potentially reduce deer population if reproductive controls could be applied parkwide 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.	Initially remove an estimated 468 deer, with fewer deer in subsequent years. To maintain the population at target levels (15–20 deer/sq. mi.), remove an estimated 50–100 deer annually.	Initially similar to alternative C. Potential for future reductions through reproductive control used as a population maintenance tool.
Time Required to Achieve Desired Forest Regeneration	Forest regeneration cannot be achieved without reducing browsing impacts.	Twelve percent of park woody vegetation would be protected or regenerated by end of plan due to exclosures; reproductive control not likely to contribute to additional forest regeneration.	Direct reduction would reduce deer population by year three, with regeneration changes observed in monitoring by year six, and trends toward regeneration success by end of plan.	Same as alternative C.
Handling of Deer	None.	No physical handling of deer required to drive them out of fenced areas. With telemetry dart application, physical handling of deer required to administer reproductive control (leuprolide). The dart is then recovered, the doe marked, the control agent administered, and the doe released.	No capture required for sharpshooting activities. For capture and euthanasia, minimized handling to reduce stress in accordance with American Veterinary Medical Association (AVMA) recommendations. Increased stress levels in captured deer compared to sharphooting method.	Same as alternative B for reproductive control and alternative C for other actions.

TABLE 6: COMPARISON OF ALTERNATIVES (CONTINUED)

	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Monitoring	Continued inventorying vegetation monitoring and monitoring of deer population numbers to assess impacts.	Continued monitoring as described under alternative A, plus monitoring of plants for signs of recovery within exclosures. For reproductive control, monitoring of treated deer using additional spotlight surveys to determine reproductive control effectiveness.	Annual monitoring of plants for six years after deer density goal reached to identify any signs of forest recovery, plus continued monitoring as described under alternative A.	Same as alternatives B and C.
Regulatory Considerations	No specific regulatory requirements. Application rate restrictions would apply to different repellents that could be used.	Application rate restrictions could apply to different repellents that could be used. Veterinarian prescription required pursuant to the *Animal Drug Use and Clarification Act* for off-label use in deer. Additional requirements could be prescribed by a veterinarian (e.g., meat withdrawal period, marking). Follow Public Health guidelines for CWD.	No prohibition of spotlights or suppression devices that could be used along with night vision equipment to reduce disturbance to the public. Any necessary ATF permits would be obtained. Coordination with state / local / nonprofit / private entities might be needed to donate meat.	Same as alternatives B and C.
CWD Testing	Testing coordinated with the state and conducted opportunistically. Targeted removal and testing of animals with clinical signs of chronic wasting disease as described under alternative A, page 47.	Same as alternative A.	Same as alternative A.	Same as alternative A.
Park Closure or Restricted Access	None.	Restricted access within exclosures or in areas of active reproductive control activities.	Areas closed or access restricted during direct reduction activities; closures or restrictions minimized by conducting activities during periods around dawn and dusk and in winter.	Areas closed or access restricted during direct reduction and reproductive control activities; closures or restrictions minimized by conducting activities during periods around dawn and dusk and in winter.
Adaptive Management	No specific adaptive management included under this alternative.	Relocation of vegetation monitoring plots, changes in action thresholds or deer density goals, possible changes in repellent use and number and locations of large exclosures, possible change in reproductive control agent used and its application procedures.	Relocation of vegetation monitoring plots, changes in action thresholds or deer density goals or possible changes to implementation procedures for direct reduction.	Relocation of vegetation monitoring plots, changes in action thresholds or deer density goals, possible change in reproductive control agent used and its application procedures, as well as number of direct reduction actions needed.
Estimated Cost (15-Year Plan)	$172,500	$9,590,400	$738,600 – $941,100	$1,425,600 – $1,628,100

TABLE 7: ANALYSIS OF HOW THE ALTERNATIVES MEET OBJECTIVES

Objective	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Vegetation				
• Reduce adverse effects of deer browsing pressure to ensure tree regeneration sufficient to reach the desired condition of a sustainable eastern hardwood forest with a native and diverse forest structure.	Does not meet objective: No reduction in deer browsing pressure, resulting in insufficient tree regeneration to achieve a sustainable hardwood forest.	Partially meets objective: Up to 6%–12% of the park's woody vegetation protected over the life of the plan; a maximum of 6% of the herbaceous cover totally protected at any one time. A minimum of 10 years for reproductive control to be effective with current methods.	Fully meets objective: Reduction of deer herd over a minimum of three years, helping ensure tree regeneration.	Fully meets objective: Same as alternative C.
• Provide protection for threatened, endangered, and sensitive plant species and their habitats (e.g., the large purple-fringed orchid) from adverse impacts related to deer browsing.	Partially meets objective: Some sensitive plant species in limited locations protected by small fenced exclosures.	Partially meets objective: Fencing required to protect sensitive herbaceous species that would never grow out of browse range. No protection for species in park areas that cannot be fenced (slope is too steep, ground is too hard, or flowing water).	Fully meets objective: Sensitive species protected if deer density goal is reached.	Fully meets objective: Same as alternative C.
• Maintain, restore, and promote a mix of native herbaceous plant species, and reduce the competitive advantage of invasive exotic plant species over native plant species through effective deer management.	Does not meet objective: No mix of native herbaceous plant species because of overbrowsing, and continued contribution to the spread of invasive species.	Partially meets objective: Mix of native herbaceous plant species in exclosures. No native herbaceous species in park areas that cannot be fenced, and continued contribution to the spread of invasive species due to overbrowsing outside exclosures.	Fully meets objective: Forest regeneration likely because of a smaller deer herd, resulting in a mix of native herbaceous plant species. No contribution to the spread of invasive species due to overbrowsing.	Fully meets objective: Same as alternative C.
Wildlife and Wildlife Habitat				
• Maintain a viable white-tailed deer population within the park while protecting other park resources.	Does not meet objective: Deer population not in balance with the forest ecosystem, resulting in compromised herd health. No protection for other park resources.	Partially meets objective: A self-sustaining deer population, but at the expense of a healthy forest. Other park resources only protected within exclosures.	Fully meets objective: A viable deer population. Other park resources protected as a result of reducing the herd size.	Fully meets objective: Same as alternative C.
• Protect lower canopy and ground-nesting bird and other wildlife habitat from adverse impacts from deer browsing.	Does not meet objective: No natural regeneration in lower canopy due to continued browsing pressure, reducing the amount of habitat within the park.	Partially meets objective: Lower canopy and habitat only protected in exclosures.	Fully meets objective. Forest regeneration possible with a smaller deer herd, resulting in a lower forest canopy and habitat.	Fully meets objective: Same as alternative C.

TABLE 7: ANALYSIS OF HOW THE ALTERNATIVES MEET OBJECTIVES (CONTINUED)

Objective	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Cultural Resources				
• Ensure that vegetation contributing to the park's cultural landscape is protected from the adverse effects of deer behavior (browsing, trampling, seed dispersal).	Partially meets objective: Landscaped areas protected from excessive deer browsing by fencing, but no protection for the park's overall cultural landscape, which is Catoctin's entire forest.	Partially meets objective: In addition to landscaped areas protected by fencing, protection of vegetation within exclosures, but no protection for the park's overall cultural landscape outside exclosures, which is Catoctin's entire forest.	Fully meets objective. Forest regeneration allowed with a smaller deer herd, thus protecting the forest as a cultural landscape.	Fully meets objective: Same as alternative C.
Visitor Experience				
• Educate the public regarding the deer population and the forest regeneration process and diversity, including the role of deer as part of a functioning park ecosystem.	Partially meets objective: Some education efforts continued.	Fully meets objective: More public outreach under all action alternatives.	Fully meets objective: Same as alternative B.	Fully meets objective: Same as alternative B.
• During implementation of any management action, minimize disruption to visitor use and experience or adverse impacts to visitor and community safety.	Fully meets objective: No visitor disruption. No complaints received about fences around orchids at Owens Creek near the campground.	Partially meets objective: Visual impacts on visitors from the intrusion of large exclosures, but no adverse impacts on visitor safety. Some disruption to visitors from implementing reproductive controls if access limited during higher visitation periods.	Fully meets objective with mitigation: Disruption of visitor experience minimized by using silencers if shooting occurred at night, and implementing deer-control actions when visitation is low (November – February). Precautions to ensure visitor and community safety.	Partially meets objective with mitigation: Same as alternative B for reproductive controls.

TABLE 8: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Vegetation	*Direct/Indirect Impact*: Adverse, long-term, and major impacts due to large numbers of deer browsing on a very large percentage of the park's woody and herbaceous vegetation, limiting natural regeneration.	*Direct/Indirect Impact*: Adverse, long-term, and major impacts as the young woody vegetation and herbaceous ground cover decreased in quantity and diversity in the majority of the park, since benefits of reproductive control would not be fully realized within the life of this plan.	*Direct/Indirect Impact*: Beneficial, long-term impacts because vegetation could recover. As natural forest regeneration occurred, current adverse, long-term, major impacts would be reduced to minor levels.	*Direct/Indirect Impact*: Beneficial, long-term impacts because vegetation could recover. As natural forest regeneration occurred, current adverse, long-term, major impacts would be reduced to minor levels.
	Cumulative Impact: Would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative impacts.	*Cumulative Impact*: Would result in adverse, long-term and moderate to major cumulative impacts.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts.
	Potential for Impairment: It is expected that impairment of vegetation resources would occur over the long term.	*Potential for Impairment*: It is not expected that impairment of vegetation resources would occur over the long term.	*Potential for Impairment*: No impairment of vegetation resources would occur.	*Potential for Impairment*: No impairment of vegetation resources would occur.
Soils and Water Quality	*Direct/Indirect Impact*: Adverse, long-term, negligible to minor impacts on soils and water quality could result from soil erosion and sedimentation due to loss of vegetation from increased deer browsing.	*Direct/Indirect Impact*: Adverse, long-term, minor impacts to soils and water quality could occur outside the fenced exclosures, resulting in increased loss of vegetation in those areas and a potential increase in soil erosion.	*Direct/Indirect Impact*: Beneficial, long-term impacts on soils and water quality would result from immediately reducing the number of deer in the park. Vegetative ground cover would be able to reestablish itself, helping reduce soil erosion and sediment loading in the park's creeks.	*Direct/Indirect Impact*: Beneficial, long-term impacts on soil and water quality would result from immediately reducing the number of deer in the park. Vegetative ground cover would be able to reestablish itself, helping reduce soil erosion and sediment loading in the park's creeks.
	Cumulative Impact: Activities both inside and outside the park, when combined with the continued pressure on forest resources expected, would result in adverse, short- and long-term, minor to moderate impacts on soil and water quality.	Cumulative Impact: Would result in adverse, short- and long-term, and minor to moderate cumulative impacts due to the large portion of the creeks' watersheds that are outside the park boundary, and beneficial long-term impacts occurring inside the park would offset cumulative impacts only slightly.	Cumulative Impact: Would result in adverse, short- and long-term, and minor to moderate due to the large portion of the creeks' watersheds occurring outside the park boundary; the beneficial, long-term impacts would offset cumulative impacts only slightly.	Cumulative Impact: Would result in adverse, short- and long-term, and minor to moderate due to the large portion of the creeks' watersheds occurring outside the park boundary; the beneficial, long-term impacts would offset cumulative impacts only slightly.
	Potential for Impairment: No impairment of park soils or water resources would occur.	*Potential for Impairment*: No impairment of park soils or water resources would occur.	*Potential for Impairment*: No impairment of park soils or water resources would occur.	*Potential for Impairment*: No impairment of park soils or water resources would occur.

Impact Topic	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
White-tailed Deer Herd Health	*Direct/Indirect Impact*: Adverse, long-term, major impacts on the health of the deer herd due to excessive deer browsing and the continued growth of the population.	*Direct/Indirect Impact*: Adverse, long-term, and major impacts would occur due to limited use of large-scale exclosures and repellents, and since the effect of reproductive control on the deer population would not be seen for many years. The overall long-term effect would be expected to remain at major adverse levels for the life of this plan.	*Direct/Indirect Impact*: The relatively rapid reduction of the deer herd and the resultant regeneration of forage would result in beneficial effects on deer herd health and reduce adverse impacts to negligible or minor levels over the long term as the deer population decreased. Adverse impacts would still range from minor to moderate while habitat recovered.	*Direct/Indirect Impact*: Implementing long-term deer population management through the use of direct reduction would have long-term and beneficial effects, and adverse impacts to deer herd health would be reduced to negligible or minor levels over the long term as the deer population decreased. Reproductive controls, with the current technology, would help maintain adverse impacts at lower levels.
	Cumulative Impact: Would result in adverse, long-term, major cumulative impacts.	*Cumulative Impact:* Would result in adverse, long-term, moderate to major cumulative impacts.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts.
	Potential for Impairment: Since alternative A would not reverse the expected long-term continued increase in the deer population, adverse health effects would continue or worsen, and impairment of the white-tailed deer herd in the park would occur over the long term.	*Potential for Impairment:* Since alternative B would provide for reproductive control of the deer herd and a potential for gradual reduction in deer herd numbers over an extended period of time, it is not expected that impairment of the white-tailed deer herd in the park would occur.	*Potential for Impairment*: No impairment of the white-tailed deer population in the park would occur.	*Potential for Impairment*: No impairment of the white-tailed deer population in the park would occur.
Other Wildlife and Wildlife Habitat	*Direct/Indirect Impact*: Even though some species may benefit from an open understory, the continued impacts of large numbers of deer browsing on vegetation would adversely affect a large percentage of habitats for other wildlife resulting in adverse, long-term, and potentially major impacts, depending on the species.	*Direct/Indirect Impact*: Overall, impacts to other wildlife would be adverse, long term, and negligible to potentially major, depending on the species, due to the majority of habitat would continue to be subject to a high degree of deer browsing, adversely impacting ground/shrub layer habitat for many wildlife species until reproductive controls took effect and reduced the deer population (more than 15 years).	*Direct/Indirect Impact*: Impacts on other wildlife would be long term and beneficial because of rapid reductions in deer numbers in the park, thereby reducing deer browsing pressure on natural forest regeneration, allowing increased abundance and diversity of other wildlife that depend on understory vegetation. Over time, present adverse, long-term impacts would be reduced to negligible or minor levels.	*Direct /Indirect Impact*: Impacts on other wildlife would be long term and beneficial because of rapidly reductions in deer numbers in the park, thereby reducing deer browsing pressure on natural forest regeneration, allowing increased abundance and diversity of other wildlife that depend on understory vegetation. Over time, present adverse, long-term impacts would be reduced to negligible or minor levels.
	Cumulative Impact: Would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative impacts.	*Cumulative Impact*: Would result in both adverse and beneficial impacts, with adverse, long-term, moderate to major cumulative impacts on other wildlife.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts to other wildlife.	*Cumulative Impact*: Would result in beneficial, long-term cumulative impacts to other wildlife.

TABLE 8: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Other Wildlife and Wildlife Habitat (continued)	*Potential for Impairment*: Since alternative A would not reverse the expected long-term continued growth in the deer population, and wildlife habitat would likely continue to be degraded, it is expected that impairment of certain wildlife species and habitat would occur over the long term.	*Potential for Impairment*: Since alternative B would provide continued protection of certain areas of the park over the long term and would introduce reproductive controls that could reduce deer numbers over an extended period of time, it is not expected that impairment of other wildlife species or habitat would occur.	*Potential for Impairment*: No impairment of other wildlife species or habitat would occur.	*Potential for Impairment*: No impairment of other wildlife species or habitat would occur.
Sensitive and Rare Species (including rare plant communities)	*Direct/Indirect Impact*: Overall, adverse, long-term, moderate to major impacts to sensitive and rare plant species due to excessive deer browsing and the resulting suppression of new viable populations in the park even though some fencing of rare species would occur. *Cumulative Impact*: Would result in both adverse and beneficial impacts. Adverse cumulative impacts would be long term and moderate. *Potential for Impairment*: Since alternative A would not reverse the expected long-term continued growth in the deer population, and damage to vegetation would likely continue, it is expected that impairment of sensitive and rare species would occur over the long term.	*Direct/Indirect Impact*: Overall, adverse, long-term, minor to moderate impacts to sensitive and rare plant species due to excessive deer browsing continuing outside the exclosures. *Cumulative Impact*: Would result in both adverse and beneficial impacts. Adverse cumulative impacts would be long term and minor. *Potential for Impairment*: No impairment of sensitive and rare species is expected because known populations would be protected from deer-browsing pressure.	*Direct/Indirect Impact*: Beneficial impacts would be expected as a result of a relatively rapid reduction in deer density and browsing pressure on rare and sensitive plant communities. *Cumulative Impact*: Would result in both beneficial and adverse impacts. Adverse cumulative impacts would be long term and minor. *Potential for Impairment*: No impairment of rare or sensitive plant species in the park would occur.	*Direct/Indirect Impact*: Beneficial impacts would be expected as a result of a relatively rapid reduction in deer density and browsing pressure on rare and sensitive plant communities. *Cumulative Impact*: Would result in both beneficial and adverse impacts. Adverse cumulative impacts would be long term and minor. *Potential for Impairment*: No impairment of rare or sensitive plant species in the park would occur.
Archeological Resources	*Direct/Indirect Impact*: Installing small fences to protect individual plant groupings would result in adverse, long-term, negligible impacts to park archeological resources since fences would be located so as to avoid direct impacts to archeological resources. *Cumulative Impact*: Would result in no cumulative impacts. *Potential for Impairment*: No impairment of park archeological resources would occur.	*Direct/Indirect Impact*: Similar to alternative A, installing small fences around individual plant groupings could result in adverse, long-term, negligible impacts to park archeological resources. *Cumulative Impact*: Would result in adverse, long term, and negligible cumulative impacts. *Potential for Impairment*: No impairment of park archeological resources would occur.	*Direct/Indirect Impact*: Similar to alternative A, the installation of small fences could result in adverse, long-term, negligible impacts to park archeological resources, as fences, bait stations and trapping locations would avoid known archeological resources. *Cumulative Impact*: Would result in no cumulative impacts. *Potential for Impairment*: No impairment of park archeological resources would occur.	*Direct/Indirect Impact*: Similar to alternative A, the installation of small fences could result in adverse, long-term, negligible impacts to park archeological resources, as fences, bait stations and trapping locations would avoid known archeological resources. *Cumulative Impact*: Would result in no cumulative impacts. *Potential for Impairment*: No impairment of park archeological resources would occur.

Impact Topic	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Cultural Landscapes	*Direct/Indirect Im*pact: Continued growth of the deer population and the associated ongoing decline in the abundance and diversity of the native plant communities would result in an adverse, long-term, minor impact to the park's cultural landscape.	*Direct/Indirect Impact*: Large exclosures would allow regeneration of native woody plant populations within 6% to 12% of the park over the life of the plan, a character-defining vegetation feature, and small fenced areas and repellents would be used to protect specific landscaped areas, orchard trees, and landscape plantings, resulting in beneficial, long-term, minor impacts.	*Direct/Indirect Impact*: Reduced browsing pressure from direct reduction of the deer population would allow native plant populations to regenerate throughout the park, and small fenced areas and repellents would help protect other character-defining vegetation such as orchard trees. These actions would result in beneficial, long-term impacts to the park and component cultural landscapes.	*Direct/Indirect Impact*: Reduced browsing pressure from direct reduction and reproductive control of the deer population would allow native plant populations to regenerate throughout the park, and small fenced areas and repellents would help protect other character-defining vegetation such as orchard trees. These actions would result in beneficial, long-term impacts to the park and component cultural landscapes.
	Cumulative Impact: Adverse, long-term, minor cumulative impacts would result from the ongoing decline of native plant communities as a result of disease and deer browsing, despite benefits from the use of small fences and repellents and exotic species control.	*Cumulative Impact*: Beneficial, long-term, minor cumulative impacts would result from some regeneration of native plant populations and the control of nonnative species, although disease and continued deer browsing would offset this impact.	*Cumulative Impact*: Regeneration of native plant populations would benefit the forested landscape, resulting in beneficial, long-term, moderate cumulative impacts.	*Cumulative Impact*: Regeneration of native plant populations would benefit the forested landscape, resulting in beneficial, long-term, moderate cumulative impacts.
	Potential for Impairment: No impairment of cultural landscapes would occur.	P*otential for Impairment*: No impairment of cultural landscapes would occur.	*Potential for Impairment*: No impairment of cultural landscapes would occur.	*Potential for Impairment*: No impairment of cultural landscapes would occur.
Visitor Use and Experience	*Direct/Indirect Impact*: Overall impacts to visitor use would be adverse, long term, and moderate as they experience a decreased ability to view scenery (including native vegetation) and other wildlife, which a large majority of visitors rated as important.	*Direct/Indirect Impact*: Adverse, short-term impacts would eventually give way to beneficial, long-term impacts as the need for exclosures diminished and the deer population declined, resulting in a restored forest ecosystem throughout the park. However, many years would be required to achieve these beneficial results.	*Direct/Indirect Impact*: Beneficial, long-term impacts would occur as a result of forest regeneration, which would have a moderate effect on visitors due to the restoration of natural resources.	*Direct/Indirect Impact*: Beneficial, long-term impacts would occur as a result of forest regeneration and visitors could see increased plant and animal diversity, and enjoy enhanced scenery.
	Cumulative Impact: Would result in both adverse and beneficial impacts (depending on an individual visitor's goals). Adverse cumulative impacts would be long term and moderate.	Cumulative Impact: Cumulative impacts to visitors would be mostly beneficial and long term due to the effects of combined forest regeneration activities.	*Cumulative Impact*: As under alternative B, cumulative impacts to visitors would be mostly beneficial and long term due to combined forest regeneration activities.	*Cumulative Impact*: Cumulative impacts to visitors' ability to enjoy the park's scenery and species diversity, regardless of the type of activity involved, would be primarily beneficial and long term.
Visitor Safety	*Direct/Indirect Impact*: Adverse, long-term, negligible impacts could occur, as it is expected that no discernible effects to visitor safety would result from deer management actions.	*Direct/Indirect Impact*: This alternative includes measures to protect visitors from accident or injury. Therefore, any adverse impacts to visitors would be short and long term and negligible.	*Direct/Indirect Impact*: Although this alternative includes actions that could be dangerous to visitors, adverse, short- and long-term, negligible impacts would occur, as safety measures are included to protect visitors.	*Direct/Indirect Impact*: Although this alternative includes actions that could be dangerous to visitors, adverse, short- and long-term, negligible impacts would occur, as safety measures are included to protect visitors.

TABLE 8: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative A: No-Action Alternative	Alternative B: Combined Non-Lethal Actions	Alternative C: Combined Lethal Actions (Preferred Alternative)	Alternative D: Combined Lethal and Non-Lethal Actions
Visitor Safety (continued)	*Cumulative Impact*: Cumulative impacts would primarily be related to other injuries that visitors could sustain in the park; these impacts would result in adverse, long term, and negligible.	*Cumulative Impact*: Would result in adverse, long-term, and negligible cumulative impacts.	*Cumulative Impact*: Would result in adverse, long-term, and negligible cumulative impacts.	*Cumulative Impact*: Would result in adverse, long-term, and negligible cumulative impacts.
Employee Safety	*Direct/Indirect Impact:* Would be adverse, long term, and negligible, as it is expected that no discernible effects to employee safety would occur as a result of deer management actions. *Cumulative Impact*: Would be related to other injuries that employees could sustain while working in the park; these impacts would also be adverse, long term, and negligible.	*Direct/Indirect Impact*: Would be adverse, long term, and negligible, as it is expected that no discernible effects to employee safety would occur as a result of deer management actions. *Cumulative Impact*: Would result in adverse, long-term, and negligible cumulative impacts.	*Direct/Indirect Impact*: Would be adverse, long term, and negligible, as it is expected that no discernible effects to employee safety would occur as a result of deer management actions. *Cumulative Impact*: Would result in adverse, long-term, and negligible to minor cumulative impacts.	*Direct/Indirect Impact*: Would be adverse, long term, and negligible, as it is expected that no discernible effects to employee safety would occur as a result of deer management actions. *Cumulative Impact*: Would result in adverse, long-term, and negligible to minor cumulative impacts.
Socioeconomic Effects	*Direct/Indirect Impact*: Browsing damage to adjacent land and crops would continue resulting in adverse, long-term, minor to moderate impacts to farmers, with the extent of damage and the degree of impact dependent on the farmer's crop, crop location, and whether deer expand or shift their home range as browse became scarcer within the park. *Cumulative Impact*: Would be adverse, short and long term, and moderate due to crop damage.	*Direct/Indirect Impact*: Adverse, long-term impacts to farmers would be moderate, with the extent of damage and the degree of impact dependent on factors such as the farmer's crop, crop location, whether deer expand or shift their home range as fences make browse scarcer within the park. Reproductive controls (if successful) would allow for only a gradual reduction in the number of deer under the duration of plan. *Cumulative Impact*: Would result in adverse, short and long term, and moderate on crops.	*Direct/Indirect Impact*: The degree of reduction in crop damage is unknown; however, the reduction would most likely be measurable, reducing adverse impacts to farmers and other landowners to minor over the short and long terms by increasing harvested yield and preserving landscaping. *Cumulative Impact*: Would result in beneficial compared to alternative A; adverse impacts would be reduced to minor over the short and long term.	*Direct/Indirect Impact*: The degree of reduction in crop damage is unknown; however, the reduction would most likely be measurable, reducing adverse impacts to farmers and other landowners to minor over the short and long terms by increasing harvested yield and preserving landscaping. *Cumulative Impact*: Would result in beneficial compared to alternative A, and adverse impacts would be reduced to minor over the short and long term.
Park Management and Operations	*Direct/Indirect Impact*: Impacts to park operations and maintenance would be adverse, long term, and moderate as present. Deer management actions allow the park's deer population to continue to fluctuate and increase over the long term, resulting in long-term demands on park staff and funding with minimal result. *Cumulative Impact*: Would result in adverse, long-term, moderate cumulative impacts.	*Direct/Indirect Impact*: Would result in adverse, long-term, moderate impacts on park management and operations from installing and maintaining large exclosures, applying repellents, and implementing and monitoring reproductive controls. *Cumulative Impact*: Would result in adverse, long-term, moderate cumulative impacts.	*Direct/Indirect Impact*: Would reduce the number of deer over a short period of time, and use of qualified federal employees or contractors, allowing park staff to have more time to apply their efforts to other areas of the park when compared to alternative A, which would reduce adverse, long-term impacts from moderate to minor. *Cumulative Impact*: Would result in adverse, long-term, minor to moderate cumulative impacts.	*Direct/Indirect Impact*: Would result in adverse, long-term, moderate impacts, as park staff involvement would be required for coordination and monitoring. Once the deer herd was reduced, more staff time would be available for other activities, resulting in adverse, long-term, minor impacts. *Cumulative Impact*: Would result in adverse, long-term, minor to moderate cumulative impacts.

ALTERNATIVES CONSIDERED BUT REJECTED

The following alternatives were considered but rejected as explained below:

MANAGED HUNT

A managed public hunt was considered as a preliminary alternative to reduce the white-tailed deer population. A public hunting alternative was not carried forward for further analysis because it would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the National Park System; it would be inconsistent with long-standing basic policy objectives for National Park System units; and the likelihood that the National Park Service would change its long-standing Servicewide policies and regulations regarding hunting in parks is remote and speculative.

Throughout the years the National Park Service has taken differing approaches to wildlife management, but for the most part it has maintained a strict policy of not allowing hunting in park units of the National Park System. 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. While the *Organic Act* gives the Secretary of the Interior the authority to destroy plants or animals for the purposes of preventing detriment to park resources, it does not give the Secretary authority to permit the destruction of animals for recreational purposes. In 1984, after careful consideration of congressional intent with respect to hunting in national parks, the National Park Service promulgated a rule that allows public hunting in national park areas only where "specifically mandated by Federal statutory law" (36 CFR 2.2). The National Park Service re-affirmed this approach in its *Management Policies 2006.*

Congress has not authorized hunting in any legislation for Catoctin Mountain Park. Therefore, in order to legally allow hunting at the park, the current NPS hunting regulation would have to be changed, or Congress would need to specifically authorize hunting. In addition to other considerations, security issues concerning NSF and allowing firearm use by the public in the park would likely limit any congressional action to allow hunting. The National Park Service has a legislative mandate to protect the natural and cultural resources within national parks in order to allow for their enjoyment by future generations. The National Park Service does not have a mandate to allow public hunting in national parks. At this time, the agency intends to exhaust all other possible alternatives before it attempts to change its governing laws, regulations, or policies due to concerns that such actions may have negative impacts on the visitors and resources of other parks in the National Park System.

In addition to legal and policy-related concerns, a managed public hunt was also evaluated based on cost, efficiency, safety, and the likelihood of achieving long-term management goals. A managed hunt has not been shown to be more cost-effective or efficient than other direct reduction methods such as sharpshooting

by agency personnel, which is currently allowed under NPS laws and policies. In fact, when compared to sharpshooting, a managed hunt lacks similar efficiency, safety, and the likelihood of successful long-term management.

Based on the literature, costs for managed hunts generally range between $83 and $237 for each deer removed (Warren 1997). A white-tailed deer study in Minnesota that compared four lethal removal methods found that the cost of a managed hunt averaged $117 per deer removed, based on the average net cost per deer after including revenues generated by selling permits to participating hunters (Doerr et al. 2001). Even after considering permit revenue, however, the cost of a managed hunt is not necessarily lower than other removal methods such as sharpshooting. Warren documents that costs for sharpshooting programs have ranged from $72 to $260 per deer harvested (Warren 1997). In the Minnesota study mentioned above, the cost for sharpshooting averaged $121 per deer harvested (compared to $117 per deer harvested in the managed hunt after revenue from license sales was considered; Doerr et al. 2001). Gettysburg National Military Park reported sharpshooting costs averaged $128 per deer (Frost et al. 1997). The range of costs for sharpshooting ($72–$260 per animal harvested) substantially overlaps the range of costs reported for managed hunts ($83–$237 per animal harvested), suggesting that there is a minimal to no cost savings by using citizen hunters.

Managed hunts are also less efficient in meeting ungulate reduction project goals when compared to sharpshooting. Doerr et al. noted that the highest harvest rate (0.55 deer per hour) was achieved when sharpshooters shot over bait. This was compared to hunting, which resulted in a rate of 0.03 deer per hour or 31 hunter-hours per deer killed. In addition to harvest rates, sharpshooting is also more selective than hunting. As the reduction in does was the primary goal, 59% of the hunting harvest was females, whereas 63% of the sharpshooting harvest was females (Doerr et al. 2001).

In addition to cost and efficiency, safety is also an issue to consider when using lethal control methods. It is suggested that sharpshooting offers safety features that a typical managed hunt does not. For example, sharpshooting over predetermined bait sites can establish shooting lanes and backstops. Also, sharpshooting can take place when park visitation is low or absent, reducing or eliminating public safety concerns. It is not suggested that hunts are not safe, and in areas where they are used, safety is a major concern that is addressed. However, the extensive planning and oversight that would be required to ensure a level of safety comparable to wildlife professionals engaged in sharpshooting activities would likely make a managed hunt less feasible.

The safety of park visitors and security in developed areas are concerns at Catoctin Mountain Park. Fully addressing these two issues would reduce the area where a managed public hunt could occur, limiting its usefulness. For example, due to developed areas and potentially occupied buildings, approximately 20% of the park would be closed to a managed hunt. This percentage would increase as buffer zones around roads and parking areas would also be created to ensure visitor safety. In addition, the topography of the park would further limit public hunter access to more remote areas of the park. These necessary safety and

security restrictions, as well as the landscape of the park, would make it difficult to meet the purpose, need, and objectives of this planning effort.

Several potential problems associated with a managed hunt could seriously impact its effectiveness as a management tool, especially over the long term. The critical assumption in using managed hunts is that an adequate number of hunters would participate annually. This assumption is extremely important because without adequate hunter numbers, management actions would likely fail or be postponed for a year, allowing ungulate populations to continue to increase. A number of studies that have analyzed managed hunts have shown that retaining adequate hunter numbers is difficult, especially as ungulate densities drop and management enters the maintenance phase. Hansen and Beringer (1997) noted that "managed firearm hunts . . . lasting more than two consecutive days are not cost effective because participation and harvest decline sharply after day 2." In fact, they experienced difficulty in recruiting adequate hunters for areas where hunts had already been conducted. Kilpatrick and Walter documented a 66% decline in hunter applicants in Connecticut from the first to the second year of a controlled hunt. This translated into a 26% decrease in hunter participation after one year (Kilpatrick and Walter 1999). Without consistent annual hunter effort, long-term management through public hunting would likely be unsuccessful.

In conclusion, the National Park Service considered and rejected a managed public hunt as a reasonable alternative for this plan for the following reasons: (1) implementing a public hunt in this park would require changes to basic NPS regulations and policy or an act of Congress; (2) case law supports dismissing an alternative that would require a major change in long-standing basic policy; (3) other direct removal alternatives, such as using agency personnel as sharpshooters, could be implemented without changing current laws and policies and would better meet the purpose, needs, and objectives of the plan; and (4) other direct removal alternatives raise fewer safety concerns and would have substantially the same environmental effects as a managed hunt.

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 Catoctin 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 non-dominant 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 winter-kill potential). The population dynamic and makeup of the herd could suffer under this alternative.

Because of the concerns described above relating to effectiveness, population stability, and genetic variability, this alternative was dismissed from detailed analysis.

PREDATOR REINTRODUCTION

Reintroduction of predators was dismissed as a reasonable alternative due to habitat limitations and human safety concerns.

Relationships between predators and prey are complex, and the impact of predators on herbivore populations is variable (McCullough 1979). Coyotes, bears, and bobcats are potential deer predators that reside throughout much of North America, including the Catoctin area. However, these species appear to be opportunists that capitalize on specific periods of deer vulnerability, and none of these predators has demonstrated a consistent ability to control deer populations. Although coyote populations have increased, and their range has expanded in the past 20 years, in many areas both deer and coyote populations have increased simultaneously. Biologists in some areas believe that coyotes are partly responsible for declining deer numbers, but changes in deer populations in other areas appear unrelated to coyote density. In addition, coyotes often are serious agricultural pests (Ellingwood and Caturano 1988).

Wolves and mountain lions are efficient deer predators, but they have been eliminated from much of the United States. Reintroducing these predators into Catoctin Mountain Park would not be feasible due to a lack of suitable habitat. Wolves have home ranges averaging 30 square miles when deer are the primary prey (Mech 1990), which is much larger than Catoctin's 9 square miles. Most of the park area is surrounded by an urban or suburban environment, making it inappropriate for such predators to be reintroduced (MD DNR 1998). Other native animals, as well as domestic pets and livestock, could also become potential prey if predators were reintroduced to the Catoctin area.

For the reasons described above relating to effectiveness, habitat limitations, and human safety concerns, reintroduction of predators was dismissed as a reasonable alternative.

USE OF POISON

Under this alternative poison would be mixed with food sources such as grains to kill deer. Death from poisoning is not immediate, and health concerns resulting from people potentially hunting and eating poisoned deer that have wandered out of the park could be an issue. In addition, non-target native wildlife or roaming pets could potentially eat a tainted carcass or the poison itself. Therefore, this alternative was dismissed.

CAPTURE AND RELOCATION

Capturing deer within Catoctin Mountain Park and relocating them would be in violation of NPS policy regarding translocation (NPS 2002b). Even if the policy was not in effect, relocating deer to areas a sufficient distance from the park to ensure that they would not return would require permits, and because of concerns of CWD testing, possible quarantine processes would be required. Given the abundance of deer in Maryland and most of the United States, recipients for such a program would be very limited. Also, live capture and relocation methods 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). Due to the concerns discussed above relating to policy, costs, feasibility, and high mortality, capture and release was dismissed as a reasonable alternative.

SUPPLEMENTAL FEEDING

Providing supplemental food sources for deer would potentially decrease browsing pressure on vegetation resources at Catoctin Mountain Park. However, increasing food sources would increase deer health and reproduction, leading to a growing deer population. In the long term this would compound problems associated with high deer numbers (MD DNR 1998). For these reasons, this alternative was dismissed.

SURGICAL STERILIZATION OF DOES

This alternative would have the advantage of permanently sterilizing individual does. Does would be captured, tagged, and surgically sterilized, usually requiring a licensed veterinarian, and then released back into the park. In addition to the stress of the capture under this alternative, 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, thus changing hormone production in the treated animal, would result in altered behavior. With a ligation procedure, normal hormone production would continue; 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 these concerns about feasibility, stress to the animals, and long-term effects on population genetics and behavior, this alternative was dismissed.

FENCING THE ENTIRE PARK

The entire park unit could be fenced to prevent deer from entering or leaving, especially deer from Cunningham Falls State Park to the south during the hunting

season or deer from agricultural lands to the north. A fence approximately 8 feet high would be needed to prevent deer from jumping over the barrier. However, vegetation within Catoctin Mountain Park would continue to suffer the effects of deer browsing, the deer population within the fenced area would continue to increase, and the health of the contained herd would suffer. Therefore, all deer within the fenced area would either need to be removed or the deer population within the fence would need to be managed with other methods to meet the objectives of the park management plan. For these reasons, this alternative was dismissed.

USE THE DEER POPULATION AS A RESEARCH MODEL

During public scoping a research alternative was suggested by the Humane Society of the United States that was based on the premise that Catoctin would "serve a more valuable role in determining the long-term consequences of having an 'overabundant' deer herd if it were left without a proactive management scheme in place." Such an alternative would closely evaluate the potential utility of a coordinated effort to link different experimental "treatments" with a "control" that would allow for research questions as yet unanswered to be better addressed.

NPS staff at Catoctin Mountain Park have been monitoring forest health and impacts from deer browsing for over 20 years, and evidence shows that the forest is no longer naturally regenerating due in large part to browsing impacts. To continue following a purely research-oriented path would not meet the plan's objectives. For these reasons, this research-only alternative was dismissed from further analysis.

ECOSYSTEM MANAGEMENT ALTERNATIVE

During public scoping, the Humane Society of the United States also suggested a type of ecosystem management alternative that would evaluate "various natural and artificial phenomena" affecting the park, such as historic uses, chestnut blight, dogwood anthracnose, storms, and the recent appearance of predators. This alternative would address the park ecosystem, focusing on developing "a deer management plan that supports forest regeneration, providing for long-term protection, conservation, and restoration of native species and cultural landscapes."

The NPS *Management Policies 2006,* as well as the park's 1998 *Resource Management Plan,* call for resource management that is based on an ecosystem perspective. In this context the National Park Service believes that forest regeneration is a crucial component of ecosystem health, and many factors influence ecosystems (deCalesta 1997). However, action is needed at this time to specifically address deer browsing impacts, which represent existing conditions that need to be changed and problems that need to be remedied, requiring a focus on deer management as a primary component of overall ecosystem health. Other factors influencing forest regeneration, such as historic activities and disease, have been incorporated into the evaluation of impacts in this plan. Therefore, an

Ecosystem — The interaction of living organisms and the nonliving environment producing an exchange of materials and energy between the living and nonliving.

ecosystem management alternative as defined above was dismissed from further analysis.

BOW HUNTING ONLY

During public scoping it was suggested that bow hunting only be offered as an alternative. Public hunting of any type (including bow hunting) has been dismissed as defined under "Managed Hunt," above.

HAZE DEER INTO THE STATE PARK

An alternative provided during public scoping suggested using volunteers to move deer out of Catoctin Mountain Park across Maryland Route 77 into Cunningham Falls State Park, "where hunters will be waiting" to shoot the deer. This alternative was dismissed for safety reasons. Pushing deer across a busy highway could increase the potential for deer/vehicle collisions. In addition, volunteers might inadvertently chase deer across the highway, putting themselves at risk of being hit by a vehicle. Furthermore, hunters waiting along the state park boundary to shoot toward deer coming from Catoctin Mountain Park would put the volunteers at risk of being shot. For these reasons, this alternative was dismissed from further analysis.

PROVIDING BIRTH CONTROL DRUGS IN DEER FOOD

Another alternative offered during public scoping suggested providing deer with food laced with birth control drugs. There are currently major obstacles to oral contraception in deer, including dosage control, absorption of active agents, and ingestion of bait by nontarget wildlife. Based on these concerns and past studies, much research is still required before a reproductive control agent becomes available (DeNicola et al. 1999). This alternative was dismissed because the technology has not been developed that would allow for adequate doses of reproductive control agents to be administered in this form, and the reproductive control agents being developed for deer have not been tested for reactions in other animals that may have access to this food.

CONSISTENCY WITH THE PURPOSES OF THE NATIONAL ENVIRONMENTAL POLICY ACT

The *National Environmental Policy Act* requires an analysis of how each alternative meets or achieves the purposes of the act, as stated in Section 101(b). Each alternative analyzed in a NEPA document must be assessed as to how it meets the following purposes:

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

(3) attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;

(5) achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The Council on Environmental Quality has promulgated regulations for federal agencies' implementation of the *National Environmental Policy Act* (40 CFR Parts 1500–1508). Section 1500.2 states that federal agencies shall, to the fullest extent possible, interpret and administer the policies, regulations, and public laws of the United States in accordance with the policies set forth in the act (sections 101(b) and 102(1)); therefore, other acts and NPS policies are referenced as applicable in the following discussion.

ALTERNATIVE A: NO ACTION

Alternative A would meet the purpose of the *National Environmental Policy Act* to some degree because limited protection of certain rare species and habitats would be continued, as well as the monitoring program. It would not fulfill the responsibilities of each generation as the trustee of the environment for succeeding generations and in preserving important aspects of our national heritage (purposes 1 and 4), because damage to forest vegetation and rare species would continue as a result of excessive browsing by high numbers of deer and continued deer population trends. Alternative A would do little to enhance the

quality of renewable forest resources (purpose 6), and the expected long-term major adverse impacts on vegetation, wildlife habitat, rare species, and deer herd health would not ensure healthful, productive, or esthetically pleasing surroundings (purpose 2).

ALTERNATIVE B: COMBINED NON-LETHAL ACTIONS

This alternative would meet many of the purposes in the *National Environmental Policy Act* to some degree, or even to a moderate degree when considering long-term results. However, it would provide only limited direct protection for forest resources (only 6%–12% of woody vegetation would be protected by exclosures over the life of the plan), and it would rely heavily on an unproven technology (reproductive control) that might not be successfully implemented for a large free-ranging deer population. Therefore, none of the NEPA purposes would be met to a large degree. In particular, the exclosures would detract from esthetically pleasing surroundings (purpose 2), and reproductive control methods would present an element of risk to health or safety or other unintended consequences (purpose 3). The lack of protection for a large percentage of the park, and the time it would take for any reproductive control to be effective, would mean that succeeding generations might not see desired results for some time (purpose 1), and probably not within the 15-year life of this plan. The adaptive management component of alternative B would help achieve some balance between population and resource use (purpose 5), but the limited history of reproductive control success and the limits on how much forest vegetation can be included in exclosures means that it would not be possible to completely approach the maximum attainable recycling of resources (purpose 6).

ALTERNATIVE C: COMBINED LETHAL ACTIONS (PREFERRED ALTERNATIVE): AND ALTERNATIVE D: COMBINED LETHAL AND NON-LETHAL ACTIONS

Alternatives C and D are very similar in the extent to which they would meet NEPA purposes. The evaluation of these alternatives by the interdisciplinary team showed that both would fulfill the responsibilities of each generation as a trustee of the environment for succeeding generations (purpose 1) to a large degree, since both would immediately reduce deer numbers and sustain that reduction through maintenance actions. Both alternatives C and D include adaptive management, which would help achieve a balance between population and resource use (purpose 5), although alternative C would have a higher likelihood of fully approaching the maximum attainable regeneration of depletable resources (i.e., forest vegetation) due to its higher certainty of success (purpose 6). Alternative D involves some concern about unintended consequences (purpose 3), since it would rely on technology that has not been proven in free-ranging deer as a maintenance tool. Risks to health and safety (purpose 3) associated with the reproductive control method would also be a concern under alternative D. Overall, both alternatives C and D would preserve important historic, cultural, and natural aspects of our national heritage in the long term (purpose 4), although alternative C would provide for more certain results.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The National Park Service is required to identify the environmentally preferred alternative in its NEPA documents for public review and comment. Guidance from the Council on Environmental Quality states that the environmentally preferred alternative means it is "the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources" (CEQ 1981). Alternative C has been selected as the environmentally preferred alternative because it is the alternative that would best protect the biological and physical environment by ensuring an immediate reduction in deer herd numbers that could be sustained with proven methods over the life of the plan. Alternative C would also best protect, preserve, and enhance the historic, cultural, and natural processes that support the park's cultural landscape and forest since there would be little, if any, uncertainty involved with implementing the selected methods to maintain low deer numbers. Although alternatives C and D are very close in meeting the goal that identifies the environmentally preferred alternative, alternative C was selected primarily because of its greater certainty in achieving the goal. Alternatives A and B were not considered environmentally preferred because of their lack of effect on deer herd numbers, which would result in potential adverse effects on the biological and physical resources of the park over the life of the plan.

The alternative that best protects, preserves, and enhances historic, cultural, and natural resources while causing the least damage to the biological and physical environment is the "environmentally preferred alternative."

NPS PREFERRED ALTERNATIVE

To identify the preferred alternative, the planning team evaluated each alternative based on the ability to meet the plan objectives (see table 7, page 79) and the potential impacts on the environment ("Chapter 4: Environmental Consequences"). Alternative C was identified as the NPS preferred alternative. Alternative C is the only alternative that fully meets all of the plan objectives.

Alternative D is similar to alternative C in its ability to meet the objectives, but alternative C has more certainty of success than alternative D. Alternative D includes the use of a yet unproven reproductive control technology. In particular, alternative D would fully meet all of the vegetation objectives only if reproductive control is effective as a maintenance tool. The effectiveness is uncertain at this time. Alternative C will also fully meet the objective for visitor experience relating to minimization of disruption to visitor use. Alternative D only partially meets that objective, because it is likely that reproductive control applications would coincide with high visitor use periods and require limiting visitor access to areas of the park.

Alternative B only partially meets each of the objectives because of the lack of immediate reduction in deer numbers and the uncertainty that the deer density goal would be achieved even over an extended period of time.

Alternative A (no action) fails to meet four of the eight objectives and only partially meets three others, since no action would be taken to reduce deer numbers or effect a change in condition that are the basis of the purpose of and need for this plan.