Chapter 4.

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Nest Box at Mabbot Pond

Environmental Consequences

4.1 Introduction

This chapter describes the environmental consequences we predict from implementing the refuge management alternatives presented in chapter 3. Where detailed information is available, we present a scientific and analytic comparison between alternatives and their anticipated consequences, which we describe as "impacts" or "effects." In the absence of detailed information, we make comparisons based on our professional judgment and experience.

We focus our discussion on the impacts associated with the goals and key issues identified in Chapter 1, "Purpose of, and Need for, Action." Direct, indirect, short-term, beneficial, and adverse effects likely to occur over the 15-year life span of the plan are discussed. Beyond the 15-year planning horizon, we give a more speculative description of the direct, indirect, and cumulative effects. The chapter identifies cumulative impacts, any irreversible and irretrievable commitment of resources and the relationship between short-term uses of the environment and its long-term productivity. At the end of this chapter, table 4-2 summarizes the effects predicted for each alternative and allows for a side-by-side comparison.

Regional, Historical, and Watershed Context
As required by the Council on Environmental Quality and Service regulations implementing NEPA, we assessed the importance of the effects of the alternatives presented in the draft EA based on their context and intensity. The context of the impacts ranges from site-specific to broader regional and eco-regional scales (table 4-1). Although refuge lands comprise a small percentage of these larger regional area contexts, all alternatives were developed to contribute towards conservation goals in these larger contexts.

Patuxent Research Refuge is located primarily within the Patuxent River watershed, which encompasses 957 square miles and stretches approximately 115 miles from headwaters near the intersection of Howard, Montgomery, Carroll, and Frederick Counties to its confluence with Chesapeake Bay. The Patuxent River watershed includes portions of Montgomery, Prince George's, Charles, St. Mary's, Howard, Anne Arundel, and Calvert Counties. The refuge includes portions of the mainstem Patuxent, the Little Patuxent, and a small portion of the Anacostia River watershed.

Table 4-1. Regional Context for Impacts Analyses at Patuxent Research Refuge

Resource	Context
Air Quality	The greater Baltimore, Annapolis, and Washington, DC area
Water Quality	Waters that pass through or are contained by the Patuxent Research Refuge and the river reaches immediately downstream
Soils	Area within the refuge boundary
Vegetation	Area within the refuge boundary

Resource	Context
Species	Immediate impacts to species while on refuge and consideration of greater populations that refuge specific individuals are a part of
Socioeconomics	Prince George's and Anne Arundel Counties
Recreation	Prince George's and Anne Arundel Counties

Across a more localized landscape scale, the refuge protects a variety of resources and provides a unique opportunity for education and outreach near the urban centers of Baltimore and Washington, DC. Connecting children and families with nature is a high-priority national program of the Service. The urban interface of the refuge provides excellent opportunities for such environmental education and conservation outreach.

Approximately 256,000 visitors from around the Baltimore-Washington Corridor and beyond visit the refuge each year. Patuxent Research Refuge is in a position where it can foster greater community understanding of natural systems, species of conservation concern, the value of the Refuge System, and the Service's mission in conserving and protecting those resources. Each of the management alternatives is consistent with State, regional, ecosystem, and watershed conservation plans identified in chapter 1. At varying levels, each of the alternatives would make positive contributions to these larger landscape-scale conservation endeavors.

Significant land use changes since European colonization brought major impacts to the refuge site and surrounding landscape, including clearing for farmland, highway construction, a major army training site, and expanded residential and industrial construction. As expressed in the refuge vision statement, Patuxent Research Refuge is a biological island in a highly urbanized landscape.

The urban environment and high levels of historical disturbance of mainly upland portions of the refuge and surrounding area also present many challenges ranging from minimizing visitor impacts, to minimizing or mitigating wildlife impacts due to degraded regional water and air quality, noise levels, and other conditions associated with urban environments.

The refuge's ability to directly and beneficially impact the regional environment is somewhat limited given the extent of surrounding land uses and the large human population, but the refuge participates to the degree possible in regional efforts for land conservation, protection of wildlife corridors, air and water quality improvements, and early detection and management of regional invasive species. Given this urban context, the analysis of impacts mainly focuses on how the Service's actions at the refuge might affect the physical and biological environment, socioeconomics, historical, and cultural resources, as well as wildlife-dependent public uses. Where possible, and information is available, we also provide discussions of how management actions would impact regional resources.

Evaluation of Environmental Impacts and Time Frames

Per Council on Environmental Quality and Service regulations on implementing NEPA, we assess the importance of the effects of the alternatives based on their context and intensity. The scale of their context ranges from site-specific to local, landscape, or regional. Although the area of the refuge is only a small percent of the context in its ecosystem or region, we developed all of our management alternatives to contribute to the many conservation goals in those larger contexts. For each alternative, we based our evaluation of the intensity of the effects on the following factors:

- Expected degree or percent of change in the resource from current conditions.
- Frequency and duration of the effect during the 15-year planning horizon.
- Sensitivity of the resource to such an effect or its natural resiliency to recover from such an effect.
- Potential for implementing effective preventive or mitigating measures to lessen the effect.

Scope, scale, and intensity can be defined on a range from negligible to major.

- Negligible: Resources would not be affected, or the effects would be at, or near, the lowest level of detection. Resource conditions would not change or would be so slight that there would not be any measurable or perceptible consequence to a population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource.
- Minor: Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset negative effects, would be easily implemented and likely be successful.
- Intermediate: Effects would be readily detectable and localized with consequences to a population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset negative effects and would be extensive, moderately complicated to implement, and probably successful.
- Major: Effects would be obvious and would result in substantial consequences to a local area or regional population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Extensive mitigating measures may be needed to offset negative effects and would be large-scale, very complicated to implement, and may not have any guarantee of success. In some instances, major effects would include the irretrievable loss of the resource.

Time scales are defined as either short-term or long-term:

- Short-term or temporary: An effect that generally would last less than a year or season.

- Long-term: A change in a resource or its condition that would last longer than a single year or season.

Management Actions Not Analyzed in Detail
The following list of management activities are not analyzed in detail in this document because they are both trivial in effect and common to all alternatives. These would qualify for categorical exclusion from further NEPA review under applicable regulations if independently proposed:

- Operations and maintenance of existing infrastructure and facilities (unless major renovation is involved).
- Issuance of new or revised management plans when only minor changes are planned.
- Law enforcement activities.
- Environmental education and interpretative programs (unless major construction is involved, or a significant increase in visitation is expected).
- Research, resource inventories, and other resource information collection activities.
- Routine, recurring management activities and improvements, including managing invasive plants.
- Small construction projects (for example, fences, berms, small stream and wetland restoration projects, trail maintenance, interpretative kiosks, and development of access for routine management purposes).
- Minor vegetation plantings.
- Reintroducing native plants and animals.
- Minor changes in amounts or types of public use.

"Extraordinary circumstances" in 43 CFR 46.215 are exceptions to our categorical exclusions. In addition, some of the management actions described in chapter 3 are not categorically excluded from NEPA, such as emergency responses to a major disease outbreak. Where either of these conditions applies, we have conducted further NEPA analysis and included it in the following section. Where possible and information is available, we provide discussions of how the below management actions could beneficially or adversely impact refuge resources:

- Restoring of open water and emergent wetland to floodplain forest under alternatives B and C.
- Restoring grassland, open water, and emergent wetland to upland forest under alternative C.
- Managing dry savannah under all alternatives.

- Restoring some areas of grassland to shrub under alternative B and additional grassland and impoundments to shrub under alternative C.
- Opportunities to use prescribed burning to manage grasslands and shrub habitats under all alternatives.
- Creating additional trails and a wildlife observation viewing tower at the North Tract under alternatives B and C.
- Reconstruction of the wildlife viewing area under alternatives B and C.
- Designation and development of an outdoor nature exploration area under alternatives B and C.
- Adjusting allowable public uses of the refuge as described in chapter 2.
- Adjusting the hunt program to increase youth and disabled persons hunting opportunities and open the trails at the wildlife viewing area during hunting season.
- Keeping the Little Patuxent River Trail open during the hunting season and eliminate hunting during January except for the firearms deer season under alternative C.
- Open Blue Heron Pond to fishing and expand fishing season at Cash Lake under alternatives B and C.
- Conducting stream assessments and corrective measures or restoration for water quality and stream function in alternatives B and C.

Adaptive Management Actions Common to All Resources

Adaptive management strategies are proposed for all management actions to mitigate uncertainties in information upon which the proposed activities are based. We propose continued and expanded monitoring, surveying, and inventorying of resources to ensure that we have sufficient scientific data, or have consulted with sufficient subject matter experts, to support our proposed activities affecting refuge resources. Where baseline data is lacking, we have proposed additional inventories. We propose continuing ongoing research and monitoring, such as deer population and impact studies, that would help inform proposed management actions. We propose strengthening and expanding partnerships with agencies, universities, and other designated parties to help conduct these activities to address uncertainties and improve management practices (see chapter 3).

All of the alternatives include a renewed focus on gathering baseline information on refuge resources and monitoring resources to evaluate the potential impacts of climate change. The potential impacts of specific monitoring, surveying, and inventorying resources to the physical and biological environment are controlled and mitigated by special use permits that specify the research activities, locations, frequency of activities and limitations, such as seasonal or temporal restrictions to mitigate potential impacts. Generally, these activities are considered to have short-term and localized adverse

impacts to physical and biological resources. However, the amount and variety of these activities could have potentially adverse cumulative impacts as discussed in section 4.19.

Organization of this Chapter
We have organized this chapter by major resource headings so that each section describes the impacts of all management activities proposed under each of the three alternatives that would likely have an effect on a given resource, such as an impact on air quality or on waterfowl. We begin with the physical environmental (air, water, soils, etc.), then the biological resources (habitats and wildlife), and finally the socioeconomic and cultural and historical environment. Under each heading, we discuss the resource context and the types of benefits and adverse impacts of management actions that we evaluated. We then discuss the benefits and adverse effects that would occur regardless of which alternative is selected and the benefits and adverse effects of each of the CCP alternatives.

4.2 Impacts on Air Quality

Chapter 2, "Affected Environment," discusses the status of air quality around the refuge. Given the urban context of the refuge, the analysis of air quality impacts considered only how the Service's actions at the refuge might affect air pollutants, visibility, and climate change to a minimal degree, focusing on the potential for localized air quality impacts or improvement.

We evaluated the following actions for their potential to protect or improve air quality:

- Managing and restoring forests and wetlands to enhance carbon sequestration and reduce greenhouse gases.
- Continuing and expanding energy efficiency practices to reduce the refuge contribution to emissions.
- Supporting regional trails and public transit to improve and encourage pedestrian and bicycle access to the refuge, and reduce total vehicle emissions.

We evaluated the following actions for their potential to cause increased emissions and adverse effects on air quality:

- Managing and restoring forests to enhance carbon sequestration and reduce greenhouse gases.
- Emissions from increases in visitors from vehicles and facilities and trespassing by off-road vehicles.
- Maintaining the existing impoundments and potential impacts from emissions of methane from the impounded area.
- Increasing use of prescribed burns.

Impacts on Air Quality That Would Not Vary by Alternative

Due to the highly urban context of the refuge, we believe that the impacts of refuge management on regional air quality would be negligible, but slightly positive overall, and would not vary significantly under any of the alternatives. Refuge land management, regardless of alternative, would be expected to have a net positive effect on air quality.

Beneficial

Our management activities should not adversely affect regional air quality. None of the alternatives would violate EPA standards; all would comply with the Clean Air Act. There would be no major stationary or mobile sources of air pollutants at the refuge created under any of the refuge management alternatives. On the contrary, Service limits public uses of the refuge to compatible wildlife-oriented activities, and land ownership and protection curtails human sources of emissions from vehicles and infrastructure by preventing development and consequent impacts to air quality.

Maintaining natural vegetation on over 97 percent of the refuge would continue to provide benefits to air quality with respect to the six air pollutants for which 1990 National Ambient Air Quality Standards (40 CFR part 50) have been established by the EPA. Trees have been shown to reduce the concentration of ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter less than 10 and 2.5 microns in diameter, primarily through direct uptake and adhesion to stems and leaves (Escobedo et al. 2007). With respect to greenhouse gases, plants absorb carbon dioxide and as a result, vegetated areas can act as an important carbon sink (Heath and Smith 2004). This carbon sequestration is essentially the process by which plants take up carbon dioxide through photosynthesis, after which it is stored in plant biomass (wood) and in the soil. Generally, succession to forest stores the most carbon, and the rate of sequestration declines as trees mature (Heath and Smith 2004).

Managing and restoring forests and natural hydrology would benefit air quality in a number of ways. Long-term benefits of restoration are healthier native plant communities that would perform more ecological services, support a greater number and diversity of wildlife year round, and sustain or improve carbon sequestration capacity. Wetlands and forests both act as carbon sinks by incorporating decaying vegetation into sediment and trees, respectively. Wetlands can also produce methane, a greenhouse gas, but overall there is a net long-term benefit to air quality. Management activities in these habitats such as removing invasive plants that suppress regeneration, and planting and protecting trees from deer browse all contribute to improvements in habitat quality and carbon sequestration capacity. These activities would occur no matter which alternative is selected, but the degree to which we practice them would vary, and thus, so would their impacts. Because of the urbanized nature of the region and the close proximity of heavily travelled roadways, we do not expect our management actions to result in measurably improved regional air quality, but they would contribute to improving local air quality.

NWVC was designed as a “green building” with energy efficient lighting, heat, and cooling; using recycled materials; and using native landscaping and tertiary treatment ponds for waste water. In compliance with Federal mandates, these and other energy

efficient practices to reduce air emissions would be continued and expanded under all alternatives.

Adverse

The most likely sources of adverse impacts to air quality from the refuge would come from exhaust fumes produced by heavy equipment, herbicide spraying, or prescribed fire. Under each alternative, the refuge would continue to use Service-approved herbicides to control invasive plants. Generally, the refuge only applies herbicides on the Field Station Approval List; as other pesticides require either Regional or Service Headquarters approval. We must request approval, through a pesticide use proposal, for all uses of chemicals on the refuge. The refuge manager, regional pest management coordinator, and national pest management coordinator have the authority to approve herbicides and their application procedures. We observe best management practices and application methods that do not result in drift into the atmosphere, such as basal bark, cut-stump, or low-volume foliar with back-packs. Occasionally, we employ low-volume broadcast sprayers with small boom sprayers for larger acres of monoculture infestations of nonnative invasive species, such as lespedeza. Again, best management practices are observed to prevent drift, such as only conducting the treatment in low or no-wind conditions, low height and direct target settings on the boom. We have no plans for aerial spraying; however, should there be a disease outbreak that threatens the forest, State forestry officials might be given authority to treat the situation, but these are tightly controlled protocols.

Prescribed burns would occur no matter which alternative is selected; however, the degree to which we practice them would vary, and thus, so would their impacts. For example, we may implement more prescribed burns under alternative B as an alternative to mowing to maintain grasslands. The major pollutants from prescribed burning are particulates (small particles of ash, partly consumed fuel, and liquid droplets), and gases (carbon monoxide, carbon dioxide, hydrocarbons, and small quantities of nitrogen oxides). Those would increase or decrease based on the alternative we select.

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Grassland Two Weeks after a Prescribed Burn On-refuge

Prescribed burning releases inconsequential amounts of gases (USDA 1989). The pollutant of primary concern is particulate matter. Particulates can reduce visibility or cause negative effects on the health of people with respiratory illnesses. Appropriate smoke management can minimize or nearly eliminate both of those negative effects. The consideration of the wind speed, direction, and mixing heights is all-important in managing smoke. In planning our prescribed burns, we consider all those factors, and other environmental and geographical factors. Based on our experience, we expect prescribed burning to produce no significant impacts.

Because air quality in the region is generally good, we do not expect our management to result in measurably improved air quality, but it will contribute to the existing good conditions.

Impacts on Air Quality under Alternative A (Current Management)

Beneficial
Benefits to air quality are the same as those discussed in *Impacts on Air Quality That Would Not Vary by Alternative*.

Adverse
In 2011, we estimated 256,000 visits to the refuge, and we expect a 3 percent average increase per year over the life of the plan. Given the urban area surrounding the refuge, this increase in visitation and the associated emissions from travel to and from the refuge is expected to have negligible impacts on air quality.

Impacts on Air Quality under Alternative B (Service-preferred Alternative)

Beneficial
Under alternative B, there would be continuing benefits to air quality from maintaining the natural vegetation on the majority of refuge lands. Natural vegetation serves to filter air pollutants, and maintaining the refuge lands precludes development and the introduction of attendant sources of pollutant emissions.

Alternative B would provide some additional long-term benefits to the air quality as a result of the restoration of 300 acres of floodplain forests. This alternative also includes emphasis on improving riparian forests and coastal plain forests. Management activities in these habitats, such as removing invasive plants that suppress regeneration, restoring grasslands and impoundments to forest, and planting and protecting trees from deer browse, all contribute to improvements in habitat quality and carbon sequestration capacity.

This alternative would result in a decrease in approximately 110 acres of open water habitat associated with a conversion to forest. Current information regarding carbon storage and methane production potential of wetlands is highly uncertain and varies based on wetland location and type (Bridgham et al. 2007). We are uncertain if the refuge

impoundments act as a net source, or sink, for greenhouse gasses in the atmosphere. If these impoundments do act as a source, restoration of forests could reduce emissions of methane, a powerful greenhouse gas. Regardless, given the relatively small size of the impoundment regionally and globally, it is not expected to be a significant source of methane.

In this alternative, we would reduce the amount of grassland management and consolidate grassland habitats into fewer, but larger, contiguous tracts and reduce the amount of grassy cover that is subjected to semi-annual or annual mowing. These measures help reduce the amount of exhaust emissions from equipment.

Adverse
The adverse impacts of alternative B are similar to alternative A, except, under alternative B, there would be more short-term impacts to air quality from equipment exhaust and particulates from soil disturbance and construction associated with the additional habitat restoration efforts. These would be offset, however, by reduced grassland acreage maintained by bushhogging.

Under alternative B, we propose to use prescribed burning for habitat management when possible. The use of prescribed burning would be smaller scale, about 135 acres of savannah and about 205 acres of priority grasslands. There may be an increase in the use of prescribed fire to maintain these areas, which could lead to an increase in particulate matter from burning associated with this maintenance. The primary gases released during prescribed fire include carbon dioxide, carbon monoxide, and water vapor, with other gases present in trace amounts (EPA 1998). With fire, the pollutant of primary concern is particulate matter. Particulates can reduce visibility or cause negative effects on the health of people with respiratory illnesses. Appropriate smoke management can minimize or nearly eliminate both of those negative effects. The consideration of the wind speed, direction, and mixing heights is all-important in managing smoke. In planning our prescribed burns, we consider all these factors, and other environmental and geographical factors, and only burn within narrow, site-specific prescriptions. Based on our experience, we expect prescribed burning to produce no significant impacts.

Impacts on Air Quality under Alternative C

The benefits and adverse impacts of alternative C are similar to those discussed in *Impacts on Air Quality under Alternative B.* There would be some additional carbon sequestration and oxygen production from the additional 250 acres of forest restoration. Given the relatively small number of acres in comparison to the total number of acres of forest, we do not anticipate additional improvements to air quality in the region to be significant.

4.3 Impacts on Soils

Chapter 2, “Affected Environment,” discusses the geologic history of the coastal plain and the soils of the refuge. Soils are the structural matrix and nutrient source for plant

productivity and must be protected to sustain the variety of upland and wetland habitats that would meet refuge habitat and species management goals.

We evaluated the following actions for their potential to conserve, restore, and improve soils:

- Limiting sources of sediment by maintaining forest and other vegetation cover, preventing erosion.
- Expanding public use facilities and signage to minimize soil loss and compaction.

We evaluated the following actions for their potential to cause adverse effects on soils:

- Disturbing soils during non-regular refuge maintenance activities.
- Improving riparian and coastal plain forests.
- Impacting soils by herbicide application and invasive plant management.
- Continuation of firing range use by outside law enforcement agencies.
- Disturbing soils during public use infrastructure construction projects.

Impacts on Soils That Would Not Vary by Alternative

Due to the highly disturbed soils in the refuge, we believe that the impacts of refuge management on soil structure and productivity would be negligible and would not vary significantly under any of the alternatives, except that in alternatives B and C, there is an emphasis on stream assessment and restoration to reduce soil erosion into the streams. We predict that refuge land management, regardless of alternative, would have a net positive effect on soil quality. The following management actions would benefit or impact soils under all alternatives depending on the scale, frequency, and duration of these activities, and the sensitivity of the soils to erosion and compaction.

Beneficial

Promoting intact forest cover and restoring forests and natural hydrology would benefit soil quality and help restore soil structure and improve the biological productivity of soil. By restoring the natural vegetation and hydrology, we encourage the natural physical, chemical, biological, weathering, and other soil-formation processes. Overall, the protection, maintenance, and restoration of habitats on the refuge are expected to benefit soils. Restoration projects would consider natural landform and transitional zones with project designs in order to replicate transitional soil characteristics, soil stability, and hydrology.

Increasing public awareness of soil erosion and the ways people can reduce soil erosion would continue to be part of environmental education and interpretation programs, including the benefits of conservation landscaping and schoolyard habitats.

Adverse

Currently, the refuge has about 4 miles of crushed gravel access roads and 14 miles of paved roads to facilitate refuge management activities and recreational access for visitors (by foot, bicycle, or special access for visitors with disabilities). Although the gravel roads are pervious to precipitation, they do cause the compaction of soils and the loss of vegetation. Gravel access roads are generally located in areas previously disturbed by the original access roads used for filling wetlands with dredge material in the 1950s. Maintenance of access roads, grading to minimize storm water erosion, and repairing soil erosion is done on an as-needed basis, and regular maintenance does not typically exceed one acre per year. No new roads are proposed under any alternative.

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Road on the Refuge

There are 8.5 miles of overhead transmission lines that cross the refuge. Maintenance of the transmission lines requires the use of machinery that causes minor soil compaction. Also, the presence of the towers that support the lines compact the soil beneath them.

We also maintain approximately 20 miles of foot paths and trails consisting of mowed paths across fields or paths cut through the woods. Soil compaction occurs on those trails as well, although not to the same extent as on gravel access roads. We would continue to prohibit certain recreational activities, such as ATVs or mountain biking on these trails that would damage soils on the refuge.

Public use impacts to soil have not been observed on the refuge. We regularly monitor trails and roads and have not observed any major impact areas resulting from wildlife observation, photography, environmental education, horseback riding, or interpretive uses. Public use trails, wildlife observation areas, parking areas, and other high use areas are designed and maintained to minimize impacts on soils. We monitor parking and other concentration areas and have not observed any significant soil impacts. Maintenance of access roads, trails, and other facilities could cause negligible, short-term, localized soil compaction and erosion. These activities would occur to some degree no matter which alternative is selected. We would continue to use best management practices to minimize any potential adverse impacts. Since use by hunters is dispersed across the landscape, this use would not likely cause soil compaction or erosion.

The use of trails and gravel roads could lead to soil compaction, exposure of tree roots, and the modification of plant species 3 to 6 feet on either side of the trail which is a

function of soil compaction, invasive species, and direct trampling of plants (Kuss 1986). The refuge will continue its management practices of the use of boardwalks, woodchips, erosion control, and user education to protect plant species and habitats along trails and roadways. Visitors are restricted to the public use trails, which are located on the North and South Tracts. Restricting visitors to these trails concentrates use to areas that can be routinely maintained to ensure a quality visitor use experience while also minimizing impacts to vegetation. The implementation of boardwalks and use of woodchips along trails has reduced impacts to vegetation and reduced soil erosion along trails.

As discussed above under *Impacts to Air Quality*, herbicidal applications would be a potential source of impacts to soil; however, we use the best management practices described above in the air quality section and use herbicides that have low mobility or persistence in soils, and generally use only direct herbicide-to-plant applications.

Impacts on Soils under Alternative A (Current Management)

Beneficial impacts on soils under alternative A would be similar to those described under *Impacts on Soils That Would Not Vary By Alternative.*

Adverse

Trampled campsites can become dead zones of compacted soil and may lack understory vegetation (Boyle and Samson 1985; Kuss 1986). The refuge would continue to rotate the location of tents within the campsite to reduce impacts of compaction and to allow for the regrowth of understory vegetation, which further maintains soil health.

Horses can cause physical impacts to soil surfaces. Horses may cause trail erosion by loosening the soil and increasing soil particle detachment under both wet and dry trail conditions (Deluca et al. 1998). Horses can also increase soil compaction (Weaver and Dale 1978). All of the trails open for horseback riding are former military roads made up of gravel and sand, or asphalt (Wildlife Loop), were extensively used by military vehicles, and are currently used by refuge and public vehicles. Therefore, soils are generally compacted and less susceptible to additional physical impact and mechanical erosion. The refuge will continue to take all reasonable measures to prevent or minimize any potential negative effects, and will evaluate the roads and trails periodically to assess whether they meet established suitability criteria and to prevent degradation. If evidence of unacceptable adverse impacts appears, the refuge will continue to re-route, curtail, or close trails to this use as deemed appropriate. The refuge will also post and enforce refuge regulations, and establish, post, and enforce closed areas. Based on the information provided above and the current and projected levels of use, the refuge anticipates that there will be minimal adverse impacts to soils associated with horse use.

Impacts on Soils under Alternative B

Beneficial

The added restoration emphasis under alternative B would potentially improve soils by improving biological function (as a result of restoring vegetation and hydrology and other

components of ecosystem structure). Restoration of additional forest would potentially restore historical soil profiles that were previously buried, removed, or known to contain contaminated sediments. As the area of the softball fields reverts to natural vegetation, soil chemistry would likely return to natural conditions.

Adverse
Alternative B proposes construction of additional facilities, including an observation tower, kiosks, fishing access, and other small improvements. These facilities will be constructed on previously disturbed sites. During the construction of these structures some upper layers of soils would be disturbed and compacted. We would use appropriate erosion and sediment controls to avoid impacts to adjacent areas. As discussed earlier, two wildlife observation trails would be located on previously disturbed road and trail access areas; there would be no impacts to soils from opening the trails. There would be no construction activities associated with opening the two additional trails. Minor compaction from foot traffic over the long term is possible.

Impacts on Soils under Alternative C

Beneficial
The benefits of alternative C would be similar to alternative B. Additional impoundments would be converted to forest which would increase the amount of the localized benefits that would be realized under alternative B.

Adverse
The adverse impacts of alternative C would be the same as those described in *Impacts on Soils under Alternative B.*

4.4 Impacts on Hydrology and Water Quality

As discussed in chapter 2, the hydrology on much of the refuge has been altered and there are a number of impoundments scattered throughout the refuge. The water quality at the refuge is variable and affected by point source pollution upstream and non-point sources both upstream and across refuge lands, and related upstream and greater watershed impacts.

We evaluated the following actions for their potential to benefit hydrology and water quality:

- Protecting, conserving, and monitoring vernal pools that are important habitat for amphibians of special concern.
- Improving water quality by managing and restoring riparian forests and upland forests, creating and maintaining buffers between habitats and high use areas, and restoring hydrologic function to these habitats.
- Maintaining a diversity of aquatic wildlife habitat and supporting wildlife in some impoundments by actively controlling water levels.

- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.
- Supporting regional restoration and riparian buffer projects, increasing visitor and public awareness through environmental education and interpretation, and continuing existing partnerships to benefit water quality and hydrology.

We evaluated the following actions for their potential to cause adverse effects on hydrology and water quality:

- Increasing floodplain and upland forests and restoring hydrologic function to these habitats.
- Invasive plant control, including the use of herbicides.
- Larger scale routine management activities, such as mowing fields, maintaining or controlling water levels in impoundments, and less regular activities, such as repairing flood damage.
- Updating, expanding, and managing public use facilities and administrative offices.
- Increasing visitation and expanding the six priority public uses.

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Impacts on Hydrology and Water Quality That Would Not Vary by Alternative

Water quality in the refuge is a variable and complex phenomenon resulting from inputs of two major waterways: the Patuxent and Little Patuxent Rivers. The contribution from each of these sources at any given time varies depending upon hydrological, climatological, and anthropogenic conditions.

Beneficial

The forested landscape that occurs on the refuge provides a buffer along the streams that pass through the refuge. Forest litter and vegetation reduce sheet flow and allow water to absorb into the ground. In addition, the natural meandering nature and braided streambed reduces the velocity of the water allowing sediments to drop out of suspension. Aquatic vegetation in the stream can increase dissolved oxygen and overhanging trees keep stream temperatures low, which can also benefit oxygen levels and reduce bacteria levels.

Adverse

Under each alternative, adverse impacts on hydrology would be associated with the continued use of at least some of the impoundments. Although these areas benefit waterbird populations and other wildlife, their existence alters the natural flow of water. Dikes can block floodwaters, which help build soils and replenish nutrients. They can also restrict the flow of water off the land, causing extended periods of inundation which can result in the loss of plant species that require periods of drying. Although there are negative consequences associated with impoundments, through the careful use of these management units, the refuge has increased the availability of wetlands, a rare and declining habitat nationwide. Additionally, the hydrology of the refuge area was drastically and permanently altered by agricultural and other development pressures long before the refuge was established, therefore, a return to "natural" hydrologic conditions would be nearly impossible. Furthermore, careful water level management within impoundments can mimic natural hydroperiods as closely as possible, benefitting species associated with these managed wetlands.

The history of the North Tract may impact water quality as the Army altered the landscape substantially through heavy equipment operation and military training exercises, creation of multiple bunkers and storage areas, and leaving behind significant amounts of unexploded ordnance. The Army has conducted extensive surface clearance and continues to respond in the event that additional ordnance is found. In addition, the firing ranges are used for training by military and law enforcement officials with thousands of pounds of lead and "green ammo" alternatives being deposited annually. Impacts to water quality from the deposition of lead and other "green ammo" components in these areas are unknown. There are no reports of lead contamination in the vicinity of the refuge or downstream on the Patuxent River.

Depending on slope, bank and trail erosion from human activity (fishing piers, foot traffic) may increase aquatic sediment loads in ponds and lakes, or alter riparian or lakeshore habitat and vegetation in ways harmful to fish or other wildlife. Many of the areas that anglers access are flat, with a sandy or graveled substrate, with no significant topography change that would result in erosion. Boat access will be restricted to designated areas only. The boat launch area at Cash Lake is constructed of concrete pavers that support vehicle use and accommodate vegetation growth. This area is adjacent to a gravel parking lot that provides ample maneuvering space for vehicles to launch a boat without hampering vegetation or aquatic resources. Trails will be monitored and may be modified, restored, or closed, if conditions warrant. Because much of refuge fishing occurs from the shoreline, the refuge will monitor boardwalks and trails adjacent to ponds, lakes, and rivers in order to reduce trail erosion due to fishing-related foot traffic.

Since hunting activities are dispersed through the refuge, we have not seen any impacts to water quality associated with hunters. Although waterfowl hunting occurs adjacent to waterbodies and the Little Patuxent River, we do not anticipate impacts to water quality because the hunters are spread out along the shorelines of these areas.

Impacts to water quality from public fishing are a concern under any alternative. For this reason, the refuge forbids the use of lead sinkers in fishing tackle and polices adherence to State regulations mandating non-lead ammunition in waterfowl hunting. We also promote non-lead ammunition for upland game hunting, which takes place near many waterways on the refuge.

We do not anticipate any impacts to water quality from the existence or maintenance of the transmission lines on the refuge, because the lines are not located directly adjacent to waterbodies. Also, we do not anticipate impacts to hydrology associated with transmission lines, because the corridors are naturally vegetated with shrub habitat and the lines have not altered local hydrology.

Impacts on Hydrology and Water Quality under Alternative A (Current Management)

Beneficial

A portion of the refuge is bordered by high-density urban residential and industrial-commercial development (such as sand and gravel operations, commuter rail system, and a State college). By maintaining and protecting the natural forest buffers and wetlands along the Patuxent, and Little Patuxent Rivers, refuge lands help protect neighboring communities from additional impacts from flooding and stormwater pollutants. Forest cover best provides and conserves such water-related ecosystem services as groundwater recharge, water quality, flood control, nutrient and pollutant uptake, and stabilizing of soils to prevent erosion and associated sedimentation in creeks. Riparian vegetation helps shade waterways, decreasing water temperatures and increasing the water's capacity to retain dissolved oxygen. The refuge would continue to manage potential impacts of refuge activities on inputs to the two waterways in order to reduce contaminants and stormwater impacts from the refuge.

The refuge impoundments would continue to be managed to provide a variety of habitats suitable for feeding, nesting, brood rearing, and resting habitats for migratory birds and resident wildlife to the degree possible using the existing infrastructure on some of the impoundments. Water levels for Lake Redington and many of the Central Tract (370 acres) impoundments continue to be adjusted seasonally to mimic natural hydroperiods. These seasonal adjustments are similar to those associated with unaltered riverine wetlands to provide the best possible habitat for priority migratory birds and wildlife species.

Adverse

Other restoration and management activities on the refuge would be limited, thus minimizing short-term impacts to hydrology and water quality. The hydrology and water quality would continue to be locally impacted by dikes and other drainage features which are not planned for restoration under current management of the refuge. Dikes block flood waters and surface drainage, which helps build soils and encourages the establishment of phragmites, and may prevent upstream fish passage or migration.

Under alternative A, the risk of herbicide contamination, used in invasive plant control, to open water and wetland habitats would be minimal. Managing invasive species at current levels has not included widespread application of herbicides adjacent to hydrologic resources. Currently glyphosate-based or triclopyr-based herbicides are the primary chemicals used for refuge management operations. Glyphosate quickly degrades making it biologically unavailable. Both are systemic agents that operate only on enzymes located on certain plant tissues within roots or vascular system structures. We would minimize potential adverse effects to aquatic organisms by applying all herbicides according to EPA label instructions and only using herbicides approved for aquatic use in and around waters and wetlands. Refuge staff that work with herbicides are licensed applicators.

There would be little change to public and administrative facilities that would affect water quality.

Horseback riding has limited potential to have effects on hydrology and/or water quality. The trails where this use is allowed do cross riparian drainages and the Little Patuxent River. However, the roads are gravel/sand or asphalt (Wildlife Loop) and are fairly resistant to erosion that might be expected on trails made out of dirt or more organic parent materials. Horse use has been linked to increased coliform bacteria from fecal contamination in at least one study in wilderness areas (Derlet et al. 2008). However, this research was conducted in areas used heavily by pack horses and in some areas by cattle. The trails themselves do alter hydrological regimes and interrupt streamflow. A significant emphasis in this CCP is to identify those drainages most impaired by man-made structures and work to restore them to a more natural hydrology where possible. Refuge staff routinely monitors roads and trails for damage and then remediates problem areas as needed. Trail maintenance is conducted to help minimize any negative effects associated with trail use. Refuge staff ensures any potential negative effects are avoided or minimized. Based on the current and projected levels of use, condition of designated routes, and minimization measures employed, adverse effects on water resources because of this use are expected to be minimal.

Impacts on Hydrology and Water Quality under Alternative B (Service-preferred Alternative)

Beneficial

Benefits to water quality are the same as benefits of proposed actions in alternative A plus:

Conversion of 210 acres of impoundments to a floodplain forest would have the additional benefits associated with reduced runoff. By doing so, the refuge would restore some of the natural floodway capacity historically present along this portion of the Patuxent River. While we do not anticipate this single action to reduce the frequency of flooding, the restoration of historic hydrological regimes and flood capacity in this location adds to the cumulative effects of other flood management efforts.

As the refuge staff work with the NSA and the Secret Service, we anticipate the opportunity to convert at least a portion of the range area to use of "green" ammunition. The use of green ammunition would reduce the amount of lead in the area that could impact water quality. In revising the compatibility determinations for the shooting ranges, we would work with the DOD agencies to ensure that they install bullet traps so that all rounds fired can be captured and recycled.

This alternative also offers a greater emphasis on stream assessment and restoration.

Adverse

Adverse impacts to water quality are the same as adverse impacts of proposed actions in alternative A plus:

Conversion of 210 acres of impoundments to floodplain forest could have short-term impacts on water quality including potential erosion of disturbed soils and potential spills and leaks from equipment associated with the restoration process. These impacts would be minimized by using best management practices. Disturbance to vegetation and soils during replacement of culverts, opening of water control structures or installation of culverts or agri-drains, would potentially cause short-term erosion and sedimentation to nearby water ways. Any restoration would include an analysis of sediments and potential transportation of contaminants before being undertaken.

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Under alternative B, the refuge would construct public use infrastructure to support the expected increase in visitors for wildlife-oriented recreation and other refuge programs. The small construction projects include additional, observation tower, blinds, and kiosks. Any disturbed soils and suspended sediment would be managed using construction best management practices, such as erosion control barriers. However, each of the planned projects would occur on previously disturbed sites, so impacts are expected to be minimal. After construction, the long-term effects to hydrology and water quality would be minimal and use of these facilities for interpretive and environmental programs would raise appreciation and awareness of the refuge's resources, including hydrology and water quality issues. Clearing vegetation and mowing previously disturbed areas to open two additional trails would have no impact to hydrology and water quality on the refuge.

Horseback riding, repeated vehicle traffic by hunters, and other trail use on the refuge have potential to have minimal impacts on hydrology and/or water quality. The trails cross riparian drainages and the Little Patuxent River and do alter hydrological regimes and interrupt stream flow. However, the roads are gravel/sand or asphalt (Wildlife Loop) and are fairly resistant to erosion that might be expected on trails constructed of dirt or more organic parent materials. A significant emphasis in this CCP is to identify those drainages most impaired by man-made structures and work to restore them to a more natural hydrology. Refuge staff would continue to routinely monitor roads and trails for damage and remediate problem areas as needed. Trail maintenance would be conducted to help minimize any negative effects associated with trail use. Based on the current and projected levels of use, condition of designated routes, and minimization measures employed, adverse effects on water resources because of horseback riding and trail use are expected to be minimal.

Human activity on the refuge, particularly fishing and foot traffic, may increase aquatic sediment loads in ponds and lakes, or alter riparian or lakeshore habitat/vegetation. Human waste and litter may also impact water quality. Public outreach and education on littering, proper waste disposal, and the prohibition of gasoline motors would lessen potential negative water quality impacts. Boat access would be restricted to designated areas and trails would be monitored and may be modified, restored, or closed, if conditions warrant.

Impacts on Hydrology and Water Quality under Alternative C

Beneficial
Benefits to water quality are the same as benefits of proposed actions in alternative B plus:

The conversion of 239 acres of impoundments to floodplain forest would also increase water quality benefits in comparison to alternative B in terms of increased filtering and uptake of pollutants by vegetation and restoring the natural hydrology. By doing so, the refuge would restore the natural floodway capacity historically present along this area of the refuge. While we do not anticipate this single action would reduce frequency of flooding, the restoration of historical hydrologic regimes and flood capacity in this location adds to the cumulative effects of other flood management efforts.

Adverse
The adverse impacts of alternative C are similar to those described in *Impacts to Hydrology and Water Quality under Alternative B*. Effects from horseback riding would not be realized under this alternative.

4.5 Impacts on Vegetation

As discussed in chapter 2, refuge lands include a variety of habitat types, including open water, forests, shrub, grasslands, and emergent or shrub wetlands (see map 2-1). Many of the habitats had been degraded or damaged as a result of the numerous impacts

previously discussed. Some habitats are the result of alteration, such as impoundments, or secondary succession forests. Despite these alterations, many of these impacted habitats have the potential to be restored through various management actions, natural succession, and specific projects. Some habitats support rare plant communities or species of concern.

We evaluated the following actions for their potential to benefit vegetation:

- Conserving and protecting refuge lands to limit the growth of development on these lands, thereby limiting impacts on vegetation and losses of ecosystem integrity.
- Protecting, conserving, and monitoring habitats that contain rare or endangered plants, unique habitats and habitats which are important for species of special concern.
- Conversion or restoration of certain impoundments and grassland areas of the refuge to forest.
- Maintaining wildlife habitat and supporting wildlife in some impoundments by actively controlling water levels, restoring certain impoundments to native forest, or maintaining static water levels in other impoundments.
- Controlling invasive species and pests that impact vegetation on the refuge, and monitoring for these pests, particularly pests known to be present in the region.
- Supporting regional restoration projects and biological and scientific studies which improve habitat management, knowledge of species of concern, or provide learning opportunities for students.
- Increasing public awareness of the importance of vegetation to habitat quality through environmental interpretation and wildlife-dependent recreation.
- Emphasis on “native” species wherever plantings or vegetation restoration is conducted, striving for species and structural diversity and consideration for overwinter survival or future native plant recruitment objectives.

We evaluated the following actions for their potential to cause adverse effects on vegetation and losses of ecosystem integrity:

- Direct or indirect actions that cause soil, hydrology, and water quality impacts that could adversely impact vegetation, and habitat productivity and integrity.
- Managing and restoring riparian forests and upland forest communities.
- Managing invasive species.
- Larger scale routine management activities such as mowing fields and maintaining or controlling water levels in the impoundment, and less regular activities such as repairing flood damage, or prescribed burns.
- Constructing, updating, expanding, and managing public use facilities and

administrative offices.

- Increasing visitation and expanding the six priority uses.

Impacts on Vegetation That Would Not Vary by Alternative

We predict that refuge land management, regardless of which alternative, would be expected to have a net positive effect on vegetation abundance and quality.

Beneficial

Overall, the protection, maintenance, and restoration of habitats are expected to benefit vegetation.

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Jack-in-the-Pulpit

Under all alternatives, we would continue to employ early detection and rapid response monitoring in conjunction with other conservation partners, to prevent establishment of any known invasive plants. We would continue to reduce the footprint of habitats degraded by stand-replacing, near-monocultures of nonnative plant species, such as Chinese lespedeza, Japanese stiltgrass or honeysuckle. Invasive species control efforts would continue under all alternatives. These efforts are expected to result in a net benefit to native vegetation across the refuge.

Under all alternatives, the refuge would continue to protect areas of upland and floodplain forests. Management efforts across all alternatives would include invasive species controls expected to result in a net benefit to native vegetation across all forested habitats.

Managing deer populations has shown a positive response by vegetation in experimental exclosures (Augustine and Frelich 1998, McCullough 1982). Deer browse lines are visible along some forest edges on certain tracts of the refuge. Signs of deer such as browse, rubbings, trails, droppings, rooting through leaf litter, and tracks are visible throughout the refuge and very few locations contain the woodland wildflowers that one would expect in the area including columbine, trillium, bloodroot, and spring beauty. In this situation, no hunting or no-culling of deer would have lasting effect on sensitive vegetation and may set back resiliency for many years depending on the ‘shelf life’ of seeds in the seed bank and in the long run would have potential negative impacts on the songbird community (Allombert et al 2005).

Under all alternatives, the refuge would continue to protect areas of wetland, river and stream habitats, and associated vegetation. The refuge would continue to protect existing lands adjacent to these rivers and stream segments within refuge boundaries that influence aquatic vegetation in and along them.

Public use can benefit vegetation through our education and interpretive actions proposed under all alternatives. By educating visitors on the importance and identification of native vegetation and intact plant communities, we help individuals to recognize the prevalence of invasive species and the benefits of native species. Under all alternatives, we would continue to encourage volunteer-based efforts to help control invasive species and restore native plant communities.

The refuge would also continue to support deer hunting under all alternatives. Deer hunting benefits a variety of vegetative communities, and native species dependent upon those communities, by keeping deer populations within the carrying capacity of the habitat, thus reducing excessive damage to vegetation caused by over-browsing, and maintaining understory habitat for other species (Rawinsky 2008).

The area under the transmission lines is managed as shrub habitat, which provides habitat for State species of concern such as the whip-poor-will.

Adverse

Managing and restoring forest communities are consistent themes within the refuge goals and are common to all of the alternatives in different degrees. Vegetation clearing or removal during construction activities (and prior to the establishment of cover vegetation) would result in a temporary loss of vegetative cover. However, the refuge would promote revegetation of areas with native species typical of the target plant communities identified for each project.

Public use can affect vegetation in a variety of ways including directly by trampling and indirectly through soil compaction which can affect root systems, or introduction of nonnative weed seeds on footwear, tires, horses and dogs. We regularly monitor trails and roads and have not observed any major impact areas resulting from wildlife observation, photography, environmental education, fishing, interpretive uses, research, or horseback riding. Public use trails, wildlife observation areas, parking areas, and other high use areas are designed and maintained to minimize impacts on vegetation. The most intense concentration of public use is from maintenance of access roads, ongoing trail, and other maintenance activities would cause negligible short-term, localized disturbance (e.g., mowing, herbicide application) to vegetation. These activities would occur to some degree no matter which alternative is selected. These impacts would be minimized by using best management practices.

Horse travel can impact plants on roads and trails by crushing them. Indirectly, horses can impact plants by compacting soils, thereby diminishing soil porosity, aeration and nutrient availability (Kuss 1986). Hammitt and Cole (1998) note compaction limits the ability of plants to re-vegetate affected areas. Plants growing in wet or moist soils are the most sensitive to disturbance from trampling effects (Kuss 1986). Weaver and Dale (1978) found horse use caused a greater loss of vegetation cover, wider and deeper roads and trails, and greater soil compaction when compared to hiker use on meadow and forest trail conditions. Some incidental grazing along roads and trails may occur as well. Therefore, it is anticipated that horses would have some impacts on refuge plant

communities growing on the designated travel routes. Designated routes for horseback riding consist of former military roads with hardened surfaces, and are located predominately on upland soils to prevent impacts to fragile wetland soils and associated plant communities. Designated routes do not have any known occurrences of rare plant species on their surface that would be affected by this use. The refuge does not allow tethering horses to trees or other vegetation, which will help prevent further damage to vegetation.

Invasive plant species that alter native vegetation may be transported onto the refuge through the presence of exotic plant seeds in feed hay, horse trailers, and horse manure. This concern has initiated strict requirements for weed-free hay in some national parks and forests. Currently, there are no programs to provide for certified weed-free hay in Maryland or surrounding states (Rayburn 2001, 2009). Due to the relatively short time-frame for horseback riding excursions on the refuge, most users do not even bring in supplemental feed. It has not been identified as a problem to this point by refuge staff. We anticipate that horse use would cause minimal increases in invasive plants relative to the current presence of invasive plants on the refuge.

We also anticipate that there would be minimal adverse impacts to plant communities on designated routes. Most routes designated for horse use have hardened surfaces where plant communities are sparse or already have a heavy mix of invasive species such as Japanese stiltgrass. Users leaving designated trails could have impacts to adjacent vegetation. Where impacts to vegetation are observed, we would take necessary measures, such as remediation and trail closures, to restore plant communities on or adjacent to the affected trail.

Hunter trampling of vegetation is undetectable due to the high acreage to hunter ratio, limited number of hunt days, sparse understory vegetation, and time of year (dormant season). Plant species vary in their resistance to trampling, leading to changes in plant communities where there is tramping. In general, plant diversity has been shown to increase with slight use and to decrease as use intensifies (Liddle 1997). Plant recovery in the Mid-Atlantic Coastal Plain is relatively rapid compared to wilderness areas located in alpine, arctic, and desert ecosystems where abiotic factors limit plant growth. Plant recovery from trampling damage in these areas can take many years and may never occur (Newsome and others 2002).

Some direct adverse impacts on vegetation may occur as a result of hunting activities. However, those impacts should be minimal, because the refuge prohibits the use of ATVs, off-road vehicle travel, permanent stands and blinds, camping, and fires, which are most likely to damage vegetation. Hunter trampling of vegetation is likely to be further minimized as a result of the high acreage to hunter ratio and the time of year most hunting occurs (dormant season).

People and vehicles can be vectors for invasive plants when seeds or other propagules are moved from one area to another. Once established, invasive species can out-compete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of

invasive plant establishment will always be an issue requiring annual monitoring and, when necessary, treatment. Staff will work to eradicate invasives and educate the visiting public.

Adverse impacts to vegetation may also be realized from lead deposition in the environment from the shooting ranges.

The transmission lines that cross the refuge displace interior forest habitat. In some areas, the edge of the forest intersects with grassland habitat, which not a natural transition and provides limited habitat benefit. However, in most areas the transition is from forest to shrub habitat, which is not as stark of a contrast between habitat types.

Impacts on Vegetation under Alternative A (Current Management)

Beneficial

Beneficial impacts from refuge management under alternative A would be similar to those described under *Impacts on Vegetation That Would Not Vary by Alternative*.

Monarch on Blazingstar at Refuge Butterfly Garden - USFWS

Adverse

Vegetation disturbance, compaction and erosion could occur on trails that are frequently used by campers to access the campground and fishing areas. In order to manage for this impact, campers are restricted to designated areas where trails have been previously established and maintained (Kuss 1986). Invasive plants gain their first footholds in sunny disturbed areas, along trails or around shelters (Scherer 2001). Campers are required to camp only in designated areas in order to alleviate the creation of newly disturbed areas which may foster invasive plants. As the refuge develops its invasive weed management plan, new control measure may be implemented to lessen the possibility of establishing invasive weed communities.

Vegetation changes in and near campgrounds appear to be responsible for the increase of alpha diversity in bird species (Guth 1978). These increases of alpha diversity birds appear to have an effect on forest dwelling species of birds. This effect would be countered by allowing the campgrounds to only be used approximately 45 days a year as well as allowing the campsites to regenerate forest undergrowth through cyclical closures if necessary.

We anticipate that there would be minimal adverse impacts to plant communities on designated trails. Most trails designated for hiking, biking, jogging, and skiing use have hardened surfaces where plant communities are sparse or already have a heavy mix of invasive species such as Japanese stiltgrass, garlic mustard, lespedeza, Chinese

silvergrass, and others. Users leaving designated trails could have impacts to adjacent vegetation. Where impacts to vegetation are observed, we would take necessary measures, such as remediation and trail closures, to restore plant communities on or adjacent to the affected trail.

Impacts on Vegetation under Alternative B (Service-preferred Alternative)

Beneficial

In addition to the benefits to vegetation described under *Impacts on Vegetation That Would Not Vary by Alternative,* alternative B would create a focus on restoring and expanding forest habitats, through converting some impoundments and grassland habitat into forested habitat over the life of the plan. This would shift the plant community structure and species composition over this time.

Remaining grasslands would be enhanced to improve vegetative structure and species composition in order to more closely resemble the grassland patches historically present in the area and to minimize interior-to-edge ratio.

In this alternative, powerline right-of-way vegetation would be primarily shrubland, except for patches of natural wetlands, which could be bogs, shrub, or emergent wetlands. This would provide additional 260 or so acres of shrub habitat.

Another benefit to this alternative is the reduced mowing and burning associated with grassland habitat maintenance. The area of the softball fields would likely regenerate to natural conditions as the land is not mowed or fertilized. Seeds and plant species would colonize from the adjacent forested areas.

Adverse

The adverse impacts of alternative B are similar to alternative A, except:

There would be minor, temporary, negative effects on vegetation associated with impoundment restoration resulting from equipment needed for restoration work and would likely be localized to the berms or dikes that form the impoundment. These effects are expected to be temporary and the restoration plan would include strategies for minimizing negative effects (e.g., damage to soils and vegetation) and revegetating disturbed areas. The vegetation communities would change with a loss of emergent wetland plants and increase in floodplain forest community associated species.

People, vehicles, boats, dogs, and horses can be vectors for invasive plants when seeds or other propagules are accidentally, or deliberately, introduced into the refuge. Once established, invasive species can out-compete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of invasive plant establishment will always be an issue requiring annual monitoring and, when necessary, treatment. Staff would work to eradicate invasive species and educate the visiting public.

Alternative B proposes construction of additional facilities that include an observation tower, kiosks, and improved fishing access points. During the construction of these structures some areas of vegetation would be disturbed. Most, if not all, small project construction would be located where vegetation is already degraded, so a minor permanent loss of vegetated cover would result in a negligible impact. To open new trails, we would clear minor amounts of vegetation (branches and parts of shrubs) from the trail corridor and mow grasses and forbs in the trail footprint.

Impacts on Vegetation under Alternative C

Benefits
The benefits of alternative C are similar to alternative B, except:

A benefit under this alternative would be the increase in floodplain and upland forest acreage. The increased acreage would aid in forest resiliency and redundancy, factors important in weathering the effects of future climate change anticipated for this area, such as increased storm events, increased temperatures, more or less rainfall, new diseases and pests, and new invasive plant species. Conversion of additional impoundments and grasslands to forest cover and shrub communities would also increase the amount of forest cover on the refuge.

Another benefit to this alternative is the reduced mowing and burning associated with grassland habitat maintenance.

Adverse Impacts
The adverse impacts of alternative C are similar to alternative B, except:

There will be less available habitat to support native plants and pollinators associated with long-term grasslands and other species in the food web that use open habitats.

As in alternative B, alternative C also anticipates an increase in refuge participation and visitation. Effects of increased visitation under alternative C are expected to be similar to those described under alternative B.

4.6 Impacts on Federally Listed and Recently Delisted Species

There are no known federally listed species on the refuge at this time. As part of the Refuge System, one of our highest priorities is the conservation and management of federally listed or recently delisted species. We evaluated each of the alternatives for its potential to beneficially or adversely affect the riparian habitat or other habitats where breeding, wintering, or foraging bald eagles concentrate. State-endangered species or species of greatest conservation need (including amphibians, reptiles, birds, and plants) also occur on the refuge and are addressed under their individual taxonomic sections.

Bald eagle
Although the bald eagle was removed from the Federal list of endangered and threatened species on August 12, 2007, it is still a federally protected species under the Bald and Golden Eagle Protection Act and the State continues to list it as a threatened species. Bald eagles remain a priority for conservation on the refuge. We would continue to adhere to the Federal management guidelines for bald eagles in Maryland.

Impacts on Federally Listed and Recently Delisted Species That Would Not Vary by Alternative

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of federally listed and recently delisted species (e.g., bald eagle). We do not anticipate any impacts to any endangered or threatened species under any of the alternatives.

4.7 Impacts on Landbirds

The conservation and management of forested habitats are a priority of the refuge and consistent with its establishment purposes, and one of our CCP goals. We evaluated each of the alternatives for its potential to benefit or adversely affect early successional and forested habitats and associated landbirds.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of landbirds and identified focal species in chapter 2 and in our biological objectives:

- Improving and restoring floodplain and upland forests.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.
- Improving and restoring stream health.
- Improving the structural and species diversity, and native composition of other habitat types, especially shrublands.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of landbird focal species:

- Disturbance from public use.
- Potential impacts from spraying of invasive species, forest restoration, and impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure such as an observation tower and viewing blinds.

- Mechanical management actions such as bushhogging.
- Construction of new facilities or de-construction activities.
- Operation and maintenance of facilities, buildings and associated infrastructure.

Impacts on Landbirds That Would Not Vary by Alternative

Beneficial

Several State-listed endangered or threatened landbirds use the refuge including blackburnian warbler, Henslow's sparrow, mourning warbler (*Oporornis Philadelphia*), northern goshawk (*Accipiter gentilis*), olive-sided flycatcher, least bittern (*Ixobrychus exilis*), and short-eared owl (*Asio flammeus*). These species primarily use upland and floodplain forests for breeding, foraging, and resting habitats. These species primarily use upland and floodplain forests foraging and stopover wintering habitats, but Henslow's sparrow used to breed here and least bitterns still breed here.

Bill Thomspon/USFWS

Short-eared Owl

Several other landbirds that are not State-listed, but are identified as regional conservation priorities, are included in this group as well. Species such as American woodcock, blue-winged warbler, prairie warbler, wood thrush, and worm-eating warbler are all noted as high management priorities in plans such as BCR 30, the Service's Birds of Conservation Concern list, and Maryland's Wildlife Action Plan.

Forest birds would also benefit by the expansion of the widths of forested riparian zones that will create more habitat for roosting, foraging, or seeking cover and, depending on the width, breeding. The acreage depends on the alternative selected, as grassland management may occupy some acreage that otherwise would be forested.

Across all alternatives, valuable shrubland habitat would be provided within the powerline right-of-ways.

Under all alternatives, the refuge would continue to restrict access and management activities when and where appropriate near known nesting sites and continue breeding success monitoring as described in chapter 3. Long-term benefits to landbirds are anticipated through the ongoing management of upland and floodplain forests and other terrestrial habitats around the refuge. Invasive species management and supplemental plantings help enhance and restore the habitats that landbirds use for nesting, foraging,

and migratory stopover. Ongoing management activities, such as invasive species management and inventory and monitoring programs, would continue to be completed in a manner that would prevent potential impacts to individual species.

The refuge would continue to coordinate with MD DNR, along with our conservation partners, to ensure that we use the best available science in our management decisions related to State-listed species.

Adverse

Regardless of the alternative, we would continue to employ a range of invasive species management tools, such as mechanical and chemical options, to achieve our objectives in managing for the improved health and integrity of landbird habitats. We would use these tools only when and where appropriate, and only with the proper training and focused application to avoid adverse impacts. Invasive species control can be detrimental to landbirds if proper timing and application are not considered, but we tailor our treatments to protect birds during the nesting and fledgling periods and to avoid harm to amphibians. A less noticeable but long-term impact would result from no action with respect to invasive species control or failing to curtail the deer population, as these have the potentially to significantly alter vegetation communities upon which birds and their prey base depend.

Disturbances vary with the wildlife species involved and the type, level, frequency, duration, and the time of year such activities occur. The responses of wildlife to human activities include avoidance or departure from the site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschen et al. 1985, Kahl 1991, Klein 1993, Whittaker and Knight 1998), the use of sub-optimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior or habituation (Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993, Whittaker and Knight 1998), attraction (Whittaker and Knight1998), and an increase in energy expenditure (Morton et al. 1989, Belanger and Bedard 1990).The presence of people hiking, jogging, biking, and skiing on refuge trails and roads can lead to displacement of animals from trails, although disturbance usually is a negligible influence on large mammal distributions and movements (Purdy et al. 1987; Boyle and Samson 1985). The effects of roads and trails on plants and animals are complex. Trail use can disturb areas outside the immediate trail corridor (Trails and Wildlife Task Force 1998, Miller et al. 2001). Studies have found that bird communities are affected by the presence of recreational roads and trails, where common species (e.g., American robins) are found near trails and rare species (e.g., grasshopper sparrows) are found farther from trails. Songbird nest failure was also greater near trails. The effects on other forms of wildlife appear to be short-term with the exception of breeding bird communities.

A study by Miller, Knight, and Miller (1998) indicates that species composition and nest predation was altered adjacent to trails in both forested and grassland habitats. It appears that species composition changes are due to the presence of humans and not the trail or roadway itself. On the other hand, nest predation does appear to be a function of the trail which allows access to mammalian nest predators. Several studies have examined the

effects of recreationists on birds using shallow-water habitats adjacent to trails and roads through wildlife refuges and coastal habitats in the eastern U.S. (Burger 1981, Burger 1986, Klein 1993, Klein et al. 1995, Rodgers and Smith 1995, Rodgers and Smith 1997, Burger and Gochfeld 1998).Overall, the existing research clearly demonstrates that disturbances from recreation activities have at least temporary effects on the behavior and movement of birds within a habitat or localized area.

Anticipated impacts of hiking, jogging, biking, and skiing on wildlife include temporary disturbances to species using habitat on the trail or directly adjacent to the trail. These disturbances are likely to be short term. Use of some roads and trails may cause direct mortality to amphibians crossing trails during migration or foraging. There may also be nest abandonment of bird species nesting on, or next to, trails should these uses become too frequent during breeding season. Long-term impacts may include certain wildlife species avoiding trail corridors as a result of this use over time. However, trails open to hiking, biking, jogging, and skiing are located primarily in continuous tracts of hardwood or mixed hardwood/pine forests, with some open meadow areas mixed in. More sensitive or underrepresented wildlife habitats such as riparian and wetland areas were avoided, reducing the potential for wildlife disturbance. Locating these trails in upland forested habitat spreads the disturbance over the largest habitat type on the refuge, minimizing the overall impact on refuge wildlife associated with this habitat.

Wildlife disturbance may be compounded by seasonal needs. For example, some species, like warblers, could be negatively affected by disturbance associated with bird watching particularly during the breeding season. When visitors approach nests too closely, they often cause the adult bird to flush exposing the eggs to weather conditions or predators (Banks and Bryant 2007, Miller et al. 2001).

As discussed throughout this document, the refuge is located in a highly urban environment, with substantial baseline disturbance associated with the international airport, Baltimore-Washington Parkway, several State routes, and numerous houses, business, community buildings, and associated human activity. By limiting the presence of humans to refuge trails and infrastructure, refuge visitors are not expected to add significantly to existing disturbance levels. Overall, the direct disturbance from public use is expected to have minimal or no adverse effects on landbirds because human presence would be limited to refuge trails and infrastructure.

Domestic or house cats, both free-ranging domestic and feral, also have negative effects on wildlife. Cats prey on wildlife, compete with native wildlife, and can transmit diseases to wildlife, pets, and people. Cat predation is an added stress to wildlife populations already struggling to survive habitat loss, pollution, pesticides, and other human impacts (ABC 2011). The cumulative negative effects of cats on wildlife are impossible to quantify; however, there is a growing body of literature that strongly indicates that domestic cats are a significant factor in the mortality of native small mammals, birds, reptiles, and amphibians (CDFG 2009). At this time, we have limited ability to control feral cat populations on the refuge, because the amount of effort that would be required to effectively reduce the feral cat population to a level that would not quickly rebound to the current level would be cost prohibitive. We would continue to monitor the impacts of

feral cats on landbirds and make changes in management or access as needed to continue our protection of these species. Other primary predators on bird populations include snakes, fox, raccoon, possum, and skunk. Minimizing edge or fragmentation helps to reduce bird predation from these animals as they prefer to work within 300 feet of forest edges. For this reason, we also seek to maximize the interior to edge ratio of our grasslands to minimize predation on ground nesting birds from snakes, raccoons, and fox.

The shooting ranges may have direct and indirect, short and long-term impacts to landbirds in the nearly 3,000-acre impact zone. Long-range fire that reaches beyond the limits of the range has the potential to disturb, flush, injure, or even cause mortality of birds in the area. While we have not directly measured the impacts of these ranges which operate daily, year-round, indirect effects can be seen. Trees are shorn of small branches and trimmed of vegetation in the area and bullets have been seen lodged in bark. Spent lead-based ammunition also accumulates beyond the berm and can contaminate the soil, or gets washed into nearby streams; it can also be taken up by plants and invertebrates, which are consumed by birds. Direct ingestion of lead by birds can occur by raptors feeding on decaying game, or by other birds which mistake fragments of shot for grit. The impact zone is unsafe for researchers or monitors to study the immediate area without shutting down the range. In revising the compatibility determinations for the shooting ranges, we will work with the DOD to ensure that it find solutions to mitigate these effects.

In the transmission line corridors, there is an overall loss of interior forest habitat. This area still provides habitat for landbirds of concern, such as the American woodcock. The edge effect along most of this area is minimized by managing for shrub habitat.

Impacts on Landbirds under Alternative A (Current Management)

Beneficial and adverse impacts to landbirds under alternative A are the same as those discussed in *Impacts on Landbirds That Would Not Vary by Alternative*.

Impacts on Landbirds under Alternative B (Service-preferred Alternative)

Beneficial

Compared to alternative A, alternative B would provide additional long-term benefits to landbirds through the protection and restoration of upland and floodplain forests, and grassland enhancements. The conversion of the 210 acres of impoundments to a mix of hardwood floodplain forest species would provide improved habitat structure and species composition needed for various warblers, such as prothonotary warbler. Phased removal and reforestation of this area would help minimize short-term impacts or habitat loss.

We would also maintain and improve larger patches of grassland in locations where this habitat has less impact on the habitat value of interior forest blocks. By expanding warm-season grass coverage in conjunction with seed-producing native flowering species, we would improve habitat quality for bird species that use these areas for foraging, nesting

and wintering. This alternative also benefits the insects and other invertebrates on which these birds depend.

Controlling the deer population under alternative B would improve plant regeneration in forested and grasslands areas of the refuge. An increased diversity and abundance of vegetation across these habitats would help improve nesting site availability and success.

Adverse

Habitat management and restoration of forests and grasslands under alternative B would likely result in short-term and infrequent disturbances to landbirds during necessary work and maintenance of these areas. We would continue to monitor known nest locations and adjust our management and timing of our actions to minimize impacts on landbirds. We would minimize activities such as prescribed burns, bushhogging, forest thinning, and broadcast spraying from April 15 through August 1 or later, and would scout areas for nesting birds prior to commencing work.

Alternative B anticipates an increase in refuge participation and visitation over the next 15 years. Much of this increase is expected in the form of school groups or recreational uses. As noted in the *Impacts on Landbirds That Would Not Vary by Alternative* discussion, increased use of existing trails poses minimal potential impact to nesting landbirds because human presence would be limited to refuge trails and infrastructure.

Researchers could cause disturbance to ground-nesting birds, or winter roosting species that have limited energy reserves. The presence of people on refuge trails and roads can lead to displacement of animals from trails, although disturbance usually is a negligible influence on large mammal distributions and movements (Purdy et al. 1987; Boyle and Samson 1985). A study by Miller, Knight, and Miller (1998) indicates that species composition and nest predation was altered adjacent to trails in both forested and grassland habitats. It appears that species composition changes are due to the presence of humans and not the trail or roadway itself. On the other hand, nest predation does appear to be a function of the trail which allows access to mammalian nest predators (Miller, Knight, Miller, 1998).

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Kestral Banding

Disturbance to wildlife and vegetation by researchers could occur through observation, a variety of wildlife capture techniques, banding, collecting blood samples, flushing wildlife, and vegetation trampling from accessing the study area by foot or vehicle. It is possible that direct or indirect mortality could result as a by-product of research activities. Mist-netting or other wildlife capture techniques, for example, can cause mortality directly through the capture method or in-trap predation, and indirectly through capture injury or stress caused to the organism. Multiple, concurrent research projects could exacerbate impacts. Additional impacts could result from abandoned research apparatus left in the field. Overall, however, allowing well-designed and properly reviewed research to be conducted by non-Service personnel is likely to have very little impact on refuge wildlife populations. If the research project is conducted with professionalism and integrity, potential adverse impacts are likely to be outweighed by the knowledge gained through allowing the research. Similarly, the refuge maintains a database and GIS maps of current research to prevent conflicts and imposes guidelines to prevent negative impacts, such as keeping vehicles on refuge roads, prohibiting intrusive marking of vegetation, or staggering the timing of research at same sites.

Disturbance to breeding birds attempting to establish and settle into nest territories, nest-building and incubating is more likely to result from off-trail visitor use, such as would occur for turkey hunting during the spring gobbler season, particularly for low-elevation or ground nesting birds and particularly if the same spots experience repeated disturbance from gunshot, vehicles, lights, and communications. Overall, direct effects from consumptive use during the spring should be greatly reduced if such use is fairly dispersed, confined to limited areas on tracts opened to public use, large areas remain undisturbed, and sensitivity to breeding season is observed. Direct effects to breeding landbirds from consumptive visitor activities may also be mitigated by observing time of year restrictions, limiting the frequency, duration, and number of locations of consumptive activity.

We would pursue opening additional trails and visitor facilities like the observation tower on the North Tract. We would evaluate the sites and programs periodically to assess whether they are meeting the objectives, and to prevent site degradation. If the use causes evident and unacceptable adverse impacts, the refuge would rotate the activities to secondary sites, curtail, or discontinue them.

Added public use infrastructure proposed under alternative B such as kiosks and trails would not occur near known nesting areas. Construction timing would be scheduled to avoid potential disturbance to nesting species in areas adjacent to the proposed trails and observation tower, as well as to minimize impacts on foraging and resting habitat during important seasonal periods such as nesting or migration. As a result, minimal adverse impacts are anticipated from proposed construction projects. Overall, we do not anticipate that visitor use numbers will change as a result of providing these new opportunities. The total number of visitors would be dispersed among these new opportunities. The level of disturbance on the refuge as a whole is anticipated to be the same under all alternatives.

Disturbance to breeding birds attempting to establish and settle into nest territories, nest-building and incubating is more likely to result from off-trail visitor use, such as would occur for turkey hunting during the spring gobbler season, particularly for low-elevation or ground nesting birds and particularly if the same spots experience repeated disturbance from gunshot, vehicles, lights, and communications. Overall, direct effects from consumptive use during the spring should be greatly reduced if such use is fairly dispersed, confined to limited areas on tracts opened to public use, large areas remain undisturbed, and sensitivity to breeding season is observed. Direct effects to breeding landbirds from consumptive visitor activities may also be mitigated by observing time of year restrictions and limiting the frequency, duration, and number of locations of consumptive activity.

Under alternative B, the use of dogs on the refuge for search and rescue training and waterfowl hunting is allowed. Dogs on the refuge could have negative impacts on refuge landbirds. The dogs could cause birds to expend energy moving to other areas of the refuge. Waterfowl hunting occurs along waterways and is not anticipated to impact landbirds. Search and rescue training occurs at low numbers and is timed to avoid nesting season and located to avoid sensitive locations.

Studies on impacts of recreational dog walking in woodlands demonstrated a 35 percent reduction in bird diversity and 41 percent reduction in abundance, regardless of whether dog walking was allowed or prohibited (Banks and Bryant 2007). Free-ranging and uncontrolled dogs can chase and flush ground-nesting or foraging birds. Potential impacts of domestic dogs could be broadly classified as harassment, injury, or death of wildlife. Harassment to ground-nesting for foraging birds is the disruption of normal maintenance activities, such as feeding, bedding, or grooming. It can take the form of disrupting, alarming, or even chasing. If dogs chase or pursue wildlife, injuries could be sustained directly or indirectly as a result of accidents that occur during the chase itself rather than direct contact with the dog. Impacts of domestic dogs can also include modification of wildlife behavior; however, the requirement that dogs be kept on a 6-foot leash would keep dogs on trails and not in habitat areas. Therefore, this use is not expected to add significantly to existing disturbances. Suitable habitat for escape is near areas where training is allowed to occur so disturbances to wildlife are expected to be temporary and minimal.

Large game hunting takes place outside of the breeding season, so negative impacts to breeding forest and grassland or shrubland birds are not anticipated.

Turkey hunting has the most potential to cause disturbance to landbirds, particularly ground nesting forest birds of conservation concern, such as worm-eating warbler, Kentucky warbler, and ovenbird. Woodthrush is another species of conservation concern that nests in lower branches and forages and sings from the ground. It is an area-sensitive forest interior species that could also be disturbed by turkey hunting. The spring hunting season currently takes place on select days between mid-April and late May, when birds are likely to be laying or incubating. Since the number of days of turkey hunting each

year is low, we have not seen significant impacts to breeding landbirds, nor do we anticipate additional impacts.

Impacts on Landbirds under Alternative C

Beneficial
Alternative C differs slightly from alternative B in benefits to landbirds. This alternative would provide additional upland forest and floodplain forest communities. Shrub and early successional habitats are currently under-represented across the refuge and region. These habitat types benefit various warbler species and other songbirds that use dense shrub cover.

Similar to alternative B, providing additional opportunities for environmental education and interpretation would raise public awareness and support for wildlife protection and habitat conservation.

Adverse
Adverse impacts to landbirds are similar to those discussed in alternative B, except, that it would result in the loss of grassland habitat of sizes and configurations that would benefit grassland generalist birds.

Alternative C anticipates slightly lower numbers of public use visitation when compared to alternative B. Potential adverse impacts under this alternative would be intermediate between alternatives A and B.

4.8 Impacts on Open Water and Wetland Bird Species

We evaluated the following actions for their potential to conserve, restore, improve, or increase habitats of waterbird focal species (e.g., American bittern, great egret, king rail (*Rallus elegans*), and least bittern):

- Managing and restoring freshwater impoundments and emergent wetlands.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.
- Improving riparian buffer vegetation.

We evaluated the following actions for their potential to cause adverse effects on habitats of waterbird focal species:

- Disturbance of species from public use.
- Restoration of some impoundments to forest.

- Potential impacts from spraying of invasive species, forest restoration, or impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure such as boardwalks and viewing blinds.

Impacts on Open Water and Wetland Birds That Would Not Vary by Alternative

Beneficial

Under all alternatives, the refuge would continue to restrict access and management activities when and where appropriate near known nesting sites and continue breeding success monitoring.

Waterfowl and shorebirds of regional conservation priority, such as American and least bittern, sora, king rail, and American black duck, would continue to use available impoundments and naturally occurring wetlands.

Sally Gentry/USFWS

American Bittern

Adverse

Bennett and Zuelke (1999) summarize several studies indicating recreation activities that would have at least temporary effects on the behavior and movement of birds using shallow water habitats adjacent to trails and roads through wildlife refuges (Burger 1981, 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1997; Burger and Gochfeld 1998). Winter hunt seasons (deer and waterfowl) have the potential to disturb winter waterbirds where hunt zones are in proximity to their forage and loafing areas. Deer hunting does not generally occur adjacent to waterbird areas. Waterfowl hunting would likely have impacts to waterbirds, especially the waterfowl that are hunted at the refuge. Each year, bag limits are set according to population goals for the species to ensure that there are no population impacts. The refuge will continue to adhere to these limits.

As discussed under the section on landbirds above, we would take all necessary measures to mitigate those effects, particularly where group educational activities are involved. We would evaluate the sites and programs periodically to assess whether they are meeting objectives, and to prevent site degradation. If the use causes evident and unacceptable adverse impacts, the refuge would rotate the activities to secondary sites, curtail, or discontinue them. Since dogs are allowed only on trails and the majority of trails are not in close proximity to areas of waterfowl nesting, loafing, or foraging, we do not anticipate significant impacts from dog walking.

Public users of the areas along the Patuxent and Little Patuxent Rivers and various impoundments could damage marsh grasses or disturb nesting or foraging marsh birds or

otherwise degrade these areas, for example through deposit of used fishing line, tackle, or other trash, or by disturbance to bank areas and creation of turbidity. Refuge signage, flyers, and other public information materials would continue to be used to ensure that the public is aware of these issues and does not engage in harmful activities.

Negative impacts to waterfowl and other wildlife from lost fishing gear may include ingestion of lead sinkers, hooks, lures, or litter; or entanglement in fishing line or hooks. Lost fishing tackle may harm waterfowl, eagles, and other birds externally by catching on, and tearing skin. Fishing line may also become wrapped around body parts and hinder movement (legs, wings), impair feeding (bill), or cause a constriction with subsequent reduction of blood flow and tissue damage. Entangled animals may become snagged by an object above or below the water surface, from which they are unable to escape. Fishing line entanglement has also caused mortality of bald eagles. Birds may also ingest sinkers, hooks, floats, lures, and fishing line. Ingested tackle may be toxic or cause damage or penetration of the mouth or other parts of the digestive tract that may result in impaired functioning or death. There have not been any documented cases of this occurring on the refuge. However, Patuxent Research Refuge would continue to provide education and outreach on the hazards of fishing tackle. The refuge has also placed monofilament recycle bins at Cash Lake, New Marsh, the Visitor Contact Station, the NWVC, and Lake Allen to reduce the probability of wildlife coming in contact with lost fishing gear. Refuge officers assist with this public outreach effort. Fishing seasons in Maryland coincide, in part, with spring to early summer nesting and brood-rearing periods for many species of aquatic-dependent birds. Anglers may disturb resting and foraging birds by approaching too closely. Flushing may expose eggs to predation or cooling, resulting in egg mortality. The refuge would continue to seasonally close areas around sensitive sites to fishing. Public outreach and placement of warning signs would also be continued.

It is important to note that the refuge exists within a highly altered area with substantial baseline levels of disturbance associated with interstate traffic, airport activities, adjacent neighborhoods, roads, and past military use. Overall, the effects from public use are expected to have minimal adverse effects on waterbirds utilizing open water and wetland habitats, except for the minor disturbance levels noted above. There are few visitor facilities (e.g., trails) in these habitats due to the presence of open water, saturated soils, and their location in a closed area of the refuge; therefore, they are relatively inaccessible to the public. The size and dense vegetation supported by freshwater emergent vegetation and portions of open water should provide adequate buffers to protect wetland bird species against human disturbance (Gibbs and Melvin 1992). Boaters that access the Cash Lake could disturb species using these habitats.

Impacts on Open Water and Wetland Birds under Alternative A (Current Management)

Benefits and adverse impacts to open water and wetland birds are the same as those discussed in *Impacts That Would Not Vary by Alternative.*

Impacts on Open water and Wetland Birds under Alternative B (Service-preferred Alternative)

Beneficial

Benefits to open water and wetland birds are the same as those discussed in *Impacts on Open Water and Wetland Birds That Would Not Vary by Alternative*.

Adverse

Alternative B would result in a decrease in open water habitats through the restoration of floodplain and upland forest. This change in focus away from some impoundment management would likely reduce the number of open water dependent waterfowl that use the refuge. The reduction in available habitat would impact the refuge waterfowl population, but given the size of the impoundments and their location on the landscape, displaced waterfowl would use other open water areas on the refuge or adjacent. As such, we do not anticipate any impacts to overall waterfowl populations.

When not properly monitored, providing increased fishing opportunities may lead to unnecessary wildlife hazards. Such negative impacts to birds could occur from lost fishing gear, including ingestion of lead sinkers, hooks, lures, or litter; or entanglement in fishing line or hooks. Lost fishing tackle may harm waterfowl, eagles, kingfishers, and other birds by catching on, and tearing skin. Fishing line may also become wrapped around body parts and hinder movement (legs, wings), impair feeding (bill), or cause a constriction with subsequent reduction of blood flow and tissue damage. Birds may also ingest sinkers, hooks, floats, lures, and fishing line. Ingested tackle may be toxic or cause damage or penetration of the mouth or other parts of the digestive tract that may result in impaired functioning or death. There have not been any documented cases of this occurring on the refuge. However, the refuge will continue to provide education and outreach on the hazards of fishing tackle. The refuge has also placed monofilament recycle bins at Cash Lake, New Marsh, Lake Allen, the Visitor Contact Station, and NWVC to reduce the probability of wildlife coming in contact with lost fishing gear.

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Sign about Proper Disposal of Fishing Line

Alternative B anticipates an increase in refuge participation and visitation. Much of this increase is expected in the form of school groups or recreational uses. As noted in the "adverse impacts common to all alternatives" discussion, use of existing trails poses minimal potential impact to birds nesting in open water or wetland habitats. The overall trend regarding the location of visitation is likely to remain the same.

There may be disturbance to wintering waterfowl during deer season and, of course, waterfowl hunting, causing wintering birds to expend more energy as they are flushed. Bag limits for waterfowl hunting are set at a flyway scale to ensure that there are no population level impacts. The majority of deer and upland game hunting on the refuge occurs in areas that are far enough away from waterfowl wintering areas that levels of disturbance are expected to be low.

Added public use infrastructure proposed under alternative B, such as kiosks, would not be constructed near known nesting areas. Construction timing for kiosks would also be considered where necessary to avoid potential disturbance to sensitive species. As a result, only minimal, short-term impacts are anticipated from proposed construction projects.

Impacts on Open Water and Wetland Birds under Alternative C

Beneficial
The increase in floodplain forest under alternative C would increase benefits associated with wetland and open water species that use adjacent floodplain forest for some of their lifecycle needs. For example, nesting wood ducks could benefit from increased nesting cavities associated with floodplain forest.

Adverse
Compared to alternative B, alternative C further decreases the number of acres of open water and impoundments by an additional 210 acres. This reduction in habitat would likely reduce the number of open water-dependent species, such as ring-neck ducks and buffleheads that use the refuge regularly or occasionally, respectively, during the non-breeding season. However, the refuge lies at the periphery of the core range for Atlantic Flyway waterbirds, especially waterfowl and shorebirds. Its largely forested and urbanized landscape does not make the refuge a key contributor to this species suite.

Alternative C anticipates a decrease in refuge visitation when compared to alternative B. Potential adverse impacts to open water and wetland birds from public use under this alternative would be intermediate between alternatives A and B.

4.9 Impacts on Fisheries

The refuge supports a relatively diverse fish community with at least 28 documented species. Water quality is generally within the tolerable range for most species. Estimates of species richness suggest the total number of species in refuge waters may be as high as 36 species. The refuge also serves as habitat for some species that are of Federal or State conservation concern, which is notable in such an urban environment (Sweka and Mohler 2010).

The refuge supports several Federal trust fish species, such as blueback herring, hickory shad (also considered State-endangered), alewife, American eel, and striped bass. These

species are considered species of conservation and management concern by the Region 5 fisheries program (Sweka and Mohler 2010).

Fishing is a regular public use at Cash Lake, Lake Allen, Rieve's Pond, New Marsh, Cattail Pond, Bailey Bridge Marsh, and the lower Little Patuxent River.

Wetland management to protect the river's fisheries and nurseries for native anadromous and catadromous fish is a priority at the refuge, one that is consistent with its original establishing purposes, and our CCP goals. We evaluated the management actions and public uses each of the alternatives proposes for its potential to benefit or adversely affect wetlands and riparian habitats used by fish.

We evaluated the following actions for their potential to conserve, restore, improve, or increase habitats of fish species on the refuge:

- Managing and restoring upland and floodplain forests, grasslands, and open waters, and freshwater emergent marsh.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the following actions for their potential to cause adverse effects on habitats of fish species on the refuge:

- Disturbance of species from public use.
- Impacts on habitat quality from the construction of facilities.
- Potential impacts from spraying of invasive species, forest restoration, and impoundment water level manipulation.
- Expanding office facilities.
- Construction of additional wildlife observation infrastructure such as boardwalks, observation tower, and viewing blinds.

Impacts on Fisheries That Would Not Vary by Alternative

Beneficial

Many of the same management actions for protecting wetlands and other species, such as controlling nonnative invasive plants and providing or improving vegetated buffers around wetland-upland interfaces and riparian edges, are actions that would take place regardless of which alternative we select, and would not only benefit wetlands but the fish species that depend on good water quality and a well-functioning wetland ecosystem.

Where floodplain forests are found adjacent to open water, trees and other vegetation falling into the water provides cover and food, as well as shade that helps to lower water

temperatures. Many related benefits of floodplain forests are also described under the section on hydrology and water quality. Benefits regarding open water and wetlands relate to fisheries as well.

Adverse
Overall, the effects from public use (both current and anticipated) would not likely have an impact on fisheries utilizing open water and wetland habitats on the refuge. By providing fishing opportunities, there would be impacts to individual fish. Anglers on the refuge are required to comply with State fishing regulations which are intended to protect fish populations. While we encourage catch and release because of the potential contaminants present in game fish, this also helps maintain local fish populations. We feel that the long-term protection benefits gained by connecting people to nature through this public use do not affect the health of fish populations as a whole and outweigh the adverse impacts on individual fish. Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of open water and wetland habitats.

Other sources of environmental contamination can be created by stormwater runoff from surrounding lands and the watershed. Use of herbicides in invasive species control could potentially cause small, localized, and temporary contamination in the event of an unintentional spill or misapplication. We would continue to employ best management practices in terms of herbicide use and spill prevention and response to minimize impacts from these other sources of contamination. Generally, the refuge only applies herbicides on the Field Station Approval List, as other pesticides require either Regional or Service Headquarters approval. We must request approval, through a pesticide use proposal, for all uses of chemicals on the refuge. The refuge manager, regional pest management coordinator, and national pest management coordinator have the authority to approve herbicides and their application procedures.

Impacts on Fisheries under Alternative A (Current Management)

Benefits and adverse impacts to fisheries are the same as those discussed in *Impacts That Would Not Vary by Alternative*.

Impacts on Fisheries under Alternative B (Service-preferred Alternative)

Beneficial
Alternative B would allow visitors improved fishing opportunities as well as access to Blue Heron Pond. As discussed under *Impacts That Would Not Vary by Alternative*, this would create isolated negative impacts for some individual fish and would increase the potential for adverse impacts associated with increased public use to occur (e.g., littering); however, we feel that connecting people to nature through this activity would help encourage habitat conservation over time.

This alternative includes an increased emphasis on stream assessment and corrective measures to restore impaired segments that have degraded physical and biological

parameters in order to improve water quality and streambed substrate. This would improve fish nursery and foraging habitat.

Adverse

Alternative B also anticipates an increase in refuge visitation, from the 233,000 estimated in 2011. Much of this increase is expected in the form of school groups or recreational uses such as wildlife observation and photography. Recreational fishing is likely to increase along with this trend. We anticipate an increase in angling based upon the increased opportunities that would be provided and associated with an increase in general visitation, which would result in an increase in the scale of impacts. At this time, we do not anticipate impacts on local fish populations as a result of this increase. As noted, this would create isolated negative impacts for some individual fish; however, we believe adhering to State fishing regulations protects fish populations and that connecting people to nature through this activity would help encourage habitat conservation over time.

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Fishing at Wounded Military Visitation Day

Accidental or deliberate introductions of nonnative fish through public fishing may negatively impact native fish populations. The refuge would continue to provide educational outreach and signage on this subject, and minimize impacts associated with nonnative species introductions, if they occur.

Deconstruction of impoundments may have minor, temporary impacts due to flushing of sediment from the impoundments. We would conduct measured releases to avoid severe sedimentation downstream. The refuge would continue to utilize best management practices, including soil erosion and sedimentation controls, as part of all construction projects to minimize the impacts to fisheries.

Impacts on Fisheries under Alternative C

Beneficial
Benefits to fisheries are similar to those discussed in *Impacts on Fisheries under Alternative B.*

Adverse
Adverse impacts to fisheries are similar to those discussed in *Impacts on Fisheries under Alternative B.*

Similar to alternative B, alternative C anticipates an increase in refuge participation and visitation although alternative C would also result slightly lower numbers of public use visitation when compared to alternative B. As discussed under *Impacts That Would Not Vary by Alternative*, this would create isolated negative impacts for some individual fish; however, we feel that connecting people to nature through this activity would help encourage habitat conservation over time.

Effects of construction and restoration projects would be similar to those described under alternative B.

4.10 Impacts on Mammals

Mammals in the vicinity of Patuxent Research Refuge occupy a diverse array of habitat types and food webs, and play an important role in habitats found within the refuge boundary. As a taxonomic group, mammals benefit from refuge land protection and management of upland and floodplain forests, grasslands, shrub, open water, and wetlands. Likewise, refuge habitats would benefit from careful attention to the impacts on mammals resulting from refuge activities.

Mammals on the refuge consist largely of relatively common species found across the Mid-Atlantic. Most of these species are able to use a variety of wetland or terrestrial woodland habitats, and their populations on the refuge would not be expected to change under each alternative.

It is possible that the endangered Indiana bat (*Myotis sodalist*) and little brown bat may use the refuge. We are concerned about the status of our forest bats given the forest fragmentation occurring on the landscape and the important role they play in the foodweb and ecosystems. River otters (*Lutra canadensis*) and mink (*Mustela vison*) have been found in the rivers on and adjacent to the refuge (PNHP 2008). The open waters of the Patuxent and Little Patuxent Rivers throughout the refuge provide suitable habitat for these two species. The refuge has the potential for the State-listed eastern harvest mouse, once documented on the refuge but which may now be locally extirpated.

We evaluated the following actions for their potential to conserve, restore, improve, or increase habitats of mammal species likely to utilize refuge habitats:

- Managing and restoring floodplain and upland forests, grasslands and shrublands.
- Management of existing hunting program.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the following actions for their potential to cause adverse effects on habitats of mammals:

- Disturbance of species from public use.
- Potential impacts from spraying of invasive species, forest restoration, or impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds.

Impacts on Mammals That Would Not Vary by Alternative

Beneficial

Our strategies for habitat improvement measures and controlling invasive or nuisance species hold potential for impacts on mammals, and would continue regardless of the alternative we select. Each management action indirectly benefits mammals over the long term by ensuring the continuation of quality natural habitats on the refuge. Ongoing management activities, such as invasive species management and inventory and monitoring programs, would continue in a manner that would minimize potential impacts to individual species.

We would continue to monitor and control overabundant species such as beaver or deer where we notice habitat degradation. These activities would benefit and improve the health of remaining individuals. Other furbearers and rodent mammals would benefit from the habitat diversity and quality, and promotion of native plants species emphasized across all alternatives. Expanded and improved forest corridors on the refuge (and locally via refuge land protection partnerships) would benefit bats and aquatic or wetland mammals such as otter and mink.

Adverse

Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of terrestrial and wetland habitats. We would use these tools only when and where appropriate, and only with the proper training and focused application to avoid adverse impacts.

One such example is control of invasive plant species or bushhogging and mowing activities associated with roadsides, facilities, or habitats. Areas where invasive species control or habitat diversity objectives warrant clearing an entire monoculture stand occur on a very small scale. The timing of herbicide applications to be most effective varies

depending on target species and treatment method. Occasionally, eliminating an entire field of a single nonnative species is necessary, but in most cases, the treatments are spot-specific. The treated sites soon regrow, and mammals still have margins of habitat or other areas nearby for alternate use. Therefore, this activity is expected to have minimal negative impacts on some individuals that are localized and short term.

Hunting of mammals would occur at some level under each of the alternatives. For the 2010 to 2011 deer seasons, hunters took 272 deer. For the 2009 to 2010 deer seasons, hunters took 242 deer. This level of harvest is expected to keep deer population level within the refuge to a density that reduces impacts to the forest understory and allows for forest regeneration (Obrecht 1992). However, it is unlikely that this level of deer harvest would negatively impact the overall deer population of eastern Maryland.

Overall, the effects from public use are not likely to have a negative impact on mammals. There is the potential for some negative impacts from increased vehicle use associated with greater visitation. Low refuge speed limits would likely keep the number of mammals hit by vehicles very low. Limiting visitors to existing trails prevents unintended disturbance to terrestrial mammals. An expected increase in visitation may create isolated negative impacts for some individual mammals; however, we feel that connecting people to nature through appropriate wildlife-dependent recreation, such as wildlife observation and photography would minimize potential impacts and help encourage habitat conservation over time.

The presence of transmission lines on the refuge will have negligible impacts to mammals, because the shrub and grassland habitat in the corridor is used by these species.

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Trash Bag Dispenser at the Refuge

<u>Impacts on Mammals under Alternative A (Current Management)</u>

Beneficial

Beneficial impacts to mammals are similar to those discussed in *Impacts on Mammals That Would Not Vary by Alternative*.

Adverse

Food and other debris may influence small mammal populations by attracting them to the campsite areas (Boyle and Samson 1985). The refuge requires all trash to be packed out when the campers leave the refuge. The sites are inspected after each visit to ensure trash has been removed from the premise.

Impacts on Mammals under Alternative B (Service-preferred Alternative)

Beneficial
Under this alternative, we would refine and improve our deer population estimations in order to evaluate the success of our hunt programs and gain insight on where improvements could be made.

Adverse
Alternative B anticipates the continued presence of dogs on the refuge for search and rescue training and waterfowl hunting. Dogs could potentially have negative impacts on refuge mammals. Free-ranging and uncontrolled dogs can chase and flush wildlife. Wintering red bats (*Lasiurus borealis*) could be flushed from their hibernacula in the leaf litter, causing them to expend energy at a time when food resources to replenish their fat reserves is low. Potential impacts of domestic dogs could be broadly classified as harassment, injury, or death of wildlife. Harassment is the disruption of normal maintenance activities, such as feeding, bedding, or grooming. It can take the form of disrupting, alarming, or even chasing. If dogs chase or pursue wildlife, injuries could be sustained directly or indirectly as a result of accidents that occur during the chase itself rather than direct contact with the dog. Impacts of domestic dogs can also include modification of wildlife behavior. However, the low frequency of dog use on the refuge is not expected to add significantly to existing disturbances. Suitable habitat for escape is near areas where training is allowed to occur so disturbances to wildlife are expected to be temporary and minimal.

Impacts from dogs on leash associated with dog walking on trails would be similar to the impacts described above; however the impacts would occur to a smaller degree. The trails that the dog walkers use are not considered ideal habitat and the impacts are limited to the trail corridors. Dogs also have endo- and ectoparasites and can transmit diseases to wild animals. Canine distemper, for example, can be transmitted freely in wild carnivore populations such as wolves, foxes, badgers, and raccoons. The best way to prevent this contact is for dog owners to prevent contact with wildlife. We do not anticipate significant impacts because dogs are required to be on a six foot leash and contact with wildlife at that distance is very unlikely.

Impacts on Mammals under Alternative C

Beneficial and adverse impacts to mammals are the same as those discussed in *Impacts on Mammals That Would Not Vary by Alternative,*except that there could be less forage habitat for bats, which forage over fields adjacent to woodlands, and less food and nest-cover for open-habitat small mammals..

4.11 Impacts on Amphibians and Reptiles

As a group, amphibians and reptiles would benefit from the refuge land protection and management of upland and floodplain forests, grasslands, shrub, open water, and wetlands. This is especially important in the context of some massive die-offs occurring

to wood frogs and spotted salamanders due to disease such as ranavirus and chytrid fungus. In other parks and refuges that have been particularly hard hit, the species persists because there were other vernal pools available that were free of the diseases (Grant 2011).

We evaluated the following actions for their potential to conserve, restore, improve, or increase the habitats of amphibians and reptiles likely to utilize refuge habitats:

- Managing and restoring floodplain and upland forests, grasslands, open waters, and emergent wetlands.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the following actions for their potential to cause adverse effects on habitats of amphibians and reptiles:

- Disturbance of species from public use.
- Potential impacts from the aerial spraying of invasive species, forest restoration, or impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure such as boardwalks, observation tower, and viewing blinds.
- Light pollution from security lights.
- Vehicle traffic during breeding season.

Impacts on Amphibians and Reptiles That Would Not Vary by Alternative

Beneficial

Long-term improvements in water quality would create benefits to environmental health and to amphibian and reptile populations. Amphibians and reptiles would likely continue to be impacted by environmental contaminants, unrelated to refuge activities, known to occur in waters around the refuge.

Long-term benefits to amphibians and reptiles are anticipated through the ongoing management of existing freshwater emergent wetlands and impoundments.

Protection of floodplain forests and associated vernal pools would continue to benefit amphibians and reptiles that rely on these sites for breeding habitat. Any protection of large, intact forests on the refuge or on the local landscape through partnerships would benefit amphibians requiring vernal pools.

Adverse

Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of open water and wetland habitats. We would use these tools only when and where appropriate, and only with the proper training and focused application to minimize or avoid adverse impacts. We would continue to avoid mowing in early successional habitats and wet grasslands when amphibians or reptiles may be breeding or seasonally moving through transitional zones. Some amphibians and reptiles may be present during aerial applications of herbicides and may experience direct contact with herbicides if they are present during applications, or if spray misses the targeted application patch. We do not expect this as a frequent occurrence. Ongoing management activities, such as invasive species management and inventory and monitoring programs, would continue to be completed in a manner that would minimize potential impacts.

Overall, the effects from public use are likely to minimally impact amphibians and reptiles utilizing forested, grassland, open water, and wetland habitats on the refuge. Impacts associated with disturbance include displacement, stress, and potential mortality. Given the size of the refuge and location of trails and roads for visitor use, we expect these impacts to be negligible.

Another source of negative impact and mortality is that of vehicular traffic after dark during warm rainy nights in the spring and summer when frogs, toads, and other amphibians are moving to or from breeding grounds. This can be a problem during the day for basking snakes and turtles as well. Some of this traffic is unavoidable (employees that live onsite, occasional evening research, law enforcement activities). Some nighttime vehicle traffic is due to users of the shooting range.

De-icing compounds used on roads in the winter may affect surrounding water quality. Wood frogs emerge for breeding in early spring at a time when there is the potential for a late winter snow or ice storm requiring de-icing for staff, residents, and other visitors to the refuge. However, we estimate that with vegetation buffers between roads and impoundments this risk is not significant. Traffic on roads and brushhogging have the potential to injure turtles during the breeding or migration seasons. These are potential areas for future monitoring.

USFWS

Leopard Frog

We have a number of buildings and residences throughout the refuge, some of which have security lights or other lighting. Artificial lighting at night, if bright and not diffused in the way moonlight and starlight may have long-term negative effects on frogs' ability to respond and move appropriately to forage or evade predators (Rich and Longcore

2006). Given the location of the refuge in the Baltimore - Washington corridor and the number of acres of natural habitat compared with the small number of lighted areas, we expect impacts to be minimal.

Impacts on Amphibians and Reptiles under Alternative A (Current Management)

Beneficial and adverse impacts to amphibians and reptiles would be the same as those discussed in *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*.

Impacts on Amphibians and Reptiles under Alternative B (Service-preferred Alternative)

Beneficial

Amphibian species (Ambystoma salamanders, wood frogs, chorus frogs, and spring peepers) that utilize forested wetlands would increase as more vernal pools, forested floodplain habitat, and green-tree reservoirs become available. Large blocks of grasslands adjacent to woodlands and forest are beneficial to box turtles that emerge to bask in the sun and feed on forbs and insects. Snake species benefit from the increased supply of rodents.

This alternative would also continue the deer management program across the refuge. Improving natural regeneration of ground cover and shrub vegetation, through reduction of the deer population, would improve available cover and non-breeding habitat for the coastal plain leopard frog and other reptiles and amphibians.

Adverse

Added public use infrastructure proposed under alternative B such as kiosks are not expected to have long-term negative effects on known amphibian and reptile breeding sites as these would be avoided. Added infrastructure could cause additional disturbance or lead to isolated stormwater runoff or sedimentation during construction. However, we would use best management practices to ensure that these disturbances, if present, would be infrequent and of negligible impact.

In early spring, particularly during rains, breeding amphibians are on the move from wintering ranges to breeding areas and may cross roads or trails. This increases the risk of injury or death from vehicles or trampling. However, amphibian movement usually occurs at night when visitor use is minimal to none. Direct impacts on wildlife in the form of disturbance can be expected wherever humans have access to an area, and the degree may vary depending on the habitat type. In general, human presence disturbs most wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Some species, such as wood thrush, will avoid areas frequented by people, such as developed trails and buildings, while other species, particularly highly social species such as eastern tufted titmouse, Carolina chickadee, or Carolina wren, seem unaffected or even drawn to a human presence. When visitors approach too closely to nests, they may cause the adult bird to flush exposing the eggs to weather events or predators. Provided that visitor use is confined to trails, disturbance

during the breeding season will be limited to the trail area. The extent of this disturbance on either side of the trail also depends on visibility, the density of vegetation through which the trail is laid. Overall, direct impacts from non-consumptive uses should be greatly reduced if trails and other high-use facilities avoid area-sensitive habitats (interiors of grasslands and forests) and are confined to a 300-foot edge zone.

The continued presence of dogs on the refuge for search and rescue trainings and waterfowl hunting could have negative impacts on refuge amphibians and reptiles. Free-ranging and uncontrolled dogs can chase and flush wildlife and occasionally prey on reptiles. Potential impacts of domestic dogs could be broadly classified as harassment, injury, or death of wildlife. Harassment is the disruption of normal maintenance activities, such as feeding, bedding, or grooming. It can take the form of disrupting, alarming, or even chasing. If dogs chase or pursue wildlife, injuries could be sustained directly or indirectly as a result of accidents that occur during the chase itself rather than direct contact with the dog. Impacts of domestic dogs can also include modification of wildlife behavior.

Impacts from traffic, roads, infrastructure and facilities maintenance are expected to be somewhat less in this alternative once the footprint of the refuge's built environment is reduced.

Impacts on Amphibians and Reptiles under Alternative C

Benefits and adverse impacts to amphibians and reptiles would be similar to those discussed in *Impacts on Amphibians and Reptiles under Alternative B.*

4.12 Impacts on Invertebrates

This broad group is the least understood within the ecosystems around the refuge. Yet, they are likely the most important contributor and modifier in the functioning of those ecosystems and related food webs. Invertebrates play key roles in those ecosystems as:

- Detritivores, returning nutrients and basic elements back to the soil and the system.
- Pollinators, without which many sexually reproducing plants would not be able to propagate.
- Prey for other species in the food web, such as the millions of mosquitoes upon which fish, frogs, birds and bats feed.
- Predators, such as spiders, that help keep rapidly producing insects in check.
- Filters of sediment, nutrients, and other contaminants, making conditions better for fish and aquatic life.

We evaluated the following actions for their potential to conserve, restore, improve, or increase habitats of invertebrates likely to utilize refuge habitats:

- Managing and restoring floodplain and upland forests, impoundments, grasslands, open waters, and emergent wetlands.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of invertebrates:

- Disturbance from public use.
- Potential impacts from the aerial spraying of invasive species, forest restoration, or impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure such as boardwalks and viewing blinds.
- Impacts of light pollution from artificial lighting.

Impacts on Invertebrates That Would Not Vary by Alternative

Invasive species control and grounds maintenance, security lighting, and forest health measures are actions common to all alternatives that may impact refuge invertebrates. Invasive species control, grounds maintenance, and prescribed burn are recurring activities throughout the year.

Beneficial

The refuge's land management provides a wide array of general habitat types and microhabitats that serve as foraging, breeding, and overwintering habitat for many groups of invertebrates. Improving stream water quality would benefit aquatic insects and other invertebrates.

Removing invasive species permits native plants to reestablish and expand. This particularly benefits insects that coevolved with the native plants, particularly those that are host-specific, such as the monarch butterfly, which mostly uses milkweed as the host plant for its eggs. Many species of invasive, nonnative plants are not optimal hosts for native insects, and do not contribute to the health or diversity of the pollinator community. Therefore, we project that removing these nonnative plants and planting or allowing native species to regenerate would be beneficial to native invertebrates. The number of native insects that use nonnative plant species as host plants is minimal and, therefore, removing them would not result in unacceptable losses in the insect populations.

Mowing and brushhogging is reduced in all alternatives where maintenance of grassy areas is needed, and generally some standing cover will be left for the overwintering stage of insects.

Adverse

Maintaining refuge grounds currently involves mowing of roadsides, parking areas, walking paths, and small lawn areas. Generally, regularly mowed areas are kept short in vegetation height (less than 6 inches). Thus, they provide very limited sources of nectar, usually clovers. Where grasses and forbs have grown tall, such as along seldom-used roads or paths where they begin to flower and set seed, pollinators and herbivorous insects would be found. Mowing in the warm months, when insects are breeding, may destroy the eggs or pupae attached to leaves, consume adults, remove food sources, or unfavorably alter microhabitat. However, the area we maintain is a very small fraction of the amount of land serving as habitat. Although we have yet to conduct a formal forest health inspection for disease and pests, staff conducting other research or surveys have not noticed an infestation to the level that would warrant intervention, as yet. We foresee, however, that there may come a time when spraying for forest pests, such as gyspy moth, (which affects oaks, a highly desired canopy tree type) could be necessary. Emerald ash borer has been detected in Prince George's County. Since we have substantial percentage of green ash in the floodplain forest composition, we are concerned. We would consult with forestry experts and the Service pesticide use authority for recommendations on the least harmful products and methods to avert impacts to non-target species. For example, there currently is a species-specific, albeit expensive, pesticide for gypsy moth, Gypcheck, a biological pesticide derived from a virus that commonly exists in the soil (USDA 2009).

USFWS

Buckeye

Although the Service approves the herbicides we use in controlling invasive species because of their neutrality on animal life, should soft-bodied insects, eggs, pupae, or organisms with permeable skin come in direct contact with an herbicide or its surfactant, mortality, reduced fitness, or abnormal development may result. Since we treat limited portions of the refuge each year, overall negative effects on invertebrates are expected to be minimal. We use only herbicides that are systemic operants on plants and approved by EPA for having little or no impact on terrestrial insects. Very few native invertebrates may use nonnative plants for feeding, breeding, or pupating. We presume that any dependence on those plants is incidental and, therefore, removing them would not result in unacceptable losses in the insect populations.

Artificial lighting for the security of existing facilities and administrative buildings such as the visitor center, and maintenance building is another potential source of adverse impacts on invertebrates, particularly nocturnal moths. Decreases in populations of moths

have been attributed to artificial lighting. However, extinctions due exclusively to lighting have not been recorded. When compounded with other disturbances, such has habitat fragmentation, unnatural lighting may weaken or eliminate local populations (Frank 2002).

The direct impacts of lighting on moths and other arthropods are increased rates of predation, entrapment, desiccation and burning of moths and other insects that fly into lamp housings, disruption in migration, and interference with mating, vision, dispersal, migration, feeding, depositing eggs, and possibly circadian rhythm. An indirect impact may result in densely illuminated urban environments where the lighting may have favored species that either fly during the day, do not fly to lamps, or do not fly at all (Frank 1988).

To the extent practical, given needs for facility security, maintenance, and access, the refuge has minimized its use of artificial lighting. No new projects proposed under any alternative would pose a substantial increase in artificial lighting.

Impacts on Invertebrates under Alternative A (Current Management)

Beneficial and adverse impacts to invertebrates are the same as those discussed in *Impacts on Invertebrates That Would Not Vary by Alternative*.

Impacts on Invertebrates under Alternative B (Service-preferred Alternative)

Beneficial

Although there would be fewer total acres of grasslands under alternative B, the remaining grasslands would be less fragmented and higher quality. The provision of large tracts of diverse grasslands in multiple locations would provide numerous benefits for pollinating, herbivorous, or predatory insects. Well-established grasslands possess a diverse array of nectaries and plant structures that would provide food and cover year round for the annual life cycles of many species. This also benefits small mammals, reptiles, amphibians, and grassland dependent birds. Prescribed fire, a grassland maintenance action, increases the production of seed in legumes, grasses and spurges in frequently burned areas. Grassland fires cause early green up of warm season grasses, improved seed-germination, and greater production of grasses and forbs. It also increases the production of berries, drupes, and pomes for two to four years after fire (Lyon et al. 2000). Fire modifies the invertebrate communities, which may continue to change a few years post burn. Different orders of invertebrates respond differently to fire depending on season and year, but prairies where fires occur in different years and seasons tend to have greater species diversity (Lyon et al. 2000.) Thus, indirect benefits may be derived to invertebrates from variable applications of the refuge fire regime. An indirect benefit is derived through increased habitat quality.

Maintenance of grasslands also requires dramatic and periodic disturbance. It is impossible to do this without cost to some species, particularly above ground insects using plant structures for roosting, egg laying, and development. Monarch butterflies are

completely migratory and are among the many species of pollinating Lepidoptera (butterflies, moths, and skippers) that use refuge habitats. Monarchs lay their eggs exclusively on milkweed. In some instances, it is necessary to conduct late growing season burns in order to more effectively set back woody encroachment. This poses a direct conflict for the latest generation of monarch should patches of milkweed be destroyed by fire or mowing. This generation, which may still be as eggs by late September to mid-October (Monarch Larvae Monitoring Project) would be the generation to migrate to the monarch wintering grounds in the Oyamel forests of Mexico (Solensky 2004). However, we do not burn or mow all the fields at once, some are left in reserve, and thus some patches of milkweed would remain. Milkweed is also stimulated or returns more vigorously after fire and mowing. We expect that these two factors bestow benefits at the population and habitat level and offset the negative impacts sustained at the individual level.

The greater diversity of habitats considered under this alternative would allow a greater diversity of host plants and their associated insects.

Adverse
No additional adverse impacts to invertebrates are foreseeable under this alternative.

Impacts on Invertebrates under Alternative C

Benefits and adverse impacts to invertebrates would be similar to those discussed in *Impacts on Invertebrates under Alternative B,* except that there would be substantially less grassland or grassy cover available to support the insects associated with native forbs and grasses..

4.13 Impacts on Public Use and Access

Annual refuge visitation is estimated to be 256,000 visits to the refuge in 2011. Most visitors to the refuge engage in some form of wildlife-dependent recreation. Environmental interpretation programs and environmental education programs are the two activities with the most participants.

Impacts on Public Use and Access That Would Not Vary by Alternative

Beneficial
The main goals of the visitor services program would be to continue working with partners to promote the benefits of wildlife and habitat conservation and management, to foster an awareness and appreciation for the refuge and its role along the Atlantic Flyway and within the Refuge System, and to provide quality wildlife-dependent recreational experiences to visitors. We would continue to evaluate environmental education programs already available across the region to identify potential needs in the environmental education community. For many residents of the Baltimore-Washington area, refuge staff may be their one and only interaction with the Service. Under all

alternatives, refuge staff would continue to be active in outreach and partnership development.

NWVC would continue to be free to the public. The facility would continue to be an important example of sustainable design and construction, and we would continue to use it as an interpretive tool for the benefits of sustainable building and relate this to effects on climate change.

USFWS

NWVC

Adverse

We would continue to limit access to ecologically sensitive areas such as nesting sites during breeding seasons and high-quality wetlands. While these would result in short-term restrictions on public access and use, we would minimize these restrictions to the extent possible while ensuring proper protection of wildlife and their habitats. We do not anticipate any long-term negative impacts on public use and access.

The presence of dogs can lead to short-term and long-term adverse impacts to wildlife populations. Some wildlife species are particularly sensitive to the presence of dogs and their response to disturbance is amplified above and beyond disturbance effects from recreationists traveling without dogs. Declines in bird diversity and abundance on trails where leashed dogs were permitted were in excess of declines observed from human disturbance alone (Banks and Bryant 2007). In addition, native carnivores, bobcats and coyotes, also appear to shift their periods and areas of activity to avoid peak times of recreational use (George and Crooks 2006). Disturbance of bats hibernating in leaf litter was discussed in the mammals section of this chapter. In all alternatives, the refuge permits dogs on leash as long as the activity is restricted to designated access road corridors.

Impacts on Public Use and Access under Alternative A (Current Management)

Beneficial

Under alternative A, we would continue to allow currently approved public uses on refuge lands. These are noted in chapter 3, alternative A. Appendix C documents the refuge manager's justification for why they are deemed appropriate and compatible. Other ownerships nearby or elsewhere sufficiently provide opportunities for other activities not determined to be compatible with the purposes of refuge management.

No major additions or changes in facilities would occur. The refuge would continue to allow already approved public uses. These include wildlife observation and photography, environmental education and interpretation, hunting and fishing.

Adverse

These impacts would be the same as those outlined in *Impacts on Public Use and Access that would not Vary by Alternative.*

Impacts on Public Use and Access under Alternative B (Service-preferred Alternative)

Beneficial

Other wildlife-dependent, priority public uses are restricted during the 5-month public hunting season. In order to minimize conflict between hunters and other user groups, the refuge has subdivided Area Y on North Tract to clearly show hunted areas versus a publicly-accessible trail. The refuge also has two trails in the Wildlife Viewing Area, which is closed to hunting, for other priority, wildlife-dependent public uses to be administered in conjunction with hunting. With the exception of shotgun season, all other trails will remain open to other users during the hunting season.

Adverse Impacts

Adverse impacts on public use and access would be the same as *Impacts on Public Use and Access That Would Not Vary by Alternative.* No additional adverse impacts would occur under this alternative.

Impacts on Public Use and Access under Alternative C

Beneficial

Under alternative C, wildlife-dependent public uses such as wildlife observation, viewing, and photography will be emphasized and expanded. If fees were implemented, we would be able to use money collected to provide improved trail maintenance and additional interpretive programs.

Adverse

Under alternative C, non-wildlife dependent uses would be reduced or eliminated. Special events and interpretive programming both on and off-site would also be reduced. We would explore implementation of a fee program for refuge entry, as well as for

programs and activities. Reducing or eliminating programs or charging fees could have a long-term negative impact on public use and access by limiting the ability of some people to access the refuge and potentially reducing the number of visitors overall.

4.14 Impacts on Cultural and Historic Resources

Impacts on Cultural and Historic Resources That Would Not Vary by Alternative

Beneficial
Under all alternatives, the refuge would expand its interpretation of cultural and historic resources related to the refuge and conservation. The extent and emphasis of cultural and historic resource interpretation varies between alternatives. Under alternative B we would increase efforts to include information about cultural and historic resources compared to alternatives A. However, under all scenarios the refuge communicates the importance of understanding and appreciating the area's rich cultural history and how it relates to our natural history. In doing so, we would potentially provide long-term benefits to regional cultural and historic resources.

The refuge would also continue its adaptive reuse of several historic-eligible buildings, such as Nelson and Merriam Labs for office space. This potentially would include other Service programs currently offsite, such as the Chesapeake Bay Field Office. Such collocation would save the Service significant General Services Administration rental expenses, and also allow for easier communication and collaboration between Service programs and other partners.

Adverse
While no adverse impacts to cultural or historic resources are anticipated, we will send this draft CCP/EA to the State Historic Preservation Office for review in compliance with section 106 of the National Historic Preservation Act. In all of the alternatives, we will consult with our regional archeologist and the State Historic Preservation Office as needed to ensure compliance with the act and other applicable laws and regulations.

4.15 Impacts to the Socioeconomic Environment

Chapter 2, "Affected Environment," discusses the socioeconomic environment of the refuge and its context with the greater Baltimore-Washington area. The refuge management activities of economic concern in the analysis are:

- Purchasing of goods and services within the local community for refuge operations;
- Spending of salaries by refuge personnel;
- Spending in the local area by refuge visitors;
- Purchasing additional refuge land and resulting changes in local tax revenues; and
- Effects of refuge management on local townships.

Although the refuge economic contribution is relatively minor, tourism and recreation contribute significantly to the local economy. The majority of the visits to the refuge were by nearby residents, although non-residents make the greatest economic contribution to the economy. This economic environment increases the potential of the refuge to increase visitation through management actions such as increased coordination with local cultural attractions and transportation hubs, and support of regional trail connections with the refuge.

Another important aspect of the socioeconomic setting is the number of educational institutions and environmental education centers in the Baltimore-Washington area. This allows the refuge partnership and recruitment opportunities from a wide range of social and cultural backgrounds.

Impacts on Socioeconomic Environment That Would Not Vary by Alternative

Beneficial

Ongoing public uses related to wildlife-dependent recreation would continue to have a small but positive effect on the local economies surrounding the refuge. Refuge visitors, researchers, and volunteers would continue to utilize businesses around the refuge for food, fuel, supplies, and lodging. The refuge would continue to provide environmental education and interpretation programming free-of-charge to local schools in order to allow all students access to quality environmental educational programming. We would also strive to provide monetary assistance to help pay for busing of students to and from the refuge for field trips.

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Environmental Eduation Activity

We would continue to provide meeting space for conservation-environmental related meetings and symposiums.

The economic value of the ecosystem services provided by the extensive forest cover and other vegetation cover types provided by the refuge and any future land protection efforts achieved by refuge partnerships has not been quantified. The services provided by refuge forests include groundwater recharge, flood control, nutrient filtration and uptake, improved air quality, and temperature moderation.

Adverse
The impact of protecting land is considered negligible on the economy of the region. Although some loss of tax revenue and commercial income results from protecting lands, the ecosystem services provided by natural landscapes – flood control, carbon sequestration, sediment and erosion control, for example – offset much of the lost tax revenue.

Impacts on Socioeconomic Environment in Alternative A

Beneficial
In summary, implementing alternative A would continue to provide socioeconomic benefits to the community. The refuge helps to maintain the quality of life not only for local residents, but also for all refuge visitors. Alternative A would continue to provide opportunities for public use, and current refuge regulations would remain in effect (see chapters 2 and 3).

The refuge provides economic benefits mainly through spending in the local area by refuge visitors and refuge staff income and taxes. It also provides benefits from public use, as in the increasingly important ecotourism industry.

Adverse
Adverse impacts under this alternative are the same as those discussed under *Impacts on Socioeconomic Environment That Would Not Vary by Alternative*.

Impacts on Socioeconomic Environment under Alternative B (Service-preferred Alternative)

Beneficial
The refuge would expand environmental education programming for local schools and teachers. This would help improve the quality of and access to quality environmental education in the region.

Under this alternative, the refuge would improve programs for under-represented audiences including providing interpretive materials in other languages, providing programs and materials designed to meet the needs of people with special needs, as well as continuing to reach out to urban youth. The refuge also tends to draw students from nearby schools that might not otherwise be exposed to environmental education programs. Under alternative B, we would create more opportunities for blind and bilingual visitors to appreciate wildlife-dependent recreation and the refuge's role in conservation. In doing so, we would reach out to new audiences to experience the refuge first-hand, and ultimately foster environmental stewardship and support for conservation in their own lives.

In our visitor services step-down plan, we would identify themed messages that support refuge purposes, the Refuge System mission, and the Service mission and that address

specific issues and challenges facing wildlife, people, and habitats on the refuge, region, and world.

Adverse
Adverse impacts under this alternative are the same as those discussed under *Impacts on Socioeconomic Environment That Would Not Vary by Alternative.*

Impacts on Socioeconomic Environment under Alternative C

Beneficial
Benefits under alternative C are similar to those discussed in *Impacts of Alternative B,* with the addition of:

We would expand wildlife-dependent public uses which could bring new and increased numbers of visitors to the refuge which may also lead to increases in visitor spending in the surrounding areas. Collection of fees would allow refuge staff to provide enhanced interpretive programs and increased trail maintenance which could lead to improved visitor experiences, which could then lead to additional visitation from word of mouth publicity.

Adverse
Under alternative C, non-wildlife dependent public uses would be eliminated or reduced in refuge habitats. We would also explore fee options for refuge entry, programs, and activities. This reduction in public uses and the creation of fees could potentially have a negative impact on the socioeconomic environment. These changes may reduce the number of visitors to the refuge and potentially cause reductions in spending by visitors in the surrounding area.

4.16 Cumulative Impacts

According to the Council on Environmental Quality regulations on implementing NEPA (40 CFR 1508.7), a cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

This cumulative impacts assessment includes the actions of other agencies or organizations, if they are interrelated and influence the same environment. Thus, this analysis considers the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference. Specific to this analysis we considered the facilities modernization plan, the potential expansion of Highway 198, the continued residential and commercial development of the surrounding area, previous military activities on and off refuge, and the potential land expansion project for the Refuge System.

Cumulative Impacts on the Physical and Biological Environment

The area around the refuge is highly developed and influenced by urban and suburban development, activities at the adjacent Fort Meade, and other local, State, and Federal agencies. Based on the environmental analysis that is presented in this document, the actions of the refuge, when added to the continuation of residential and commercial development, will not cumulatively effect the natural or socioeconomic environment at or adjacent to the refuge.

Overall, habitat management and maintenance of the open space on the refuge provides a net positive impact on species, vegetation, water quality, and air quality of the region. Given the relative size of the refuge in the surrounding landscape, the benefits that are provided are noticeable, but do not rise to a level of significance.

We expect that refuge management activities have a net benefit to water quality as detailed in the previous sections. We do not anticipate that these improvements will provide a net overall improvement of water quality outside the refuge, given the level of development that is occurring in the region.

Cumulative Impacts Related to Climate Change

Climate Change Impacts on Vegetation

The Patuxent Research Refuge is predominately forest. Refuge management goals have been guided by conditions of pre-settlement times. Advocates of climate change argue that past conditions are inadequate models for future targets. We may need to remain flexible, manage in increments that allow some reversibility, and avoid single solution approaches in the face of so much uncertainty (Millar et al. 2007). Plant communities and species adapted to warmer subtropical latitudes are expected to expand and establish beyond their northern boundaries. Increasing dominance of mixed pines and southern oak species would be a likely scenario. This may be a favorable outcome for some of the focal refuge forest bird species, bats, and other associated wildlife.

Some positive effects on forests include increased forest productivity through longer growing seasons, increased precipitation, and increased carbon dioxide fertilization which will increase primary production and yield greater biomass and soil inputs (Swanston 2010).

Some negative effects include extreme weather events causing damage and erosion, altered timing of aquifer recharge leading to potential declines in summer seasonal streamflow, species range shifts which would mean a decline of some species, increased severity in stress factors and increased susceptibility to disturbance. We may also expect expanded pest and disease ranges due to decreased probability of lower lethal temperatures, migrations to the north and accelerated life cycles. Also expected is an increase in the frequency or intensity of fire where there is less summer moisture. Mature trees, however, should fare better because of developed root systems and higher carbon reserves (Swanston 2010).

Changing conditions surrounding a healthy forest can cause stress and enhance vulnerability to climate change-related stressors. If an adequate buffer is not maintained, refuge forests could face ground level ozone and acid deposition (caused by nitrogen oxide and sulfur dioxide emissions from cars and power plants) which stress trees (Rogers and McCarty).

The U.S. Forest Service assessed the current and predicted range of 134 tree species following climate change. This interactive program, the Climate Change Tree Atlas, allows the end user to generate future scenarios for the distribution based on suitable habitat and importance values for each of the 134 tree species by the year 2100. Distribution and importance predictions are based on three global climate or general circulation models and two emissions scenarios, high or low, which can also be combined to produce an average. The model produces a range of importance values per species analyzed, which is a measure of the relative dominance of a species in a forest community based on three criteria: how commonly it occurs across an entire forest, the total amount of area it occupies, and the total number of individuals.

We ran this model for some mast-producing upland hardwood species--white oak, southern red oak, scarlet oak and American beech, and the most common coniferous species, Virginia pine. We also ran the model for some of the most dominant floodplain species: green ash, red maple, and sweetgum. White oak will shift its entire range northward. In the vicinity of the refuge, its importance value will decline from about 7 to 10 to about 4 to 6. Southern red oak will expand its range northward and increase in importance in the deep south, but may lose importance values in Maryland from current 7 to 10 to 4 to 6 or even lower. Scarlet oak will maintain its footprint but will decline in importance from its current 7 to 10 or 11 to 20, down to 1 to 3 depending on emissions scenario. Beech will decline in importance value overall throughout the eastern U.S., but importance values 1 to 3 will cover more of the landscape than it does currently. Around the refuge, the importance values will decline from 11 to 20 to 1 to 6. Virginia pine will retract its range in the Mid-Atlantic to higher elevations and shift toward the north, but will decline in importance value, 1 to 3. Green ash will shift its range to the northwest and dwindle in importance value from 1 to 3. Red maple will maintain its current footprint in the eastern U.S. but its higher importance values will shift to the Northeast or higher elevations. Around the refuge its importance will decline from the current 11 to 20 to 4 to 6. Sweetgum will benefit from warmer climates and higher emissions by gaining importance throughout its range. On the refuge this may mean an increase from 1 to 3 to as much as 11 to 20.

Loblolly pine, a species that currently is not dominant in Maryland, will expand its range to the north and its importance value will increase from current 1 to 3 to 7 to 10 or even 11 to 20, depending upon the emission scenario. We can expect the surrounding landscape to become increasingly fragmented by development and infrastructure, and non-forest land uses, which will have an impact on species range expansion, and recruitment rates.

For the 15-year planning horizon of this document, these trends will barely register.

Climate Change Impacts on Biological Resources

Climate change will have a range of effects on vegetation and ecological systems. It is expected that species ranges will shift northward or toward higher elevations as temperatures rise, but responses will likely be highly variable and either species or family-specific. Under these rapidly changing conditions, migration, not evolution, will determine which species are able to survive. Species that cannot migrate will suffer the most. For example, plants, mussels, and amphibians are more vulnerable to temperature shifts that may affect their ability to survive, grow, and reproduce (USFWS 2009).

Four types of responses by animal and plant species are possible. First, the density of species may change locally and their ranges may shift in response to the need to find areas within their range of tolerance. Second, there will likely be changes in phenology, or the timing of such important life history events as flowering, egg-laying, or migration. Third, changes in body sizes and behaviors may occur. And fourth, genetic frequencies may shift. In a study that investigated 61 studies on phenology changes of 694 species over the past 50 years, a statistically significant shift toward earlier timing of spring events was evident.

Species with short generation times, such as insects and annual plants, might be helped in adapting to change because of their more rapid evolution. Longer lived species such as trees, would experience longer evolution time frames and thus be less adaptable (Rogers and McCarty n.d.) Since so many animal species time important events in their life cycles, particularly reproduction, so that young are produced when food sources are available, changes in other phonological events such as flowering or insect hatching, could be disastrous for species that fail to adapt in time. We cannot, at this writing, predict how this will play out at Patuxent Research Refuge, but we can seek to provide biologically diverse habitats and connected corridors diversity to increase their options and ensure resilience.

Climate Change Impacts on Birds

According to a recent analysis of Christmas Bird Count data over the past 40 years, a significant northward shift of the winter center of abundance is occurring among at least 305 bird species in North America (Niven et al. 2009). Of these, 208 species shifted north with 123 species shifting more than 50 miles. Landbirds as a group shifted more than waterfowl or coastal species. Seventy-five percent of land birds shifted north an average of 48 miles. Landbirds were further analyzed according to four habitat guilds: woodland, grassland, shrub, and generalist. Woodland birds shifted the most, followed by shrub species, while grassland birds and generalist shifted the least. This study confirmed northward shift of species already suspected, such as red-bellied woodpecker (*Melanerpes carolinus*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), and northern cardinal (*Cardinalis cardinalis*). These are all common species at the refuge throughout the year.

Thomas Tetzner/USFWS

Northern Cardinal

Waterfowl range contraction is anticipated as milder, warmer winters shift northward, reducing the need to migrate as far south. Fewer waterfowl now winter in the Chesapeake Bay area, attributed to climatic changes occurring in the breeding grounds of the Prairie Pothole region, milder winters further north, and decline of eelgrass in the bay (from warmer water temperatures, turbidity, and sea-level rise).

Department of the Interior Secretarial Order 3226 states that "there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making. This order ensures that climate change impacts are taken into account in connection with Departmental planning and decision making." Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as a CCP.

The Wildlife Society published an informative technical review report in 2004 titled "Global Climate Change and Wildlife in North America" (Inkley et al. 2004). It interprets results and details from such publications as the Intergovernmental Panel on Climate Change reports (1996 to 2002) and describes the potential impacts and implications on wildlife and habitats. It mentions that projecting the impacts of climate change is hugely complex because not only is it important to predict changing precipitation and temperature patterns, but more importantly their rate of change, as well as the exacerbated effects of other stressors on the ecosystems. Those stressors include loss of wildlife habitat to urban sprawl and other developed land uses, pollution, ozone depletion, nonnative species, disease, and other factors. Projections over the next 100 years indicate major impacts such as extensive warming in most areas, changing patterns of precipitation, and significant acceleration of sea level rise. According to the Wildlife Society report, "…other likely components of on-going climate change include changes in season lengths, decreasing range of nighttime versus daytime temperatures, declining snowpack, and increasing frequency and intensity of severe weather events" (Inkley et al. 2004). The report details known and possible influences on habitat and wildlife, including: changes in primary productivity, changes in plant chemical and nutrient composition, changes in seasonality, sea level rise, snow, permafrost, sea ice decline, increased invasive species, pests and pathogens, and impacts on major vertebrate groups.

The effects of climate change on populations and range distributions of wildlife are expected to be species specific and highly variable, with some effects considered negative and others considered positive. Generally, the prediction in North America is that the ranges of habitats and wildlife would generally move upwards in elevation and northward as temperature rises. Species with small or isolated populations and low

genetic variability would be least likely to withstand impacts of climate change. Species with broader habitat ranges, wider niches, and greater genetic diversity should fare better or may even benefit. This would vary depending on specific local conditions, changing precipitation patterns, and the particular response of individual species to the different components of climate change (Inkley et al 2004). The report notes that developing precise predictions for local areas is not possible due to the scale and accuracy of current climate models, which is further confounded by the lack of information concerning species-level responses and to ecosystem changes, their interactions with other species, and the impacts from other stressors in the environment. In other words, only generalizations can be made about the implications of our refuge management on regional climate change.

Our evaluation of the proposed actions concludes that only one area of activities may contribute negligibly, but incrementally, to stressors regionally affecting climate change: our use of vehicles and equipment to administer the refuge. We discuss the direct and indirect impacts of those activities elsewhere in chapter 4. We also discuss measures to minimize the impacts of both. With regards to our equipment and facilities, we are trying to reduce our carbon footprint wherever possible by using alternative energy sources and energy saving appliances, and using recycled or recyclable materials (as exemplified by the green construction incorporated in NWVC), along with reduced travel, more energy efficient vehicles, and other conservation measures.

In our professional judgment, most management actions we propose would not exacerbate climate change in the region or project area, and in fact, some might incrementally prevent or slow down local impacts. We discuss our actions relative to the 18 recommendations the Wildlife Society report gives to assist land and resource managers in meeting the challenges of climate change when working to conserve wildlife resources (Inkley et al. 2004).

- Recommendation #1: Recognize global climate change as a factor in wildlife conservation: This recommendation relates to land managers and planners becoming better informed about the consequences of climate change and the variability in the resources they work with.

Throughout our alternatives we have highlighted the need to address climate change, specifically in regard to habitat changes and new species introductions on the refuge. We have proposed a series of strategies involving monitoring habitat changes, new species introductions, and other potential impacts of climate change as it relates to the long-term protection and management of habitats.

The Service is taking a major role among Federal agencies in distributing and interpreting information on climate change. There is a dedicated webpage to this issue at: *http://www.fws.gov/home/climatechange/* (accessed March 2012). The Service's Northeast Region also co-hosted a workshop in June 2008 titled "Climate Change in the Northeast: Preparing for the Future," and a similar workshop for all Federal, state, and nongovernmental organization land managers and conservationists of the Mid-Atlantic

was held in March 2009. Both workshops provided valuable scientific information and resources to aid managers in land management planning in the context of climate change. All of the Northeast Region refuge supervisors and planners attended, as did over 20 refuge field staff.

- Recommendation #2: Manage for diverse conditions: This recommendation relates to developing sound wildlife management strategies under current conditions, anticipating unusual and variable weather conditions, such as warming, droughts and flooding.

Our proposed habitat management actions described in chapter 3 promote healthy, functioning upland and floodplain forests, open waters, and grasslands. We have identified monitoring elements, which will be fully developed in the inventory and monitoring step-down plan, to evaluate whether we are meeting our objectives and to assess changing conditions. We will implement an adaptive management approach as new information becomes available.

- Recommendation #3: Do not rely solely on historical weather and species data for future projections without taking into account climate change: This recommendation relates to the point that historical climate, habitat and wildlife conditions are less reliable predictors as climate changes. For example, there may be a need to adjust breeding bird survey dates if migratory birds are returning earlier to breed than occurred historically.

We are aware of these implications and plan to build these considerations into our inventory and monitoring plan so that we can make adjustments accordingly. The Service is working to establish long-term monitoring protocols and sites to document future trends in the Northeast.

- Recommendation #4: Expect surprises, including extreme events: This recommendation relates to remaining flexible in management capability and administrative processes to deal with ecological “surprises” such as floods or pest outbreaks.

Refuge managers have flexibility within their operations funds to deal with emergencies. The refuge has already experienced a series of large flood events over the past 10 years. Due to the frequency experienced, these types of events are being considered as a “new normal” when planning annual needs. Other regional operations funds would also be redirected as needed to deal with an emergency.

- Recommendation #5: Reduce non-climate stressors on the ecosystem: This recommendation relates to reducing human factors that adversely affect resilience of habitats and species.

Similar to our response to #2 above, the objectives of our habitat management program are to protect the biological integrity, diversity, and environmental health of refuge lands.

Objectives to enhance riparian habitat for watershed protection, and establish healthy, diverse, native, and resilient forests, would help offset the local impacts of climate change.

- Recommendation #6: Maintain healthy, connected, genetically diverse populations: This recommendation relates to the fact that small isolated populations are more prone to extirpations than larger, healthy, more widespread populations. Large tracts of protected land facilitate more robust species populations and can offer better habitat quality in core areas.

As noted in chapter 2, the refuge is in many ways a biological island surrounded by dense urbanization. Where we can restore or preserve connections, we pursue these opportunities. We would also continue to work with our many conservation partners at the State and regional level to support and complement restoration and protection efforts, build upon existing conserved tracts and target others to create corridors.

- Recommendation #9: Reduce the risk of catastrophic fire: This recommendation acknowledges that fire can be a natural part of the ecosystem, but that climate change could lead to more frequent fires and/or a greater likelihood of a catastrophic fire.

Our plans to maintain forests and grasslands, control invasive plants, provide for structural diversity, reduce dense monocultural stands of early succession pine in combination with the natural and man-made firebreaks (roads, utility corridors, etc.) found across the refuge would reduce the overall risk of a catastrophic fire.

- Recommendation #10: Reduce likelihood of catastrophic events affecting populations: This recommendation states that increased intensity of severe weather can put wildlife at risk. While the severe weather cannot be controlled, it may be possible to minimize the effects by supporting multiple, widely spaced populations to offset losses.

Our response to recommendations #2, #3, and #6 above describes the actions we are taking to minimize this risk. Unfortunately, the limited footprint of the refuge and lack of nearby undeveloped lands limits opportunities for the refuge itself to support multiple, widely spaced populations. A proposed land protection plan would help address this issue. In the meantime, we will work with other regional conservation land managers to support this effort.

- Recommendation #11: Prevent and control invasive species: This recommendation emphasizes the increased opportunities for invasive species to spread because of their adaptability to disturbance. Invasive species control will be essential, including extensive monitoring and control to preclude larger impacts.

Invasive species control is a major initiative within the Service and on the refuge. The Northeast Region, in particular, has taken a very active stand. In chapter 3, we provide detailed descriptions of our current and future plans on the refuge to control existing invasive plant infestations. We also describe monitoring and inventorying strategies to protect against any new infestations.

- Recommendation #13: Account for known climatic conditions: This recommendation states we should monitor key resources through predictable, short-term, periodic weather phenomena, such as El Nino, to aid us in future management efforts.

We plan to develop a monitoring program that would help us evaluate our assumptions and success in achieving objectives, assess the health and contribution of our forests and other habitats toward our objectives, as well as help us make future management decisions. Any restoration activities or management actions would be carefully planned and their effectiveness monitored and documented so we can use this information in future management decisions.

- Recommendation #14: Conduct medium- and long-range planning: This recommendation states that plans longer than 10 years should take into account potential climate change and variability as part of the planning process.

This 15-year CCP addresses climate change with its emphasis on restoring and maintaining healthy, contiguous, native habitat areas, reducing human stressors on refuge lands, working with private landowners to improve the health and integrity of their lands, and pursuing larger conservation connections and corridors with partners to enhance protected core areas. Our monitoring program and adaptive management strategies would also facilitate our ability to respond to climate change.

- Recommendation #15: Select and manage conservation areas appropriately: This recommendation states that establishing refuges, parks and reserves is used as a conservation strategy to try to minimize the decline of wildlife and habitats in North America. Decisions on locating future conservation areas should take into account potential climate change and variability. For example, it is suggested that decisions on new acquisition consider the anticipated northward migrations of many species, or the northern portion of species ranges. Managers of existing conservation lands should consider climate change in future planning.

The Service as a whole is working with partners on making decisions on where and how to provide conservation areas in light climate change. In particular, the Service is developing landscape conservation cooperatives throughout the country. The refuge would continue to support these nationwide initiatives, as well as more local efforts.

- Recommendation #16: Ensure ecosystem processes: This recommendation suggests that managers may need to enhance or replace diminished or lost

ecosystem processes. Manually dispersing seed, reintroducing pollinators, treating invasive plants and pests, are examples used.

While we plan to take an aggressive approach to treating invasive plants species, we also are planning actions to enhance or replace ecosystem processes. None of our proposed management actions would diminish natural ecosystems processes underway. Should our monitoring results reveal that we should take a more active role in enhancing or replacing those processes, we will reevaluate and/or refine our management objectives and strategies.

- Recommendation #17: Look for new opportunities: This recommendation states that managers must be continually alert to anticipate and take advantage of new opportunities that arise. Creating wildlife conservation areas out of abandoned or unusable agricultural land, and taking advantage of industry interest in investing in carbon sequestration or restoration programs, are two examples cited.

Refuge staff has maintained many conservation partners in the area which, in turn, are networked throughout the larger region. We are apprised of many opportunities for land protection or habitat restoration through this broad-based network. Our Northeast Region has field offices and a regional office that integrates the other Service program areas, including those that work with private entities. We have developed outreach materials, and make ourselves available to interested organizations and groups, to provide more detailed information on the Service and Refuge System missions, refuge goals and objectives, and partnership opportunities.

- Recommendation #18: Employ monitoring and adaptive management: This recommendation states that we should monitor climate and its effects on wildlife and their habitats and use this information to adjust management techniques and strategies. Given the uncertainty with climate change and its impacts on the environment, relying on traditional methods of management may become less effective.

We agree that an effective and well-planned monitoring program, coupled with an adaptive management approach, will be essential to dealing with the future uncertainty of climate change. We have built both aspects into alternatives B and C of our draft CCP/EA and in the draft habitat management plan. We will develop a detailed step-down inventory and monitoring plan designed to test our assumptions and management effectiveness in light of on-going changes. With that information in hand, we would either adapt our management techniques, or reevaluate or refine our objectives as needed.

Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause harm to the environment and that cannot be avoided, even with mitigation measures. All of the alternatives would result in some minor, localized, unavoidable adverse effects. For example, forest restoration projects would produce minor, short-term, localized, adverse effects on waterfowl populations. Increased visitation could have minor unavoidable

effects. However, we do not believe that any of these effects would rise to a significant level.

Many of the habitat management and facility construction projects in the alternatives have a certain level of unavoidable adverse effects, especially during the actual construction. Those effects are mitigated to some degree by the use of practices and precautions that safeguard water quality, avoid sensitive habitats, or time the actions (or include safeguards) to avoid or minimize impacts on fish and wildlife. The adverse effects generally are short-term and more than offset by the long-term gains in habitat quality and fish, wildlife, and plant productivity.

Forest habitat is also likely to undergo changes in species composition and structure as we create a more natural forest composition resembling native coastal plain or floodplain forests. The transition from one habitat type to another is not drastic in measure and occurs over an extended period of time. Restoration of habitats may cause an initial adverse effect on some plant or wildlife species, but in the long-term, populations are not expected to be harmed.

Some aspects of wildlife-dependent recreation, such as hunting or fishing, would result in the unavoidable adverse impacts on individual fish and wildlife as a result of providing that activity. However, we would protect populations from adverse effects by requiring all participants to follow applicable State and refuge regulations. In addition, we anticipate long-term benefits to species and habitats from connecting people with nature through these activities. Fishing, under all alternatives, would continue in designated areas on the refuge. This activity results in the unavoidable adverse loss of individual fish. However, this activity constitutes a relatively minor impact on species populations. In addition, alternatives B and C propose management actions that would result in improved and increased habitat for fisheries. The deer management programs under all alternatives would also result in the unavoidable loss of individuals. However, overall health of the refuge's deer population would likely improve by reducing competition for limited resources. In addition, there would be long-term benefits to refuge habitats, particularly upland habitats, and the other species that depend on them.

USFWS

Kids' Fishing Day at the Refuge

All of these unavoidable adverse effects on the physical and biological environment would be relatively local and more than offset by the long-term benefits for the diversity and ecological health of the broader landscape.

Some impacts on certain individuals or refuge neighbors may be unavoidable, but our responsibility is to provide equal opportunities to the American public, not a select few. We believe we have sought a fair balance in minimizing and mitigating adverse impacts while providing quality recreational opportunities to the public. All of what we propose in the arena of public use results from public involvement and input during the planning process.

Potential Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be undone, except perhaps in the extreme long term. One example is an action that contributes to a species' extinction. Once extinct, it can never be replaced and is an irreversible loss. By comparison, irretrievable commitments of resources are those that are lost for an extended period of time, but could be undone given sufficient time and resources, although there may be a loss in productivity or use for a time. An example of an irretrievable commitment is converting what was once a mature forest and actively managing and maintaining it in an early successional forest habitat condition. If, for some reason, that early successional habitat was no longer an objective, those acres could progress gradually to mature forest again over a period of 70 or more years, or we could determine it best to expedite that reversion by planting shrubs and trees and controlling invasive plants.

Environmental Justice

President Clinton signed Executive Order No. 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" on February 11, 1994, to focus Federal attention on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The order directs Federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high, adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The order is also intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority and low-income communities with access to public information and participation in matters relating to human health or the environment.

We expect none of the three proposed alternatives to have significant adverse cumulative impacts on the economy of the towns or counties in which refuge lies. We would expect none of the alternatives to alter the demographic or economic characteristics of the local community. The actions we propose would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. Consequently, no adverse impacts would be expected including changes in the community character or demographic composition.

Overall, we expect none of the alternatives would place a disproportionately high, adverse environmental, economic, social, or health effects on minority or low-income persons. Our programs and facilities are open to all who are willing to adhere to the established refuge rules and regulations, we acquire land only from willing sellers, and

we do not discriminate in our responses for technical assistance in managing private lands. In addition, proposed refuge construction projects under alternatives B and C would occur within the refuge boundary and are not expected to have disproportionate adverse effects on any group or area.

4.17 Summary of Environmental Consequences by Alternative

Table 4-2. Summary of the Foreseeable Consequences of Each Alternative.

Alternative A: Current Management	Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)	Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses
Effects on Air Quality		
Current management activities neither substantially benefit nor adversely affect local and regional air quality. Minor long-term benefits in air filtration and carbon sequestration from protection of vegetated upland, riparian, and wetlands habitats. We would continue energy efficient practices and adopt additional practices as feasible, such as hybrid vehicles. Negligible adverse effects from prescribed burning on small patches to maintain grassland and control invasive species. Anticipated increase in annual refuge visits by motor vehicles would cause a negligible increase in air emissions in the long term.	Long-term benefits for air filtering and carbon sequestration from land protection would increase under alternative B as a result of restoring forest habitat. Same energy efficient practices as in alternative A. Negligible adverse effects from increased use of prescribed burning on small patches to maintain grassland and control invasive species. Other impacts similar to alternative A.	Long-term benefits to improved air quality would be similar to alternative B, with a small increase as a result of allowing additional acres to succeed to forest. Same energy efficient practices as in alternative A. Reduced adverse effects from particulate emissions, compared to alternative B, due to less prescribed burning, on approximately a smaller number of acres/year. Slight increase over alternative A. Other impacts similar to alternative A.
Effects on Soils		
<u>Impacts Common to All Alternatives:</u> We would continue to maintain native vegetation cover on the refuge that stabilizes and minimizes soils losses through erosion. Intact forest cover would help restore soil structure and biological productivity. Within each of the alternatives, construction and/or maintenance of some dikes would continue in		

Alternative A: Current Management	Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)	Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses
order to manage impounded wetlands, causing some soil disturbance. Regardless of which alternative is selected, we would continue to use best management practices; conduct all prescribed burns under a strict prescription and in optimal weather conditions; permit mowing and brush hogging only in dry grassland areas and only on a rotational basis; use approved herbicides to control invasive plants; and limit public use to designated areas.		
Same as common to all alternatives.	Alternative B would increase long-term benefits to soils through reconnecting the hydrology in some areas.	Impacts to soils would be similar to alternative B; however, more acres would benefit from un-impounded wetlands.
Effects on Hydrology and Water Quality		
<u>Impacts Common to All Alternatives:</u> Under each alternative, the forest landscape provides a buffer along streams that pass through the refuge. Forest litter and vegetation reduce sheetflow and reduce erosion from water coming from off-refuge. In managing the refuge, we would closely monitor and mitigate all of our routine activities that may result in chemical contamination of water directly through leakage or spills or indirectly through soil runoff.		
Same as common to all alternatives.	Under alternative B, additional acres of riparian forest habitat would be restored. Benefits would be similar to those described under alternative A, but would be greater because more area would be restored. Also, removing or breaching dikes at select impoundments would further restore the area's natural hydrology. There are slight risks of short-term adverse effects on water quality associated with new construction of trails and kiosks, when compared to alternative A.	Under alternative C, additional hydrologic processes would be restored by restoring additional impoundments to forest, thereby reducing the acreage of emergent marsh and increasing the acreage of forested wetlands. Compared to alternatives A and B, alternative C offers additional flood plain forest and would restore connectivity to existing hydrology. This could offer additional flood protection and could potentially improve water quality by increasing natural filtration, and reducing sediment loads in flood waters.

<table>
<tr><th>Alternative A: Current Management</th><th>Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)</th><th>Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses</th></tr>
<tr><td colspan="3">Effects on Vegetation</td></tr>
<tr><td colspan="3"><u>Impacts Common to All Alternatives:</u>

Regardless of which alternative we select, we would use standard and effective habitat management techniques to conduct forest, shrubland, and grassland management activities in the refuge uplands. Whenever feasible, we would replace nonnative plant species with native species to restore the ecological integrity of the refuge. Management actions would cause no major mortality or loss in local populations, because actions occur on a rotational basis, meaning no major habitat components would change completely in any one year.

We would continue a hunt program under all alternatives that includes the harvesting of white-tailed deer, to control the deer population on the refuge and minimize the negative impacts of overbrowsing. We anticipate an increase in visitation that may lead to direct and indirect impacts on these habitats.

Indirect impacts could result from the activity of visitors trampling vegetation, as well as potential impacts associated with habitat restoration or general service activities, including chemical leaks or spills.</td></tr>
<tr><td><u>Forests, Shrublands, and Grasslands</u>

Same as those effects listed as common to all.</td><td><u>Forests, Shrublands, and Grasslands</u>

Beneficial impacts to forests would be greater under alternative B through increased restoration and invasive plant control.

Additional biological staff under this alternative would allow for more control of invasive species.

Our reforestation activities would be strategically focused to decrease edge and increase connectivity of forested tracts on the refuge.

Adverse effects would increase slightly under this alternative as a result of constructing new trails and kiosks.</td><td><u>Forests, Shrublands, and Grasslands</u>

Benefits to forest habitat under alternative C would be greatest because acreage would be increased as a result of allowing impoundments, shrublands, and grasslands to convert to forest.

This approach would benefit floodplain forest, but adversely impact early successional habitats.

An indirect benefit would come from the reduced use of heavy equipment and increased opportunities over several forested tracts to increase the recruitment of forest species and improve stand health.</td></tr>
</table>

Alternative A: Current Management	Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)	Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses
	Shrublands Under this alternative, units that would be maintained as shrublands are more suited to this habitat and would therefore provide high-quality scrub/shrub species. This alternative would result in a loss of acres of shrubland compared with alternative A. Localized adverse effects from mowing include soil compaction, damage and loss of vegetation. Grasslands The refuge would maintain about 255 acres of grassland habitat on the refuge. Although this alternative provides less acreage than alternative A, the quality of existing grasslands would improve from our efforts to remove hedgerows, decrease fragmentation, and increase species diversity within grassland units.	Shrublands Under this alternative, the refuge would maintain about 240 acres of managed shrubland. This acreage would be maintained along forest edges to provide a gradual transition from forested areas to roads. The loss of potential rare plant communities and plant species would likely be an adverse effect under this alternative. Grasslands Alternative C would provide the least benefits to grasslands on the refuge. Only 78 acres would be maintained as grassland habitat; however these areas would provide high quality habitat in locations ideally suited for obligate grassland breeding birds. The loss of grassland habitat would adversely impact grassland dependent wildlife, and the refuge would reduce its part in sustaining this habitat type in the region.
Effects on Federally Listed and Recently Delisted Species		
Impacts Common to All Alternatives: We do not anticipate any impacts to any endangered or threatened species under any of the alternatives.		
Effects on Landbirds		
Impacts Common to All Alternatives:		

Alternative A: Current Management	Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)	Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses
Regardless of the alternative we select, we would continue implementing our habitat management objectives, including improving forest stands affected by off refuge and past land management activities and controlling and managing invasive species. All of these management actions directly benefit landbird species by improving the quality of habitat, areas in which they nest and forage, and further protecting them from loss of habitat to development. The addition of new trails and visitor infrastructure would be strategically located to minimize any adverse effects on landbirds. The expected increase in visitation could have additional adverse impacts on landbirds; however, we would take all measures necessary to mitigate potential negative impacts by evaluating which sites to use for environmental education and interpretation programs, and time of year to conduct certain events.		
The effects would be similar to those described under common to all alternatives.	Raptor species that require large tracts of intact forest would benefit under this alternative as forested areas would increase. Alternative B would provide additional long-term benefits to landbirds through the protection and restoration of upland and floodplain forests, and grassland enhancements. The conversion of the 210 acres of impoundments to a mix of hardwood floodplain forest species would provide improved habitat structure and species composition needed for various warblers, such as prothonotary warbler. Phased removal and reforestation of this area would help minimize short-term impacts or habitat loss. Although overall shrubland acreage would decrease under this alternative, improved management would have a beneficial impact on species that depend on this habitat type. Some grassland species, such as	Alternative C differs slightly from alternative B in benefits to landbirds. This alternative would provide additional upland forest and floodplain forest communities. It would reduce shrub and early successional habitats which are currently under-represented across the refuge and region. These habitat types benefit various warbler species and other songbirds that prefer dense shrub cover.

Alternative A: Current Management	Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)	Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses
	sedge wren, bobolink, and savannah sparrow would decline on the refuge (but not regionally) as less acreage of grassland would be available.	
Effects on Open Water and Wetland Birds		
Impacts Common to All Alternatives: Under all alternatives, the refuge would continue to restrict access and management activities when and where appropriate near known nesting sites and continue breeding success monitoring. Waterfowl and shorebirds of regional conservation priority, such as American and least bittern, sora, king rail, and American black duck would continue to use available impoundments and naturally occurring wetlands. Across all alternatives, waterbirds would benefit from our control of nonnative invasive species and maintenance of native plant communities. The refuge would continue to offer a hunt program that includes the harvesting of waterfowl. The waterfowl hunt program follows Federal and State regulations for annual harvest levels and seasons by species, and does result in individual losses, but the projected cumulative harvest would not negatively impact any species' population on the refuge. An increase in visitation is likely to occur under any alternative; we would continue to work with the State in implementing a public education and outreach program. The impacts of recreation on waterbirds are well-documented and disturbance on these species include displacement, higher occurrences of flushing, and general avoidance.		
Effects would be the same as those described as common to all alternatives.	Under alternative B, benefits would be similar to those described as common to all alternatives. Alternative B would result in a decrease in open water habitats through the restoration of floodplain and upland forest. This change in focus away from some impoundment management would likely reduce the number of open water dependent waterfowl that use the refuge. The reduction in available habitat would impact the refuge waterfowl	Under alternative C, benefits would be similar to those described as common to all alternatives. The increase in floodplain forest under alternative C would increase benefits associated with wetland and open water species that use adjacent floodplain forest for some of their lifecycle needs. For example, nesting wood ducks could benefit from increased nesting cavities associated with floodplain

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	population, but given the size of the impoundments and their location on the landscape, displaced waterfowl would use other open water areas on the refuge or adjacent. As such, we do not anticipate any impacts to overall waterfowl populations. Alternative B anticipates an increase in refuge participation and visitation. Much of this increase is expected in the form of school groups or recreational uses. As noted in the "adverse impacts common to all alternatives" discussion, use of existing trails poses minimal potential impact to birds nesting in open water or wetland habitats. The overall trend regarding the location of visitation is likely to remain the same.	forest. Compared to alternative B, alternative C further decreases the number of acres of open water and impoundments by an additional 210 acres. This reduction in habitat would likely reduce the number of open water dependent species that use the refuge, such as ringneck ducks and buffleheads. However, the refuge lies at the periphery of the core range for Atlantic Flyway waterbirds, especially waterfowl and shorebirds. Its largely forested and urbanized landscape does not make the refuge a key contributor to this species suite. Similar to alternative B, alternative C anticipates an increase in refuge visitation. As noted in the discussion of Impacts on Open Water and Wetland Birds under Alternative B, precautionary measures already in place on the refuge would result in infrequent, localized impacts on open water or wetland birds with the anticipated increase in visitation. We would continue to monitor refuge visitation and potential impacts on open water and wetland birds and adjust our management to continue our protection of these species as needed.

<table>
<tr><th>Alternative A: Current Management</th><th>Alternative B: Balance of Interior Forest, Grasslands, and Public Uses (Service-preferred)</th><th>Alternative C: Increased Interior Forest Management and Reduced Non-wildlife Dependent Public Uses</th></tr>
<tr><td colspan="3">Effects on Fisheries</td></tr>
<tr><td colspan="3"><u>Impacts Common to All Alternatives:</u>

Under all of the alternatives, we would take management actions to protect wetlands, refuge impoundments, and open water, such as controlling nonnative invasive plants and providing and improving riparian buffers around wetland-upland interfaces.

Where floodplain forests are found adjacent to open water, the debris from trees and other vegetation falling into the water provides cover and food, as well as helping to lower water temperatures. Many related benefits of floodplain forests are also described under the section on hydrology and water quality. Components regarding open water and wetlands relate to fisheries as well.

Overall, the effects from public use (both current and anticipated) are not likely to have an impact on fisheries utilizing open water and wetland habitats on the refuge. By providing fishing opportunities, we do have impacts to individual fish. While we encourage catch and release because of the potential contaminants present in game fish, this also helps maintain local fish populations. Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of open water and wetland habitats.

Other sources of environmental contamination can be created by stormwater runoff from surrounding lands and the watershed. Use of herbicides in invasive species control could potentially cause small localized and temporary contamination in the event of an unintentional spill or misapplication. We would continue to employ best management practices in terms of herbicide use and spill prevention and response to minimize impacts from these other sources of contamination.</td></tr>
<tr><td>Effects would be similar to those described as common to all alternatives.</td><td>Impacts to fish would be similar as described under alternative A. Our additional restoration efforts along the riparian zone would offer greater benefits to the fish population.

Alternative B would allow visitors improved fishing opportunities as well as access to Blue Heron Pond. As discussed under Impacts That Would Not Vary by Alternative, this would create isolated negative impacts for some</td><td>Effects would be similar to alternative B.</td></tr>
</table>

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	individual fish and would increase potential for adverse impacts associated with increased public use (e.g., littering).	
Effects on Mammals		
Impacts Common to All Alternatives: We would continue to use habitat management techniques, such as maintaining impoundments, prescribed burning, mowing, and controlling invasive species, all of which provide benefits to the habitats wildlife reside in, as well as adverse effects previously described under Wetlands and Uplands. Hunting of mammals would occur at some level under each of the alternatives. For the 2010 to 2011 deer season, hunters took 272 deer. For the 2009 to 2010 deer seasons, hunters took 242 deer. This level of harvest is expected to keep deer populations level within the refuge to a density that reduces impacts to the forest understory and allows for forest regeneration. However, it is unlikely that this level of deer harvest would negatively impact the overall deer population of eastern Maryland. Overall, the effects from public use are not likely to have a negative impact on mammal populations.		
Effects on Amphibians and Reptiles		
Impacts Common to All Alternatives: Long-term improvements in water quality would create benefits to environmental health and to amphibian and reptile populations. Amphibians and reptiles would likely continue to be impacted by environmental contaminants, unrelated to refuge activities, known to occur in waters around the refuge. Long-term benefits to amphibians and reptiles are anticipated through the ongoing management of existing freshwater emergent wetlands and impoundments. Protection of floodplain forests and associated vernal pools would continue to benefit amphibians and reptiles that rely on these sites for breeding habitat. Any protection of large, intact forests on the refuge on the local landscape through partnerships would benefit amphibians requiring vernal pools. We would continue to avoid mowing in early successional habitats and wet grasslands when amphibians or reptiles may be breeding or seasonally moving through transitional zones. Some amphibians and reptiles may be present during aerial applications of herbicides and may experience direct contact with herbicides if they are present during applications, or if spray misses the targeted application patch. We do not expect this as a frequent occurrence. Ongoing		

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management activities, such as invasive species management and inventory and monitoring programs would continue to be completed in a manner that would minimize potential impacts. Overall, the effects from public use are likely to minimally impact amphibians and reptiles utilizing forested, grassland, open water, and wetland habitats on the refuge. Impacts associated with disturbance include displacement, stress, and potential mortality. Given the size of the refuge and location of trails and roads for visitor use, we expect these impacts to be negligible.		
Effects would be similar to those described as common to all alternatives.	Amphibian species (Ambystoma salamanders, wood frogs, chorus frogs, spring peepers) that utilize forested wetlands would increase as more vernal pools, forested floodplain habitat and green-tree reservoirs become available. Large blocks of grasslands adjacent to woodlands and forest are beneficial to box turtles, which emerge to bask in the sun and feed on forbs and insects. The continued presence of dogs on the refuge for search and rescue trainings and waterfowl hunting could have negative impacts on refuge amphibians and reptiles. Free-ranging and uncontrolled dogs can chase and flush wildlife and occasionally prey on reptiles.	Effects would be similar to alternative B.
Effects on Invertebrates		
<u>Impacts Common to All Alternatives:</u> Patuxent Research Refuge's land management provides a wide array of general habitat types and microhabitats that serve as foraging, breeding, and overwintering habitat for many groups of invertebrates. Improving stream water quality would benefit aquatic insects and other invertebrates. Removing invasive species permits native plants to reestablish and expand. This particularly benefits insects that coevolved with the native plants, particularly those that are host-specific,		

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such as the monarch butterfly, which mostly uses milkweed as the host plant for its eggs. Many species of invasive, nonnative plants are not optimal hosts for native insects, and do not contribute to the health or diversity of the pollinator community. Maintaining refuge grounds currently involves mowing of roadsides, parking areas, walking paths, and small lawn areas. Generally, regularly mowed areas are kept short in vegetation height (less than 6 inches). Thus, they provide very limited sources of nectar, usually clovers. Where grasses and forbs have grown tall, such as along seldom-used roads or paths where they begin to flower and set seed, pollinators and herbivorous insects would be found. Mowing in the warm months, when insects are breeding, may destroy the eggs or pupae attached to leaves, consume adults, remove food sources, or unfavorably alter microhabitat. However, the area we maintain is a very small fraction of the amount of land serving as habitat. Artificial lighting for the security of existing facilities and administrative buildings such as the visitor center, and maintenance building is another potential source of adverse impacts on invertebrates, particularly nocturnal moths. Decreases in populations of moths have been attributed to artificial lighting. To the extent practical, given needs for facility security, maintenance, and access, the refuge has minimized its use of artificial lighting. No new projects proposed under any alternative would pose a substantial increase in artificial lighting.		
Effects would be similar to those described as common to all alternatives.	An important, direct benefit is the provision of large tracts of diverse grasslands in multiple locations for pollinating, herbivorous, or predatory insects. Well-established grasslands possess a diverse array of nectaries and plant structures that would provide food and cover year round for the annual life cycles of many species. The greater diversity of habitats considered under this alternative will allow a greater diversity of host plants and their associated insects.	Effects would be similar to alternative B.
Effects on Public Use and Access		
<u>Impacts Common to All Alternatives:</u> The main goals of the visitor services program would be to continue working with partners to		

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promote the benefits of wildlife and habitat conservation and management; to foster an awareness and appreciation for the refuge and its role along the Atlantic Flyway and within the Refuge System; and to provide quality wildlife-dependent recreational experiences to visitors. We would continue to evaluate environmental education programs already available across the region to identify potential needs in the environmental education community. For many residents of the Baltimore-Washington area, refuge staff may be their one and only interaction with the Service. Under all alternatives, refuge staff would continue to be active in outreach and partnership development. NWVC would continue to be free to the public. The facility would continue to be an important example of sustainable design and construction, and we would continue to use it as an interpretive tool for the benefits of sustainable building and relate this to effects on climate change.		
Effects would be similar to those described as common to all alternatives.	Under alternative B, the refuge would expand public uses and strive to maintain a better balance among the wildlife-dependent public uses on the refuge. For example, allow hiking trails to be open during some hunting seasons.	Under alternative C, wildlife-dependent public uses such as wildlife observation, viewing, and photography would be emphasized and expanded. Under alternative C, non-wildlife dependent uses would be reduced or eliminated. Special events and interpretive programming both on and offsite would also be reduced. We would explore implementation of a fee program for refuge entry, as well as for programs and activities. This would allow refuge staff to implement enhanced interpretive programs and increase trail maintenance. Reducing or eliminating programs or charging fees could have a long-term negative impact on public use and access by limiting the ability of some people to access the refuge and potentially reducing the number of visitors overall.

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Effects on Cultural and Historical Resources		
Impacts Common to All Alternatives: Under all alternatives, the refuge would expand its interpretation of cultural and historical resources related to the refuge and conservation. The extent and emphasis of cultural and historical resource interpretation varies between alternatives. Under all scenarios the refuge communicates the importance of understanding and appreciating the area's rich cultural history and how it relates to our natural history. In doing so, we would potentially provide long-term benefits to regional cultural and historical resources. The refuge would also continue its adaptive reuse of several historic register-eligible buildings, such as Nelson and Merriam Labs for office space. This potentially would include other Service programs currently offsite, such as the Chesapeake Bay Field Office. Such collocation would save the Service significant General Services Administration rental expenses, and also allow for easier communication and collaboration between Service programs and other partners. While no adverse impacts to cultural or historic resources are anticipated, we will send this draft CCP/EA to the State Historic Preservation Office for review in compliance with section 106 of the National Historic Preservation Act. In all of the alternatives, we will consult with our regional archeologist and the State Historic Preservation Office as needed to ensure compliance with the act and other applicable laws and regulations.		
Effects on the Socioeconomic Environment		
Impacts Common to All Alternatives: Ongoing public uses related to wildlife-dependent recreation would continue to have a small but positive effect on the local economies surrounding the refuge. Refuge visitors, researchers, and volunteers would continue to visit businesses around the refuge for food, fuel, supplies, and lodging. The refuge would continue to provide environmental education and interpretation programming free-of-charge to local schools in order to allow all students access to quality environmental educational programming. We would also strive to provide monetary assistance to help pay for busing of students to and from the refuge for field trips. We would continue to provide meeting space for conservation and environmentally related meetings and symposiums. The economic value of the ecosystem services provided by the extensive forest cover and other vegetation cover types provided by the refuge and any future land protection efforts achieved by refuge partnerships has not been quantified. The services provided by refuge forests include groundwater recharge, flood control, nutrient filtration and uptake, improved air quality, and temperature moderation. Although some loss of tax revenue and commercial income results from protecting lands, the		

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impact of protecting land is considered negligible on the economy of the region. Under all alternatives, providing opportunities for wildlife research would remain a priority for the refuge. It is difficult to predict the amount of future research that will occur. Funding sources and research priorities change over time and refuge staff will work with potential partners to ensure that opportunities are available for compatible research activities.		
Impacts would be similar to those described as common to all alternatives.	The addition of full-time staff would minimally increase benefits for the local economy in jobs, income, and expenditures. Under this alternative, the refuge would improve programs for under-represented audiences including providing interpretive materials in other languages, providing programs and materials designed to meet the needs of people with special needs, as well as continuing to reach out to urban youth. The refuge also tends to draw students from nearby schools that might not otherwise be exposed to environmental education programs. Adverse impacts under this alternative are the same as those discussed as common to all alternatives.	Impacts would be similar to those described as common to all alternatives.